ECogS 2025

International Conference on Embodied Cognitive Science

Okinawa, November 10 - 14

Agency Across Scales

From Cells to Societies

OIST OKINAWA INSTITUTE OF SCIENCE AND TECHNOLOGY

ECSU EMBODIED COGNITIVE SCIENCE UNIT

Ver 2.2 as of 11 Nov

ORGANIZERS

TOM FROESE
Conference Chair
tom.froese@oist.jp

MARK JAMES
Program Chair
mark.james@oist.jp

KAORI YAMASHIRO
Local Organizer
kaori.yamashiro@oist.jp

TAE MORRISSEY
Local Organizer
tae.morrissey@oist.jp

BRIAN MORRISSEY
Technical Support
brian.morrissey@oist.jp

About the Workshop

Welcome to the 2025 International Conference on Embodied Cognitive Science, hosted by the **Embodied Cognitive Science Unit** at the Okinawa Institute of Science and Technology, Japan.

This year's keynotes will focus on the **theme of Agency Across Scales: From Cells to Societies.**

This meeting aims to gather an international group of theoreticians and experimentalists from cognitive science, psychology, developmental biology, artificial life, computer science, neuroscience, and philosophy to examine the state of the art in the phenomenon of agency and its manifestation across different scales, from cells to society. The focus will be on exploring shared organizational principles connecting diverse expressions of agency and the interaction between them. By drawing on strong theoretical foundations of cognitive agency at the individual human level, the goal is to investigate whether these insights can open new perspectives on smaller (e.g., cells) and larger living systems (e.g., ecologies), and vice versa. The outcomes of this inquiry can enhance our interacting with and shaping of biological regulation at all scales, with broad implications for health-giving interventions.

WEEKLY SCHEDULE

	Nov. 10th (Mon)	Nov. 11th (Tue)	Nov. 12th (Wed)	Nov. 13th (Thu)	Nov. 14th (Fri)	
8:30	Coffee, **Welcoming with traditional music instrument**	Coffee	Coffee	Coffee	Coffee	8:30
9:00	**L11**	**L21**	**L31**	**L41**	**L51**	9:00
9:20	**Sheila Macrine (Remote)**	**Mike Levin (Remote)**	**Enara Garcia**	**Glenda Satne**	**Wen Wen**	9:20
9:40			**S32** Norihiko Kamaya, Katsunori Miyahara	**S42** Philip Kurian		9:40
10:00	**S12** Alexander Hölken	**S22** Beatrice de Gelder	**S33** Georgii Karelin	**S43** Nagarjuna G	**Theme Tables**	10:00
10:20	Buzz Circles	Buzz Circles	Buzz Circles	Buzz Circles	C015 - 16 people C016 - 20 people D014 - 20 people	10:20
10:40	Coffee	Coffee	Coffee	Coffee		10:40
11:00	**L13**	**L23**	**S34** Natalya Weber	**L44**	Coffee	11:00
11:20	**Tom Froese**	**Jonathan Delafield-Butt**	**S35** Taraneh R Wilkinson	**Rieko Osu**	**Group Reflection**	11:20
11:40	Buzz Circles	Buzz Circles	Buzz Circles	Buzz Circles	C209	11:40
12:00	Lunch	Lunch	Lunch	Lunch	Lunch	12:00
13:20	**S14** Alessandro Solfo	**S24** Patrick Grüneberg	**S36** Jay McKinney	**S45** John Anderson P-Duarte	**S52** Keisuke Suzuki	13:20
13:40	**S15** Milan Rybar	**S25** Akhi Kumar Singh	**S37** Mark James	**S46** Moritz Kriegleder	Closing remarks, and thank you	13:40
14:00	**S16** Benjamin Gaskin	**S26** Konrad Werner	End	Buzz Circles	Grad School Pitch	14:00
14:20	Buzz Circles	Buzz Circles	**Excursion** **14:20** Bus Departure **14:40** *Pottery Village **16:00** Bus Departure **16:10** Zakimi Castle Ruins **16:40** Bus Departure **17:00 - 18:15** *Banta café **18:30 - 20:00** *Gala **20:15** Bus Departure * free time	Coffee	**OIST Campus tour**	14:20
14:40	**Poster Fire Rounds (25 posters)**	Coffee		**Poster Session** Coffee's available throughout		14:40
15:00		**L27**				15:00
15:20		**Charles Stanish**				15:20
15:40	**ECSU Lab tour**	Buzz Circles			**BBQ** **15:45** Taxi Departure **16:00** Arrive at OIST Seaside House *drinks are available **17:00 - 20:00** BBQ	15:40
16:00	Group1: Human Behavior Lab -> Main lab Group2: Main lab -> Human Behavior Lab	End				16:00
16:20	Coffee					16:20
16:40	**L17**			End		16:40
17:00	**Kevin Mitchell (Remote)**					17:00
17:20						17:20
17:40	End			**Banquet** **17:45** Taxi Departure		17:40
18:00	**Evening Reception** at OIST main campus					18:00

L11: Monday 9:00

Shelia Macrine

Professor, University of Massachusetts Dartmouth

An Agency Continuum: From Carbon to Silicon, and Beyond

The conventional divide between biological and artificial agency is a misleading artifact of the cognitivist gambit—the assumption that cognition can be abstracted from its material substrate. This brain- and computation-centric view neglects the essential role of embodiment in shaping agency. This presentation introduces a multi-dimensional framework that situates agency along a continuum rather than within binary categories. By disaggregating agency into nine dimensions—including intentionality, autonomy, reflexivity, temporal depth, and embodiment—the framework generates distinct agency profiles. These profiles reveal the basic capacities of cells, the integrated competencies of animals, the fragmented and disembodied character of current AI, and the uniquely complex agency of humans. This approach shifts the central question from "Is it an agent?" to "What kind of agent is it?" By reframing agency as a graded and embodied phenomenon, it contributes to ongoing debates in philosophy of mind, cognitive science, and artificial intelligence. Ultimately, it points toward artificial systems whose development will depend not only on computational power, but on cultivating embodied forms of agency.

L13: Monday 11:00

Tom Froese

Associate Professor, Okinawa Institute of Science and Technology

Quantifying what is efficacious yet not observable: Cognitive neuroscience's measurement problem has a solution

Cognitive neuroscience faces a measurement problem: core features of the human mind cannot be directly observed in the brain. For example, intentions are efficacious in behavior generation but cannot be reduced to sub-personal quantities of neural activity without losing their purpose-driven, normative character. This instrumental limitation is fundamental yet remains insufficiently recognized. To forefront this issue and reorient the field toward a solution, I argue that theories of the mind-brain relation must meet the Participation Criterion: they must specify what measurable difference the presence of mental efficacy produces compared to its absence. When the Participation Criterion is accepted alongside the measurement problem, a feasible solution arises: the dynamical relevance of *unobservable* mental efficacy may manifest indirectly as increased unpredictability of *observable* neural activity, quantifiable via information-theoretic entropy. The concept of irruption is introduced to specifically name this part of unexplained variability. This conceptual advance reframes context-dependent neural "noise" as a key signature of the mind at work, offering new avenues for research in cognitive science, clinical interventions, and AI.

L17: Monday 16:40

Kevin Mitchell

Associate Professor, Trinity College Dublin

Chance, Choice, and Control – Agency in Real Time

Agents are not just caught up in the swirl of happenings around them – they make things happen in the world. But how can that kind of causal power come to be invested at the level of a whole macroscopic entity, rather than its parts? I will consider how the indeterminacy of microscopic goings-on leaves scope for macroscopic organisation to exert causal influences over how the dynamic state of the system as a whole evolves through time. Importantly, this kind of causal power can be exerted by constraining macroscopic dynamics, without having to micromanage individual microscopic events. In creatures with nervous systems, this kind of top-down causation manifests in the choice of goals and actions and the control of behaviour in real time and through time. Agents do things for agent-level reasons, working in an integrative and holistic manner to guide action in the world by constraining their own parts to make happen what they want to happen.

KEYNOTE SPEAKERS

Michael Levin

L21: Tuesday 9:00

Professor, Tufts University

Unconventional embodiments: model systems and strategies for addressing mind-blindness

One of the most salient aspects of any agent's environment is the question of how many, what kind, and what degree of agency exists in it. It is as relevant to biological organisms as to robots in human environments. It is also critical for scientists, philosophers, and engineers, as well as for human societies which will increasingly contain modified, synthetic, and hybrid beings of every possible description. In this talk I will argue that our evolutionary history has left us with significant mind-blindness, which makes it difficult for us to recognize minds of unfamiliar scales, problem spaces, or embodiments. I will describe our lab's work to develop conceptual tools for recognizing and communicating with diverse intelligences. I will also present recent data from our new synthetic proto-organisms, in which we test those ideas by creating and studying the behavioral properties of beings who have not been specifically selected for them. I will conclude the talk with a speculative idea about the latent space from which novel intrinsic motivations ingress into physical, biological, and computational systems.

Jonathan Delafield-Butt

L23: Tuesday 11:00

Professor, University of Strathclyde

Sensorimotor Agency: A cohesion of purposeful power

This talk examines the early development of agency in human life, and the role of the sensorimotor system as an active generator of experience. The significance of this early embodied agency sheds light on its prospective, future-oriented nature common to all agent action. In human ontogenesis, simple intentional actions create responses that are learned. Arranged in sequences, these prospective intentions grow in awareness and reach, with greater capacities for control enabled by higher cognitive tools of memory, conceptual organisation, and planning. But from the very beginning of life, human infants co-create meaning in shared, reciprocal, and rhythmic exchanges of affects, interest, and intentions that yield narratives, or shared projects of social meaning. These units of embodied action, whether solitary or social, structure human intelligence before verbal language. In autism, new evidence reveals a subtle, but significant disruption to this embodied motor agency, it thwarts intentions and disrupts prospective awareness, with consequential change in affective, conscious experience that adjusts intelligence to serve the needs of the organism. By tracing human agency in development to its earliest roots in infancy and embryonic life, this talk will define a critical psychophysical feature of biological agency – a conscious coherence of power and purpose..

Charles Stanish

L27: Tuesday 15:00

Professor, University of South Florida

Group selection, path dependency, and the evolution of human cooperation

The unit of selection in socio-cultural evolution is the group, or more specifically the cooperative strategies of that group. We can also refer to this as strategy selection in which the groups with the strongest norms of cooperative behavior produce more social (prestige) and economic utility than others. This favors their selection in any competitive landscape. Embedded in this evolutionary process is path dependency in which the trajectory of any historical sequence is constrained by existing institutions and norms. Cost-benefit calculations by individuals enmeshed in utility-enhancing groups within a context of contingent and unpredictable events alter the cost and benefits of various strategies. Comparative analysis of early complex societies around the world suggest that a restricted diversity of cooperation-reinforcing social forms evolved as a result of group strategy selection constrained by path dependent processes. The unit of selection in socio-cultural evolution is the group, or more specifically the cooperative strategies of that group. We can also refer to this as strategy selection in which the groups with the strongest norms of cooperative behavior produce more social (prestige) and economic utility than others. This favors their selection in any competitive landscape. Embedded in this evolutionary process is path dependency in which the trajectory of any historical sequence is constrained by existing institutions and norms. Cost-benefit calculations by individuals enmeshed in utility-enhancing groups within a context of contingent and unpredictable events alter the cost and benefits of various strategies. Comparative analysis of early complex societies around the world suggest that a restricted diversity of cooperation-reinforcing social forms evolved as a result of group strategy selection constrained by path dependent processes.

Enara García

L31: Wednesday 9:00

Lecturer, University of the Basque Country

The Path-Dependent Mind: Individuation, Vulnerability, and the Ontogenesis of Mental Conditions

The enactive approach to mental conditions offers an alternative to neurocentric and static models, adopting a process and relational ontology of the mind and its disorders. Accordingly, it has been proposed as a theoretical framework to feed individualized dynamic network models. However, network theories often rely on synchronic explanations (causal, mechanistic, topological), while the enactive approach advocates for an ontogenetic perspective—viewing mental conditions as intertwined with a person's developmental individuation. This paper argues for integrating ontogenetic explanations into network models, suggesting a propensity-based form of explanation that draws on Piagetian mechanisms of sensorimotor individuation. Empirical evidence, such as links between the Big Five personality traits and pathological dimensions (the cybernetic theory of psychopathology), supports this view. By incorporating developmental processes, the enactive approach offers a dynamic understanding of mental conditions and aligns with shifts toward vulnerability-based and preventive paradigms in psychiatry.

Glenda Satne

L41: Thursday 9:00

Associate Professor, University of Wollongong

Enacting human collectives: autonomy, normativity and agency at the collective scale

A vast amount of research in contemporary philosophy of mind and neuroscience studying interactions between agents is (almost entirely) concerned with the study of joint action and collective emotions. In contrast to this narrow focus, a family of views that span enactivist and phenomenological traditions hold that "[c]onsciousness necessarily involves an intersubjective dimension that any study of it must seriously pay attention to" (Thompson 2001) for "[t]here is little consciousness without intersubjective engagement and independently of it" (Satne & Roepstorff 2015). Offering a broad understanding of collective intentionality, i.e. the set of capacities and scaffolds that allow an agent to engage with other agents in joint activities, this approach studies shared experiences and affects, social norms, cultural practices, customs, institutions, and traditions. This talk addresses the nature of collective agency within the enactive and phenomenological theoretical framework focusing on its different forms. I will first introduce the paradigmatic methodology for the study of different kinds of collective activity and illustrate how this methodology helps advance their interdisciplinary study. I will then concentrate on the characteristic features of collective activities at different scales, namely, autonomy, agency and normativity, and discuss how they interact with one another in practice.

Rieko Osu

L44: Thursday 11:00

Professor, Waseda University

Interacting Brains: Social Engagement and Synchronization

Social interaction is essential to human well-being, and its absence can negatively affect both mental and physical health. In recent years, social isolation and loneliness have emerged as pressing societal concerns. Against this backdrop, research on the nature and neural mechanisms of interpersonal interaction is gaining traction. A growing area of interest is behavioral and neural synchronization between interacting individuals. Although such synchrony has been observed, its mechanisms and functional significance are still under debate. In this talk, I will present our studies showing that greater EEG synchronization can occur in less intimate pairs or during poorer task performance. Rather than interpreting this as a simple marker of rapport, we propose that such synchrony may reflect increased effort to achieve social engagement, especially under challenging conditions. I will also introduce our work with individuals with autism spectrum disorder (ASD), focusing on how implicit attitudes toward social interaction relate to feelings of loneliness. Implicit Association Test results suggest that although individuals with ASD do desire connection, qualitative differences in communication may lead to mismatches and increased isolation. These findings underscore the importance of considering individual differences and interaction contexts when studying neural synchrony, and they highlight the need for more inclusive models of social communication and engagement.

Wen Wen

Associate Professor, Rikkyo University

L51: Friday 9:00

Capture the individual difference in the sense of agency

The sense of agency—the feeling of controlling one's own actions and their consequences—varies greatly across individuals, yet this variability has often been overlooked in experimental and theoretical studies. In this talk, I will highlight the importance of capturing individual differences in the sense of agency and discuss how computational approaches can provide a principled framework for doing so. Specifically, I will present a Bayesian integration model that distinguishes between sensitivity (linked to the variability of likelihood distributions for self-generated cues) and criterion (linked to prior beliefs in self-agency). By estimating these parameters at the individual level, the model enables a quantitative characterization of variability in agency experiences across people. This approach not only clarifies the mechanisms underlying individual differences but also offers a pathway toward understanding how agency may be altered in developmental stages and clinical populations.

Alexander Hölken

S12: Monday 10:00

Embodied learning as a self-organized, multi-scale process

Learning in biological organisms is often an embodied and environmentally-embedded process: Whether a learner succeeds or fails a task depends to a large degree on how they coordinate their actions with the way their environment reacts. Thus, the acquisition of knowledge and skills can be framed in terms of coordination dynamics (Kelso & Engstrøm, 2007): How do agents learn to coordinate their speech, movements and behaviors with the dynamics of other systems in their environments? This paper presents a multi-scale approach to answering this question: Successful learning requires the simultaneous coordination of processes on the neurobiological, the behavioral, and the psychological scale. Accordingly, any model representing only one of these scales will inadvertently fail to capture essential aspects of the learning dynamics of biological organisms. Thus, we argue that models of biological learning should include explicit representations of processes at the three scales and aim to capture the complex dynamical relations between them. To facilitate the development of these models, we introduce the concept of coordinative structures based on dimensionality reduction techniques (such as Principal Component Analysis) employed in sports psychology and behavioral analysis to identify synergies between limb- and whole-body movements.

Alessandro Solfo

S14: Monday 13:20

The origin of agency: A synchronic and diachronic approach

Even though agency has been intensively studied, how it originates remains unknown. We claim this gap stems from the reluctance to embrace phenomenological methods, even when genuine phenomenal experiences, such as agency, are examined. To fill this gap, we follow a procedure designed for mutually validating phenomenological insights and scientific results: front-loaded phenomenology. This procedure consists of a phenomenological and a scientific stage. In the phenomenological stage, by the phenomenological methods of epoché and reduction, we adopt a synchronic approach to identify the invariant structure of agency. This structure unveils that agency is an experience composed of two complementary constituents: enfleshed and enworlded agency. Enfleshed agency manifests itself proprioceptively, and enworlded agency exteroceptively. We argue that the two constituents are temporally coordinated in every experience, thus solving Husserl's paradox of subjectivity: The Ego is subject for and object of the world ("re-entry" in second-order cybernetics). In the scientific stage, we assume a diachronic approach to test whether this proprio-exteroceptive coordination is decisive for agency. Our test takes place through two research designs: controlled experiments and integrative reviews. The controlled experiments analyze the emergence of agency in adults engaged in sensorimotor coordination (timescale of seconds). The integrative review aims to reinterpret phenomenologically human development since gestation (timescale of months). Results demonstrate that the metastable coordination between proprio- and exteroception can be deemed the fundamental interaction originating agency at short or long timescales. More broadly, our findings confirm the necessity of phenomenological scrutiny in scientific investigations to account for human agency.

Milan Rybar

S15: Monday 13:40

When Decisions Matter: Entropy Dynamics in EEG Reveal Deliberate versus Arbitrary Choices

Human decision-making is often examined by contrasting arbitrary choices, which lack consequence, with deliberate choices, which are reasoned and meaningful. Electroencephalography (EEG) studies have reported readiness potentials preceding arbitrary but not deliberate choices, suggesting distinct underlying neural mechanisms. We re-analyzed EEG data from a donation-choice task using multiple entropy and complexity measures. Our results revealed clear differences in post-stimulus entropy dynamics between decision types. Deliberate choices exhibited higher entropy and complexity than arbitrary choices. These findings reframe neural "noise" as a functional element of cognition rather than a nuisance variable. Entropy does more than quantify uncertainty in brain signals—it captures how unpredictability is selectively recruited when decisions are meaningful versus arbitrary. Entropy-based measures thus offer promising biomarkers of agential involvement, highlighting the constructive role of neural variability in adaptive behavior and decision-making.

Benjamin Gaskin

S16: Monday 14:00

Internally-funded improbability: a thermodynamic account of agency

While hurricanes can uproot forests, we argue that they occupy a thermodynamically passive class of dissipative structures: they inevitably follow the steepest descent in an energy landscape and disappear when that gradient expires. Even a simple eukaryote, in contrast, regularly performs a feat which is for the hurricane impossible: by investing energy it moves in ways that physics deems wildly improbable. This contrast between passive dissipation and metabolic leverage grounds our conception of agency. We define agency as a costly reweighting of the probability of future trajectories, and introduce a formal quantification of this as the Kullback-Leibler divergence between passive and active path distributions. This capability rests upon an internal niche construction which metabolically reroutes the principle of least action, as explained with reference to the concept of Brownian ratchets. We will further distinguish between agency and intelligence: agency is this potency, whereas intelligence concerns its use. Our view will then be contrasted with other accounts, particularly its nearest neighbour, the Free Energy Principle (FEP), and these will be applied to understanding E. coli chemotaxis. Unlike FEP's belief-centred scheme, our account dispenses with generative models and centres embodied activity; we will see how this account more parsimoniously accounts for this chemotactic behaviour. By defining agency in terms of internally-funded improbability, we aim to provide a concise and extensible conception of agency. This principle, applicable as much to animals and social actors as eukaryotes, clarifies how even the smallest organism differs fundamentally from the mightiest storm in shaping its own future.

Beatrice de Gelder

S22: Tuesday 10:00

How body perception contributes to social interaction

Understanding how the human brain processes body movements is essential for clarifying the mechanisms underlying social cognition and interaction. In a series of studies we investigate the visual basis of body perception with the goal of tracing its roots in processes known to play a core role in embodiment. One set of studies addresses possible origins of preferentialperception of human bodies for conspecifics (Li et al., 2023). To explain this specificity Marrazzo et al., 2025 investigated biomechanically possible and impossible body movements using ultra-high field 7Tesla fMRI. By predicting the response of single voxels to impossible/possible movements using a computational modelling approach, the findings demonstrated that a combination of postural, biomechanical, and categorical features significantly predicts neural responses in the ventral visual cortex, particularly within the extrastriate body area (EBA), underscoring the brain's sensitivity to biomechanical plausibility. Further EEG and TMS studies support this explanation and investigate the relation with action understanding. Ongoing studies adopting a computational ethology perspective investigate how biomechanics of the human body are organised in body part movement synergies.

Patrick Grüneberg

S24: Tuesday 13:20

Embodied Agency Begins in the Muscles: Abductive Control from Intent to Action

How do agents realize goal-directed movements without relying on rigid, pre-specified motor plans? Building on an improvisational model of abductive performance (Bertinetto & Grüneberg 2022, 2023), I argue that agency operates not only at the intentional, cognitive level but also within neuromuscular systems themselves. Intentions do not dictate detailed actions; rather, they define a flexible range of relevant behaviors. Situated world-coupling (interaction between the agent and the environment) then specifies actions dynamically in response to unfolding circumstances. Conscious, intentional motor control thus leverages abductive processes that allow spontaneous adaptation and the emergence of new action goals. Similarly, the neurophysiological referent control model shows that central control (i.e. the higher neural functions above the level of α-motorneurons) specifies a spatial-temporal frame of reference rather than issuing fixed motor commands. Within this frame, muscles autonomously realize movement through continuous interaction with the environment. This structural continuity between conscious intent and neuromuscular action suggests that agency operates across scales. Neuromuscular processes exhibit abductive autonomy, functioning as a foundational form of motor agency such that intentional, cognitive agency interacts with embodied neuromuscular agency rather than controlling it. By recognizing that agency is realized both intentionally and neuromuscularly, we can better understand the layered organization of embodied cognition. I will conclude by discussing implications for motor rehabilitation, where restoring neuromuscular agency plays a critical role in recovering intentional action.

Akhi Kumar Singh

S25: Tuesday 13:40

Hands and Minds Together: Using Scaffolding and Offloading in Learning

Embodied cognition says learning begins in the body. When children move, gesture, and shape their setting, they ease the load on working memory. Two linked ideas explain how this works: cognitive scaffolding and cognitive offloading. Scaffolds are simple supports—paper grids, finger counts, peer prompts—that help a learner set up a task. Offloading is the next step, shifting parts of the task onto those supports so the mind can focus on meaning rather than mechanics. This paper shows practical ways for teachers to weave these moves into daily lessons without costly tools. First, design tasks that invite physical aids: folding sheets to mark place value, arranging coins to model fractions, or using body positions to map verb tenses. Second, allow time for learners to push work onto these aids, such as tracking steps on a number line taped to the floor. Third, fade the aids once understanding is firm but keep them close for quick recall. By cycling through build–use–fade, classrooms become flexible spaces where thinking is shared among minds, bodies, and materials. The approach aligns with the child-centred goals of India's NEP 2020 and offers a clear path for teacher training. The session will unpack each step and invite feedback from fellow scholars and practitioners.

Konrad Werner

S26: Tuesday 14:00

Institutions and the enactment of shared problem domains

Institutions, whether conceived as top-down formal rules or spontaneously generated patterns of behavior, are factors that structure collective behavior and thereby enable the social pursuit of problem solving. For example, money is part of an institutional system that makes it much easier to coordinate exchange than barter. However, since all collective action takes place in a particular domain or environment, there must also be structures in that domain that enable agents to recognize the need to coordinate their behavior. This means not only physical infrastructure, but also a network of collectively recognized goals, opportunities, challenges, or threats. From this perspective, one thing is still largely a "black box" in institutional theory – the problem domain. The existence of problems themselves, i.e. specific situations in which agents need to change their behavior and make efforts to at least marginally reshape their environment, is usually assumed in the literature – as if problems were just "out there" in the world, waiting for someone to pick them up. Meanwhile, this assumption has already been challenged within the embodied cognition paradigm and niche construction theory. Building on these insights, the paper raises the following question in the field of social ontology, thereby contributing to bridging embodied and institutional inquiries: How are problems enacted through collective action, or how is it possible for a collective to enact a shared problem domain? Further, what is the role of institutions in this endeavor?

Norihiko Kamaya & Katsunori Miyahara

S32: Wednesday 9:40

Embodied agency at the cellular scale: a body-schema perspective on testate amoeba behaviors

In this presentation, we propose to advance our understanding of agency across scales by extending the concept of body-schema and embodied agency to unicellular organisms. In phenomenological philosophy, it is argued that the body-schema plays a crucial role in human agency (Merleau-Ponty 1945; Gallagher 2005). We examine if this account of agency and embodiment applies at the simplest biological level. The body-schema is a sensorimotor system that governs bodily movement in a non-conscious manner (Gallagher 2005). It adjusts the body holistically to ensure flexible goal-directed engagement with the environment. It can also functionally extend beyond the biological body to incorporate parts of the environment, thereby enabling complex forms of adaptive behavior such as tool use. We apply this body-schema framework to analyze the behaviors of testate amoebae, single-celled protists that construct external shells. These organisms use their pseudopodia to gather environmental particles, such as silica and diatom fragments, for shell construction. Furthermore, some species utilize parts of their shells as a "weapon" (Dumack et al 2024) to immobilize and tear prey. We hypothesize based on these and other behaviors and that these single-celled organisms possess a body-schema. This hypothesis suggests that the evolutionary history of complex goal-directed behaviors, including primitive forms of tool use, is far deeper than is previously understood. It also opens new research avenues regarding the developmental dynamics of the body-schema in organisms; and the potential for embodied consciousness structured by the body schema at the cellular scale.

Georgii Karelin

S33: Wednesday 10:00

Some Philosophical and Practical Implications of Non-determinism in Computations

Synergy between stochastic noise and deterministic chaos is a route to unpredictable behavior in nonlinear systems. This talk will present the recent pre-print which analyzes the origins and consequences of indeterminism that has recently appeared in leading Large Language Models (LLMs), drawing connections to open-endedness, precariousness, artificial life, and the problem of meaning. Computational indeterminism arises in LLMs from a combination of the non-associative nature of floating-point arithmetic and the arbitrary order of execution in large-scale parallel software-hardware systems. This low-level numerical noise is then amplified by the chaotic dynamics of deep neural networks, producing unpredictable macroscopic behavior. We propose that irrepeatable dynamics in computational processes lend them a mortal nature. Irrepeatability might be recognized as a potential basis for genuinely novel behavior and agentive artificial intelligence and could be explicitly incorporated into system designs.

Natalya Weber

S34: Wednesday 11:00

Untapped Potential in Self-Optimization of Hopfield Networks: The Creativity of Unsupervised Learning

The Self-Optimization (SO) model can be considered as the third operational mode of the classical Hopfield Network (HN), leveraging the power of associative memory to enhance optimization performance. Moreover, is has been argued to express characteristics of minimal agency which, together with its biological plausibility, renders it useful for the study of artificial life. In this work, we draw attention to another facet of the SO model: its capacity for creativity. Drawing on the creativity studies literature, we argue that the model satisfies the necessary and sufficient conditions of a creative process. Moreover, we explore the dependency of different creative outcomes based on learning parameters, specifically the learning and reset rates. We conclude that the SO model allows for simulating and understanding the emergence of creative behaviors in artificial agents that learn.

Taraneh R Wilkinson

S35: Wednesday 11:20

Heteronomous selfing and multi-scale pathologization of IPV survivorship agency

Embodied cognitive approaches have increasingly shed light on mechanisms of structural harm (e.g. Liao & Huebner 2020, Brancazio 2020, Liao & Carbonell 2023, Catala 2025). Recent work by Toro, Rietveld, and Kiverstein (2024) on pathological embodiment builds on Dokumaci's "habitus of ableism" (2023) and Young's "inhibited intentionality" (1980). They argue that first-person cognition can be pathologized through what they term "disabling scaffolding." In this process of pathologization, an agent's usual experience of "I can" shifts to a pervasive "I cannot" wherein the agent only experiences an "I can" under limited, rigid conditions. Importantly, this pathologization can be framed as an external, disabling constraint on individual agency. This paper expands on Toro et al.'s ecological and enactive view of disabling scaffolding and applies it to the case of interpersonal violence (IPV). In the case of IPV I argue that taboos, structural violence, and what I call structural enabling constrain the survivor's experience in a pathologizing way. I understand the multi-scale mechanisms of pathologization through the notion of heteronomous selfing (cf. Kyselo 2014, Di Paolo et al. 2018). Pathologized agency and pathologizing the agency of others is not determined at a single scale. Social cognition strongly affects whether we contribute to the pathologizing of another's agency or find our own agency pathologized. Interacting factors include environmental scaffolding, meso-level dynamics, and direct interpersonal affordances.

Jay McKinney

S36: Wednesday 13:20

Heijoshin and the Threat of Automating Agency

The rapid development and relative success of connectionist AI systems necessitates a response from interactionist and embodied accounts of cognition. Creativity, information generation, and agency are targets for automation. Where generative AI can produce coherent prose and images in seconds, agentic AI promises to replace or mediate our interface with everyday technology. Both systems represent genuine challenges for human agency. My paper will address these challenges by appealing to empirical research on the creativity of skilled behavior from ecological psychologists across Japan (Nonaka 2024; Tanaka 2021; Kono 2011). Their findings make the vital point that agency is central to human expertise. As we lose opportunities to make choices, make mistakes, and correct them, we give up opportunities to learn (Dingemanse et al. 2023; Dingemanse & Enfield 2024). The theoretical aspect of my project will integrate interactionist, enactive, and ecological accounts of agency to critique agentic systems. The empirical aspect will investigate the role of agency for coordinated skilled activity in Kyudo, the Japanese martial art of archery. The unique postural and coordinative dynamics of expert practitioners sheds light on the creative and exploratory nature of skilled agentic activity. This has aesthetic and practical implications. Kyudo is a martial practice that shapes our body and affordances. Kyudo is also an aesthetic that cultivates Heijoshin [平常心 - everyday mind], shaping our senses of the world and ourselves. This aesthetic turn is vital for appreciating the subtle and interaction-dependent nature of cognition and the central role agency plays in our lives.

Mark James

S37: Wednesday 13:40

Catalysing Change: From Spontaneous Noise in Multiscale Alignment to Wayshaping

This talk develops an understanding of dosed noise as a mechanism for realignment across biological, psychological, and social levels. It frames noise, in this context, as a brief fluctuation that opens a window for re-coordination of perception, affect, narrative, and action. Using familiar examples, I argue that endogenous and exogenous "shocks" can be tuned and scaffolded to canalise valuable transitions at different scales into novel stable forms. I will also briefly introduce wayshaping as a multiscale framework that aims to translate these and related insights into a theoretically informed practice for enabling sustainable behaviour change.

Philip Kurian

S42: Thursday 9:40

From slime molds to sentience: Morphological computational capacity of *Physarum polycephalum*

As physical systems, all life in the universe processes information according to physical laws. Estimates for the computational capacity of living systems generally assume that the fundamental information-processing unit is the Hodgkin-Huxley neuron. However, *Physarum polycephalum*, a unicellular, multinucleated amoeba, is capable of complex problem-solving despite lacking neurons [1, 2]. By analyzing growth dynamics in two distinct *Physarum* strains under diverse biological conditions, we map morphological evolution to information processing (Fig. 1). As the Margolus-Levitin theorem constrains maximum computation rates by accessible energies, we analyze high-throughput time-series data of *Physarum*'s morphology—quantified through area, perimeter, circularity, and fractal dimension—to determine upper bounds on the logical operations achievable through hydromechanical, chemical, kinetic, and quantum-optical degrees of freedom [3-6]. Fourier and power spectral density analyses of *Physarum* while solving the traveling salesman problem also reveal signatures of Fröhlich condensation in the optically pumped, non-equilibrium steady state [2]. Our analytical results for helical distributions of quantum emitters [4], numerical simulations of protein fiber networks [4-6], and experimental validation of superradiant quantum yield enhancements in microtubules [5] suggest that tryptophan lattices in diverse protein fibers exhibit observable and robust effects with increasing length, due to quantum coherent interactions in the single-photon limit. Superradiant enhancement and high quantum yield in neuroprotein polymers would thus play a crucial role in information processing in the brain [3], photoprotection in the onset of Alzheimer's and related dementias [6], and a wide array of other pathologies characterized by anomalous protein aggregates. Our results motivated a revisiting of the computing limits of cytoskeletal architectures [3], where superradiant states in these tryptophan lattices allow information-processing pulses at orders of magnitude faster speeds than conventional Hodgkin-Huxley chemical potential spikes, at significantly lower power consumptions, by operating within two orders of magnitude of the Margolus-Levitin quantum speed limit for ultraviolet-excited states. The robustness of superradiant states (~picosecond) complemented by subradiant states (~seconds to minutes) in these protein architectures thus offers a novel paradigm for understanding the role of large collectives of quantum emitters in warm, wet, and wiggly environments, and it may illuminate the vast computational capacities of both neural and aneural organisms [1-3] in the search for the elusive “Heisenberg cut” in quantum measurements.

Nagarjuna G

S43: Thursday 10:00

From habit-habitat to memet-memetat: An enactive-embedded model of a cognitive agent from cells to societies

Cognitive actions span a spectrum — from deeply ingrained habits tied to an organism’s habitat (its environmental niche) to sophisticated socio-cultural behaviors, or memets, situated within the agent’s memetat (its memetic or cultural world). 4E models explain cognition primarily through embodied actions, often rejecting the ontological status of representations or symbols. In contrast, cognitivist models privilege symbolic processing, relegating actions to a secondary role. We propose an enactive approach that models the body as a sensory-motor network, structured by a topologically tubular, polarized, layered, segmented, antagonistic, and bilaterally symmetric body plan. Within this architecture, we distinguish between fixed-action patterns (FAPs) — mandatory, environmentally adapted behaviors — and haltable-action patterns (HAPs), which are punctuations in FAPs as afforded by body-environment coupling via attunement. Some HAPs, when saturated with object-interaction, shape the external world (e.g., tool use), while unsaturated ones (e.g., gestures) may evolve into symbols, enabling semiotic processes. These punctuations across multiple action zones support the emergence of generative syntax. When HAPs leave traces on external media, they externalize memory and symbols, enabling intersubjectivity and giving rise to transactional action patterns (TAPs) — memets that constitute ontological building blocks of the memetat. Thus, we trace the development of memet-memetat from habit-habitat through two important transitions (1) from FAPs to HAPs and (2) from HAPs to TAPs. In this view, both actions and symbols are treated as ontologically real, unlike radical enactivists, with increasing under-determination as we move from FAPs to TAPs — without reducing one to the other.

John Anderson P-Duarte

S45: Thursday 13:20

"Bodily" Presence in Joint Digital Interaction

This paper explores whether subjects can be genuinely present during episodes of digitally mediated social interaction, particularly those involving cooperation based on attention. While face-to-face interactions are typically regarded as involving genuine presence—grounded in veridical perception and embodied agency— digitally mediated interactions are often thought to lack this quality, due to the absence of direct perceptual access to shared objects or spaces. Drawing on phenomenological insights from Husserl, this view holds that digital interactions merely elicit imaginative or illusory experiences, undermining authentic agency and presence. In contrast, I argue that subjects can indeed be bodily present in digitally mediated interactions when they engage in attention-based cooperation. Activities such as conversing via video call, co-writing documents online, or collaborating in multiplayer games exemplify cases where tasks are jointly resolved through shared attention. The central claim is twofold: (i) cooperation in these digital contexts can be accurately described as joint attentional activity, and (ii) exercising attention in these settings constitutes a genuine form of presence—that is, subjects are present where attention unfolds. Based on this, I propose a notion of presence that goes beyond material embodiment. Drawing on the phenomenological concept of the lived or agentive body, I argue that digital presence, though not materially corporeal, is still bodily insofar as it involves genuine agency through joint attentional engagement in digital contexts. The point is that the kind joint task determines the form of bodily presence required, offering a novel framework for understanding presence in virtual environments.

Moritz Kriegleder

S46: Thursday 13:40

Embodied cognition as the forgotten dimension in the neuroscience of consciousness

Embodied cognition has made several contributions to the study of consciousness and the reintegration of subjective experience into neuroscience. This influence is particularly evident in neurophenomenological research (Berkovich-Ohana et al. 2020) and contemplative neuroscience (Dahl et al. 2015), but in recent reviews of theories of consciousness, embodiment plays only a minor role (Northoff & Lamme 2020, Seth & Bayne 2022, Signorelli et al. 2021). While global workspace theories (GWT), integrated information theory (IIT), higher order theories (HOT), and recurrent processing theories (RPT) are usually considered to be the main theories, the advances of embodied cognition and enactivism seem to have been relegated to the sidelines. This fact seems to be the blind spot of the neuroscience of consciousness (Frank, Gleiser, Thompson 2024). In a big data analysis of the consciousness literature of the last three decades, we show that this is a misrepresentation of the current state of consciousness science. We analysed over 13000 papers spanning research on theories of consciousness and mapped the semantic similarity of published papers. This leads to clustering of different strands of research, and our map of consciousness science reveals the significant contributions that embodied and enacted cognition research is still making to the field. In this talk, we will discuss possible reasons for this misrepresentation, such as the structure of the public debate on consciousness and the empirical difficulties of comparing and integrating third-person and first-person methods.Kriegleder

Keisuke Suzuki

S52: Friday 13:20

Embodied Minds Between Being and Doing: A Computational Neurophenomenological Approach to Mindfulness

Mindfulness practices yield well-documented benefits (such as reduced stress and improved emotional regulation), yet the cognitive processes distinguishing a mindful "being" state from our ordinary "doing" mode (exemplified by mind-wandering) remain unclear. We present an embodied computational model—a neural network agent grounded in the free-energy principle and allostasis—to investigate these modes of cognition. The model integrates interoceptive (bodily), proprioceptive (movement), and exteroceptive (environmental) signals, minimizing variational free energy throughout past and future contexts. In simulated rest, the agent naturally alternates between a present-focused "being" mode and an externally engaged "doing" mode. We interpret these modes as distinct forms of embodied agency, each reflecting a different strategy of predictive regulation. The "being" mode is an autonomous, present-centered strategy guided by interoceptive homeostasis, whereas the "doing" mode is a goal-directed, future-oriented strategy involving sensorimotor engagement. Accordingly, the "being" state keeps free-energy (prediction error) low by prioritizing bodily stability, whereas the "doing" state tolerates higher free-energy to pursue future goals. A higher-order "meta-attention" parameter biases the agent toward one mode or the other, tuning its cognitive attitude. Pushing this bias toward a deep "being" stance yields a mindful state of sustained low prediction error and present-moment awareness. In contrast, a bias toward a belief-driven "doing" stance produces spontaneous future-oriented predictions (mind-wandering), often leading to anxiety-like feelings. These findings offer insights into how mental states and feelings emerge from embodied predictive regulation. More broadly, balancing "being" and "doing" may represent a fundamental principle of embodied agency across scales—from simple organisms to advanced AI.

Katarina Woodman

PS01

The Influence of Social Identity on Native Speakers' Processing of L2 Speech

Japanese language classes in Fukuoka Prefecture face two major challenges: (1) a decline in learner participation due to low awareness of the classes and busy schedules, and (2) difficulty maintaining learners' motivation over time. These issues are often rooted in the social isolation learners experience in Japanese society, even after achieving advanced proficiency. This research explores how the social identity of foreign-appearing speakers influences the language processing of native Japanese speakers. Surprisal theory in computational psycholinguistics explains that the difficulty of processing language depends on how unexpected the input is based on prior context. For example, in the sentence "She spread the bread with...", the word "butter" is highly expected and easy to process, whereas "socks" is unexpected, leading to greater processing difficulty. Study 1 examines how Japanese native speakers' surprisal response varies when listening to Japanese-appearing (in-group) versus foreign-appearing (out-group) speakers. Study 2 expands on this by investigating how "proximity to Japanese-ness" influences surprisal, introducing both Japanese-coded and foreign-coded speakers. Eye-tracking and reaction time data show that participants experience greater cognitive load when listening to foreign-coded speakers, with increased surprisal responses for those with lower proximity to Japanese identity. Results reveal that foreign-appearing speakers elicit higher surprisal responses, indicating increased cognitive effort during processing, while in-group speakers' words are encoded with greater detail, suggesting a bias toward in-group identity in speech processing. These findings provide insight into JSL learners' challenges in Japan and emphasize the importance of addressing social dynamics in language education to promote integration and mutual understanding.

Maria Valeria Pazos

PS02

Imagination, Agency, and Dynamic Synergy within 4E Cognition

This article explores attention as a form of creative and situated agency, challenging the idea of perception as a passive registration of stimuli. Drawing from phenomenology, 4E cognitive science, and aesthetics, it argues that attention is not merely a filtering mechanism but a dynamic structure that organizes consciousness. Through this lens, creativity is redefined as the capacity to reconfigure attentional patterns, and perception itself becomes a field of variation and composition. Inspired by the work of Sebastian Watzl, Shaun Gallagher, and Merleau-Ponty, the article develops the notion of phenomenal freedom: the embodied potential to rearrange what appears in experience. Attention is described as a modifiable and affectively charged act that shapes how we inhabit the world. In this context, art —particularly immersive and multisensory art— emerges as a technology of attentional agency, enabling the body to train its perceptual pathways through aesthetic experimentation. The article also introduces the concept of sensory poetry as a dispositif that reorganizes sensory associations through rhythm, metaphor, and multimodal stimulation. By engaging smell, sound, texture, and memory, sensory poetry becomes a technology for rerouting perception, disrupting habitual attentional hierarchies and inviting the body to feel and imagine otherwise. Artistic practices are thus understood not only as expressive acts but as epistemological and political gestures that modulate how reality is sensed, constructed, and reimagined. Ultimately, this text defends the idea that perception can be poetically reorganized, and that such reorganization is both a creative act and a critical form of resistance. To attend is to compose; to sense is to choose a world; to imagine is to unsettle the given.

Marina Saskovets

PS03

Emergent Agency in Stress Recovery: A Multimodal Perspective from Brain, Body, and Sound

How do we regain control and recover after stress? In this study, we explore stress recovery as an example of emergent agency — a process that arises not from a single system but through the dynamic interaction of the brain, body, and environment. Using a multimodal approach, we examine how external sound (soothing vs. robotic vs. silence) influences internal regulation following psychosocial stress. Thirty-five participants underwent a standardized stress-inducing task followed by a ten-minute recovery period. During recovery, they were exposed to one of three auditory conditions: a natural, soothing voice; a flat, robotic voice; or silence. Throughout the experiment, we recorded brain activity using functional near-infrared spectroscopy (fNIRS), along with electrodermal activity and salivary cortisol as markers of physiological stress. Our results showed that participants exposed to the soothing voice recovered more quickly, with faster reductions in physiological stress markers. This group also exhibited distinct prefrontal activation patterns, including reduced asymmetry and lower sustained activation typically associated with stress, suggesting more efficient cognitive and emotional regulation during the recovery period. We propose that agency in stress recovery is not isolated to the brain alone, but emerges through the coordinated activity of neural, autonomic, and environmental systems. The voice, in this context, acts as a regulatory partner, helping to scaffold the recovery process. These findings offer a new perspective on embodied agency, highlighting how supportive environments can shape adaptive capacity. They also suggest practical avenues for designing interventions that engage multiple systems to promote well-being.

Javier Meneses-Pinto PS04

Exploring Embodied Recovery: An Enactive-Educational Model for Persistent Low Back Pain Rehabilitation

Background/Objective: Persistent low back pain (PLBP) challenges conventional physiotherapy, necessitating innovative, embodied approaches grounded in cognitive science. This study tests an enactive-educational model (MEE) against classical rehabilitation with pain neuroscience education (MC+PNE), evaluating its efficacy in reshaping PLBP experiences. Rooted in enactivism (Varela et al., 1991), MEE integrates co-constructed sensorimotor exploration, critical pedagogy, and relational dynamics to foster autonomy and reframe pain as an embodied, context-dependent process rather than a mere sensory event (Coninx & Stilwell, 2021). By operationalizing the enactive-biopsychosocial model (Cormack et al., 2022), MEE emphasizes complexity, self-management, and adaptive motricidad, challenging dualistic pain conceptualizations and promoting agency through lived experience. The study assesses pain, kinesiophobia, catastrophizing, functionality, and autonomy, highlighting MEE's potential to transform rehabilitation. Method: A sequential explanatory mixed-methods pilot involved 13 adults (18-64 years) with PLBP, randomized to MEE (n=7) or MC+PNE (n=6). Each group underwent 10 sessions. Pre- and post-intervention measures included pain (NPRS), kinesiophobia (TSK-11), catastrophizing (PCS), functionality (RMDQ), and autonomy/education perceptions via semi-structured interviews. Quantitative data were analyzed using SPSS 28 and Jamovi 2.3.21; qualitative data were coded with ATLAS.ti 8, employing interpretative phenomenological analysis. Results: MEE significantly outperformed MC+PNE in reducing pain ($p<0.05$, $\Delta d=0.85$-1.52) and catastrophizing ($p<0.05$, $\Delta d=0.77$), with large effect sizes, and improved intragroup kinesiophobia ($p<0.05$, $\Delta d=0.83$). Qualitative findings underscored MEE's enhancement of autonomy, embodied learning, and relational engagement, contrasting MC+PNE's therapist-dependent approach. Conclusion: MEE's enactive framework shows promise for PLBP management, redefining pain through embodied autonomy and critical education. Larger trials are needed to validate scalability. Keywords: Enactivism, persistent low back pain, physiotherapy, autonomy, embodied cognition

---

Ethan Reiter PS05

Bridging Husserl and Mahāmudrā in Neurophenomenological Mindfulness Research: Nondual Meta-Awareness, Pre-reflective Self-awareness, and Epistemic Agency

Neurophenomenological studies of mindfulness frequently encounter a methodological challenge when examining purportedly nonconceptual experiences, such as the nondual meta-awareness emphasized in Mahāmudrā. How can mindfulness experiences described as ineffable, non-discursive, or devoid of sensory content be faithfully characterized beyond third-person neuroimaging data? A tension arises between the embodied immediacy of these states and the meditator's epistemic agency, which some worry is compromised in experiences lying beneath or beyond discursive thought. This poster argues that, despite these concerns, there are strong philosophical grounds for affirming the coherence of first-person reports of purportedly nonconceptual mindfulness states. Drawing on Husserlian phenomenology, I suggest that the minimal form of self-consciousness disclosed by way of transcendental inference resonates with the nondual meta-awareness that contemplative traditions such as Mahāmudrā describe cultivating. This resonance challenges the assumption that meditators lack epistemic agency during these states, offering a framework for reflective articulation of these states. I posit that reports of nondual meta-awareness experiences may ultimately refer to meditators' pre-reflective self-awareness—the lived form of subjectivity—amounting to an apperception of consciousness as both reflexive and marked by the inseparability of subject and object. I then connect this philosophical framework to neurophenomenological accounts of dereification, a key mindfulness mechanism through which habitual identification with mental contents is attenuated. I contend that dereification is best understood not through neuro-representationalist frameworks, but via an enactive, embodied conception of self-consciousness. Through interweaving cognitive neuroscience, Yogācāra Buddhist philosophy, and Husserl's transcendental method, I propose a resolution to methodological concerns in mindfulness research on nondual meta-awareness.

Enkhmurun Chibaatar

PS06

Associations of Vocal Features, Psychiatric Symptoms, and Cognitive Functions in Schizophrenia

This study explored the use of advanced computational techniques in vocal analysis to improve the assessment of psychiatric symptoms and cognitive functions in schizophrenia. We hypothesized that digital signal processing techniques, such as mel spectrogram and mel-frequency cepstral coefficients (MFCC), could be used for objective evaluation of psychiatric symptoms and cognitive functions based on the analysis of alterations in the vocal characteristics. Patients and methods: Voice samples from 14 participants diagnosed with schizophrenia (92.9% female) were collected using a microphone array, and vocal features were extracted from the samples using mel spectrogram and MFCC techniques. Psychiatric symptoms and cognitive functions were assessed using the Positive and Negative Syndrome Scale (PANSS) and the computer-based tool Cognitrax. Results: We found significant negative correlations between specific vocal features (mel spectrogram and MFCC) and cognitive functions, particularly working memory ($\beta = -0.645$, $p = 0.023$) and sustained attention ($\beta = -0.626$, $p = 0.029$). No direct correlations were found between vocal features and psychiatric symptoms, as measured by PANSS scores. However, the correlations between cognitive functions and PANSS total scores were significant ($\beta = -0.604$, $p = 0.037$), suggesting that cognitive functions may mediate the relationship between psychiatric symptoms and vocal characteristics. Conclusion: This study underscores the potential of vocal analysis as a non-invasive tool for assessing cognitive impairment in schizophrenia. Future research should focus on expanding the sample size and including diverse populations to enhance the generalizability of these findings.

Rocco Ruan

PS07

Weaving tangible, normative meaning into online group interactions using physical games embodied by robotic swarms

As social interaction moves online, evidence shows decreased social well-being. Seeing this, technologies like video calls attempt to "replicate" missing in-person information, like body language - but does this truly make online interaction more meaningful? From the enactive view of participatory sense-making, an interaction's "meaning" is woven emergently between embodied, co-regulating agents by the overlapping pursuit of normative goals. Inspired by this, we concurrently develop (1) a technological platform that recreates tangible co-presence with distant others and (2) physical games that normatively motivate dynamic, meaningful online interactions. The technological platform uses a simple, table-top robot swarm to tangibly embody a small group of separately-located friends; each robot is a local "extension" of distant friends' embodied agency. Users control their remote robot extensions in real-time by physically manipulating a local equivalent, sharing the space with - and potentially touching - others' extensions. Games weave normativity into these interactions, encouraging real-time physical coordination. Using a game engine to track robot positions, draw lightweight graphics, and render haptic feedback, we can frame interactions as wrestling matches, "Charades" routines, or apple-picking outings. We can adjust levels of participation; one game may turn mundane check-ins into opportunities for casual fun, while another game heightens stakes for an immersive social experience. We design game mechanics to encourage dynamic coordination between perception and action, leveraging the tangible robots as both sensors and effectors. Participants in preliminary investigations have resonated with our prototypes and approaches. Through comparative neurophenomenology experiments, we will refine our design and generate recommendations towards online social well-being.

Jialin Chen

PS08

Plant Agency: Rethinking Goal-Directed Behavior Beyond the Brain

The concept of agency has long been attributed only to animals and considered as one of the key characteristics of intelligence. Plants, in contrast, have been viewed as passive objects without intelligence, simply because they lack brain analogs and do not exhibit quick movements. Plants can exhibit environmentally sensitive adaptive behaviors similar to those of animals, and at the same time are deeply involved in the construction of ecosystems and social systems. I therefore want to answer the question: are plants capable of active goal-directed behaviors? If so, why should the goal-directed behaviors of plants be distinguished from the "stimulus-response" physiological processes? Agency theories from the enactive approach may provide a basic framework for examining plant action, as they suggest that the minimal agency can be found in a single cell, rather than being dependent on any particular organ. While I will examine plant action on a case-by-case basis in light of the three basic conditions for agency proposed by E. Di Paolo et al. I find that the key difficulty that ensues is how lower-level individuals such as single cells can continue to be integrated into higher-level individuals that initiate action if they do not depend on a central brain-like controller. The decentralized features of plants make this difficulty particularly striking, and for this reason, it is necessary to explore a cognitive theory that is both thoroughly decentralized and allows for self-integration through plant study.

Ruby Prinsen

PS12

Shared Moments: investigating physical intimacy and closeness between partners

To know someone physically, through shared moments of affection and sexual encounters, involves a shared, embodied knowledge that involves dynamic, patterned social interactions. However, physical intimacy is often overlooked in intersubjective or psychological models, possibly because it is considered a biological phenomenon rather than a cultural one. This one-sided perspective can obscure the ways in which intimacy contributes to social understanding and involves processes of negotiation, coordination, and shared meaning. In this study, we investigate shared moments of physical affection and intimacy through multimodal, semi-structured interviews with pairs. During this talk, I will be discussing both the model for physical intimacy, and the preliminary findings.

Shiho Sugiura

PS13

The Loss of Agency in Trauma Survivors: An Enactive Perspective

This work presents an enactive perspective on the disruption of embodied agency in post-traumatic experience. Embodied agency is central to understanding disruptions of sense-making in psychiatric conditions. Such disruptions are not limited to discrete symptoms but concern the individual's fundamental mode of being-in-the-world. While various conditions such as schizophrenia and depression are marked by disturbances in bodily orientation and meaningful engagement with the world (Fuchs 2005; Ratcliffe 2015), I argue that post-traumatic experience offers a unique case for analysing the dynamics of this breakdown. To sketch how the sense of embodied agency breaks down after trauma, I draw on the enactivist notion of agency as a balance between self-determination and openness to the environment (De Jaegher & Di Paolo 2007). In post-traumatic experience, this balance is destabilized by a collapse of temporal integration. Trauma leaves individuals "frozen in time," as the past intrudes upon and overrides present experience (van der Kolk 2014). In this state, self-determination becomes rigid and overdetermined by the trauma, while openness to environmental affordances is diminished. I discuss the resulting transformations, such as altered bodily perception and disrupted body ownership, in light of Merleau-Ponty's (1945) concept of "I can," which highlights the sensorimotor basis of perceptual access to the world. This account contributes to enactive psychiatry and trauma theory by offering a conceptual framework for understanding the breakdown of embodied agency in the context of post-traumatic experience. It also highlights the importance of therapeutic approaches focusing on restoration of flexible, embodied engagement with the world.

Ryuzo Hirota

PS15

A Monoid Theory of Self

We intuitively attribute "selfhood" to various phenomena, from unicellular organisms to our bodies and our subjective mental lives. What common structure underlies these intuitions? This paper argues that what we call "selves" universally exhibit a formal structure: a "monoid of mediation." Mediation expresses dependency relations of the form "without A, there would be no B." A monoid, in category theory, is a category with a single object where all morphisms are endomorphisms (morphisms from the object to itself) and can be composed with each other. We propose that the self is essentially a structure where various forms of self-mediation are composable through an object that is itself essentially empty—a locus of mediation rather than a substantial entity. First, we demonstrate that biological autonomy, previously formalized as the "closure" of dependency relations, can be understood as a monoid of mediation. Second, drawing particularly on Husserl's phenomenology, we show that the phenomenological self can likewise be formalized as a monoid of mediation. Finally, we explore how this framework may extend to our understanding of the bodily self. This formalization offers a comprehensive understanding of various aspects of selfhood while avoiding both extremes of substantialism (which reifies the self as an entity) and eliminativism (which denies the reality of the self altogether). By employing category theory, we provide a mathematical foundation for understanding what makes a self across different domains, revealing unexpected formal similarities between biological, phenomenological, and bodily conceptions of selfhood.

Mario Zarco PS17

A Computational Phenomenology of Derealisation: Modelling the World as it Feels Unreal

Depersonalisation-derealisation disorders attenuate the felt reality of both the body and the external world. While depersonalisation has attracted extensive study, perceptual disturbances in derealisation remain poorly characterised. Understanding how the world itself appears "less real" promises new diagnostic markers and therapeutic targets, but it requires a bridge between lived experience and measurable stimulus properties. We propose such a bridge by pairing computational phenomenology — a framework that seeks to model phenomenological properties using computational methods— with contemporary deep-learning tools. First, we fine-tune a convolutional network (GoogLeNet) on the ArtEmis dataset so that it learns to recognise visual features people with derealisation report—flattened affect, muted colours, altered depth cues, and so on. Next, we will synthesise a new dataset of everyday scenes (e.g., house and work rooms) whose perceptual signatures are algorithmically amplified via Activation Maximisation algorithm, much as Deep Dream accentuates latent motifs. The result is a curated "derealised" image set explicitly crafted to evoke the condition's characteristic ambience. To validate this new dataset, an online study will couple the Cambridge Depersonalisation Scale with a forced-ranking task: participants will order images by how closely each resembles their own perceptual world. By balancing affective valence, we dissociate emotional blunting from derealisation-specific distortions. We predict to find a positive correlation between high derealization traits and the images generated by the described method. Beyond refining assessment, this work also sets the stage for immersive XR setups that safely recreate derealised perception—providing an ethically controlled window into a clinically significant yet elusive state.

Artur Gromadzki & Álvaro Entrenas Bernal PS18

Directedness and dependent co-origination: Parallels between early Varela's dialectics, Nishida's logic of place and Tanabe's logic of species

This presentation examines structural parallels between the philosophy of the Kyoto School and the enactive approach, with a focus on dialectics, mediation, and individual agency. While enactive theorists often acknowledge Buddhist influence, direct engagement with Buddhist texts risks oversimplification or falling into "Buddhist modernism." The Kyoto School, however, offers a philosophically rigorous middle path. Thinkers like Nishida Kitarō and Tanabe Hajime pursued a critical synthesis of Western philosophy and Buddhist tradition, articulating ideas that anticipate and complement enactive theories of mind. Recent scholarship has revived interest in Francisco Varela's early writings predating The Embodied Mind. These works propose a dialectical shift in both logic and science—from representationalist models to a self-producing, culturally embedded conception of mind—arguing that cognition is constrained not only biologically but also normatively, by what is considered intelligible within a given sociocultural domain. Such constraints align with Tanabe's view of the self as nothingness, mediated through species, praxis, and historicity. Similarly, Nishida takes selfhood as dialectically emergent through mutual co-conditioning with an environment. Rooted in autopoietic theory, living systems sustain themselves through selective engagement, exhibiting dynamics of attraction and repulsion. This inherent directedness raises questions about norm generation and meaning-making. We attempt to explore this through Tanabe's "logic of species"—as a site of practical mediation between individual and social dimension—and Nishida's "logic of place", where self and world emerge in reciprocal determination. Additionally, reframing the notion of "dependent co-origination" through these lenses may clarify core tensions within enactive approach itself, particularly the asymmetry of self–world coupling.

Ryutaro Uchiyama

PS19

Cultural unbinding of open-ended behavioral complexity

Humans behavioral and technical complexity remain an enigma. In real behavioral ecologies, adaptive learning requires simultaneous exploration of both motor control ("policy") and latent environmental structure ("world model"), each posing its own form of search complexity. The challenge of this problem yields a cost–benefit calculus that prioritizes standardized action repertoires and behavioral conservatism, which indeed pervade non-human animal behavior. Humans however exhibit open-ended behavioral variation, likely species-unique. Dual motor–environment exploration creates a structural credit assignment problem, where failure to achieve a meaningful outcome may be due either to uncontrollable properties of the task structure or to poor action execution with potential for improvement. For instance, if you have difficulty turning the key on a rusty door, it may be unclear whether this is due to mechanical defect or ineffective technique. Continued exploration toward a behavioral solution, and hence behavioral innovation, is unlikely unless the learner can represent the existence of yet-unknown but prospectively discoverable action–outcome contingencies. Here I argue that humans extract such representations of "latent teleology" through mechanisms for social goal inference. I present a taxonomy of modalities of social goal inference — goal attribution, theory of mind, action imitation, and latent teleological inference — and discuss how the last constitutes a pathway for the cultural evolution of behavioral complexity that does not rely solely on the "brute force" population dynamics of blind variation and selective retention. The proposed mechanism elucidates causal links between putatively species-unique features of human behavior like behavioral open-endedness, action imitation, and aesthetic production.

Anurag Das

PS20

Agency of the Artist in Art

Carl Jung once described the creative process as something dreamlike—an act that unfolds beyond conscious control or reason. This perspective calls into question how much agency an artist really has when making art. In today's world, where artificial intelligence can produce poetry, paintings, and music, and where thinkers like Roland Barthes once argued for the "death of the author," it becomes harder to see the artist as a fully autonomous creator. Instead, it may be more accurate to think of the artist as someone who is deeply involved in the world—what Heidegger called "being-in-the-world". From this viewpoint, art doesn't simply come from within the artist; it emerges through their relationship with the world around them. Heidegger, in "The Origin of the Work of Art", suggests that art reveals truths and opens up new ways of seeing. The artist, then, isn't the sole origin of the work but part of a broader process of revealing. Take Leonardo da Vinci's "Mona Lisa", for example—a painting he never considered finished. Its ongoing revisions suggest that the act of creation isn't a one-way street. The artwork influences the artist as much as the artist shapes the work. Rather than being a matter of complete control, artistic agency becomes something more mutual and evolving—a conversation rather than a declaration.

Joshua Large

PS22

Digital Doubles and the Self Construct: Assessing the Impact of Personalized AI Models on Agency, Identity, and Accountability

How does human self-consciousness evolve in conjunction with cognitive offloading and technology? Strong arguments can be made that the autobiographical self emerged through language (Dennett, 1981) and was altered via the advent of writing (Ong, 1982). Lately, much attention has been given to artificial intelligence and virtual reality engendering a "second self" (Turkle, 1984) or "extended self" (Belk, 2013). This talk will consider the potential impact of another emerging technology, "digital doubles"—personalized, semi-autonomous AI agents that individuals will deploy on their own behalf to undertake online tasks—on the human self construct. Specifically, it will report on preliminary findings of a study designed to understand how this emerging technology may impact self-perception, agency, and accountability. In the study, test subjects will extensively train a Small Language Model (SLM) with personal data to produce approximations of digital doubles. Subsequently, subjects will be told that their doubles are being used to complete an online task and then receive feedback regarding their doubles' performance in positive, negative, or neutral terms. Psychometric evaluations will assess individual self-esteem and agency, while questionnaires and interviews will assess the degree to which subjects feel responsible for their doubles' performance. In addition to discussing the study's findings, the talk will situate the technology of digital doubles within broader philosophical conversations on the relationship between cognitive offloading, technology, and consciousness. It will also touch on the ethical implications ensuing from the emergence of virtual selves.

Earnest Kota Carr **PS25**

Agency as the Evaluation of Structure
Embodied Agency as Constructivism, not (mere) Constructionism

Embodied approaches rightly emphasize structure and physicality: bodily constraints bound—but do not determine—sensorimotor activity. Morphological structure is then seen as enabling emergent behaviour, what we call the constructionist approach. The textbook case is the passive walker, often read as "morphology (structure) produces stable walking (function)."

Look closer, however, and the causal arrow reverses. The roboticist continuously applies a **functional criterion**—stable passive walking—to select, adjust, and repair the walker's morphology. Structure is in fact not the source of function; it **expresses or realizes a** function under ongoing evaluation. The roboticist's selection and interventions proceed while respecting the material's lawful transformations—the hallmark of structure—yet are guided by functional evaluation.

Because the walker's mechanics degrade slowly, this regulation can be easy to miss; living systems make it more obvious. Constructionism (structure) is therefore **necessary but insufficient** for intelligent behaviour: structures that open and constrain perception–action possibilities cannot regulate, preserve, or reorganize themselves. A **constructivist** program—a superordinate schema that evaluates, selects, and reshapes structure—is required.

Crucially, we distinguish **internally defined functionality** (system-intrinsic pragmatics) from **external objectives** (designer tasks, rewards, fitness). Agency resides in the former: agents that carry their own functional criteria **form, select, and preserve** structures, and **reorganize** references and schemas, all while leveraging structural laws.

Our proposal organizes cognition as a triad:

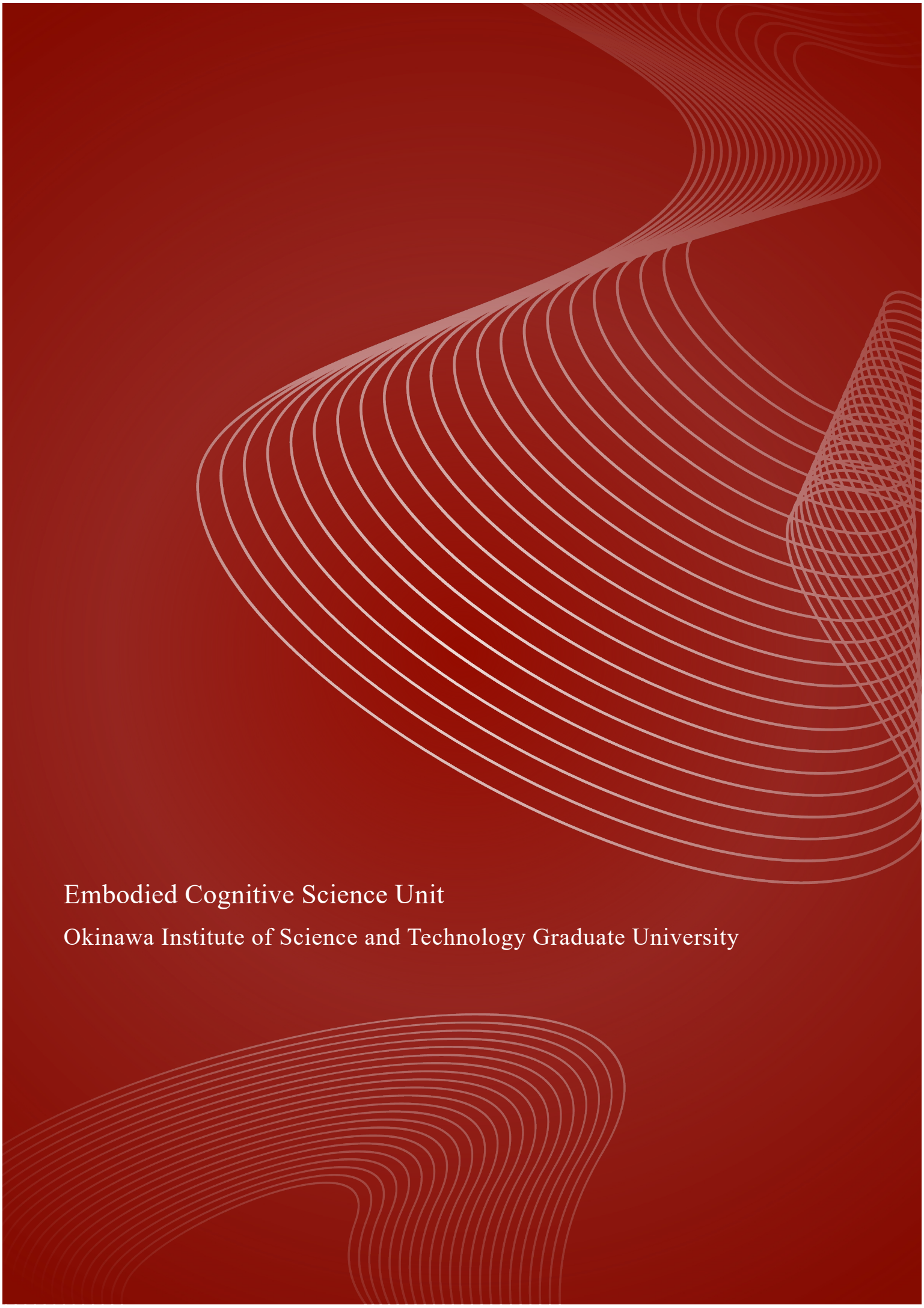
- **Functional Criterion:** essential variables / intrinsic motivation / equilibration / pragmatics
- **Structure:** morphology / schemas / set-points / control variables / syntax
- **Content:** perception–action stream / stimulus–response / semantics

In short: Functional evaluation **selects and regulates** structure; structure **constrains yet underdetermines** content; and content—the **perception–action** stream—**closes the loop via the environment to realize function**. **Agency** then is the continual **evaluation of structure** against an internally held functional criterion.

Kazuma Takada **PS30**

Investigating the Cognitive Bases of the Sense of Agency Emerging from Regularity Detection and Prediction

The Sense of Agency (SoA) is the subjective feeling that one's own movements cause changes in the external environment or a target. When we attempt to control a target smoothly, the SoA changes through a regularity detection process that involves understanding the causal relationship between one's own movements and the target. Conversely, prior research suggests that when an object is already under control, the SoA changes during the prediction process that detect the error between one's own movements and the object. However, it remains unclear whether these changes in the SoA emerge from the same cognitive mechanism. The present study investigated this question by measuring changes in the SoA during control changes in a single-dot control detection task, using a metacognitive approach. Results showed that despite the same magnitude of control change occurring in both the increasing and decreasing control conditions, participants' sensitivity and subjective experience differed. This suggests that the two processes are supported by different mechanisms.


Embodied Cognitive Science Unit
Okinawa Institute of Science and Technology Graduate University