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Book of Abstracts

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SWEDISH COGNITIVE
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LUND
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SweCog25 final program, October 7th-9th, Lund, Sweden		
Tuesday, Oct 7	**Wednesday, Oct 8**	**Thursday, Oct 9**
	Location: Stadshallen, Lund	Location: Palaestra, Lund Campus
08:00	**Registration opens**	**Registration opens**
09:00	**Welcome to SweCog25!**	**Group Photo Session**
09:10 09:55	**Keynote: Mathias Osvath**	**Keynote: Marianne Gullberg**
10:00 10:15 10:30	**Oral presentations, session 1** Chairs: S. Stedtler, S. Mirzaeighazi Dodig-Crnkovic G., *The layered autopoiesis of life-cognition* Ekström A., *How (not) to infer communicative behavior from fossils* Lindelöf M. et al., *Rhythmic parameters across contexts in the percussive behaviour of chimpanzees*	**Oral presentations, session 3** Chairs: L. Damjanovic, G. Askin Kwon J. et al., *The neurophysiological sources of statistical prediction in lexical processing* Hörberg T. et al., *The semantic organization of the odor vocabularies of eight languages* Khan F.A., *Code-switching in the formation of conceptual pacts*
11:00	**Coffee break**	**Coffee break**
11:15 11:30 11:45 12:00	**Registration opens**	**Oral presentations session 1** Athanasopoulos P., *The role of language context in bilingual decision making* Quedenfeld H.B., *Exploring university students' cognitive offloading with GenAI* Petersdotter L., *War-related experiences and cognitive control over thoughts and*	**Oral presentations session 3** de Livio C. et al., *Investigating the role of conceptual vagueness in interactive dynamics* Rosenfrost J., *Movement matters: How movement coordination affects comfortability in HRI*

		emotions predict post-traumatic stress symptoms	Severinsson S., *Book Talk with a Social Reading Robot Challenges Girls' Competence*
12:15		**Lunch and Poster Session**	**Lunch**
13:15		**Keynote: Johanna Rączaszek-Leonardi**	**Keynote: Alessandra Fasulo**
14:00	**Workshop sessions 1 and 2**	**Oral presentations, session 2** Chairs: A. Lind, A. Wallin Szychowska M. et al., *Sensory cognitive maps: How smells and sounds shape spatial memory* Fredborg W. et al., *Working Memory Across the Senses* Rosberg T. et al., *Comparing remote and traditional train driving* Forsgren M., *Group averages obscure counterintuitive predictions: new tests for the decision by sampling core mechanism*	**Oral presentations, session 4** Chairs: V. Fantasia, S. Yang Hällström E., *The effects of morphological training on reading ability for children learning to read in Swedish* Järnefelt P., *Egentligen causes trouble. How L1 speakers and advanced L2 speakers process and interpret Swedish discourse particles* Nikolaev A.R. et al., *Nonlinear effects of multitasking on learning: A gaze-based investigation of relational memory* Holmer E. et al., *Lexical neighbors support the acquisition of novel words with common phonological patterns*
15.20		**Fika and Coffee**	**Fika and Coffee**
15:35	**Workshop sessions 3 and 4**	**Oral presentations session 2** Holm L., *Learning from the enemy – inferred competence trumps deceptiveness in belief updating and curiosity*	**Oral presentations session 4** Kumar R., *AI-driven emotion recognition in student psychology* Lanfranco R., *Minimal exposure durations reveal processing priorities for seeing,*

		Jansson F., *Epistemic trust based on source compatibility gives rise to polarised belief systems* Thellman S., *Does AI have beliefs? A case for similarity-based criteria of belief ascription*	*embodying, and becoming aware of emotions* Tagesson A. et al., *Wanting to help*
16:45		**Speed Mentoring Session**	**Closing Remarks with P. Gärdenfors**
19:00		**Social dinner @ Eatery**	

Oral presentations

Wednesday, Oct 8

Keynote 1: 9.10 am - 10.00 am

Osvath, M.: **Thought for food – or why you can think**

The evolution of whole-body endothermy occurred independently in dinosaurs and mammals and coincided with some of the most significant neurocognitive shifts in life's history. These included a 20-fold rise in neuron numbers and the emergence of new brain structures, supporting similar functions in both lineages. We propose the endothermic brain hypothesis, which holds that elaborations in endotherm brains evolved to boost caloric intake through efficient foraging. The hypothesis rests on the intrinsic link between cognition and organismal self-maintenance. To support the 30-times increase in food intake required by endotherms compared to ectotherms, we suggest that their model-based cognitive repertoires expanded, along with more detailed cognitive maps, as such cognition is known to enable far more efficient foraging than model-free exploration and learning. In this talk I will present some of our work comparing the cognitive skills of crocodilians with those of the neurocognitively least derived birds. These groups phylogenetically bracket the extinct non-avian dinosaurs, in which endothermy and the proposed cognitive adaptations evolved, helping us trace the changes that unfolded over these critical 200 million years.

Session 1: 10.00 am - 11.00 am

Dodig-Crnkovic, G.:

see 3. Short papers

Ekström, A.: **How gibbons articulate to maintain distinctive sound repertoires**

Bridging the conceptual gap between the production of animal calls and human speech requires understanding how nonhuman primates produce vowel-like sounds. In particular, it has been argued that call behaviors with acoustic properties resembling human vowels reflect different production mechanisms. However, there are currently no agreed-upon methods for studying primate articulation. We explore the potential of video content analysis to illuminate the production of primate vowel–like qualities and provide evidence related to primate articulation using an audiovisual corpus of gibbon (Hylobatidae spp.) call behavior sourced from online video platforms. We also speculate on the relationship in call perception between the vowel-like quality of a call, as perceived by human listeners, and the fundamental frequency (f0, perceived as pitch) of the call. This study contributes to available methods for researching articulation by nonhuman primates.

Lindelöf, M. et al.: **Rhythmic parameters across contexts in the percussive behaviour of chimpanzees (Pan troglodytes)**

Humans have a propensity for rhythmicity, notably expressed in the domains of language and music. It is expressed through the abilities to produce and perceive rhythmic signals, as well as entrainment, which is the ability to synchronise movements in relation to external rhythmic stimuli (e.g., dancing). However, it remains unclear as to how, why or when this rhythmic propensity evolved. A comparative approach has become increasingly relevant for answering these questions, where one is investigating the rhythmic capabilities of various non-human species, including non-human primates, pinnipeds, birds and bats. The most basic form of rhythmicity is the production of rhythmic behaviour, such as vocalisations and percussive behaviour, which is present across a multitude of species. Less common is the competence to recognise rhythmic structures in external stimuli, and be able to synchronise according to these rhythmic structures. In this observational study concerning spontaneous percussive behaviours in chimpanzees (Pan troglodytes), 159 bouts were collected from 20 individuals across three sites (Furuvik, Sweden; Kolmården, Sweden; Mona Fundacion, Spain). For these bouts, the frequency rates were established, as well as rhythmic parameters such as variability, integer ratios, and best fitting model of the frequencies. These measurements were analysed in relation to various categorical variables, such as context, sex, and type of behaviour, enabling assessments of how rhythmicity varies depending on these variables. Mapping the rhythmic competencies of the closest living relatives to humans could elucidate the evolutionary trajectory of the rhythmic propensity found in humans. The results of this study contributes to this endeav-

our, by characterising the rhythmic properties of percussive behaviour, and how it potentially varies depending on context. The contextual variables recorded in this study are more specific than previous studies, yielding potential for novel findings. Thus far, preliminary results indicate that the percussive behaviour taken altogether is quasi-isochronous, and that males compared to females are more prone to engage in percussive behaviour (3:1).

Session 1: 11.15 am - 12.15 pm

Athanasopoulos, P.: **The role of language context in bilingual decision making: Evidence from risk/benefit judgments**

Studies on bilingual decision-making have typically found that reasoning in a second language (L2) leads to fewer decision-making biases compared to a first language (L1), and a higher tendency to choose utilitarian options when faced with moral dilemmas in an L2 compared to an L1 (e.g., Corey et al., 2017; Costa et al., 2014a; 2014b). Collectively, these findings of differences between L1 and L2 contexts are referred to as the Foreign Language effect in decision making. However, previous studies on the Foreign Language effect have predominantly used the same, somewhat suboptimal methodology. Firstly, the majority of these studies have used between-subject designs, i.e., compared different participants in the L1 and L2 conditions. This is problematic as it assumes that language background is categorical and homogenous when, in actuality, it is highly heterogenous. In fact, results found in previous studies in other domains of multilingual cognition seem to be affected by how linguistic background is measured (Champoux-Larsson & Dylman, 2020). Designing experimental studies where the participants are compared to themselves in a within-subjects fashion is therefore crucial. Secondly, most studies investigating the Foreign Language effect have used artificial and ecologically unconnected tasks such as hypothetical moral dilemmas (e.g., asking participants to imagine having to kill/sacrifice one person to save the lives of five). While theoretically informative, these situations are detached from the daily lives of most people. In this talk, we will present data from a study investigating risk/benefit judgments in Swedish-English bilinguals. In contrast to previous studies, this experimental setup used a within-subjects design whereby all participants were presented half the materials in their L1 and the other half in their L2. Furthermore, instead of the hypothetical moral dilemmas, the participants in this study were asked to make judgments on the perceived risk and benefit of various current and debated activities and technologies (such as artificial intelligence, vaccines, chemical fertilizers, bicycles etc) for society as a whole. Language context was blocked, and prior to each block, participants were immersed in the specific language mode by

way of reading literary text excerpts in each language, followed by answering content-based questions about said texts. This ensured that the participants engaged in language specific activities both in terms of comprehension and production in order to maximize language induction. Data collection for this study is currently ongoing, and the results from this study will clear up methodological uncertainties in the hitherto reported studies on the effect of language context in multilingual decision making.

Quedenfeld, H. B.: **Exploring University Students' Cognitive Offloading with GenAI**

The widespread use of generative AI (GenAI) in education raises questions about the roles GenAI has in learning and cognition. In Finnish universities, guidelines encourage GenAI use in student independent work while allowing course-specific regulations and stipulating that students explicate GenAI use. While we experience this relatively open encouragement and widespread adoption among students, there is a lack of depth in our understanding of how students use GenAI as a cognitive resource during independent study. The objectives of this research are to understand how first-year university students use GenAI during independent study and how their use develops over an academic year. Specifically, the research will explore patterns of GenAI usage in log data to uncover how GenAI is used as a cognitive resource during learning and knowledge work. Participants will be 100 first-year university students across various disciplines. GenAI usage data will be collected through chat log files of student-GenAI interactions (Microsoft Co-pilot). Data will be collected every three months for three total rounds, covering most of the academic year. The researchers will develop a coding scheme for a deductive qualitative content analysis that will reveal the cognitive functions involved in the activities outsourced to GenAI during students' independent studies. This approach will allow us to apprehend whether students offload cognitive processes to GenAI, including but not limited to identification, differentiation, mental representation, mental transformation, comparison, classification, coding, decoding, memory retrieval, analysis, synthesis, or any kind of reasoning. Analysis may uncover empirical evidence of epistemic actions that deserve epistemic credit, thus, if GenAI functions similarly to a cognitive process, it should also be called a cognitive process. Yet, data analysis and interpretation will also be sensitive to requirements for forming a coupled, cognitive system, as well as the drawbacks of GenAI cognitive extension. Since knowledge-making depends on cognitive processes, analyzing them during student-GenAI interaction is a fruitful approach to understand what roles GenAI plays in the knowledge-making process. This research is timely due to a paradigm shift in educational practice. It will illuminate GenAI use in a highly ecologically valid manner (i.e., GenAI use for coursework), and in a longitudinal perspective. Informed by extended cognition theory, we will explore

how GenAI is situated as an extension of student cognition building on a framework to analyze students' knowledge construction in higher education. Further, via application of the extended mind theory, the research calls for more attention to the offloading of cognitive functions to GenAI in this new educational context. As such, this study may inform the understanding of cognitive offloading and the epistemic roles of GenAI in this age of GenAI in education.

Petersdotter, L.: **War-related experiences and cognitive control over thoughts and emotions predict post-traumatic stress symptoms – A cross-sectional survey study in Ukraine**

The full-scale invasion of Ukraine by Russia in February 2022 profoundly disrupted the lives of Ukrainians, exposing millions to traumatic experiences. War-related trauma significantly increases vulnerability to persistent psychological distress, notably post-traumatic stress symptoms (PTSS), characterised by intrusive memories, avoidance, negative alterations in cognition and mood, and heightened arousal. This study investigates the relationship between subjective war-related experiences, cognitive control over thoughts and emotions, and PTSS severity three years post- invasion. We conducted a large-scale, preregistered cross-sectional survey (N = 377) using validated psychometric instruments. PTSS severity was measured using the PTSD Checklist for DSM-5 (PCL-5), while cognitive control over intrusive thoughts and emotional responses was assessed via the Cognitive Control and Flexibility Questionnaire (CCFQ). Participants also reported on the nature and perceived severity and impact of their war-related experiences. PTSS severity was significantly associated with both the perceived impact of war-related events and the level of cognitive control over thoughts and emotions. Specifically, individuals experiencing greater subjective distress and reduced capacity for cognitive control reported more severe symptoms. However, cognitive control did not moderate the relationship between war impact and PTSS severity, indicating these factors contributed independently. In additional planned analyses, we explore how specific types of war-related experiences— distinguishing between self-determined (e.g., voluntary decisions under wartime conditions) and externally imposed events (e.g., forced displacement, witnessing violence)—may differentially predict PTSS. Furthermore, we examine whether characteristics of trauma reminders (e.g., their frequency and nature) mediate or moderate these relationships. We discuss these findings in the context of neurocognitive mechanisms involved in emotion-memory interactions and coping with trauma, with particular emphasis on the role of cognitive control in managing intrusive memories. Enhancing our understanding of these relationships may help guide future research and inform the development of support strategies for trauma-exposed populations.

Keynote 2: 13.15 pm - 14.00 pm

Rączaszek-Leonardi, J.: **Can we Begin with Context? - Ecological and enactive methods integrate for the study of cognition in interaction**

Our cognition develops in a social world that is structured by the presence and actions of others. The "action-first" cognition is immanently for co-action: it arises by participating in meaningful events with living and feeling beings. In the first months of life a reliable "caregiver permanence" is much more important than any "object permanence"; control over the world and agency develops in engagement, by learning the structures and timings of participation. Ecological psychology seems to have adequate theoretical tools to understand perception and action in engagement. Due to its radical empiricist roots, it is concerned not with individual mind cognizing an independent world, but, rather with relations, the primary of which is the relation between the organism and its environment. Dynamical systems tools used by ecological psychology are able to capture the complexity and multi-scalar nature of engagements, while the recognition of the ubiquitous environmental structures orient researchers towards description of the world in terms of standing patterns of behavior emergent from, and, in turn, constraining co-action. Enactivism can complement this understanding by foregrounding human experience as an omni-present relatum in every perception and action. Our own movement is felt in its "kineasthetic livelines" and the various nature of engagements can be distinguished on the basis of our first- and second-person experience. In my talk I would like to point to the promise of integrating these two approaches for the study of mind and cognition arising in human interaction, and point to the most urgent challenges that face development of the concrete methods to capture experience in engagement.

Session 2: 14.00 pm - 15.20 pm

Szychowska, M. et al.: **Sensory cognitive maps: How smells and sounds shape spatial memory**

As we walk around in an environment, interact with it, and form memories, our brains create a neural representation of that local space. This representation is embodied as sets of cognitive maps located primarily in the hippocampal and entorhinal cortical network. Specific cognitive maps are needed to retrieve spatial memories. Successful restructuring of these maps, called remapping, is crucial for separating memories from each other and accurately retrieving spatial memories. Formation and remapping of cognitive maps have been extensively studied in rodents, but in humans, a few

studies have focused on neural representations of spatial memories based on visual impressions. We investigate whether sensory-specific cognitive maps emerge when we are memorizing locations of objects perceived through smelling and hearing. Participants were first trained in a virtual reality (VR) environment to memorize locations of smells (olfactory condition) and sounds (auditory condition) associated with four specific objects: coffee, lawnmower, bonfire, and popcorn. The VR environment was a grassy meadow surrounded by a wall, and five visual landmarks behind that wall (four different trees and a mountain). After participants learned objects' locations in both conditions to a satisfactory degree, they were placed in an fMRI scanner and, on a trial-by-trial basis, presented with the smells and sounds and asked to place them in the correct location on the same grassy meadow presented on a computer screen, as precisely as possible. We expect to find two distinct cognitive maps in the hippocampal-entorhinal network, one that underlies memory recall of olfactory objects' arrangement on the grassy meadow, and a different one that underlies the recall of auditory objects' arrangement. We also expect to observe no activation of these cognitive maps on trials where participants made an error. Such results would provide evidence for sensory-specific cognitive maps, and underscore the importance of successful remapping in correct memory retrieval. Preliminary behavioral data (n=11) suggest participants are able to successfully carry out the task in the fMRI scanner environment. We also expect to find activity related to cognitive mapping in olfactory primary cortex, but not in the auditory primary cortex, because of the unique structural and functional integration of olfaction with the hippocampal network. This is the first study that will investigate cognitive maps remapping to changes only in the sensory channel through which we perceive the information necessary to create spatial memory. Results from behavioral and fMRI data analyses (n=25) will be presented at SweCog 2025.

Fredborg, W. et al.: **Working Memory Across the Senses: A Multi-Task, Factor Analytic Approach to Visual, Auditory, and Olfactory WM**

Working memory (WM) is often assumed to be modality-general, with individual differences reflecting a shared underlying capacity across sensory modalities. In this within-subject, cross- sectional study, we tested 55 healthy young adults on a battery of WM tasks (e.g., spatial probed recall) using visual, auditory, and olfactory stimuli. We compared performance across similar tasks in each modality to assess the extent to which WM is modality-specific or modality-general. Correlation analyses revealed significant correlations within each sensory modality, particularly among the olfactory tasks. Some visual and auditory tasks also showed significant correlations with each other, suggesting a common WM capacity across sensory modalities. However, olfactory WM performance appeared to form a distinct cluster. To formally test the

dimensionality of WM across modalities, we conducted an exploratory factor analysis. The results revealed a two-factor solution: one factor captured variance in visual and auditory WM tasks, while the second factor loaded exclusively on olfactory WM tasks. These findings support the hypothesis that olfactory WM relies on a partially distinct mechanism from visual and auditory WM, despite some shared variance.

Rosberg, T. et al.:

see 3. Short papers

Forsgren, M.:

see 3. Short papers

Session 2: 15.35 pm - 16.45 pm

Holm, L.: **Learning from the enemy – inferred competence trumps deceptiveness in belief updating and curiosity**

At the SWECOG 2023 meeting, we presented findings suggesting that human participants factor in the information source credibility in both curiosity and subsequent learning, consistent with curiosity acting like a rational learning opportunity signal. But what happens with curiosity and learning when information is judged to be potentially deceptive? Partisanship has been identified as a critical factor behind information and belief polarization, but causal evidence is scarce. In this study, we manipulated group membership experimentally and led participants to believe the outgroup might provide deceptive information. Seventy-four participants read 100 biology trivia questions and rated their curiosity for answers implied to come from the in – or out-group, respectively. Despite rating the in-group as more trustworthy than the outgroup, belief updating indicated in a later memory test was as high regardless of implied source. As the learning conditions were comparable to our earlier information source credibility study, we can interpret our results as the rational outcome of a learning decision that assigns similar competence to either group and judge deception to be relatively infrequent. Thus, humans seem to update beliefs also when listening to seemingly deceptive enemies, provided the enemy is judged to be competent.

Jansson, F: **Epistemic trust based on source compatibility gives rise to polarised belief systems**

Polarisation is a pervasive societal phenomenon characterised by the formation of distinct groups holding possibly coherent but mutually opposing belief systems, often across multiple unrelated issues. Understanding the cognitive mechanisms driving such multi-dimensional polarisation is critical for cognitive science, given its implications for belief formation, epistemic trust, and cultural transmission. Here, we introduce and investigate a minimal cognitive modelling framework designed to explore how epistemic filtering processes at the individual level lead to emergent cultural polarisation and associative belief structures. In our model, beliefs and their interrelations are represented as weighted networks. Individuals acquire beliefs through social transmission, employing one of two filtering strategies: content filtering, where beliefs are evaluated based on internal coherence with existing beliefs, and source filtering, where beliefs are accepted based on perceived credibility derived from the consistency between the belief systems of the source and the recipient. These two heuristics capture fundamental aspects of epistemic vigilance, namely coherence-based belief evaluation and source credibility assessment. Mathematical analysis and agent-based simulations reveal that source filtering rapidly generates highly polarised groups, with unrelated beliefs spontaneously becoming tightly correlated. Two groups tend to dominate, and those groups have opposite beliefs for each issue. This cognitive mechanism thus produces ""belief packages"", where the acceptance of one belief strongly predicts the acceptance of other, initially unrelated beliefs. For example, belief in anthropogenic climate change can become strongly predictive of attitudes towards vaccine safety, even if there is no logical or factual necessity for such an association. Content filtering can also produce polarised groups, but beliefs remain aligned with existing logical or factual structures. Further, we examine the influence of external signals representing real-world empirical biases, such as differential innovation and loss rates for beliefs aligned or misaligned with empirical evidence. Our results indicate that polarisation and belief associations can be maintained even with such external signals, allowing the empirical advantage of a single belief to propagate associated beliefs. It is also possible for asymmetric associations to emerge, where, say, a belief in anthropogenic climate change is not associated to any specific belief, but a non-belief is associated to another fringe belief. Unlike previous models relying on inherent irrationality or explicit negative updating mechanisms, our framework demonstrates that simple cognitive strategies for managing epistemic trust and coherence naturally lead to multi-dimensional polarisation. These findings provide insight into cognitive biases in social belief transmission, suggesting that polarisation can emerge even under minimal cognitive assumptions without relying on innate cognitive predispositions or complex motivational structures. The two filtering mechanisms have algorithmic counterparts. Recommender systems used to include more content-based

filtering. However, collaborative filtering took the lead on many platforms a couple of decades ago because of its effectiveness. Collaborative filtering selectively curates content based on semantic consistency between the user and other users, that is, the potential sources, and thus resembles our operationalisation of source filtering. Our results suggest that the success of collaborative filtering has societal side effects.

Thellman, S.: **Does AI have beliefs? A case for similarity-based criteria of belief ascription**

The question of whether AI can have beliefs is both philosophically rich and practically pressing. While some theorists argue that AI systems—such as robots and language models—merely simulate cognition without genuine understanding, belief ascription remains a widely used interpretive tool. Both laypeople and researchers routinely rely on it to make sense of AI behavior (Salles et al., 2020; Thellman et al., 2022), though this may risk misguided anthropomorphism (McDermott, 1976). This talk surveys the philosophical landscape surrounding AI beliefs, tracing positions from realism— where attributing beliefs is justified if it enhances prediction or reflects appropriate functional organization (Dennett, 1987; Fodor, 1975; Putnam, 1967)—to strong skepticism, which holds that, without conscious experience (Dreyfus, 1986), intrinsic intentionality (Searle, 1980), or linguistic competence in understanding objective truth, AI cannot have beliefs. The issue parallels debates about animal minds, where the question "Do animals have beliefs?" raises a dilemma. On the one hand, animal behavior is often successfully predicted by attributing beliefs, which seems to justify belief ascription. On the other hand, animals' conceptual frameworks differ markedly from ours, making it difficult to say exactly what they believe (Stich, 1979). Consider the statement "Fido believes there's a bone in the yard"—how can we justify that claim, given Fido's limited grasp of concepts like "bone" and "yard"? A similar dilemma arises with AI: while AI may not possess beliefs in the same way humans do, they exhibit internal states that serve belief-like functions—e.g., causing an autonomous vehicle to yield to a pedestrian or prompting a chatbot to answer intelligibly. Yet, as with animals, these states are embedded in unfamiliar doxastic networks, and we often cannot specify what, if anything, the AI actually believes. To resolve this dilemma, I draw on Stephen Stich's (1983) proposal that belief ascriptions should be understood not as identity claims (which require doxastic equivalence) but as similarity claims grounded in functional and contextual resemblance. When we say "Fido believes there's a bone in the yard," we implicitly acknowledge the conceptual differences (in doxastic content) between canine and human understanding, while also recognizing the functional similarities (in behavior and causal roles). This raises an empirical question: do people recognize similar conceptual differences between human and machine cognition? Can we—whether lay or expert—reach a compara-

ble level of interpretive awareness in our dealings with AI as with Fido? If so, then doxastic differences between humans and AI need not preclude belief attribution. In conclusion, I argue that current AI does not possess beliefs in the rich sense attributed to adult humans—those grounded in consciousness, language, and lived experience. Nevertheless, many AI systems exhibit belief-like states that are functionally similar to human beliefs in specific domains. Framing belief ascription as similarity claims rather than identity claims allows us to navigate between naive anthropomorphism and premature eliminativism, preserving the practical utility of belief talk while supporting a more nuanced account of cognitive agency in artificial systems.

Thursday, Oct 9

Keynote 3: 9.10 am - 10.00 am

Gullberg, M.: **Do gestures compensate for language difficulties?**

It is now widely recognised that language use is a multimodal phenomenon that involves the systematic and non-trivial integration of speech/sign (of sing language) and gestures both in language production and comprehension. However, a frequent parallel assumption is that gestures are essentially compensatory devices and help addressees understand unclear messages and speakers convey information they have difficulties expressing. Somewhat surprisingly, these assumptions are also found in theories about the relationship between speech and gesture. I will challenge this compensatory view of the speech-gesture link drawing on both comprehension and production studies. In comprehension, I will show that individual experience and contextual factors mitigate the degree to which gestures improve understanding. For production, I will demonstrate that gestures are coordinated with fluent, not disfluent speech; that speech and gestures express similar, not different information; and that when gestures are recruited as problem-solvers, the problems are often not lexical. Based on these findings, I argue for a more nuanced view of the speech-gesture relationship in both comprehension and production.

Session 3: 10.00 am - 11.00 am

Kwon, J. et al.: **The neurophysiological sources of statistical prediction in lexical processing**

Spoken language processing relies heavily on rapid, probability-based prediction. Over a lifetime of language use, individuals form lexical probability distributions shaped by factors such as word frequency, phoneme frequency, and transitional probability of word or phoneme sequences. In Swedish, a pitch-accent language where the stressed syllable serves as the tone-bearing unit, both the probability of initial phonemes and tone accents have been shown to contribute to predicting word endings. This process is reflected in the Pre-activation Negativity (PrAN), an event-related potential (ERP) component associated with lexical prediction (Hjortdal et al., 2024; Roll et al., 2015; Schremm et al., 2018; Söderström et al., 2016, 2017). Neuroimaging studies using fMRI suggest that Swedish tone accents play a dual role in word processing. For familiar words, tone accents are integrated into lexical identity representations, with activation observed in the left Planum Temporale. In contrast, when processing nonce words lacking stored representations, tone accents function as morphosyntactic cues, eliciting activation in the Inferior Frontal Gyrus supporting a rule-based predictive mechanism (Schremm et al., 2018). However, the functional significance of tone accents in Swedish remains unclear when considering both temporal dynamics and spatial localization. In the current study, we employ a novel electrophysiological frequency-tagging approach to investigate the combined temporal and spatial neural signatures of tone-based prediction in the context of word ending anticipation. Data collection is currently underway, and we expect to identify distinct neurophysiological markers that capture both tonal and statistical prediction processes during spoken word recognition.

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Hörberg, T. et al.: **The semantic organization of the odor vocabularies of eight languages**

Describing smells is often difficult (Olofsson & Gottfried 2015), yet some studies indi-
cate that culturally distinct languages vary widely in their capacity to express odor ex-
periences (Majid & Burenhult, 2014). Do these differences coexist with cross-cultural
similarities among odor vocabularies on a deeper semantic level, differentiating, for ex-
ample, primarily between pleasant and unpleasant odors (Hörberg et al. 2022; Wnuk
et al. 2020)? No comprehensive cross-linguistic comparison of such odor-semantic or-
ganization exists to date. Here, we present the results of an ongoing study of the odor
vocabularies of eight languages (Swedish, English, Polish, Russian, Spanish, Turkish,
Hindi and Cantonese) from five different language families. In an on-line survey,
over 50 speakers of each language (total N = 504) provided odor descriptors of a total
of 121 imagined odors. We present analyzes of the resulting vocabularies that investi-
gate similarities and differences between them in terms of codability (e.g., Majid et al.
2018) and descriptive strategy (i.e., to what extent speakers use abstract, source-based
or evaluate odor descriptors; see e.g. Poulton 2020; Hörberg et al. 2022). We also
investigate the primary dimensions of the semantic organization of the vocabularies.
We hypothesize that although odor vocabularies differ in terms of how well they en-
code odor experiences (i.e. they differ in codability, cf. Majid et al. 2018) and with
respect to their preferred descriptive strategies (e.g., some languages use more abstract
odor descriptors than others, cf. Poulton 2020; Hörberg et al. 2022), they are highly
similar in their underlying semantic organization: In line wirh previous work (e.g.,
Wnuk et al. 2020; Hörberg et al. 2022), odor vocabularies of all languages primarily
differ between odors in terms of pleasantness and secondarily in terms of edibility
(Hörberg et al. 2022) or ””dangerousness”” (Wnuk & Majid 2014).

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Khan, F. A.: **Switching Contexts: Pragmatic Effects of Code-switching in Spanish-English Dialogue**

Using two or more languages to navigate interaction is a resource available to multilingual speakers. Although switching between languages is cognitively demanding (Green & Abutalebi, 2013; Green, 2018), multilingual speakers interact seamlessly while code-switching. Previous studies on the pragmatics of code-switching have observed that speakers systematically switch languages depending on surprisal induced by the context (Myslin & Levy, 2015). This work investigates the idea that code-switching may be used as a mechanism for maintaining intersubjective coordination on the axis of information structure. In particular, we examine whether code-switching indicates a dip in informativeness i.e., predictability of the dialogue-level context on the upcoming contribution. We statistically test the following hypotheses using linear mixed effects models:

H1: The informativeness of dialogue context tends to be lower following code-switch points compared to non-code-switch points.

H2: Among code-switches, the informativeness of dialogue context is lower when the switch coincides with incongruous functions (such as topic change) versus congruous functions (such as borrowing).

To analyse context-informativeness of code-switching, we used the Bangor Miami corpus (Deuchar, 2010), which is a set of 56 spontaneous conversations between Spanish-English bilinguals living in Miami (USA). We define context informativeness (CI) as the difference between turn-level surprisal and dialogue-level surprisal. CI and surprisal metrics were computed with Llama 3.2, a multi-lingual language model. Annotations of code-switching functions for the Miami-Bangor corpus obtained from a list of 11 code-switching functions defined by Belani & Flanigan (2023). We selected topic change and borrowing as examples of incongruous and congruous CS functions due to their relatively high frequency and inter-annotator agreement. Linear mixed-effects regression models were built using R Studio (R Studio Team, 2020) to test the hypotheses H1 and H2.

Results show that both context-informativeness and turn-level information value have a statistically significant effect on code-switching. In line with hypothesis H1, the predicted probability of code- switching increased when context-informativeness decreased. Furthermore, turn-level surprisal increases when the probability of code-switching increases. This increase in surprisal is offset by the context-level information at code-switching points in dialogue. These results suggest that multilingual speakers code-switch when it might be misleading to rely heavily on dialogue context i.e., when the context is incongruent with their utterance. As a result of code-switching, the turn level information value increases. This is consistent with findings from previous studies on code-switching surprisal (Calvillo et al., 2020). The models testing hypothesis H2 did not indicate a significant relationship between code-switching functions and CI, although likelihood of borrowing increases when turn-level surprisal decreases. Even though the results do not confirm hypothesis H2, they suggest that any relationship between borrowing and CI may depend on the turn-level surprisal of the borrowed term. Overall, our results show that code-switching is more common when the context is least informative. As a consequence, the information value of speaker turns are high when code-switching occurs. These outcomes reflect the communicative efficiency of code-switching as observed by previous studies on multilingual speech (Myslin & Levy, 2015; Belani & Flanigan, 2023).

Session 3: 11.15 am - 12.15 pm

de Livio, C. et al.:

see 3. Short papers

Rosenfrost, J. et al.: **Movement matters: How movement coordination affects comfortabilty in human-robot interaction**

Interpersonal synchrony is a dynamic coordination of bodily movements that changes over time, continually supporting further social interaction and social engagement in human-human interaction [1-2]. This study investigated if this is true for human-robot interaction. We aimed to highlight the role played by bodily coordination in the interaction between humans and a humanoid robot, and what influence this has on the affective and intersubjective perception of the robot, i.e. the perception of comfortably in progress. To investigate this, 34 participants (15F, M age 28.5, SD 9.7) engaged in a fully embodied face-to-face mirroring task with either a human or a social robot. Kinematic data was quantified as interpersonal synchrony by gathering speed, tempo, and direction of movements between partners in a motion capture lab. Each participant wore 14 light sensors, 7 for each side of the body. The motion capture lab allows to capture the light sensors movements as 3D coordination via 16 infrared cameras. The localization error of measurements is between 0.5- 0.8mm, this allowed a very high accuracy in gathering kinematic data. To access affective experience qualitative measures were conducted via pre- and post-interaction questionnaires; NARS [3], and Comfortability self-report [4]. The kinematic and qualitative data were combined to investigate our research aim. Our findings show that human-human interaction established synchrony rapidly and maintained this throughout the interaction, while human-robot synchrony developed gradually but significantly over time. Linear models of both post-interaction and summed comfortability scores showed that greater synchrony with the robot was correlated with greater experienced comfortability in the interaction. This suggests that synchrony plays an important role in how humans experience and interact with social robots. Similar to previous research on human-human interaction [5], this study indicates that building interpersonal synchrony is a situated, dynamic process that can take longer to establish with a social robot than with a human. By exploring how synchrony unfolds over time in human-robot interaction, this research offers further insight into embodiment and what embodiment affords in social interaction with a robot.

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Severinsson, S.: **Book Talk with a Social Reading Robot Challenges Girls' Competence**

This presentation derives from an interdisciplinary research project, about designing a social reading robot that has been tested in an authentic school environment. The project concerns the design process of a social reading robot that, in the end, could conduct book-talks with students to increase motivation to read. The empirical material consists of 30 video-recorded observations of fourth grade students' having book-talks with a "reading robot", Furhat Robotics. In a human-robot interaction, purpose is constructed in a situated coordination and negotiation of meaning (Fantasia, Brinck& Balkenius, 2022). The analysis focus engagement and participatory sense-making processes where motivation is a drive to engagement produced as a joint action in a knowing-in-connection. Research on reading and motivation (Chapman et al. 2000) shows that it is intrinsic motivation that is most important for reading competence and not extrinsic, external motivation such as rewards. In Self Determination Theory intrinsic motivation depends on autonomy, competence and relatedness (Ryan & Deci, 2020). In reading research, the concept of self-efficacy (Bandura 1997), is often used which is defined as the confidence a person has in their own ability to solve a certain task in a certain context. Research also shows that working to strengthen self-efficacy in relation to reading in the early years of school can help to improve reading skills in later years. Reading research has shown that efforts to increase self-efficacy is particularly important for students who struggle to read, as otherwise their desire to read decreases and negatively affects their reading development (Chapman et al. 2000; Tabassam & Grainger 2002). Motivation to participate in a book-talks and want to discuss books with a robot and in the long run increase the motivation to read, can consequently be strengthened if participants get a sense of autonomy, competence and relatedness. In an analysis of the 30 conversations (half boys and half girls) based on what in the interaction with a social reading robot could work as a motivator, it was noted that girls to a greater extent than boys end up in interactions where girls' way of communicating is interpreted as insecurity and incompetence by the robot. This should not be interpreted as the girls being more ig-

norant or insecure, rather the other way around, but the girls are made more ignorant in the interaction with the robot. The empirical examples show how sense-making processes, where motivation is at stake, are constructed in joint actions. The presentation gives examples of what characterises this interaction and what it could this means for girls´ sense of competence.

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Keynote 4: 13.15 pm - 14.00 pm

*Fasulo, A.:*There's nothing in the head but brains: A situated perspective on human functioning

The talk will unpack the ethnomethodological challenge included in the title, and argue for a study of human activities that does not separate the inner from the outer world, but focuses instead on levels of organisation that are publicly observable where and when they unfold. This approach considers language, bodies and the social and material elements that constitute an activity field as co-constitutive of cognition and inseparable from it.

Using naturalistic observations in different settings, such as psychotherapy, workplaces and family homes, and involving people with and without communication differences, I will demonstrate how cognition is something that social actors "do" for each other and with each other, and discuss the implications of this view for theoretical development and applied work.

Session 4: 14.00 pm - 15.20 pm

Hällström, E.: **The effects of morphological training on reading ability for children learning to read in Swedish – An intervention study for children with decoding difficulties and typical readers**

Background: Morphological knowledge refers to the knowledge that words consist of smaller parts (affixes), which can be combined and taken apart to change the word's grammar and/or meaning, e.g. mis-take, un-help-ful or farm-er. Previous research in other languages (mainly English) has found that morphological training can be beneficial for developing decoding ability and reading comprehension, but this has not been examined in Swedish. The effect is noted to be larger for children with reading difficulties (RD) than for peers with typical reading development (TRD), and can be especially effectful for primary grade students. This study will investigate how an intervention to improve morphological knowledge impacts decoding and reading comprehension among second-grade children (8-9 years old), both for those with TRD and those with RD, compared to an active control condition. The research questions focus on whether different subgroups (TRD and RD) benefit differently from the morphological training and how this training affects their decoding ability and reading comprehension.

Method: This study was designed as a randomized controlled trial (RCT) involving n = 254 second grade-children from eleven different schools situated in the Northern part of Sweden. All children were assessed at three time points: ≤3 weeks before the intervention, ≤3 weeks after the intervention, and six months post-intervention. Assessment included reading comprehension, decoding, phonological skills, verbal reasoning, working memory, general intelligence an morphological knowledge. After initial baseline testing, children were assigned to either the group of children with TRD or the group of children with RD. Children were thereafter randomly assigned to either the intervention group (n = 113) or the active control condition (n = 141). The intervention focused on derivational affixes and was delivered through the app Kaptein Morf II (Torkildsen et al., 2022) which was adapted to Swedish within this project. The training was designed to target implicit statistical learning of affixes. Children worked with one targeted affix per day in multiple combinations, paired with >24 unique root words, presented in 12 different task types. Every fifth day, the children had a review session including the four previous targeted affixes. Exercise length per day was about 15 minutes for 8 weeks (a total of 40 exercises). The control groups worked with reading fiction digitally for the same amount of time through an app.

Results: The data collection for this study is just finished, and data management is

ongoing. We will present preliminary results regarding the possible effects of morphological training on decoding and reading comprehension from the intervention, presented both for the children with TRD and the children with RD.

Järnefelt, P.: **Egentligen causes trouble: How L1 speakers and advanced L2 speakers process and interpret Swedish discourse particles – Evidence from Visual World eye tracking experiments**

A major component of understanding each other is the ability to read between the lines and decode speaker meaning from context. How is it that, despite being severely under-specific, most utterances are properly understood? A prolific tool for shortening and enriching sentences with information is to use discourse particles (DPs). They are a class of highly frequent, uninflected and unstressed words that are used to express speaker attitudes. DPs are reflexive; not only do they anchor the sentence in context, but they can also alter the context (Aijmer & Simon-Vandenbergen, 2004). They operate on the conceptual (content) words in sentences and can, if felicitously used, convey several sentences worth of information that the speaker would otherwise have to spell out. This quality is referred to as procedural (Loureda et al., 2022). They have been called the "grammar of conversation" (Aijmer, 2011) and are communicatively obligatory (Diewald, 2010). For all their might and glory, there is one caveat; when misunderstood, or improperly used, they can cause communication break-down and misunderstandings. Second language learners find them notoriously difficult to acquire (Hogeweg et al., 2016) and fully immersed and highly integrated advanced L2 speakers will often use them too much or not enough (Fant, 2016). In two eye tracking experiments, using a novel version of the Visual World paradigm, we investigate how L1 and L2 speakers of Swedish interpret and process the DPs ju, nog, egentligen and faktiskt. With a total of 170 participants (85 participants per experiment, equally divided between L1 (N=85) and advanced L2 (N=85) speakers) this study constitutes, to the best of the authors' knowledge, the largest empirical investigation into the L1 and L2 use of Swedish DPs. For ju and nog, no differences were found among L1 and L2 speakers. This is not taken to mean that the L2 command of ju and nog is nativelike; it is more likely to do with the unstressed, semantically bleached nature of ju and nog and the fact that they do not alter the propositional content for the L1 speakers. If L2 speakers simply ignore these DPs, their results will resemble that of the L1 speakers, and such a conclusion is more in line with previous literature. Egentligen, however, constitutes a problem for L1 speakers. It causes processing costs as relayed by gaze patterns and pupillometry, and delays in reaction times as well as a large variability in behavioral responses. These results are discussed in terms of immediate integration, under-specificity and Grice's maxim of quantity (1975). L2 speakers do not exhibit the same difficulties in online measures, nor do they interpret the DP like the L1 speakers

do, although some participants show a more nativelike tendency. Implications for the field of L1 pragmatics will be briefly touched upon, and contributions to the field of L2 pragmatics, as well as the methodological advances the design offers, will also be discussed during the presentation.

Nikolaev, A. R. et al.: **Nonlinear effects of multitasking on learning: A gaze-based investigation of relational memory**

Multitasking imposes competing demands on attention and has been shown to impair cognitive performance, particularly when individuals must encode and integrate multiple pieces of information. This study investigated how multitasking affects learning by examining its influence on relational memory encoding and associated eye movement behaviour over time. Forty participants encoded visually presented "events" composed of six elements drawn from distinct semantic categories, while their eye movements were recorded. The elements were simultaneously displayed in fixed, spatially distinct locations on the screen, with three designated goal-relevant for the later memory test and three as goal-irrelevant. Encoding occurred in two types of blocks: multitasking blocks, which alternated between dual-task trials (event encoding combined with a concurrent dot-counting task) and single-task trials (event encoding only), and non-multitasking blocks, which consisted solely of single-task trials. Critically, dual-task trials within multitasking blocks were unpredictable, requiring participants to remain prepared for the possible onset of the secondary task. Relational memory was operationalised as the ability to recall which goal-relevant elements were presented as part of the same event and was assessed using forced-choice associative memory tests. To capture the complex, nonlinear dynamics of memory performance over time, we applied generalised additive models (GAMs) to trial-level data. The analysis revealed significant nonlinear learning trajectories in both block types: in multitasking blocks, memory performance peaked mid-experiment and then declined, whereas in non-multitasking blocks, performance continued to improve, albeit with fluctuations. To examine how multitasking shaped gaze-memory interactions, we analysed a set of gaze measures reflecting both within-element and between-element visual behaviour across three regions of interest: goal-relevant elements, goal-irrelevant elements, and the centre of the screen, where the secondary task could appear. Within-element measures included the number of fixations and total dwell time in each region, indexing the depth of visual processing. Between-element measures included the number of transitions and revisits across these regions, capturing how attention was distributed across event elements during encoding. Comparing models incorporating these measures from single-task trials across the two block types revealed a striking difference: multitasking led to greater variability in the relationship between gaze behaviour and memory, indicating more heterogeneous and less structured visual exploration. This

disruption suggests that multitasking destabilises the systematic organisation of attention that typically supports effective encoding. Overall, our findings demonstrate that multitasking alters the dynamics of gaze-memory interactions by disrupting how eye movements support relational memory encoding, ultimately impairing learning under divided attention.

Holmer, E. et al.:

see 3. Short papers

Session 4: 15.35 pm - 16.45 pm

Kumar, R.: **AI-Driven Emotion Recognition in Student Psychology: A Computer Vision-Based Study on Learning Engagement and Mental Health**

Understanding students' emotional responses during lectures is crucial for optimizing learning outcomes and identifying potential psychological stressors. This study investigates the application of AI-powered emotion recognition to analyze student engagement, cognitive load, and mental health indicators in an academic setting. Using a computer vision-based AI system, we monitored and analyzed emotional expressions of 68 student volunteers across 20 lecture sessions (each lasting 1 hour 30 minutes). Participants were categorized based on academic performance:
• 25 students with a CGPA of 8.5 and above
• 21 students with a CGPA between 6.5 and 8.5
• 22 students with a CGPA below 6.5
Facial emotion recognition (FER) was performed using TensorFlow's pre-trained FER dataset (Goodfellow et al., 2016), processing video footage captured through classroom cameras. The AI model identified and classified six primary emotional states: happiness, fear, sadness, anger, surprise, and neutral expressions (Li & Deng, 2020). The study aimed to evaluate the correlation between emotional patterns and academic performance. Fear was the most frequently detected emotion ($\approx$57%), particularly among students with lower CGPAs, indicating a strong link between anxiety and academic performance. Students in the <6.5 CGPA group exhibited fear expressions in $\approx$67% of cases, suggesting possible learning stress or cognitive overload. Sadness was the least observed emotion ($\approx$6%), reinforcing the hypothesis that academic stress primarily manifests as anxiety rather than depressive states during lectures. Happiness was detected in 18% of cases, mostly among high-CGPA students ($\approx$27%), correlating with confidence, engagement, and comprehension levels. Neutral expressions

accounted for 42% of the dataset, particularly among students with CGPA > 8.5, indicating focused attention and cognitive processing. Low-CGPA students exhibited disengagement-related expressions more frequently, including distraction and frustration, with a notable decline in attention spans as lectures progressed. These findings suggest that emotion recognition technologies (computer vision) (Baltrusaitis et al., 2018) can provide real-time insights into students' cognitive and emotional states, enabling institutions to design personalized mental health interventions. Fear-driven responses, particularly among lower-performing students, indicate a need for stress-mitigation strategies, such as adaptive learning techniques and psychological support. This study demonstrates the potential of AI-driven cognitive emotion recognition in understanding student psychology, engagement, and mental health diagnostics. The insights gained highlight the need for data-driven educational policies that incorporate real-time emotional feedback to enhance learning environments. Future research will focus on refining model accuracy, integrating multi-modal data (e.g., voice tone analysis and physiological signals like heart rate variability), and addressing ethical concerns regarding privacy, bias, and AI-driven psychological interventions in educational settings. By leveraging AI-powered emotion recognition, institutions can identify at-risk students early, optimize learning methodologies, and create emotionally supportive academic environments that foster both psychological well-being and academic success.

Lanfranco, R.: **Minimal exposure durations reveal processing priorities for seeing, embodying, and becoming aware of emotions**

Human faces convey multiple types of information, including structural configuration, emotional expression, and social intention. Although the visual system is highly specialised for detecting and recognising faces, the sequence in which it extracts these meaningful attributes—and the extent to which this occurs without conscious awareness—remains poorly understood. In this study, we used a novel LCD tachistoscope capable of presenting images for as little as 0.002 ms to identify the minimal exposure durations required for the visual system to extract information about facial configuration and emotional expression. We combined psychophysical measures, electroencephalography (EEG), and electromyography (EMG) to assess both emotional processing and conscious awareness. Across a series of experiments, we assessed perceptual emotion processing using psychophysical and EEG markers (i.e., indicators that differentiate emotional from non-emotional stimuli), alongside embodied emotion processing via EMG markers of facial mimicry—the automatic tendency to mimic others' facial expressions. We found that the minimum exposure durations required to elicit perceptual and EEG markers of emotion were equal to or longer than those required for conscious awareness (4 ms), suggesting that emotional processing at

these levels does not occur unconsciously. In contrast, EMG markers of fear-related mimicry emerged at shorter exposures—before psychophysical or EEG markers of awareness—indicating that facial mimicry of fear can occur without conscious awareness. For happiness-related expressions, however, EMG responses emerged only at exposure durations equal to or longer than those associated with conscious awareness, suggesting that the embodiment of threatening and non-threatening emotions differs in its dependence on awareness. These findings illuminate the visual system's priorities in processing facial information. While challenging the idea that emotional expressions are processed unconsciously, our results also reveal that facial mimicry—central to empathy and social communication—can operate independently of awareness for fearful expressions, but not for happy ones. This highlights the nuanced role of consciousness in emotional processing.

Tagesson, A. et al.: **Wanting to help**

Decades of research have connected empathy and compassion to helping behavior (Batson, 2011). Lately, empathy – sharing others' emotional states - has been criticized for generating short-sighted and biased helping behavior misaligned with normative standards. Conversely, compassion – motivation to help others in need - is continually praised as a robust motivator of helping behavior suitable for situations where help recipients are abstract (Bloom, 2016; Decety & Yoder, 2016; Jordan, Amir, Bloom, 2016). We address this debate by testing differences between empathy and compassion for direct and concrete help, e.g., donating money to an individual, and indirect and more abstract help, e.g., donating money via an organization. We operationalize "direct helping" as help that directly benefits the target of empathy and compassion, and "indirect helping" as help benefiting people in similar situations, but not necessarily the target itself. In Study 1, participants learned about a person suffering from poverty. Participants were asked to distribute a bonus payment between three alternatives: donations directly to the person; indirect donations to a helping organization that helps people in similar situations as the person; keep their bonus for themselves. All donation decisions involved real money. After making their choices, participants rated the empathy and compassion they felt with the person in need. Results show that participants who felt the most compassion tend to donate directly to the individual, opposing results from previous studies that suggest that compassion will motivate people to engage in abstract helping behavior. Interestingly, participants who felt the most empathy were less likely to donate, suggesting a reversed effect of empathy on motivation to help. Empathy is often understood to be a motivated process affected by underlying motives and contextual factors (Zaki, 2014; Cameron et al, 2022). Following up on Study 1, we will account for the potentially moderating effects of contexts on empathy and compassion. We will use a within-participant de-

sign, where each participant completes two randomly presented trials. The first trial includes an alternative to donate directly to the individual and indirectly to the organization after learning about the person in need, and the second trial includes two alternatives for indirect donations to organizations after reading about the person. This will test how empathy and compassion relate to direct and indirect helping behavior. Additionally, some of the participants will learn about their donation options before reading about the person in need. This design lets us examine if the helping context modulates participants' empathy and compassion. In our planned Study 3, we will use perspective-taking interventions (Batson, Early, Salvarini, 1997) and empathic efficacy interventions (Cameron et al, 2019) to target participants' empathy and compassion. This helps us better understand how different levels of empathy and compassion, manipulated via interventions, relate to direct and indirect help, and test the assumed causal role of empathy and compassion in motivating helping behavior. The overarching contribution of this study is to further study how empathy and compassion can be understood as motivators of different helping behaviors. We account for relevant contextual effects on empathic tendencies (Depow, Francis, Inzlicht, 2021) by letting participants learn about the constraints on their helping behavior both before and after empathically engaging with the person in need.

Posters

Arriagada-Mödinger, F.: **Do emotional words break through visual suppression more quickly?**

Emotionally valenced stimuli, such as faces or images, have been shown to gain prioritized access to consciousness over neutral stimuli, even without conscious awareness. This facilitation effect is attributed to a fast subcortical pathway enabling rapid processing of evolutionary relevant stimuli (Fang et al., 2016; Méndez-Bértolo et al., 2016). The Motivated Attention Account (Lang et al., 1990) proposes that emotional stimuli automatically capture attention due to motivational significance, enhancing perceptual and cognitive processing, even for language. From the Global Neuronal Workspace Theory (GNWT) perspective, conscious access depends on the strength of sensory signals and focused attention, both of which may be modulated by emotional valence. However, unlike faces or images, written words rely on high-level symbolic and semantic processing, raising the question of whether emotional linguistic stimuli can benefit from similar prioritization in access to consciousness. Moreover, cross-linguistic evidence suggests that the ability to extract emotional meaning under suppression may vary with language orthography. For example, studies using logographic scripts such as Chinese have not found evidence of unconscious emotional word processing under b-CFS (Yang Yeh, 2011; Cheng et al., 2019). This study employed the breaking Continuous Flash Suppression (b-CFS) paradigm to examine whether emotionally valenced words (positive or negative) break through suppression more rapidly than neutral words. Participants viewed dynamic Mondrian patterns in one eye, while a target Spanish word, varying in valence (positive, negative, neutral) and form (scrambled, intact, inverted, upright), was gradually introduced to the other eye. Scrambled and inverted forms ensured that differences in suppression times were not driven by high-level semantic processing. In Experiment 1A, words were presented either in intact or scrambled forms; in Experiment 1B, they appeared upright or inverted, resulting in a 3 (valence) × 2 (word form) factorial design. Participants indicated as quickly as possible when they detected any part of the word and reported

its spatial location (above or below the fixation cross) by pressing the corresponding key on a keyboard. Building on prior research, we hypothesized that emotionally valenced words will show shorter breakthrough suppression times than neutral words, thereby indicating a facilitation effect of emotional content on conscious access. If confirmed, such findings would suggest that emotional valence modulates access to consciousness under b-CFS. Although previous b-CFS studies using Chinese characters did not find differences between emotional and neutral words, we hypothesize that they may emerge with alphabetic stimuli. By testing this with Spanish words, the present study contributes to the broader discussion on whether language structure modulates unconscious emotional processing. If a facilitation effect is observed, it may suggest that emotional meaning is more accessible in alphabetic languages during visual suppression. Conversely, the absence of such an effect would support the view that facilitation in behavioural paradigms arises from later processing stages, such as attention or memory, rather than early unconscious semantic access.

Askin, G.: **Understanding how children conceptualize a robot through imagination and enactment**

This study investigates how children attribute gender (as assigned), autonomy (as control), agency (as invitation for an interaction), adaptability (as flexible capability), and affordances (as assigned action possibilities) to imagined robots. Five children (2 boys, 3 girls, aged 8–10) participated in two sessions where they drew and enacted robots they imagined. All assigned gender to their robots— four as boys (2 boys, 2 girls), and one (girl) as a girl. Two girls and two boys designed animal-like robots (panda, dog, spiders), while one girl drew a human-like robot. Boys assigned stereotypical masculine traits—Spiderman faces, lasers, fire, or hitting arms—while girls emphasized care and empathy. Children's affordances were influenced by the robot's type, motivations, and social role. Bambu (panda robot, drawn by Girl 2) could eat, play, climb, jump, read, and express emotions physically jumping when happy, curling up when sad. Pablo (dog-like robot, drawn by Girl 3) grabbed with his mouth, helped with homework, and later gained the ability to climb, run, and jump (after observing her sister's robot). Ella (human-like robot, drawn by Girl 1) helped, danced, and responded to sadness. Bob (spider-like, drawn by Boy 1) could fly, eat birds, and play football, but did not respond when someone was sad. Imposter (spider-like, drawn by Boy 2) could hit, slice, shield, and attack, think about sadness without responding. These affordances became most visible through enactment. Bob (Boy 1) threw himself flat on the floor to demonstrate sleeping; Imposter and Pablo (Boy 2) lunged forward without limbs to eat; Ella (Girl 1) used stiff hand movements to eat cake. Bambu rejected a yellow pen and chose green to mimic bamboo, then mimed eating with two hands. Bambu (Girl 2) and Pablo (Girl 3) also crawled on all fours, enacting

animal-like motion. These scenes show that children conceived affordances as species-specific, and relational shaped not only by what the robot could do but by who it was imagined to be. Autonomy was often expressed through phrases like "no one can control him/her" or "moves on its own," but always accompanied by bodily controls (buttons on tails, ears, noses) or dependencies like battery replacement—suggesting autonomy as relational rather than absolute. Agency was situated in social dynamics. Bambu initiated play and approached others; Pablo waited to be invited. Ella helped and empathized but did not initiate. Bob avoided others and remained passive when someone was sad. Imposter communicated only with babies and made no invitations. Agency, then, was not about capability alone, but about how and with whom actions were socially negotiated Adaptability was understood as context sensitive. Bambu was good at helping people and climbing; Pablo was good at helping and catching ball; Ella was described as "good at everything." Bob and Imposter were good at football playing. Children framed adaptability not as mechanical skillsets, but as an extension of personality and inner life. This study positions children as active, embodied theorists whose robot imaginations offer situated understandings of robots as emotional, relational-beings—prompting us to reconsider how we design and relate to social robots in children's worlds.

Avntouli, M.: **Improving Visual-Spatial Memory Performance: The Method of Loci in Aphantasia and Hyperphantasia**

Background: Visual Mental Imagery (VMI) is often described as the "mind's eye". Its role has been highlighted as pivotal in memory, reasoning and imagination abilities. Recently coined terms underlined as pivotal concepts within the VMI, are aphantasia and hyperphantasia. Aphantasia is described as the complete lack visual mental imagery, whereas hyperphantasia as the extremely vivid mental imagery (Zeman, 2024). Notably, little is known regarding if and how aphantasia and hyperphantasia affects cognitive functioning such as visuospatial abilities. Although, aphantasia is associated with impaired mental imagery ability, studies suggest that aphantasic individuals outperform control participants on spatial manipulation tasks. However, evidence on this remains inconsistent (Keogh Pearson, 2017; Ganczarek et al., 2020). This inconsistency led to the proposal of two sub-types, spatial and object aphantasia, where the individual complete lacks spatial or object imagery, respectively (Blazhenkova Pechenkova, 2019). Despite the emerging interest in the imagery systems, no studies to date have examined spatial imagery abilities for hyperphantasic individuals, nor investigate memory training strategies. The Method of Loci (MoL) is a visuospatial mnemonic strategy that involves the placing of items (object) in familiar imagined locations and spaces (spatial) (Yates, 2014; Sandberg et al., 2023). Given its reliance on mental visualization and spatial mapping, MoL offers a promising framework for

evaluating how cognitive training may interact with the extremes of VMI. Purpose: Ergo, the purpose of this study is to investigate whether the Method of Loci (MoL) training enhances visuospatial memory performance and abilities in individuals with self-reported aphantasia, phantasia and hyperphantasia. Method: Fifty individuals- 16 aphantasic, 17 phantastic and 17 hyperphantasic- were recruited and completed a baseline assessment, including the Paper Folding Test (PFT), the Rey-Osterrieth Complex Figure Task (ROCF) and the Vividness of Visual Imagery Questionnaire (VVIQ). After a 7-day training period, via an app, on the MoL technique, all participants were called in and administered the same tests. Participants filled out the VVIQ on the post-training to explore potential changes in their self- reported mental imagery. Results: The main hypothesis is that the Mol training would lead to improvements in visuospatial performance in the hyperphantasic group as compared to the aphantasic group. The aphantasic group is expected to showcase stability before and after the training, maintaining high visuospatial performance scores. Additionally, correlations in demographic variables (sex, age and art experience) will be explored. Conclusion: The findings of this study are expected to demystify the effects of mnemonic training of aphantasic and hyperphantasic individuals on visuospatial task performance. It will contribute to the growing interest on aphantasia and hyperphantasia and shed light on the effectivity of MoL on a non- phantastic populations. Moreover, this study addresses key gaps in understanding the internal visualization ability and its interaction with spatial memory performance.

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Keogh, R., Pearson, J. (2017). The blind mind: No sensory visual imagery in aphantasia. Cortex, 105, 53–60. https://doi.org/10.1016/j.cortex.2017.10.012 Sandberg, P., Boraxbekk, C., Zogaj, I., Nyberg, L.

Bramão, I.: The effect of ingroup sources in knowledge acquisition through memory integration

Knowledge can be acquired and updated by integrating information encountered in separate situations. For instance, one might learn on one occasion that Pandora was the first mortal woman in Greek mythology, and on another that Zeus created her. Integrating these two facts in memory can lead to the novel understanding that Zeus

created the first mortal woman in Greek mythology. This illustrates how memory integration supports the flexible construction of new knowledge. In this study, we investigated whether the source of information influences the formation of integrated representations. Specifically, we examined whether people are more or less likely to integrate information from ingroup versus outgroup sources. Participants (N = 62) completed a computerised knowledge acquisition task in which they learnt novel and related facts (e.g., Apple seeds are called pips and Cyanide is found in pips) and were tested on their ability to integrate these into new factual inferences (e.g., Apple seeds contain cyanide). Crucially, the information was presented by fictitious personas representing either ingroup or outgroup members. Participants first created these personas by selecting faces and attributes for teammates (ingroup) and opponents (outgroup). During the encoding phase, these personas presented the novel facts and participants were instructed to learn the information and rate each statement for its novelty. At test, participants judged whether integrated statements were true or false, reported their confidence, and completed a source memory task in which they indicated who had originally provided that information. Results revealed that participants rated information from ingroup sources as more familiar than that from outgroup sources. They were also more likely to accept false integrated statements when the information had come from an ingroup source and reported higher confidence in the information received from the ingroup. Source memory performance further indicated better memory for ingroup than outgroup sources when false statements were accepted. Moreover, there was a tendency for better outgroup source memory when true integrated statements were erroneously rejected than when false statements were correctly rejected. These findings suggest that the social source of information influences how knowledge is acquired and updated through memory integration processes. Specifically, people may be more receptive to information from ingroup sources, even at the expense of accuracy, while monitoring information from outgroup sources more critically. We propose that increased cognitive resources may be allocated to monitoring information received from outgroup sources, potentially reducing its integration with existing knowledge. This work highlights the role of social context in shaping everyday knowledge acquisition.

Bingefors Wahlqvist, E.:

see 3. Short papers.

Boeltzig, M.: ‚It has begun‘ – Social Identities and Event Impact as Predictors of Flashbulb Memories of the Russian Invasion of Ukraine

Flashbulb Memories (FBMs) are autobiographical memories of the reception context of public events which are marked by high confidence and vividness. One highly influential FBM model (Berntsen, 2018) postulates that if an event activates one's social identity, an FBM is encoded. However, it remains unclear which factors predict FBM formation in outgroups that are not directly affected by an event. We therefore tested whether differences in supranational social identities are the decisive factor for FBM formation in these groups, or whether the impact of the event or warmth towards the affected ingroup are more important. Furthermore, we tested whether the first two factors can explain variance within the affected ingroup. To that end, a survey study (N = 823) was conducted in three countries, using the beginning of the full-scale Russian invasion of Ukraine as the event of interest. Ukrainian participants served as the ingroup directly affected by the invasion. Polish and German participants formed the less affected outgroups. We queried participants on FBM details, confidence, and vividness, and obtained measures of the three predictors of interest, specifically the centrality of an array of relevant identities, the psychological and material impact of the invasion, and (in Germany and Poland) warmth towards Ukrainians and Russians. Results revealed strong country-based differences in FBM occurrence and strength. Ukrainians had the most frequent, most vivid, and most confident FBMs, followed by Poles, and then Germans. Supranational identities explained differences in FBMs within each country. The most consistent identities predicting FBMs were "The West" in Germany, Communist past and EU in Poland, and Slavic identity in Ukraine. The self-assessed psychological impact of the war predicted FBM vividness in all countries. Lastly, while there was mixed evidence that warmth towards Ukrainians predicted FBMs in Germany and Poland, warmth towards Russians emerged as a consistent negative predictor in both countries. Importantly, social identities emerged as the most influential predictor across the three sub-samples and could explain differences between participants even when controlling for country. This finding supports the idea that FBMs are a firmly social phenomenon, related to social identities and belonging to a group. The study extends previous findings by showing that multiple supranational identities can be influential and can explain variance in FBMs in affected ingroups, as well as less affected outgroups.

Damjanovic, L.: **Turn that frown upside down: cross-cultural variation in the conceptual representation of emotion**

Do we all recognize scowls as 'anger' and smiles as 'happiness'—or does culture shape what we see (e.g., Damjanovic et al., 2025)? We explored this issue with images of

facial expressions from seven basic categories of emotion: anger, contempt, disgust, fear, happiness, sadness and surprise posed by Asian Japanese and European American individuals selected from Matsumoto and Ekman's (1988) database of facial expressions. These faces were presented to European British participants living in the UK, Asian Japanese participants living in Japan, and Asian Japanese participants living in the UK. Participants were asked to group the faces freely into as many categories as they chose. Multidimensional scaling revealed striking cross-cultural differences in both the number and structure of emotion groupings. Overall, the cognitive representation of emotion did not conform to the seven distinct groupings anticipated by the proposed "universal" patterns in any of our samples, despite the faces used being deemed as having "stimulus equivalence." Instead, British participants showed between three to four groupings, that were particularly well-defined for culturally familiar faces. Japanese participants in Japan showed more diffuse groupings but displayed clearer groupings for culturally familiar faces. Japanese participants in the UK showed hybrid patterns of grouping behaviour — between those of monocultural groups. These findings contribute to growing evidence that emotion concepts are shaped by culture—and importantly, they reveal that these conceptual systems are not fixed but are malleable through exposure to new cultural contexts.

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Dylman, A. S.: Language context and linguistic similarity in the foreign language effect in decision making and emotional resonance

We report two experiments investigating the role of linguistic similarity in the Foreign Language Effect on decision-making and emotional resonance. Previous research has found that using a foreign language (L2) leads to reduced emotionality and increased rationality compared to a first language (L1). Experiment 1 used English as the target language and Experiment 2 used Swedish and participants were either L1 or L2 speakers of each respective language. Participants in both experiments completed three decision-making tasks, including the Asian disease problem, a moral dilemma, and the Cognitive reflection test. The L2 speakers also reported their reduced emotional resonance in L2 using the RER-LX scale. Results from Experiment 1 showed

no significant effect of language in the decision-making tasks but indicated that linguistic similarity affects emotional resonance. Experiment 2 found a classic Foreign Language effect in all decision-making tasks, with participants in L2 contexts making more rational and utilitarian decisions. However, linguistic similarity did not consistently affect the magnitude of the FLE. The study highlights the complexity of the Foreign Language effect and suggests that factors such as language proficiency, age of acquisition, and immersion may influence its manifestation.

Estgren, C.:

see 3. Short papers

Falck, A.: **Does digital collaboration enhance vocabulary learning? The role of "leading" and "advising" in collaborative exchanges.**

Is collaboration a useful tool for language learning in third graders, and if so, why? Here, we employ an app-based vocabulary learning program to investigate whether collaboration is more effective for learning vocabulary compared to working alone, and to provide insights into which aspects of a collaborative exchange may promote learning. To this end, we use an adaptation of the language learning app Captain Morph, designed to support vocabulary acquisition for primary grade students by training morphology. The app trains derivational affixes, such as "-ist" in cyclist or "re-" in reuse, by exposing children to tasks about how such affixes change the meaning of words (e.g. "cycle" vs "cyclist"). In a recent randomized controlled trial with 717 Norwegian second graders, the app demonstrated durable effects on word knowledge, including untrained words containing trained morphemes. For the present study, we expanded the single-player version of Captain Morph to include a multiplayer mode. In this mode, students collaborate on solving morphological tasks while alternating roles as "game leader" and "game advisor" in an experimentally controlled fashion. This setup allows investigation of whether collaboration yields better learning outcomes than working alone, as well as effects of different roles in the collaboration. Do students learn more from solving a collaborative task when having a leading role, or when giving advice to others' solutions? We present preliminary data from a within-subject experiment including approximately 190 Norwegian third graders, in which we investigated whether being either the leader or advisor in a collaborative exchange enhanced learning compared to solo play. We also investigated whether the potential added value of collaboration (compared to solo play) differed between students who score lower or higher on language or attention measures. Outcome measures included both receptive and productive vocabulary on three sets of test items: trained words,

untrained words including trained morphemes, and newly invented words including trained morphemes (e.g. "If 'over-sing' was a word, what would it mean?"). On the group level, students improved between pre- and posttest on all measures. When it comes to the effectiveness of collaboration and of the different roles of leader and advisor, results were mixed: collaboration was not always more effective than solo play, and the advisor role seemed the most effective for learning (counter to our initial expectations). However, rich process data collected by the app (still being analyzed at the time of abstract submission) may provide additional insights on the circumstances under which a collaborative setting improves learning.

Gander, P.: **The role of mental simulation for differences in memory qualities between real and fictional events**

Remembered events – both those that are experienced and those that originate from reading text – are associated with phenomenal memory qualities, such as clarity and visual details. Recent findings by Gander and Lowe (2023) suggest that reading about negative fictional, as opposed to factual, events results in memories with higher clarity. Here, we attempted to replicate these previous findings. From previous theoretical accounts in the literature, we synthesized the fiction-simulation hypothesis as an explanation: engaging with fictional (compared to non-fictional) texts involves a higher degree of mental simulation and through increased imagery leads to memories with higher clarity. In two preregistered studies (N = 131 and N = 254) we labelled stories as either fact or fiction and measured participants' experienced memory qualities. We also measured mental simulation using a novel scale. The results indicated that the earlier finding was not replicated and no differences in memory qualities or mental simulation were found comparing fact and fiction. The results align with previous research which has not found differences in memory qualities between fact and fiction, and we conclude that the finding from the original study does not hold.

Hermansen, T.: **Parents sensitively adjust their question asking to scaffold child epistemic reasoning at different ages**

With increasing age, children become more likely to efficiently test a surprising claim, but only when they are able to provide a reason for their (dis)belief (Hermansen et al., 2024). They are also increasingly likely to justify exploration as a necessary means to confirm whether a surprising claim is true or not (Cottrell et al., 2022). As such, a remaining question essential to any educational approach that seeks to enhance children's capacity to learn is how children's social environment scaffolds their reasoning about the foundations of their beliefs following situations of epistemic uncertainty.

Children's ability to reason about their beliefs develops with age, and therefore it is plausible that their social environment, including how adults attempt to prompt their reasoning, also shifts in ways that support this developmental trajectory (e.g., Booth et al., 2020). This study aims to test the hypothesis that parents' tendency to adapt their questioning strategies, and in particular their inclination to prompt their children to provide explanations for their beliefs (as indexed by their use of the word 'why'), to elicit reflective thought in their children systematically varies as a function of the child's age. To test this hypothesis, we presented 4-7-year-old children (N=140 48-84 months, 46.6% girls, 53.6% boys] and their parents with a task prompting parent-child conversations about eight different scenarios of epistemic uncertainty. The scenarios reflected excerpts of Olivier Tallec's children's books "Who What Where?" and "Who Done It?", with each scene involving an event and a group of characters with features that may or may not provide evidence as to who may have been involved in the event. Preliminary analyses with a subsample of the transcribed data* indicate a negative correlation between child age and the number of questions parents asked in general (r = -.330, p = .001), and a positive association with the proportion of explanation prompts (r = .188, p = .045). Together, this suggests that parents ask fewer task-related questions to their child in general as the child grows older. However, with increasing child age, the proportion of parent's prompts for their child to provide justification for their beliefs increases. This resembles prior work in young children showing how parental sensitivity to their child's developmental stage may play a critical role in fostering child information seeking and inquiries (Zambrana et al., 2020). By increasingly prompting older children to justify their beliefs, parents adaptive scaffolding strengthens their child's ability to reflect on and evaluate their beliefs—ultimately supporting their developing epistemic reasoning. *Note: Data collection is completed with a total of 140 children. The preliminary analyses reflect a subsample of 50 dyads that have been transcribed so far. Pending conference acceptance, data from the full data set will be presented together with more nuanced regression analyses of parents types of indirect and direct explanation prompts.

Hermansen, T.: **Parent-child dialogic interactions during situations of epistemic uncertainty: Investigating the role of parents personal epistemology and socioeconomic background**

With information being abundantly available from a range of sources, children may come across situations where what they see or hear is inconsistent with what they know. To resolve such situations of epistemic uncertainty, it is essential that they seek clarifying information. This requires not only the ability to recognize the link between beliefs and evidence but also the disposition and willingness to engage in such reflective thinking. To the extent that children are particularly attuned and learn from

trusted family members (Harris, 2012), they are also likely to learn ways of knowing through their early conversational environment (Booth et al., 2020). In this study, we explored how parent's socio-economic status (SES, as reflected in their educational level) as well as their beliefs about knowledge (as reflected in their responses to a questionnaire about personal epistemologies) are reflected in conversations with their children in situations of epistemic uncertainty. In particular, we expect parents with a more evaluativist personal epistemology to be more likely to use explanation prompts (indexed by their use of the word 'why') to encourage their child to provide justifications for their beliefs, compared to parents with a less evaluativist epistemology. Furthermore, as an exploratory analyses we assessed the impact of parents' SES on this relationship. To test this hypothesis, we presented 4-7-year-old children (N=140 48-84 months, 46.6% girls, 53.6% boys) and their parents with a task prompting parent-child conversations about eight different scenarios of epistemic uncertainty. The scenarios reflected excerpts of Olivier Tallec's children's books "Who What Where?" and "Who Done It?", with each scene involving an event and a group of characters with features that may or may not provide evidence as to who may have been involved in the event. Preliminary analyses* indicated a positive correlation between parent's SES and their personal epistemology (r = .331, p <.001). There was also a positive correlation between parent's SES and their tendency to ask questions (r = .214, p = .026), but not to provide explanation prompts (r = .094, p = .333). Furthermore, there was a positive correlation between parent's personal epistemology and their inclination to ask questions (r = .237, p = .013), as well as a marginal association with their explanation prompts in particular (r = .170, p = .079). This provides tentative support for the notion that parental beliefs about knowledge, not only their educational levels, are directly reflected in their interactions with their child. Given how prior research has shown that such explanation prompts are key to children's developing critical thinking, this would suggest a potential for low-cost parent-oriented interventions to enhance reflective thinking in everyday family interactions. *Note: Data collection is completed with a total of 140 children. The preliminary analyses reflect a subsample of 50 dyads that have been transcribed so far. Pending conference acceptance, data from the full data set will be presented together with more advanced moderation analyses of the relationship between SES and parental epistemologies on their tendency to ask questions and provide explanation prompts. References Booth, A. E., Shavlik, M., Haden, C. A. (2020). Parents' causal talk: Links to children's causal stance and emerging scientific literacy. Developmental Psychology, 56, 2055. doi:10.1037/dev0001108 Harris, P. L. (2012). Trusting what you're told: How children learn from others. Harvard University Press.

Hetzberg, L.:

see 3. Short papers.

Hoggard, N.:

see 3. Short papers.

Holmberg, L.: **A Grid Space Based Investigation of Agent Behaviour Explanations**

Artificial agents are increasingly integrated into everyday life. Therefore, it is crucial to understand how humans interpret and explain artificial agent behaviour to be able to improve human-agent interaction (Anjomshoae et al., 2019). Moreover, it is important to understand how such explanations are interpreted by humans and what kinds of explanations users prefer in different situations. Explanations are important for facilitating understanding of system behaviour (Anjomshoae et al., 2019; Endsley, 2023), helping diagnose failures (Das et al., 2021), and improving human-AI collaboration (Bansal et al., 2021; Endsley, 2023). The eXplainable AI (XAI) community has predominantly focused on explainability of data-driven algorithms (Anjomshoae et al., 2019), often in a decision-making context aimed at improving decision quality. This study focuses on explanations of artificial agents (explainable agency), with the primary aim of making systems more predictable and understandable to users. Specifically, we investigate how people explain artificial agents' behaviour in task-oriented activities in a grid space environment and explores what kind of explanations participants prefer given certain behaviours. In our online setup, participants observed an agent perform a series of tasks with successful and failed results—either technical or interaction failures—drawing on work from Honig Oron-Gilad (2018). After each observation, participants were asked to provide an explanation for the agent's behaviour. They then selected their preferred explanation from set of five types:

1. Mechanistic explanations (emphasising internal rules or causes) (Lombrozo Carey, 2006; Miller, 2019)
2. Functional explanations (emphasising the purpose or outcome of the behaviour) (Lombrozo Carey, 2006; Miller, 2019)
3. Folk-psychological explanations (mental states, intentions, or desires) (Miller, 2019)
4. Their own explanation.
5. No explanation.

Our primary interest was individuals' explanatory preferences when interpreting arti-

ficial agent behaviour, particularly observing successful behaviours and different kinds of failures. Having participants provide their own explanations offer insight into their understanding of the system (their mental model), making it possible to analyse how users' current understanding influences their preferred explanations. In this ongoing work, we expect individuals to explain the agent's behaviour using folk-psychological terms. Regarding explanation preferences, we believe they will differ depending on whether the agent is successful or not in its action. More specifically, we hypothesise individuals are more likely to want explanations when the agent fails. Additionally, we expect that participants will prefer folk- psychological explanations over mechanistic explanations (Harbers et al., 2009). Lastly, we expect participants to have an unwarranted trust in mechanistic explanations (Eshan et al., 2024). These findings have important implications for designing more understandable artificial agents. By understanding how users interpret agent behaviour and what kinds of explanations they prefer, it becomes possible to provide explanations only when they are needed and in a form that aligns with users' mental models. Overall, this research contributes to the growing field of XAI and explainable agency by investigating user understanding of agent behaviour and identifying which types of explanations are preferred under different conditions. Ultimately, these insights support the development of more understandable and predictable artificial agents.

Johansson, A.: **Brain engagement during planning and execution of a sequential manual task in autistic and neurotypical adults: a fMRI study**

Autism spectrum disorder (ASD) is a neurodevelopmental condition characterised by difficulties in reciprocal social interaction and behavioural flexibility. Motor impairments are frequently co- occurring, prompting some researchers to argue that these impairments may constitute a core feature of the condition. Despite the high prevalence of motor impairments, the underlying neural correlates remain understudied. To address this, we used functional magnetic resonance imaging (fMRI) to investigate the neural basis of motor planning and execution in autistic adults (N = 21; 9 females, 3 non-binary; M = 26.0 years) and a neurotypical comparison group (N = 28; 15 females; M = 27.5 years) during a visually guided, goal-directed, sequential manual task. Participants performed a two-step button-pressing sequence using a rotatable object when pressing, with brain activity measured during planning prior to execution and execution, respectively. Task complexity was modulated by the degree of object rotation, allowing isolation of neural responses related to motor planning and execution under differing cognitive-motor demands (simple vs. complex). The hypothesis is that adults with ASD will activate similar brain regions as NT adults, but with differing magnitude and direction, during both planning and execution. Contrasts assessed blood-oxygen-level- dependent (BOLD) activation differences between

NT and ASD adults during planning and execution and overlap in activation patterns across groups. Additionally, given prior findings linking motor deviations to severity of core ASD traits, the correlation between individual brain activity in motor- related regions of interest and extent of self-rated autistic traits was investigated. The results from this novel study design may inform diagnostic practices, guide the development of targeted interventions, and advance theoretical models of ASD.

Khan, F. A.: **Code-switching in the Formation of Conceptual Pacts**

Dialogue studies show that speakers conventionalise referring expressions through lexical entrainment and grounding where they implicitly agree to use the same expression to describe an object (Brennan Clark, 1996; Mills, 2014; Nölle et al., 2020). However, there are no studies on how using multiple languages in the same conversation (i.e., code-switching) affects the formation of conceptual pacts even though psycholinguistic studies have noted that bilinguals can have shared conceptual representations despite lexical resources being separate among languages (Gollan et al., 2005; De Bot, 2020). In this study, we investigate how referring expressions become established in bilingual chat-based interactions, and whether or not speakers code-switch when invoking an established conceptual pact. We hypothesise that if the formation of pacts requires lexical entrainment, bilingual speakers are unlikely to code-switch when producing an established referring expression. We conducted an experiment in which 25 Swedish-English bilingual participants interacted via a chat tool (Mills Healey, 2013). The participants' proficiency in English was recorded by administering the LexTALE vocabulary test (Lemhöfer Broersma, 2012) and the Language Experience and Proficiency Questionnaire (Marian, Blumenfeld, Kaushanskaya, 2007). The experiment involved a tangram task consisting of two language conditions –English (non-mixed), and Swedish-English (mixed). The critical trials of the non-mixed condition involved 8 target tangram figures used to elicit the formation of conceptual pacts. In the mixed condition, we reused the target figures from the non-mixed condition to test whether the participants maintained the language in which the pact was established or if they code-switched. We quantitatively analysed the data by categorising the responses in the mixed condition as either code-switched or non-code-switched. Results from a mixed-effects logistic regression model show that the type of response depends on whether or not the conceptual pact was established. Considering the participants' everyday language experience, participants who are used to code-switching in general code-switched in the experiment when their partner had failed to identify the correct target tangram. On the other hand, bilingual speakers who did not code-switch often in everyday life used English in the non-mixed condition and Swedish in the mixed condition. We conclude that language environment and experience of bilingual speakers equally determine code-switching behaviour when referring to objects

in interaction. More importantly, we observe that code-switching affords grounding even in the absence of lexical entrainment.

Kohlhoff, S.: **Exploring autistic peer support groups in higher education: communication, knowledge, community building and student engagement**

Autistic higher education students (AS) often possess strengths especially useful for academic studies, including high intellectual potential, creative thinking and intense focus. However, they also experience exceptional challenges impacting learning, such as responding to social demands, managing sensory overload and executive dysfunction. Support for AS has been defined in a plethora of academic and non-academic practices. Reported social support mostly consists of social skills training and peer mentoring by a non-autistic student. Less is known about autistic-to-autistic support, while some studies point towards positive outcomes. Research on autistic adults' interaction and communication is still scarce, especially on interaction in real world group settings. Studies of conversational structures report amongst others of differences in backchanneling, speaking times and turn-taking and -timing. Social interaction studies have shown autistic people communicating efficiently with one another, as well as high rapport in all-autistic group interaction, despite the common conception of autistic people having deficits in social interaction and communication skills and low social motivation. This exploratory qualitative study looks closer into the intersubjective dynamics of autistic communication in autistic-to-autistic peer support groups (PSG) in higher education. Particularly, it investigates how participating in these groups build social repertoires that can strengthen AS study progress and student wellbeing. The study's specific aims are to (1) examine the specificities of social interactions and communication in the PSG, (2) understand autistic knowledge and community building in PSG, and (3) explore AS experiences and perceptions of PSG as well as the impact of participation on student engagement, a concept tying together student wellbeing and study progress. From a cognitive science perspective, this work will be grounded on an enactive approach to social cognition, particularly the theoretical developments in participatory sense-making, to guide the analysis of languaging and communication between AS and frame how they experience interacting with other AS. Data will be collected via interviews and video recordings of group sessions. Interview data of AS that have participated in PSG will be analyzed with the help of thematic analysis, to bring forward recurring themes and patterns of experiences. Data from video recordings of PSG sessions is analyzed in different ways: conversation analysis allows us to explore autistic interactions and communication dynamics, potentially unravelling new understandings of autistic intersubjectivity. Discourse analysis supports an in-depth look into the socially situated interaction and communication, and to discover more about autistic knowledge and community creation in

the PSG context. This research aims to contribute to knowledge on autistic social interaction and communication. New knowledge can also be expected on the building of autistic epistemic communities in higher education, as well as on the possibilities of PSG strengthening student engagement and through this, student retention.

Lagerstedt, E.: **Because the adults ask you to: why do you respond how you do to how and why questions?**

'How' and 'why' questions are often posed in conversation to probe other people's reasoning processes. Such questions can further provide insights into the respondent's assumptions about the reasoning process of the asker, which constitute a kind of joint or meta reasoning. The respondent can engage in reflections regarding the reason behind the question and address it accordingly. For instance, the asker might be quizzing the respondent to see if they know the answer, the asker might genuinely be missing some general or key information, or the questions might be part of a more casual conversation. To understand reasoning in dialogue, adults rely on topoi – associative rules of thumb which underpin everyday inferences and allow us to interpret non-logical incomplete (enthymematic) arguments. Topoi are assumed to hold generally or in a typical case but not by necessity. They can represent everything from facts acceptable to all inhabitants of planet earth (such as if we let go of something it generally falls downwards), to aspects of common ground that are specific to a subculture (e.g. that in the UK you need to order your drink at the bar rather than expecting table service), family norms (such as not having phones at the dinner table) or even just an understanding between two individuals. Asking 'why' and 'how' questions can thus be a strategy for probing (different aspects of) which topoi are available to a speaker and perceived as salient in the context. This is particularly the case with children as they become more adept at commonsense reasoning as they may overgeneralise topoi or rely on esoteric topoi that are not generally acceptable. We therefore investigate responses to 'how' and 'why' questions about everyday objects (e.g. 'how do you use a bicycle?' or 'why do you eat ice cream'). Our data consist of responses to such questions from Norwegian speakers, with three groups; children at age 5 and 7, and adults. The context was that the asker was an alien robot (represented by a cartoon avatar on a computer screen) curious about, but with no prior knowledge of, earth. We further compare these responses with output from an LLM prompted with the same questions to evaluate to what extent the LLM mirrors human strategies for responding to these questions (with or without additional instructions to respond as a human of a certain age). Our results show that children's answers are typically shorter than adult's answers, and they tend to only produce one reason as a sufficient answer (perhaps the one representing the most salient topos). In contrast, the LLM tends to provide as many reasons as possible, and also include irrelevant additional

information. There are, however, also both interesting similarities and differences between the different human age groups, both between age groups and question types. Better understanding of these differences might provide insights regarding developmental psychology and human learning and reasoning, but it can also contribute to explainable AI and inform the design of more human-like dialogue systems.

van Klaveren, L.-M.: **Intersubjective sense-making in contact improvisation: Toward a theoretical and methodological integration of LBMS, ecological psychology, and biosemiotics**

Background
In this ongoing project, we develop a theoretical and methodological framework for investigating intersubjective sense-making as a 5E cognitive process—embodied, enactive, embedded, extended, and emotional—by bringing together Laban Bartenieff Movement Studies (LBMS), ecological psychology, and biosemiotics. We use Contact Improvisation (CI) as a case to explore how people make sense together through movement and touch. CI exemplifies what Sheets-Johnstone (2009) calls "thinking together in motion": a continuous, mutual process of perception and action shaped through real-time psychophysical, affective dialogue. Dancers respond to shifting weight, pressure, balance, and spatial cues, collaboratively exploring movement possibilities. This negotiation turns movement into a dynamic, relational process of sense-making—making CI a powerful site for studying 5E cognition in action.

Theoretical Proposition
To examine this process, we draw on Laban Bartenieff Movement Studies, a comprehensive framework for analysing movement across six interrelated categories: body, shape, effort, space, relationship, and phrasing, encompassing around sixty distinct parameters (Kennedy, 2014). LBMS synthesizes Rudolf Laban's movement theory with Irmgard Bartenieff's somatic practices, offering a holistic view of bodily function, spatial orientation, and movement dynamics. In this project, we focus on the categories of effort and shape. Effort describes how energy is modulated through time, space, weight, and flow, while shape examines how the body transforms in space in response to the environment. These dimensions are complementary: shape embodies continuous positioning, while effort expresses the tone and direction of engagement, often with affective resonance. To deepen this analysis, we bring LBMS into dialogue with biosemiotics, which frames sense-making as a process involving perception, imagination, conceptualization, and analysis (Van Heusden, 2015), and with ecological psychology, which explores how agents respond to affordances, seek optimal grip, and dynamically couple with their environment (Gibson, 1979; Chemero, 2009; Kull, 2022). This integration allows us to interpret movement not only de-

scriptively, but as meaningful, relational action embedded in cognitive and affective orientation.

Methodological Proposition
To explore the dynamics of intersubjective sense-making, we combine LBMS-informed movement analysis with non-linear time series methods, specifically Chromatic Recurrence Plots (CRPs) and (Cross) Recurrence Quantification Analysis (CRQA). In our case study, we recorded CI duets and coded second-by-second movement initiations in LBMS categories. These were translated into 1Hz time series and analysed to uncover temporal patterns and coordination between dancers. Additionally, we conducted video-cued interviews with each dancer, inviting them to reflect on their experience while viewing the recording. Transcripts were coded for semiotic strategies using a modified scheme based on van Heusden et al. (2013). CRPs visualize recurring movement states over time, while RQA metrics such as recurrence rate, laminarity, determinism, and entropy quantify system stability, complexity, and change. CRQA extends this by exploring coupling between dancers or between movement dimensions.

Conclusion and Implications
We propose this framework as a way to investigate intersubjective sense-making as a dynamic 5E cognitive process. Our approach opens interdisciplinary dialogues between movement analysis, cognitive science, and cultural theory.

Low, M.: **When sensory maps collide: How smells and sounds compete in spatial memory**

Spatial memory has traditionally been studied with vision, but less is known about how we remember the locations of smells and sounds. It has been proposed that olfaction evolved in parallel with spatial navigation for the purpose of foraging (Dahmani et al., 2018; Szychowska et al., 2025). Therefore, it is plausible that cognitive maps of olfactory objects could dominate over other sensory modalities. Indeed, a recent study by (Szychowska et al., in press) reported olfactory dominance in memory errors—that is, participants tended to place sounds at the locations of associated smells, rather than placing smells at the locations of associated sounds. In the present study, we aim to further explore this phenomenon by testing if olfactory maps will dominate over auditory maps when ambiguous cues are presented. Our findings will contribute to a better understanding of how conflicting sensory information influences modality-specific spatial navigation. This poster will focus on behavioural data from a larger fMRI (functional magnetic resonance imaging) study. Data collection is ongoing, with an expected sample size of N = 50 healthy participants (18-40 years) by October 2025. Subjects begin by navigating a virtual reality environment to mem-

orize the locations of four objects (coffee, lawnmower, popcorn, and bonfire) in two sensory conditions—olfactory and auditory. Each olfactory object (e.g., the smell of coffee) has a corresponding auditory counterpart (e.g., the sound of a coffee maker). In the testing phase, an ambiguous cue with no olfactory or auditory information is presented (e.g. the word "coffee") and subjects are asked to place the word at the location for either the sound or the smell. Subjects are screened beforehand with pure-tone audiometry and Sniffin' Sticks testing to control for normal hearing and olfaction, respectively. Unexpectedly, preliminary raw data screening (n = 10) shows a slight tendency towards auditory dominance (54% for coffee; 56% for lawn mower; 57% for popcorn; 53% for bonfire). This will be further investigated on the complete data set using a Bayesian binomial regression model with a logit link function, with predictors for chosen location (olfactory, auditory) and sensory condition presentation order (olfactory first, auditory first). Varying effects will be estimated for individuals (intercept and coefficient for chosen location). After analyzing the complete data set, we will discuss whether there is support for olfactory dominance in cognitive maps and consider the implications for theories on the evolutionary role of olfaction in spatial navigation.

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Maraev, V.: **Laughter and apologies in aesthetic evaluations**

We present ongoing work on an experimental platform designed to study social actions accom panied by laughter in spoken dialogue. Laughter is a social signal ubiquitous in human dialogue, it is a key interactional resource, serving as a key interactional resource crucial for managing social relationships [1, 2, 3]. The theoretical models of laughter meaning and use are derived from humans, but is unclear how much of this knowledge can be extended to virtual entities, which this work aims to explore. Perkins Booker et al. [4] show that laughs in interactions with virtual assistants are less frequent than in human-human dialogues. In this study, following

Maraev et al. [5] we focus on laughter produced in association with social acts of apologising. Downplayers are commonly produced as the adjacency pair counterpart to apologies, realised by utterances like "Don't worry" or "It's alright". Both downplayers and apologies are accompanied by laughter much more often than other dialogue acts [6]. Assessment of art is subjective and relies on the social context. When making assessments in conversation, speakers often claim insufficient knowledge, understate disagreements and indicate their sense of experience [7]. Our case study focuses on apologies arising in the task of aesthetic evaluation of works of art. We employ a vision-language model (VLM)-driven spoken dialogue system with controlled interventions to probe laughs in appropriate moments. We conduct an experimental study where participants interact with a conversational agent capable of laughing and producing apologies. Each participant interacts with two versions of the dialogue system in pseudo-random order, each controlled for a) visual artwork with potentially controversial elements, and b) produced apologies with or without laughter. The dialogue system uses image descriptions from a VLM to prompt a large language model (LLM) to generate responces in the context of dialogue. Responses containing apologies are rewritten into either "Sorry." or "Sorry [h.h]". Additionally, the dialogue is scripted to contain an apology after the system being silent while retrieving image description from a VLM, so- called "attributable silence" [8, 9], and apologies after time-up notifications. In laughter condition, all apologies are followed by laughter. After each dialogue, participants fill a survey containing questions about the artwork, the experience of interaction with a social agent and the perception of agent's warmth and competence. The final survey after the experiment contains a questionnaire about social functions of laughter. We will analyse the interactions to determine whether participants reciprocate the apologies with downplayers depending on them being enriched by laughter and whether system-produced laughter influences participant laugh production.

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Morell-Ruiz, M. & Ceruti, F.A.: **Design Matters: A Screen-Based Task for Children's Probabilistic Intuition**

see 3. Short papers.

Mystakidou, M.: **Complexity and resource allocation in human visual processing**

Understanding how resource is allocated is central to models of visual working memory. We developed a trial-level framework connecting pupil markers of resource with behavioral precision to distinguish between cognitive computation and implementation. By framing pupil size as indexing information processing rather than motivation or effort, we identified distinct strategies that varied both within and across individuals. Unsupervised clustering in resource–precision space revealed diverse individual strategies: some participants achieved high precision with minimal resource, others mainly with high resource investment while others showed mixed strategies. Notably, participants from different encoding-time groups (200 ms vs. 1200 ms) were often more similar than those within the same group. These findings challenge assumptions of stable cognitive models to characterize the behavior of one or a group of participants and highlight the importance of trial-by-trial analyses over traditional aggregation. Our approach offers a new path to understanding cognitive variability, with implications for rethinking pupillometry, resource allocation, the interpretation of individual differences and the concept of capacity in visual working memory. We further explored recursive coding in visual working memory, building upon traditional mechanisms such as chunking, associative chaining, and ordinal processing. By integrating these mechanisms and employing an analytical approach that captures the dynamic interplay of different encoding strategies at the trial level, we provide a more nuanced view of the meaning behind the otherwise well-studied notion of capacity. Our findings suggest that participants may switch between or combine these strategies, while the extent each is used depends on stimulus complexity. The implications of our work extend beyond theoretical advancements, offering potential applications in educational and healthcare settings. Training the mechanisms involved in recursive coding through simple visual representations, may translate to higher processes, ultimately enhancing abstract thinking and problem-solving abilities, and may offer new pathways for mitigating cognitive decline, such as in Alzheimer's disease, that seems

to start from visual working memory. Finally, we introduce three new algorithmic measures designed to improve the generation of VWM stimuli, addressing key limitations in current experimental designs. These algorithms offer practical tools that can be widely adopted by the field, facilitating more precise investigations of visual working memory and resource allocation.

Mirström, M.:

see 3. Short papers

Ngaosuvan, L.:

see 3. Short papers

Nyberg, V.: Simulator-Based Assessment of Driver Anticipation: Preliminary Insights for Enhanced Safety Evaluation

Traffic crashes, frequently linked to human behaviors such as errors or violations, represent a major safety issue, with novice drivers being particularly overrepresented (Möller et al., 2021). These errors and violations are explained by driver's incorrect mental models (Keskinen, 2007), which prevents the driver from proactively adapting before anticipated situations (Nygårdhs, 2020). Furthermore, failure to anticipate potential events in said situation produces a surprise reaction, such as harsh braking (Engström et al., 2018; Markkula et al., 2016). Assessing a driver's ability to anticipate and proactively adapt to critical traffic situations is challenging in real-world conditions due to the rarity of such situations (Johnsson et al., 2018), which limits assessment to vehicle handling and outcome of common situations (Forward et al., 2017; Hatakka et al., 2002). Driving simulators, however, offer a safe and controlled environment to study driver behavior in these rare situations (Thorslund, Thellman, Nyberg, et al., 2024). Therefore, the aim of this study was to explore driving behaviors in critical traffic situations among drivers with high standard of driving performance. By answering the following research questions: to what extent are outcomes in simulated critical traffic situations able to assess driver's anticipation? How can surprise, as an indication of failed anticipation, be quantified from continuous vehicle kinematics and driver inputs? How can proactive adaptation, as an indicator for anticipated critical situations, be identified and measured? Twenty participants, defined as driving experts based on being professional driving teachers, took part in the study. They started with a survey for demographic data and self-assessment, followed by a 15-minute route

in the simulator to familiarize themselves with the simulator. Next, a 35-minute trip with 15 critical situations, created by other experts (Thorslund, Thellman, Selander, 2024), where their driving behavior (accelerator use, braking and steering) and vehicle data (speed, distance, distance-to-event, lane position) were recorded at a frequency of 10 times per second. Lastly, they finished with a survey regarding their self-assessed performance, how probable situations were, and their perceived risk. Preliminary results show 6 participants had at least one registered collision, with accompanying harsh braking. In situations where collisions occurred, several participants showed harsh braking without a registered collision. In the same situations participants who did not show harsh braking adapted before entering the situation and/or close to the potential point of conflict. Interestingly, the participants with the initial highest speed were not always the same as those who collided. These findings suggest the possibility to assess driving behavior in addition to outcome, reducing the risk of false positive and false negative tests.

Parthemore, J.: **Which is the real radical enactivism?**

Enactivism is that philosophical tradition within cognitive science that emphasizes the co-creation of agent and environment, to echo the language of Humberto Maturana and Francisco Maturana. Enactivism eschews the traditional distinction between internal processes and external world. Daniel Hutto has long advocated for a radical enactivism based on the central idea of cognition without content. It is hard to tell what that means. If it means only that cognition, for the majority of cognitive agents on Earth, does not involve representation in any meaningful sense, then I agree. If it means that the great majority of human cognition does not require representations – in the sense of an agent using something to stand in place of something else for that or another agent – again I agree. I think though that, in talking about satisfaction conditions, Hutto and Myin intend something more. Concepts may be understood as systematically and productively structured thought. As I argued in my doctoral thesis and in numerous papers since, concepts – for the conceptual agent capable of self- reflection – just are representations when the agent stops and reflects on them as concepts. On the other hand, when the agent is simply getting on with using them non-reflectively, they must, logically, be something else: something non-representational. Critically though, they still have something that could be taken as satisfaction conditions: not ones that could necessarily be determined by the agent herself, to be sure, but ones that could be determined by an appropriately enabled observer. I have argued that conceptual agency and consciousness are two sides of a single coin, meaning that, wherever one appropriately attributes consciousness, one should attribute conceptual agency as well. For those agents capable of self-reflection, including self-recognition,representations play a small but critical role – because the

recognition of self as myself, of other as other, involves representation in the sense I offered above. It seems that a range of species have the capacity for self-recognition. If right, that means that representations cannot by limited to human-style language. A great many more species appear capable of pre-reflective conscious awareness and basic conceptual agency (first-order concepts) – so they have, in the sense that I would talk of content, a form of content, for they have systematically and productively structured thought. The truly radical notion lurking in enactivism is not contentless cognition but an underlying continuum between agent and environment, self and other – where the dividing line (for agents capable of drawing it) is a conceptual not a prior onto-logical one: an idea repeatedly raised by Maturana and Varela. As such, it is capable of being redrawn as circumstances require and, in certain circumstances, disappearing entirely. The idea of the self as an isolated island of consciousness is a distinctly West-ern one. As Kaipainen et al. write: "Just as Extended Mind incorporates but goes well beyond embeddedness and embodiment; so, too, does enactivism incorporate but go well beyond Extended Mind in seeing an underlying bringing the other forth in an act of co-creation." Too many enactivists balk at the consequences.

Thorslund, B.:

see 3. Short papers

Thunberg, S.: **Tracking Mental Models of a Humanoid Robot**

Mental models influence what humans expect from, and how they interpret, AI sys-tem behaviour (Bansal et al., 2019; Kulesza et al., 2012; Rueben et al. 2021). This, in turn, directly affects human-AI teaming (Bansal et al., 2019; Endsley, 2023a), trust (Bansal et al., 2021), and safety (Anjomshoae et al., 2019; Endsley, 2023b) when collab-orating with these systems. However, how mental models of robots develop remain largely under explored (Rueben et al., 2021). As social robots are becoming more common, understanding how humans form and update mental models of robots is increasingly important. Previous research indicates that users often will hold on to their initial mental models (Kulesza et al., 2012), sometimes even when faced with contradictory behaviour or explanations (Druce et al., 2021; Staggers Norcio, 1993; Tullio et al., 2007). In this study, we investigated how people's mental models de-velop and update through repeated interaction with a humanoid robot. More specif-ically, the study addresses two research questions: 1) how do mental models evolve through interaction, and 2) how does physical appearance, observed behaviour, and explanations affect model updates? We hypothesise: H1) the robot's physical appear-ance significantly influences users' initial mental models and that visible sensors are

more likely to be included (Bargh et al, 1996); H2) participants will primarily update their mental models with small adjustments rather than major revisions (Druce et al., 2021); H3) expected behaviours (i.e. behaviours predictable by their mental models) will induce little to no mental model updates (Rueben et al., 2021); and H4) global explanations will lead to a more accurate first mental model (Kulesza et al., 2012). We designed a between subject design experiment where 16 participants (2x2 (global explanations/no global explanations x local explanations/no local explanations)) engaged with a Pepper robot. The experiment had three stages:

1) Initial Exposure—Participants first interacted with Pepper, and half received global explanations about what it can do. After initial exposure, we try to elucidate participants mental models of Pepper. Since mental models are hard to elucidate, we used multiple strategies, as suggested by Hoffman et al. (2018, 2023). These methods included cued retrospection (Ward et al. 2018), diagramming (Cañas et al., 2003), and prediction tasks (Muramatsu Pratt, 2001).
2) Observing Successful Tasks—Participants observed Pepper complete a series of tasks to showcase its capabilities. After watching Pepper complete the tasks, we utilised the same methods to capture the participants' mental models.
3) Observing Failures—Participants observed Pepper fail a set of tasks. These planned failures were meant to reveal some of Pepper's limitations. Half of the participants got local explanations for the failures. We utilised the same methods again to capture mental model updates.

By systematically eliciting mental models at multiple stages, this study traces the initial development of participants' understanding of Pepper. Specifically, we explored how visual cues (e.g. robot's body shape, actions, and apparent sensors), observed behaviours (success and failures), and explanations (global and local) impacted formation and revision of mental models.

Tu, H.-F.: **Peripartum psychological distress and the development of attentional control in infants: a cross- cultural study in Taiwan and Sweden**

Peripartum mental health significantly impacts children's cognitive development, with emerging evidence suggesting that maternal distress during pregnancy and postpartum is associated with variations in infants' attentional control. Previous developmental research also suggests that individual differences in information processing speed, such as fast versus slow lookers, indicate different attentional styles. Fast lookers tend to focus on more focal characteristics of objects, while slow lookers are more likely to focus on global features, such as the relationships between objects and their background. Moreover, cross-cultural research highlights that attentional styles can vary across populations. For example, East Asian infants often process visual scenes holis-

tically, attending to the relationships between objects and their background, while Western infants tend to focus more on individual objects. Previous evidence has also shown that in an individualistic society, infants are more susceptible to maternal depression influencing their gaze behaviors, while in collectivist societies with larger family networks, infants' gaze-following behaviors, which are important for joint attention and interpersonal interaction, are less influenced by maternal depression. According to the available evidence, it remains unclear how infants' attentional control is shaped by cultural context and whether cultural differences moderate the impact of peripartum maternal distress. Therefore, the current ongoing longitudinal study investigates the relationship between peripartum psychological distress and the development of attentional control in infants from two countries with different cultures, Sweden and Taiwan. Compared to Taiwan, Swedish society has higher level of individualism (Hofstede's Individualism Index, Sweden: 71, Taiwan: 17). In contrast, Taiwan aligns with collectivism. The Swedish sample consists of 118 mother-infant dyads, with data collection completed at the Uppsala Child and Baby Lab. In Taiwan, recruitment is ongoing at E-Da Hospital in southern Taiwan. Initially, 139 pregnant women were enrolled during the second trimester, 137 remained in the third trimester, and to date, 8 infants have completed assessments at 6 months old. Maternal mental health is assessed by the Edinburgh Postnatal Depression Scale, the Depression, Anxiety, and Stress Scale (21 items), and the Perceived Stress Scale, during the second and third trimesters of pregnancy, as well as six months postpartum. Infant attentional control is measured at 6 and 18 months through well-established eye-tracking tasks. The primary outcomes include focused attention and attentional processing speed, which reflect different attentional styles. It is anticipated that maternal distress will affect infant attentional control differently in the two countries, potentially reflecting the distinct cultural orientation. Specifically, it is expected that Swedish infants, in line with individualistic cultural context, may demonstrate more focused attention and faster processing speeds, while Taiwanese infants may show more holistic processing, consistent with collectivist cultural context. Moreover, in Taiwan, where larger interpersonal networks exist, maternal depression may have less of an impact on infants' attentional control. The study aims to gain a deeper understanding of how cultural contexts can influence the effects of peripartum distress on infant development.

Tu, H.-F: **Bridging the knowledge gap: The role of active learning in vocabulary acquisition in learners with varying prior knowledge levels**

Background: Learning is a lifelong process, with prior knowledge often considered a key predictor of learning outcomes. Effective knowledge acquisition typically involves repeated practice, but not all practice methods yield the same results. Retrieval prac-

tice, defined as the actively recalling information, has been consistently shown to facilitate learning across modalities, cognitive abilities, and different age groups. However, its interaction with prior knowledge remains unclear, as studies yield mixed results. Some suggested retrieval practice may eliminate performance differences between experts and novices, while others did not. This ongoing study uses a well-established word learning paradigm and examines whether combining prior knowledge with retrieval practice facilitates the most optimal learning outcomes.

Methods:
Participants
Thirty native Swedish speakers (18-25 years old) will be invited. Inclusion criteria are (1) no prior exposure to Swahili and German, (2) normal or corrected-to-normal vision, and (3) no neurological or psychiatric, or learning disorders.

Experimental design and procedure
Using a within-subjects design, participants learn 160 words from German and Swahili. Words are selected based on their frequency (top 2000 nouns) in Swedish. The lexical similarity of Swedish- German and Swedish-Swahili is quantified using Levenshtein distance and Jaccard index, with German representing high prior knowledge and Swahili low prior knowledge. Participants visit the lab on two separate occasions, with the first session dedicated to training and the second session for retention testing. The training procedure was divided into two main components: retrieval practice trials and restudy trials, both of which were randomized within the training session. In the retrieval practice trials, participants are asked to recall the meaning of the target word from memory, while in the restudy trials, they are presented with the word and its translation. The training consists of six rounds, each consisting of both retrieval practice and restudy trials. Following the training, an immediate test is administered where participants are asked to answer all learned words as well as new words (40 words/language) in Swedish. Retention test, which is identical as day 1, is scheduled 7 days after the training session.

Statistical Analysis
The outcome of the training methods is assessed through accuracy measures (proportion of correctly recalled words) during both the immediate test and retention test. Statistical analyses will be performed using a repeated-measures ANOVA to compare performance across conditions (retrieval practice vs. restudy) and languages (German vs. Swahili). Current state and expected outcome: Several participants have enrolled in a pilot study. We hypothesize significant effects of learning strategy and prior knowledge. For the interaction, the expected learning effect, ranked from largest to smallest, is as follows: "High prior knowledge + Retrieval practice" > "Low prior knowledge + Retrieval practice" > "High prior knowledge + Restudy" > "Low prior knowledge + Restudy" on both day one (immediate testing) and day seven (delayed

testing).

Veldi, J.:

see 3. Short papers

Sevdalis, V.: **Dance and positive youth development**

As a social activity that requires non-verbal communication and elaborate full-body movements subject to complex environmental affordances, dance presents an enticing manifestation of 4E cognition operating in real-world settings. Especially during adolescence, dance provides an avenue for young people's exploration of their embodied, embedded, enacted, and extended developing minds. To that end, positive youth development relies on the assumption that all youth have the potential for positive developmental change, for example, through involvement in organized youth activities. The aim of the current review is to summarize key findings from empirical studies that used dance as a means for fostering positive youth development. This work has proven to be informative about physical-motor, cognitive-educational, and social-emotional outcomes in youth. Dance has been mostly used as an extracurricular activity or as part of a youth program, often alongside other activities (e.g., other sports or performing arts). Understanding how dance contributes to positive youth development, along with the possible factors that may influence this interaction, can assist the development of educational and intervention approaches that aim at improving the effectiveness of dance as a tool for achieving positive youth development. Future research may strive to elucidate the behavioral and brain mechanisms by which dance, as an individual action and as a coordinated interaction, may enhance performance and well-being indices in youth.

Schelin, M.: **Re-examining group development theory: A recurrence quantification analysis of interaction dynamics and performance in newly formed teams**

In contemporary dynamic organizational contexts, newly formed, continuously evolving and project- based teams are expected to coordinate and perform effectively from the outset, often under strict time and task constraints. While Wheelan's (1994) Integrated Model of Group Development (IMGD) outlines team development as a progression through distinct stages, few studies have examined whether and how such assumptions are reflected in the temporal structure of team interactions - especially in

contexts characterized by fluid team composition. Drawing on a dynamic systems perspective, this study investigates whether early interactional patterns exhibit structured, non-linear dynamics, and how these patterns relate to performance. Team behavior data was collected from 30 newly formed teams completing escape room simulations in a controlled laboratory setting. Verbal statements were transcribed and coded using the Group Development Observation System (GDOS; Wheelan et al., 2003), which categorizes utterances into seven team behaviors associated with the different stages of group development: dependency, counter-dependency, fight, flight, pairing, counter-pairing and work. The coded data was structured into time-ordered categorical sequences by team and task, based on utterance timing. To analyze the temporal dynamics of team interactions, Recurrence Quantification Analysis (RQA) and chromatic recurrence plots were applied to examine (1) intra-team interaction patterns, (2) inter-team differences, (3) relationships with team performance, and (4) the extent to which observed interaction patterns correspond with theoretical expectations for early-stage development in the IMGD model. Initial analyses suggest that while temporal trajectories of team behavior varied within and between teams and tasks, they did not consistently relate to performance, nor did they exhibit the predictable dynamics expected in early-stage development. This study contributes to team development research by exploring how interaction dynamics in newly formed teams may align with, challenge, or extend assumptions embedded in sequential models of group development, particularly in relation to team performance.

Stille, L.: **Improving risk assessments in simulated custody evaluations using AI-based decision support**

Custody evaluations are cognitively demanding assessments with profound legal and emotional consequences. In Sweden, approximately 7,000 such evaluations are conducted annually to inform court decisions on custody, visitation, and the child's best interests. Risk assessments—central to these evaluations—aim to identify potential threats to the child, such as neglect, psychological abuse, or abduction. Despite their legal weight, risk assessments in social services have been widely criticized for lacking transparency, logical consistency, and methodological rigor. Contributing factors include limited formal training, cognitive load, and the absence of structured decision-support tools. This project investigates how generative AI can support professional judgment in simulated custody evaluations. We report on two experimental studies designed to assess whether AI-supported tools can improve the quality, efficiency, and clarity of social workers' risk assessments, without undermining their professional autonomy. Study 1 uses a within-subjects design where experienced Swedish social workers conduct structured interviews with actors simulating parents involved in custody disputes. Each social worker performs one risk assessment using current practice and

another with AI support. The AI system (TalkToAlba) transcribes the interview and generates a draft risk analysis, which the social worker then edits and finalizes. Each assessment is evaluated by the practitioner via a user experience questionnaire and by blinded independent reviewers—experienced social workers—using a structured review questionnaire. Study 2 builds on this design but replaces the human-simulated parent with an AI chatbot simulating a parent in a custody dispute. Here, social workers (N ≈ 50), recruited via Prolific, are randomly assigned to either the AI-supported or control condition and complete one assessment based on a text-based dialogue with the AI parent. This enables scalable testing of the same hypotheses, using the same experience and quality evaluation measures as in Study 1. Both studies aim to test whether AI-supported assessments are: Higher in quality, clarity, and transparency, as rated by independent, blinded reviewers More structured and professionally reassuring for the assessor, based on user experience responses More time-efficient, measured through self-reported and system-recorded task durations Better at identifying critical risk-related information embedded in complex case narratives, as measured by comparing identified risks to scenario instructions and intended risk profiles To assess sensitivity to risk variation, case scenarios are designed to include different types and levels of risk (e.g., physical vs. psychological violence), enabling comparison of how well AI-supported and traditional methods capture the severity and specificity of each. The project is grounded in cognitive science theories of reasoning under uncertainty, naturalistic decision making, and distributed cognition. It also contributes methodologically by introducing structured methods for identifying common reasoning errors in risk assessments (e.g., lack of definitions, conceptual confusion, logical fallacies). The use of generative AI is not to replace human judgment, but to scaffold and enhance it in ethically sensitive and cognitively complex domains. This work bridges theory and practice by advancing research on hybrid cognition and offering a working model for how AI can be responsibly integrated into professional settings, without compromising human judgment.

van Klaveren, L.: **Opening the Black Box of Team-Based Learning: The Impact of Teacher Decisions and Student Preparation on Team Learning Dynamics**

Background: Team-Based Learning (TBL) is a structured instructional method shown to support student engagement, collaboration, and deeper learning. Existing research on TBL has primarily focused on its effects on learning outcomes, with consistently positive findings on student perceptions and attitudes. However, as recent reviews highlight, this focus represents only a narrow slice of the broader conceptual model underpinning TBL. Key elements—such as the processes by which team learning unfolds and the specific interactional dynamics that contribute to performance—remain

underexplored. To advance understanding of how TBL actually works in practice, more nuanced research is needed that goes beyond outcome measures and opens the "black box" of team interactions. Our study responds to this gap by examining team learning dynamics during online TBL application sessions, and by analysing how these dynamics relate to task design, student preparation, and team performance.

Methods: This observational study explored team learning dynamics during two online TBL application sessions in a second-year medical course at the University of Amsterdam. Seventy-three students across twelve teams participated voluntarily. Student preparation was measured via iRAT and tRAT scores; team performance was defined as the number of correct answers per task. The first session focused on psychological trauma, with two complex diagnostic tasks: one involving an adolescent with a traumatic childhood (1A) and another on PTSD in a war refugee (1B). The second session addressed paediatric orthopaedics, with three diagnostic tasks on leg deformities (2A), leg length discrepancies (2B), and hip abnormalities in children (2C). Sessions were audio-recorded, transcribed, and coded for five behaviour types: sharing, co-construction, constructive conflict, procedural, and off-task. Coded transcripts were transformed into one-second-resolution time series and analysed using descriptive 5statistics, chromatic recurrence plots (CRPs), and recurrence quantification analysis (RQA). CRPs visualized interaction patterns over time; RQA provided metrics such as Recurrence Rate, Laminarity, 5Trapping Time, and Categorical Entropy. Multilevel regression models assessed effects of task, preparation, and team learning dynamics on performance. Ethical approval was granted.

Results: Teams spent over 85% of their time on sharing, co-construction, constructive conflict, or procedural interactions, with co-construction being the most dominant behaviour. Constructive conflict was absent in three teams during the first session. Despite uniform task formats, teams varied widely in how they distributed interaction time, particularly in the second session, which showed increased sharing and co-construction but fewer procedural or conflict episodes. CRPs revealed substantial variability in interactional sequences between teams and tasks. Some teams alternated smoothly between behaviours, while others engaged in prolonged stretches of co-construction or conflict. RQA confirmed these differences: entropy and recurrence rates varied across teams, indicating distinct conversational rhythms. Tasks also shaped dynamics, with some promoting cohesive exchanges and others leading to fragmentation. Certain tasks showed positive associations between recurrence rate and performance, though overall relationships between preparation, dynamics, and outcomes were mixed.

Conclusion and Implications: Our study shows how team learning dynamics vary across teams and tasks and are shaped by both preparation and instructional design. These findings highlight opportunities to intentionally design TBL tasks that foster

more productive and engaging team learning interactions.

Short papers

The Impact of Expert Commentary on Driving Behavior and Risk Awareness in a Simulator Training Environment

Bingefors Wahlqvist, E. Hertzberg, L., Thorslund, B.

Introduction

Young drivers represent a particularly vulnerable demographic, with a significantly elevated risk of being involved in accidents (Banz et al., 2019; Walshe et al., 2017). This increased risk is partly due to limited knowledge and awareness of potential driving hazards (Fisher et al., 2006; McKnight & McKnight, 2003). In addition, developmental, social, and cultural factors further contribute to their vulnerability (Arnett, 2000; Bates et al., 2019; Walshe et al., 2017). Given the difficulty in controlling surrounding traffic and arranging specific training scenarios in real traffic settings, driving simulators serve as invaluable tools in driver education (e.g., Ābele et al., 2019; Vlakveld et al., 2011)

A study by Thorslund et al. (2024) demonstrated that simulated screening tests can identify drivers who, although they may feel ready for the on-road driving test, lack the necessary risk awareness to be considered safe drivers. Additionally, combining practical training in a simulator environment with road commentary training has been shown to enhance driver safety. Research has indicated that commentary training leads to improved hazard detection in young drivers, bringing their performance in simulator tests in line with that of more experienced drivers (Isler et al., 2009; Crundall et al., 2010). However, the effect of combining expert commentary with a driving exercise in a simulator remains largely unexplored.

Aim and research questions

The aim of this study was to investigate whether expert guiding during driving practice in a simulator enhances the training experience by increasing students' understanding of risks. To achieve this, the following research questions were formulated:

How does commentary training in a simulator environment affect:

- Driving behavior in potentially risky situations?
- Self-rated risk awareness?

Method

This study employs a mixed-methods design with driving data from the simulators and subjective ratings from a questionnaire.

Participants

The study was conducted at a Swedish automotive high school during spring 2025, using nine simulators at a time and involved in total 50 participants, all with prior simulator experience. Participants were aged 16–17, with a mean age of 16.5 years. The gender distribution was approximately 60% male and 40% female.

Equipment

High-fidelity fixed base driving simulators, equipped with software from Skillster (skillster.se), were used for data collection (Figure 1A. Each simulator featured a force-feedback steering wheel, a pedal set, and multiple screens for an immersive driving experience. The simulation software created a realistic urban environment (Figure 1B). The traffic sound and expert comments were delivered via headphones. Expert comments was added to a simulator training session, based on interviews with 3 driver instructors.
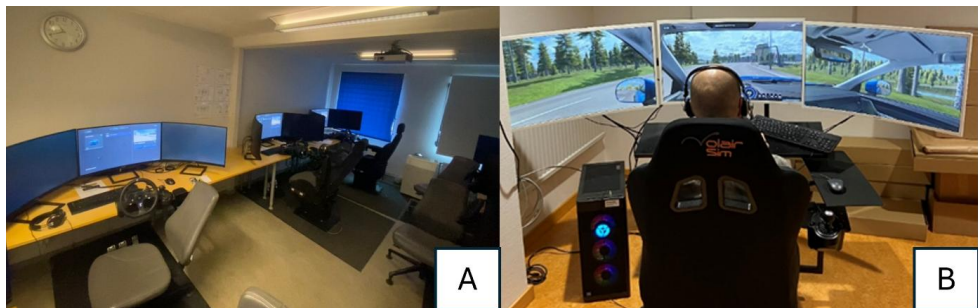

Figure 1: The driving simulator set-up.

Procedure

Participants were provided with both oral and written information about the study and were informed that they could withdraw at any time before signing the informed consent. Each participant completed a background questionnaire that included questions about their gender, the duration of their driving practice, and their self-assessed level of risk awareness as drivers on a Likert scale (from 1 = not at all to 6 = to the highest degree). Afterward, they completed the training session in the driving simulator of approximately X minutes. Half of the participants received expert commentary during the session, while the other half did not. This was followed by a second simulator session, approximately X minutes in duration. Following the driving sessions, participants completed a questionnaire that included One open-ended question about the risks they experienced during the two simulator drives, together with questions on self-rated driving performance, and repeated self-assessment of risk awareness, both using the same Likert scale as before the drive, from 1 (not at all) to 6 (to the highest degree).

Preliminary Results

Driving behavior metrics, such as collision frequency, proximity to other road users or obstacles, and driving speed, will address the first research question regarding the impact of commentary training in risky situations. Self-reported performance and risk awareness will answer the second research question, which examines the effect of self-rated risk awareness. These two data sources will be analyzed using one-way ANOVAs. Responses to open-ended questions will be analyzed through thematic analysis. The results will be updated in the next version of this paper.

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The Layered Autopoiesis of Life-Cognition: Information, Agency, and Self

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Introduction

At the heart of contemporary enactive and autopoietic thought lies a simple generative insight: *cognition = life*. This idea, first formulated by Maturana and Varela (1980) and reaffirmed by (Stewart, 1996), asserts that the very processes that allow living systems to maintain themselves are also the roots of their "knowing". To live is to "know"— where "to know" does not primarily mean abstract conceptual knowledge, but rather a spectrum starting with "*to feel"*, to be affected, to experience. This is akin to the deeper meaning of *cogito* in Descartes' *cogito ergo sum*: an act of experiencing oneself as a living, sensing, and responding being. For simple life forms, this "knowing" is feeling — a direct, embodied, self-sustaining sensitivity to difference, both internal and external.

This broader sense of knowing — starting evolutionarily as intrinsic sensitivity, as felt presence, as an organism's way of being affected by and responding to the world — reorients our understanding of cognition. It reminds us that cognition is not confined to intellectual operations or symbolic representation. Rather, it has its roots in the very act of living: in the regulation of boundaries, the modulation of internal states, the navigation of viability conditions. In many languages, the verb 'to know' overlaps with 'to feel' or 'to perceive,' indicating a deeper, pre-reflective foundation to all knowing.

From this foundation of "knowing", we build a layered account of how life processes information, expresses agency, and constitutes identity. Each level of biological and cognitive complexity builds upon the previous, subsuming earlier forms while generating new modes of interaction and selfhood. This essay outlines five such levels of organization, integrating insights from autopoiesis, information theory, systems thinking, and philosophy of mind.

Cellular Autopoiesis: The Origin of Distinction

A single cell, such as a bacterium, enacts its own boundary through metabolic self-production. It distinguishes between itself and its environment — not as a symbolic act, but as a structural necessity. It responds to chemical gradients, as well as to changes in light, pressure, electromagnetic fields, and

gravity. These differences only become information insofar as they "make a difference" for the cell — a formulation drawn from Gregory Bateson's (1972) definition of information.

In this sense, the cell is already a basal cognitive agent. It registers distinctions, processes environmental inputs, and acts to preserve its identity. The cell's *self* is its network of dynamic metabolic processes as described by (Stewart, 1996) and (Lyon, 2015).

Non-Neural Multicellular Autopoiesis

Simple multicellular organisms, fungi, and plants develop coordination beyond single-cell regulation. These organisms respond to light, touch, gravity, pressure, electromagnetic fields and humidity — not through centralized nervous systems but through distributed hormonal and structural processes.

Their agency is slower, embodied in morphogenetic flows rather than rapid locomotion. Yet they still distinguish, respond, and maintain themselves. Their selfhood is expressed in the form they grow into — a self shaped by both inner regulation and environmental context, (Di Paolo, 2005).

Sensorimotor Autopoiesis: Perception and Movement

In animals with nervous systems, a new organisation of information processing emerges: the sensorimotor loop. Sensory input is tied directly to movement; perception is shaped by action. Here, agency becomes more flexible, adaptive, and immediate. Animals can learn, explore, and anticipate (Varela et al., 1991).

The self at this level is enacted through movement and perception — a body that knows the world by moving in it. The distinction between self and environment becomes more plastic, mediated by memory and habit (Damasio, 1999).

Symbolic/Reflective Autopoiesis: Language and the Narrative Self

Primates, and especially human beings focus on a symbolic dimension of information processing. Through language, imagination, and abstract thought, humans not only interact with the world but reflect upon those interactions. Humans create inner models, simulate futures, question their own motives. Agency becomes reflective and transformative: we can choose, reinterpret, and reconfigure our lives. The narrative self is not just an actor, but a storyteller. This self can observe itself, critique itself, and change (Damasio, 2010).

Social/Cultural Autopoiesis: The Collective Self

Finally, at the collective level, human beings participate in socially extended systems of meaning — language communities, institutions, traditions, norms. These systems process information through communication and shared practices. They are autopoietic in their own right: they maintain themselves by producing and reproducing the distinctions that define them (Luhmann, 1995). Agency is distributed. No single person controls a language, a legal system, or a cultural identity — yet these systems act, evolve, and adapt. The self here is plural and participatory: we are shaped by our roles, affiliations, and shared narratives.

Distinction, Difference, and the Making of the Self

This layered model of autopoiesis is resonant with two foundational concepts:

> Gregory Bateson's (1972) "difference that makes a difference" which defines information as meaningful difference for an agent.

> George Spencer-Brown's (1969) "distinction" in *Laws of Form* that frames the creation of form — and thus of being — as an act of drawing boundaries.

In this view, to draw a distinction is to define a world. And when a system distinguishes itself from its environment and uses those distinctions to regulate its own activity, it becomes an agent (an entity acting on its own behalf) — a self.

The evolution of life, then, can be seen as an evolution of distinction-making: from cellular boundaries to symbolic identities to collective meaning systems. Each step brings new forms of input information, richer agency, and more complex forms of selfhood.

Conclusion

The narrative that unfolds from "cognition = life" suggests seeing living systems not as machines that compute symbols, but as beings that enact meaning through their own organization. Information is never just out there — it is always a difference that makes a difference for a cognizing agent, (Dodig-Crnkovic, 2017).

Through the act of distinction, life makes itself. And in doing so, it begins to "know". This is the deep logic of autopoiesis — a logic of form, difference, and the layered emergence of self.

Acknowledgment

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Exploring Attitudes and Barriers to Bicycle Helmet Use Among Urban Young Adults: Insights for Design Improvement

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Introduction

Each year, approximately 2,500 cyclists are seriously injured and 20–30 are killed in traffic accidents in Sweden. According to the Swedish Road Administration (2025), up to 50% of head injuries and 25% of fatal injuries could be prevented if all cyclists wore helmets. In 2020, the national helmet usage rate in Sweden was 47.2% (Hurtig, 2024), which remains well below the EU target of 80% by 2030.

Bicycle helmets still have significant room for improvement in terms of safety, functionality, and visual design. As a result, many people perceive existing helmets as inadequate or unnecessary. This is reflected in usage statistics—for example, in 2020, only 28% of adult cyclists in Linköping wore helmets (NTF, 2021).

Although the fatality rate is lower among younger individuals compared to seniors (European Road Safety Observatory, 2021), serious head injuries can still lead to lasting consequences. As the 18–28 age group represents the future of society, their views on helmet use are crucial for increasing adoption. Helmets must not only offer improved protection but also appeal to urban, everyday cyclists. While previous research has explored reasons for not wearing helmets, few studies have examined the deeper attitudes behind these choices.

While previous research has compared the opinions of helmet users and non-users (Forward et al., 2020), to the authors' knowledge, no study has yet examined how non-users' attitudes may change after a period of helmet use. This study contributes to the field of cognitive science through its human-cantered approach, grounded in theories of decision-making, risk perception, social psychology, and planned behaviour. The focus is on the user, specifically, the cyclist who chooses not to use the product. By exploring cognitive aspects beyond surface-level barriers, this study seeks to provide deeper insights and fresh perspectives on the challenges of increasing helmet adoption.

Aim and research questions

This study aims to explore the attitudes, thoughts, and behaviours related to bicycle helmet use among urban young adults who currently do not wear helmets. Using qualitative interviews conducted before and after a helmet trial period, the study seeks to uncover key barriers and design-related issues. The insights gained will inform design recommendations for helmets that better align with user needs and potentially increase usage. The purpose results in the following research questions:

1) What practical, aesthetic, or social factors influence young adults' decisions not to wear bicycle helmets?

2) How can helmet design be improved to address these concerns and better meet user needs?

Method

The study has an overall layout following the design methodology of the double diamond including the phases *Discovery, Define, Development,* and *Delivery,* see Figure 1. Using a qualitative approach, the study involved two semi-structured interviews, one-week helmet trial, and an iterative design process.
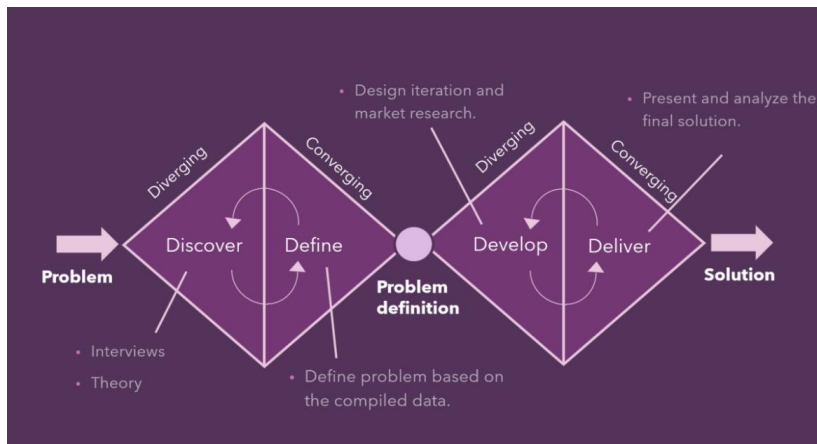

Figure 1: Illustration of the double diamond methodology fitted to the study.

Participants

Participants were recruited through social networks and were all current or former students at Linköping University. The study targeted young adults in Linköping who cycle regularly but do not use helmets. To qualify, participants had to use a bicycle as their primary mode of

transportation and be considered everyday urban cyclists—mainly biking within the city for practical purposes. To better isolate the cognitive and cultural factors influencing helmet use, the sample was deliberately homogenized: only individuals under the age of eight when Sweden's helmet law was introduced and without children were included. In total, 10 participants (6 men and 4 women), aged 23–27, were interviewed.

Equipment

During the helmet trial week, all participants used the Align II helmet. This model was selected for its affordability (approx. 700 SEK) and its classification as "A Good Choice" in Folksam's helmet tests. Its matte black, neutral design and range of sizes (up to 62 cm in circumference) made it suitable for accommodating different head sizes and serving as a neutral design baseline.

Procedure

The *discovery phase* included a literature review and interview data. Participants first completed an interview before using the helmet, focusing on cycling habits, helmet attitudes, and risk perceptions, accompanied by a sorting task about common reasons for not wearing helmets. A second interview after the helmet trial focused on the experience in terms of social, aesthetic, and practical aspects and included the same sorting task for comparison. Participants were informed orally and in writing about the study and provided informed consent with the option to withdraw at any time.

In the *define phase*, data were analysed thematically to identify key challenges related to helmet use. The *development phase* explored design solutions—both existing and potential gaps—through discussion and ideation. The delivery phase presented final design proposals and their real-world relevance. Research question 1 was addressed in the discovery and define phases, while research question 2 was addressed in the development and delivery phases.

Preliminary result

The following results are preliminary and will be updated in the next version.

The practical, aesthetic, or social factors contributing not to wear Helmets

The main reason for not wearing a helmet is the perceived imbalance between benefits and risks. Participants feel the risk is low, based on past minor injuries and confidence in their cycling ability. While they generally acknowledge helmets improve safety, they still face barriers and conflicted feelings about wearing one, despite recognizing it as the rational choice.

The main barrier to helmet use is social perception, particularly how others view helmet wearers. Participants cared more about this in their teens, but it remains a key obstacle. Prejudices against helmet-wearing cyclists, first experienced around age 13, persist into adulthood. These prejudices are less prominent when adults cycle with helmets, but are stronger when young adults or students wear them, as they're seen as overly safety-conscious and odd. However, participants are aware of this bias and generally don't think much about it when seeing others wear helmets.

Other barriers included helmets looking unattractive, being cumbersome to carry and store, limiting hairstyle options, and reducing the sense of freedom, particularly in planning where to store it. No significant overall change in barriers was found before and after the helmet trial, with individual differences outweighing group trends. However, the factor "uncomfortable" ranked lower as a barrier after the trial.

How bicycle helmet design can be improved to address the issues

Based on the thematic analysis, solutions may involve innovative helmet designs, improved infrastructure for helmet storage, or strategies to change attitudes toward helmet use. Regardless of the findings, the goal is to develop a strategy that makes helmets more appealing to users, achievable through various approaches.

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Group averages obscure counterintuitive predictions: new tests for the Decision by Sampling core mechanism

INTRODUCTION

At least since Thurstone (1927), cognitive psychology has been interested in subjective valuations: for example, what determines how much 100 SEK is believed to be worth? Why is it perceived as a small fortune by some and as mere pocket money by others?

The Decision by Sampling ("DbS", Stewart, 2009; Stewart et al., 2006) theory proposes a radical explanation for valuations of numerical quantities (e.g. money): subjective valuations are constructed (Slovic, 1995) in the moment by sequential ordinal comparisons. The cognitive algorithm proceeds as follows: an exemplar is retrieved into working memory. It is evaluated whether the target is greater than the exemplar or not. If yes, an accumulator is updated. A new exemplar is retrieved, and so on, until the process terminates (Stewart & Simpson, 2008). The subjective value of the target is simply the number of accumulated evaluations where the target was greater than the exemplar: the target's position in a (very) sparse cumulative distribution. Formally, the closed form expression is:

$$V(x) = \frac{\sum_{y_i \in Y} \text{I}(x > y_i)}{\text{card}(Y)} \tag{1}$$

where V is the subjective value of target x, $y_i \in Y$ is the sample of exemplars, and I is an indicator function that takes the value 1 if $x > y_i$ is true, else 0. Importantly, only a "small" (Stewart et al., 2006; Stewart & Simpson, 2008) number of exemplars is sampled into Y from both long-term memory and recently experienced stimuli.

A key prediction is thus that by manipulating recently experienced stimuli, we should be able to affect subjective valuations and thereby choices (Stewart et al., 2015). This prediction has been challenged empirically (Alempaki et al., 2019; André & de Langhe, 2021b, 2021a; Forsgren et al., 2025a). A proponent of DbS may counter this by conceding that the influence of recently experienced stimuli has been overstated but that the core mechanism is sound (see Forsgren et al., 2025a). We thus need to device new empirical tests that directly scrutinise the core mechanism (Forsgren et al., 2025b). Here, I present a first, analytical step towards that.

A main attraction of DbS has been that it provides a cognitive foundation for the value functions traditionally assumed "as-if" in economics. I report the previously omitted fact that DbS *does not* predict the smooth, well-behaved value functions famously depicted in Stewart

et al. (2006) and Stewart et al. (2015) for any one individual. Rather, it predicts severe instability. This leads to (at least) two previously unrecognised predictions. Firstly, the theory predicts that numerical quantities that are distinct on the objective scale should often be of identical subjective value (ties). For example, 35 000 SEK should often be believed to be of identical subjective value to 57 000 SEK. Secondly, when $a < b$ on the objective scale, the subjective value of b should often be greater than a (monotonicity reversals). For example, 39 500 SEK should often be of greater subjective value than 44 000 SEK. These predictions are counterintuitive in the sense that they *a priori* seem unlikely to hold. To avoid them, the theory requires sample sizes so large that they cannot feasible be evaluated sequentially in working memory because of that system's well-known capacity limits (e.g. Miller, 1956). If these predictions are not borne out empirically, they challenge the DbS core mechanism.

METHODS

A known challenge with the DbS theory (Equation 1) is that, to make individual-level predictions for a specific set of target attribute values, we need to know the distribution of attribute values stored in memory (see Forsgren et al., 2025). The key insight that I leverage here is that we can switch to modelling the process described in Equation 1 in terms of probability mass. That is, instead of modelling the probability of drawing exemplars that, for example, are smaller than 100 SEK we can model the probability of drawing a sample below the k:th percentile in the distribution. This way, the model conveniently reduces to sums and products of binomials: $P(\chi) = \binom{n}{\chi} p^{\chi}(1-p)^{n-\chi}$ where χ is the numbers of times the target is greater than an exemplar, n the number of samples, and p is the probability mass below the target. This "unit free" approach allows predictions that apply to any unit of measurement and any memory distribution.

Simulations of subjective value functions

We can simulate the subjective value of a target, according to Equation 1, in some arbitrary unit as a binomial distribution $P(\chi) = \binom{n}{\chi} p^{\chi}(1-p)^{n-\chi}$ where p is the probability mass below the target.

Simulations of tie rates

The only exemplars that discriminate between two targets are those that sit in-between the two. We can therefore calculate the probability of a tie as the probability of not drawing any exemplar in-between the two target attribute values:

$$P(\text{tie}) = \sum_{\chi=0}^{n} \binom{n}{\chi} p^{\chi}(1-p)^{n-\chi} \cdot \binom{n}{\chi} p^{\chi}(1-p)^{n-\chi} \qquad (2)$$

Simulations of monotonicity reversals

A monotonicity reversal occurs when the target that is higher on the objective scale wins more ordinal comparisons than the target that is lower on the objective scale. We can simulate the probability of this as follows:

$$P\big(V(\text{low}) > V(\text{high})\big) = \sum_{\chi=0}^{n} \left(\binom{n}{\chi} p_{\text{low}}^{\chi}(1-p_{\text{low}})^{n-\chi} \cdot \sum_{k=0}^{\chi-1} \binom{n}{k} p_{\text{high}}^{k}(1-p_{high})^{n-k} \right) \quad (3)$$

RESULTS

Figure 1A displays the subjective value function reported in Stewart et al. (2015) and Figure 1B displays individual-level subjective value functions implied by the theory. Clearly, the latter are substantially more volatile than the function reported in Stewart et al. (2015), especially when taking a "small" sample of exemplars. When sampling 1000 exemplars, we get something closer to the function reported in Stewart et al. (2015).

When sampling up to 10 exemplars from memory, the probabilities of ties and monotonicity reversals remain high even for highly distinct stimuli (Figure 1C). For example, even when the stimuli are separated by 40% of the mass of the full distribution of exemplars in memory, the probability of a tie remains at 18%. For the probabilities of ties and monotonicity reversals to become negligible, thousands of exemplars need to be sampled.

CONCLUSION

DbS has recently been challenged by empirical work demonstrating that group-level predictions do not hold (Alempaki et al., 2019; André & de Langhe, 2021b, 2021a; Forsgren et al., 2025a). Here, I report that the figures presented in previous work – as a consequence of averaging over groups instead of inspecting individual-level predictions – obscure a substantial volatility. This volatility gives rise to two previously unrecognised predictions: high frequencies of ties and monotonicity reversals. To support the DbS core mechanism, one needs to show that these counterintuitive predictions match empirical data. This illustrates the importance of scrutinising individual-level predictions (cf. Fischer et al., 2024).

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Figure 1 – DbS predictions on group level and individual level
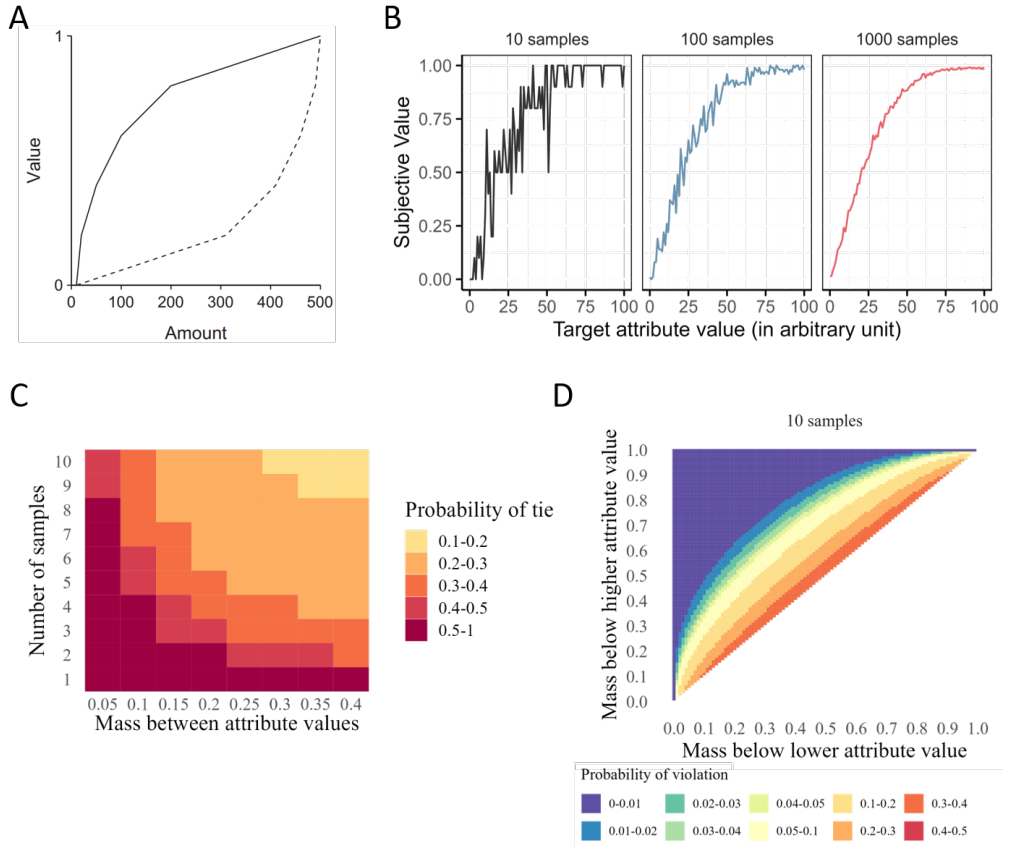
Note. A: Example of smooth, well-behaved value functions predicted on group level, reproduced from (Stewart et al., 2015). B: Examples of individual level value functions. At about 1000 exemplars sampled, the function starts looking fairly smooth. C: Predicted tie rates by number of samples and probability mass between two target attribute values in the distribution of exemplars in memory. D: Predicted monotonicity reversal rates by probability mass below the higher/lower target attribute value in the distribution of exemplars in memory.

Driving Simulators in Education: Current Use and Instructor Motivation

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In pace with the development of technological aids and digital tools, the way we educate and learn have changed. In practical education, for example in educating programs for professional drivers, digital tools such as driving simulators offer new learning opportunities by recreating realistic driving situations that, in a controllable, risk-free, and safe manner, enable training in a virtual environment (de Winter et al., 2012). Driving simulators as learning tools can also create support opportunities for driver learners with challenges in their learning process since the simulation can be individualized depending on the specific student's needs (Cox et al., 2017; Ābele et al., 2019; Vlakveld et al., 2011). Moreover, previous research indicates that driving simulators can improve driving ability in novice drivers (Cox et al., 2009; Brooks et al., 2016; Bruce, Unsworth & Tay, 2014).

Also, using driving simulators as a learning is in line with Experiential Learning Theory (Kolb, 1984) which is based on the idea that the most effective way to learn is through direct experience. Learning activities such as practicing in a driving simulator can support learning by offering an environment where students can both acquire theoretical knowledge and have meaningful experiences simultaneously (Kolb, 1984). Nevertheless, despite digital advancements and the potential educational benefits, the use of driving simulators in traffic education remains limited. While previous research has highlighted the advantages of driving simulators in improving driving ability (e.g., Roenker et al., 2003), the factors that motivate driving instructors at driving schools to use these tools are less explored (Gustavsson et al., 2020).

Purpose

The purpose of this study is to examine how driving simulators are used in driver education today. The study also aims to understand what influences driving instructors' motivation to use simulators in teaching. The following research questions will be explored in this study:

1. How are driving simulators used in driver education today?

2. What influences driving instructors to use driving simulators in driver education?

Metod

This study uses an inductive qualitative design with semi-structured interviews with driving instructors.

Participants

The sample consists of a total of 8 respondents (X women), including both teachers and other key actors (such as managers and training coordinators) from driving schools and practical upper secondary schools specializing in education for professional drivers. The participants were recruited using a convenience sampling method (Kjellberg & Sjökvist, 2015). This means that individuals who were asked and agreed to participate were included in the sample. Participants were initially recruited by identifying driving schools and upper secondary schools that use driving simulators. The schools were then contacted via email or phone with a request for participation. The participants were informed about the purpose of the study and participated voluntarily. All participants gave their written consent to participate in the study.

Design and procedure

The chosen qualitative methodology is often recommended and used to collect rich and in-depth data concerning people's experiences as well as attitudes and motivation (Taylor et al., 2015). The interviews were conducted through Microsoft teams and lasted approximately 30 minutes. The interview guide (see appendix) included open-ended questions where the respondents were given an opportunity to express their thoughts and experiences on using driving simulators when teaching. The participants were also asked spontaneous questions based on their answers.

Analyses

The data of the transcribed interviews was analyzed using Thematic analysis according to methodology described by Clarke & Braun (2016). Thematic analysis is often used for identifying, analyzing, and interpreting recurring patterns found in qualitative data and provides a clear and structured methodology of processing the data material (Clarke & Braun, 2016). Initially, the transcribed interviews were read to obtain a general understanding of the data. Secondly, content units of the transcripts containing meaningful aspects related to the research questions were identified and marked i.e., the transcripts were processed into codes. When the codes were identified, potential patterns among the codes were evaluated. The codes were

grouped based on the identified patterns and processed into themes. To ensure quality in the analysis, the themes were tested against the coded data and then examined in relation to the entire dataset (Clarke & Braun, 2016).

Preliminary Results

The results are presented based on the thematic analysis of the semi-structured interviews, with a focus on the central patterns and themes that emerged during the coding process.

Use of Driving Simulators in Driver Education

The results show that driving simulators are used in various ways within driver education, depending on the school's resources, as well as the instructors' views and approaches. These factors, in turn, influence both when the simulator is introduced in the training and which aspects are prioritized in its use. A common view among the interview participants was that the simulator is primarily seen as a complement to traditional driving instruction. Several instructors described how the simulator is used both to practice specific driving tasks and to introduce risky situations that would otherwise be difficult or impossible to train for in real life. The use of simulators also varies depending on the level of education, the student's individual needs, as well as the type of driver's license the student is aiming for.

Areas of Use and Typical Training Scenarios

A recurring theme in the interviews was which specific tasks driving simulators are most commonly applied to. One frequent area of use is maneuvering practice, particularly reversing, parking, and gear shifting tasks that are often perceived as especially challenging at the beginning of training, especially when learning to drive a manual transmission vehicle. Several instructors also highlighted the simulator's advantage when it comes to risk-related scenarios, such as driving in the dark, on slippery roads, or in unexpected traffic situations that are difficult to recreate in real-life settings for example, when someone suddenly runs across the road at a bus stop. Using driving simulators as a tool for theory integration, i.e., connecting theoretical knowledge with practice (e.g., right-of-way rules).

Factors Influencing Driving Instructors' Motivation

Another central theme concerns the factors that influence driving instructors' motivation to use driving simulators. Many highlighted the pedagogical benefits as a key motivator, the ability to create controlled and repeatable exercises was considered particularly valuable. One instructor expressed it as: *"We can create structured scenarios that don't always exist in real life."*
Economic and practical factors also play a role. Simulators can help reduce costs for both students and schools, while also having positive environmental effects through decreased fuel consumption.

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Appendix

Intervjuguide - Körsimulatorer i förarutbildning

Inledning

1. Presentation av mig själv.

2. Presentera vad studiens syfte är och hur lång intervjun beräknas att ta. Ge en kort introduktion till intervjun.

3. Förklara att deltagandet är frivilligt och att de kan avbryta när som helst.

4. Informera om anonymitet.

5. Fråga om tillåtelse att spela in intervjun.

Intervjufrågor

Bakgrundsfrågor

1. Kan du berätta lite om din yrkesroll och erfarenhet som trafiklärare/gymnasielärare?
2. Hur länge har du arbetat som trafiklärare/gymnasielärare?
3. Vilka undervisningsmetoder använder du främst i din undervisning?

Användning av körsimulatorer (första forskningsfrågan)

Hur används körsimulatorer idag i undervisningen, och vilka mönster kan identifieras i deras användning?

1. Har du erfarenhet av att använda körsimulatorer i din undervisning? (Om JA →) Kan du berätta om din första erfarenhet av körsimulatorer?
2. Hur används körsimulatorer idag i din undervisning? Kan du beskriva några typiska moment där de används?
3. Vilka fördelar ser du med att använda körsimulatorer i undervisningen?
4. Finns det några utmaningar eller begränsningar med att använda körsimulatorer?
5. Har du märkt några mönster i hur simulatorer används? ex. vid specifika moment som i början av utbildningen, när eleverna övar på specifika färdigheter eller för specifika elever?

Attityder till körsimulatorer (andra forskningsfrågan)

Vad påverkar trafiklärares motivation och intresse för att använda körsimulatorer i undervisningen?

1. Vilka är dina åsikter om användningen av körsimulatorer som pedagogiska verktyg?
2. Vad påverkar din motivation att använda eller inte använda körsimulatorer i undervisningen?
3. Finns det något som skulle kunna öka din motivation att använda körsimulatorer mer? ex. stöd i utbildning (introkurs), resurser (manualer).
4. Hur ser dina elever på användningen av körsimulatorer? Upplever du att de är engagerade och motiverade?
5. Har du fått någon form av stöd eller vägledning i hur du kan använda körsimulatorer?

Avslutning

1. Finns det något annat du vill tillägga om körsimulatorer och deras användning undervisningen?

Tacka intervjupersonen för sitt deltagande och fråga om personen har några funderingar är det bara att höra av sig på mejl. Avsluta ljudinspelningen.

Lexical neighbors support the acquisition of novel words with common phonological patterns

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Abstract

Previous work suggests that phonological neighborhood density (ND) and phonotactic probability (PP) sometimes show an interacting effect on word learning in children. The purpose of the present study was to investigate whether this interaction is observed across different age cohorts in a Swedish language context. Children from Grades 1, 3 and 6 performed a word learning paradigm in which they listened to two stories and learned pseudowords that were orthogonally manipulated across low and high ND and PP. The results indicated better learning in older children and with repeated exposure to the psuedowords. The interaction between ND and PP was evident across all Grades. There was a trending negative effect of high ND when PP was low, but a positive effect when PP was high. Similarly, the effect of high PP was positive when ND was high. These results indicate that children in elementary school can utilize lexical neighbors to support word learning when the phonological patterns are familiar, but not when the patterns are unfamiliar. In other words, more cognitive resources for word learning might become available when the lexical context allows for it.

Introduction

The foundation of learning language involves the acquisition of language-based representations in the mental lexicon. When representations of language input are established, these will influence consecutive learning (Leach & Samuels, 2007). This has been shown in experimental work both in children (van Der Kleij et al., 2016) and in adults (Storkel et al., 2006). For example, both the size of the lexical neighborhood to which a novel word belongs (neighborhood density, ND) and the frequency of occurrence of the phonological patterns of the word within the language context, i.e., phonotactic probability (PP), seem to influence learning, and sometimes produce an interacting effect (Han et al., 2016; van Der Kleij et al., 2016). In the present study, we tested whether ND and PP showed an interacting effect on word learning in Swedish-speaking children.

Word learning has three critical steps: triggering, configuration, and engagement (Leach & Samuels, 2007; Storkel et al., 2006). A prerequisite for learning a new word is that it is perceived as new; this will *trigger* learning. After learning is triggered, the novel word form is *configured* as a representation in the mental lexicon. When re-exposed to the new word, engagement of relevant sub-lexical and lexical features in the lexicon occurs, and, over time, the new word will affect the structure of the mental lexicon. Some (e.g., Han et al., 2016; van Der Kleij et al., 2016) propose that a novel word in a lexical context characterized by low ND (few lexical neighbors) and low PP (uncommon phonological patterns) is more likely to trigger learning because multiple cues indicate that it is novel. Furthermore, in the configuration process, existing representations (i.e., high ND and high PP) are assumed to support successful configuration into the mental lexicon by alleviating the strain on working memory. In line with these ideas, convergence between ND and PP is often reported to produce better learning than when either factor is low, and the other is high.

The potential interacting effect between ND and PP in word learning has to the best of our knowledge not been investigated in a Swedish context. One reason for this is that the appropriate lexical metrics have not

been available until recently (see, Witte & Köbler, 2019). In the present study, we investigated whether the interacting effect between ND and PP was observed across school-aged children in Grades 1, 3, and 6 in a Swedish context.

Methods

Participants. A total of 56 Swedish-speaking pupils from Grade 1 (3 boys, 13 girls), 3 (9 boys, 13 girls), and 6 (6 boys, 12 girls) participated. No one had a developmental disability, and all showed typical levels of receptive vocabulary, phonological awareness and verbal working memory on standardized tests. The study was conducted in accordance with the Helsinki declaration and participating children gave their written informed consent, and caregivers approved their participation.

Word learning experiment. Sixteen Swedish pseudowords were created based on algorithms developed by Witte and Köbler (2019). ND and PP were orthogonally manipulated: four words had high PP/high ND (dˈuːt, rˈadː, pˈeːl, bˈɵŋː), four high PP/low ND (ɟˈafː, fˈøːm, mˈɛvː, sˈeːf), four low PP/high ND (ɕˈoːs, jˈɑːv, nˈøːl, lˈyːn), and four low PP/low ND (dˈoːf, vˈədː, rˈɛːp, vˈɵjː). The word learning experiment was based on an English model (Storkel et al., 2006) and was adapted to work well for children (c.f., van Der Kleij et al., 2016). Pictorial materials (i.e., word referents and story characters acting on these) and two short stories were received from the authors of the English model. Swedish versions of the stories were audio-recorded in a female voice with clear pronunciation. Each story had two versions, both containing eight monosyllabic pseudowords (2 from each category of the combination of low/high PP/ND) that each referred to an unfamiliar object presented in a meaningful context (see Storkel et al., 2006). Across the two versions, the mapping between types of word (e.g., high PP/high ND, low PP/high ND) and the referent was varied. Versions were balanced across participants. Each story had three Episodes, and learning was tested between Episodes by asking the participant to name the referents with their associated word. The pseudowords were presented once in the first episode and three times each in episode two and three. A laptop was used for the presentation of pictorial and auditory materials. For each picture in the picture naming task, the test leader used a scoring sheet to manually note whether the participant responded with the correct pseudoword.

Data analysis. A generalized linear mixed effects model was fitted to the data to predict the success probability of correct picture naming by using the *lmer* package in R. As predictors of interest, Episode (three levels: 1,2, and 3), Grade (factor, three levels: 1, 3, and 6), PP (factor, two levels: low and high), ND (factor, two levels: low and high), as well as all interactions between PP, ND and Grade, were included in the model. Story (factor, two levels: Story 1 and Story 2) was added as a variable of no interest. Participant was used as a random effect over ND and PP. The *emmeans* package was used to follow up on interactions. An α-level of .05 was applied in all analyses.

Results

Learning improved as a function of Episode (success rates: 11% for Episode 1, 27% for Episode 2, and 41% for Episode 3) and Grade (success rates: 9% in Grade 1, to 25% in Grade 3, and, finally, 51% in Grade 6). When PP was low, there was a trend for a negative main effect of high ND that did not reach statistical significance, OR = 0.51, $p < .094$. When ND was low, there was no effect of high PP, OR = 0.84, $p = .64$. However, in the follow-up of the statistically significant interaction between high PP and high ND, OR = 2.97,

p = .025, low ND words showed a poorer success rate (21%) than high ND words (34%), OR = 0.53, p < .001 (see Fig. 1) for high PP words. For high ND words, low PP words also showed a poorer success rate (17%) than high PP words (34%), OR = 0.38, p < .001 (see Fig. 1). All interactions between Grade and ND and PP were non-significant (ps .43-.93).

Discussion

We investigated the interacting effects between ND and PP on word learning in school-aged children from Grades 1, 3, and 6, in a Swedish context. As reported from studies on children in other language contexts, we also saw evidence of an interaction, with optimal learning when high ND and high PP converged. Learning improved with repeated exposure and in later Grades.

Most previous studies showed an interacting effect between ND and PP in word learning in English- (Han et al., 2016) or Dutch-speaking (van Der Kleij et al., 2016) participants. To the best of our knowledge, no previous

Fig. 1. Estimated success probabilities (% correct) for novel words with low/high neighborhood density (ND)/phonotactic probability (PP) across Grades 1, 3, and 6.

study observed the interaction in a Swedish-speaking sample. Moreover, the interaction was not investigated in children 9 years or older in previous work. Here, we replicated the interacting effect between ND and PP in a new language context and across a wider age range of children. Typically, the interaction has been interpreted in terms of the triggering and configuration steps of word acquisition. However, the fact that the interaction is not always observed (e.g., Storkel et al., 2006) seems to suggest that it does not represent the different steps in the word learning process, unless there is a good reason to assume that one step might not apply in all situations. Thus, alternative interpretations are warranted.

If one takes an overarching perspective on the studies that have reported an interaction between ND and PP, it seems like the interaction is observed when the cognitive resources are limited. For example, Han et al. (2016) observed the interaction in adult participants when learning took place in the presence of background noise. Furthermore, others have reported evidence of an interaction when resources are developmentally constrained, that is, in child populations (e.g., van Der Kleij et al., 2016). It might be that for novel words with phonological patterns that are more frequent in the mental lexicon (high PP), processing is less taxing on cognitive resources and the lexical neighbors can then be utilized to support the successful configuration of the new word. However, when more cognitive resources are required for processing because the novel word contains uncommon phonological patterns that are poorly represented in the mental lexicon (low PP), lexical neighbors might instead compete with the new target, leading to inadequate configuration. Thus, the lexical context will influence the cognitive resources available for learning.

Using a story format to investigate lexical mechanisms involved in word learning has the advantage of being engaging, especially for children. It also mimics a natural learning situation for the child. However, we believe it might constrain the precision of the conclusions that can be drawn in relation to the steps in the word learning acquisition process. Triggering refers to the identification of a novel word, which logically should be
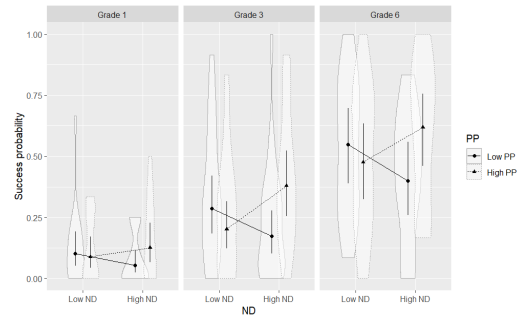
assessed when it occurs. When learning is assessed as a continuous process over the course of a story, triggering will be confounded with later parts of the acquisition process. Configuration is better captured within the story format, since the picture naming task captures the participant's knowledge about the novel words. If, however, the answer is incorrect, it cannot be determined whether this was because triggering did not occur, or if some step of the configuration process was incomplete. Thus, we see room for improvement in the experimental paradigm applied in the present and previous studies. Future research should identify the specific roles of ND and PP in different steps of acquisition, potentially by combining behavioral and physiological (e.g., electroencephalography) measures.

The type of corpus-based data that we and others have utilized to create the pseudowords is useful to study psycholinguistic effects (Witte & Köbler, 2019). However, the learning effect occurs at the individual level, and we do not know how well the individual's lexicon matches the corpus-based estimates of ND and PP. If estimates instead were based on the level of the individual, the precision of the manipulations and, after that, analysis would be improved. This does not mean that neither the present nor the earlier results are less important, but using corpus-based estimates is a likely source of error in the manipulation of the variables. By introducing participant as a random effect in the statistical model in the present study, some errors from variability in the familiarity with the lexical neighbors and phonotactic patterns was likely removed. In future studies, it might be useful to assess individual-level corpuses and establish relevant manipulations based on those.

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The evolution of cognition – two similar theories compared

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Abstract Just before publication of my paper, a very similar study done 25 years earlier by Professor Richard L Coren came to light. Both propose a geometrically accelerating sequence of 13 milestone events in the evolution of cognition from the Big Bang to the invention of the computer. Here I present a brief summary of my theory´ and compare it with Coren's theory.

My theory concerns the emergence of different methods for an organism to pass on heritable variation to the next generation. The different kinds of heritable-variation information are closely related to cognition level. This approach sees all biological, cultural and technological evolution as part of a continuing process leading inevitably to human intelligence. I also find an explanation for the pattern of evolution in chaos theory.

Coren discussed chaos, but did not know of the Feigenbaum Constant, and overlooked links to chaos theory.

Introduction

Just before publication of my theory on the evolution of intelligence, a very similar proposal published 25 years earlier by Professor Richard L Coren came to light (Coren, 1998). Here I will give a summary of my theory and compare it with Coren's theory.

Theory Heritable variation is information in different forms such as genetic codes, acquired or taught skills and knowledge, or found in books or on the Internet. (For simplicity, I shall refer to useful information as "heritable variation", and almost all information is useful.) I argue that each distinct type of information belongs to a different cognitive level and is passed on to the next generation by a different method. I propose a geometric sequence of 13 different methods of transmitting heritable variation to the next generation (Hoggard, 2024). These methods are in 3 groups: biological, cultural technologically. (Nothing was passed on in the initial physical evolution of the universe, because there was no life and no next generation.) The sequence of dates is geometric because the ratio of successive time intervals between the emergence of each method is always the same (measured to be between 4.61 and 4.83).

The sequence of events I use is based on studies by Gärdenfors and Högberg (G&H) of Intentional Teaching among humans and animals. They propose that there have been 6 methods[2] of teaching during cultural evolution.

Figure 1. Disruptive innovation and method of passing on variations of it. Arrows are predicted dates. Error bars at arrow tips are actual dates.
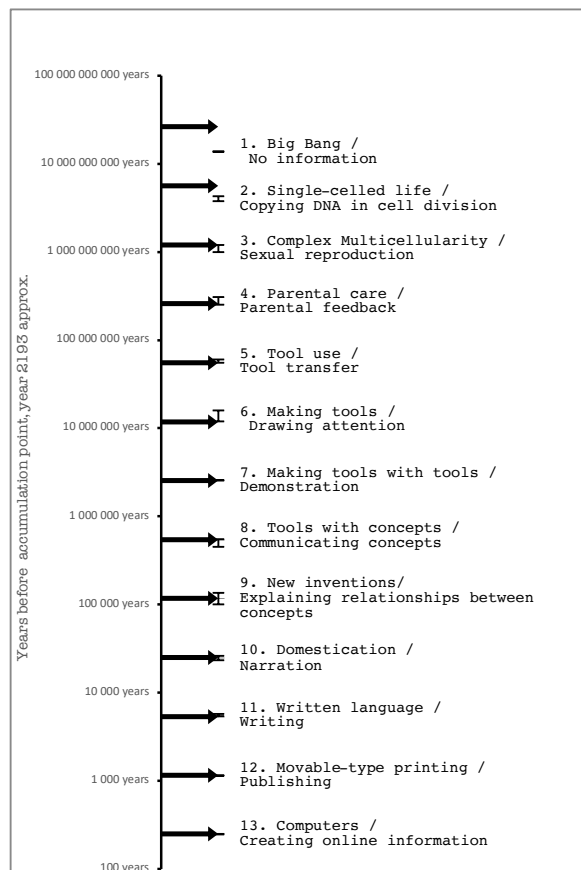
Teaching methods are difficult to date because they rarely leave any traces that can be found millions of years later. But I assumed that each method is associated with a "disruptive" innovation ("disruptive" because it requires a new method of teaching). I then ascertained which innovation was linked to which teaching method. Then I extrapolated the sequence back to the Big Bang, and forward to the invention of the computer.

The 13 disruptive innovations are: 1) *Big Bang, 2) Single-celled life, 3) complex multicellularity, 4) parental care, 5) tool use, 6) making tools, 7) making tools with tools, 8) making tools according to concepts, 9) new inventions, 10) domestication, 11) writing, 12) printing, 13) computers*. For each of the disruptive innovations in the list above, there is a new method of passing on heritable-variation information[1]: *1) No transmission, 2) Copy DNA, 3) Sexual reproduction, 4) Parental approval, 5) Tool transfer[2], 6) Drawing attention, 7) Demonstration, 8) Communicate concepts, 9) Explain relationships between concepts, 10) Narration, 11) Writing and reading, 12) Teaching from books, 13) Online information.* For details, see paper (Hoggard, 2024). In figure 1, events 1, 2 and 3, converge to the predicted dates. Each interval between predicted dates is 4.669 times shorter than the previous interval.

Cognitive understanding The disruptive innovation and the method to pass on heritable-variation information about the innovation are mutually dependent, which is why they arise simultaneously. The organism has the

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[1] Six of the transmission of heritable-variation information events (4, and 6-10) are from G&H, and all the other events are extrapolated from these.

[2] The intervals indicated that there was an event missing in G&H's list. It turned out that a behaviour known as "tool transfer" had recently been re-classified as a teaching method (Musgrave et al., 2016). This event matched the date of the missing event. Teaching is defined as "facilitating learning".

ability both to use and pass on variations of the innovation. At the cell level, this is probably unconscious, but at higher levels the conscious ability to use and pass on is what we might call "understanding".

New evolution processes Each pair of events on the timeline is actually part of a complete new and faster evolution process. The previous evolution process does not have a method for passing on information about the disruptive innovation, and new evolution process takes the lead in evolution because it is faster (otherwise it would not take over). The previous evolution process takes a back seat, but it continues to work, together with earlier evolution processes. As Gärdenfors and Högberg write, a new teaching method does not replace existing ones, it adds to them.

Levels of cognition The heritable variations that are passed on to the next generation via various channels correspond to cognitive levels. My theory divides cognition into the 13 stages: (1) No cognition; (2) Cell-cognition with learning but little or no consciousness; (3) Multicellular animals evolved senses such vision, hearing, smell, etc., creating instinctive cognition; (4) Cognition related to sociality, social learning, and teaching. (5, 6, 7, 8, 9) No less than five levels of cognition where tools and communication develop together; (10) Domestication and other new livelihoods, and a complete language; (11, 12, 13) Writing, movable-type printing, and computers primarily facilitate *collective* cognition. At each new cognition level there are a lot of possibilities to explore, even though the type of knowledge to be gained is specific for each level.

Chaos theory The geometric ratio of the event sequence was measured to be between 4.61 and 4.83. This is likely to be the Feigenbaum Universal Constant, 4.669201… which fits the measured ratio. It is associated with geometric series. It comes from chaos theory, which is the study of iterated, nonlinear, dynamic systems, such as evolution. Such sequences can be found in iterated nonlinear systems including Complex Adaptive Systems, of which life is an example. Finding the Feigenbaum Constant in our data tells us that we have a sequence of thresholds where a small quantitative change in the "bifurcation parameter" causes emergent phenomena, that in turn cause a *bifurcation* in the output variable, which is usually population if one is studying population dynamics. In the case of evolution, yearly fluctuations in population due to emergent phenomena are not detectable, but many of the emergent phenomena themselves are detectable directly and the date of emergence known.

If this is true, then the evolution of human intelligence is deterministic. Many readers may at this point say "it cannot be true". Chaos theory is normally associated with sensitivity to initial conditions making prediction impossible. But in other phenomena described by chaos theory, the presence of Feigenbaum constant "implies an *insensitivity* to initial conditions which is just about the opposite of the sensitivity to initial conditions found in

chaotic systems (the butterfly effect)" (Goldstein, Jeffrey, 2015). Cherry-picking of data has hopefully been avoided by using a list of cultural inheritance methods (teaching) compiled without regard to timing. The 2 biological inheritance methods in figure 1 have long been known to be dominant methods, until relegated by a faster method. The three technological inheritance methods are still tentative, but are plausible. (My original paper is unclear about "alternative" means of variation, inheritance, sex, and other aspects of evolution. Their existence cannot be denied, so it seems that the methods in my list are the dominant methods, not the only methods.).

It is worth recounting at this point that the physicists who were the first to be told about chaos theory found that its universality, which made chaos theory so useful, was also what made it so difficult to believe (Gleick, 1987).

Comparing Coren's sequence The first 3 and the last 3 events in Coren's sequence were the same as my disruptive innovations, but the rest were taxonomy, as follows: *4) Mammal, 5) Anthropoid, 6) Hominoid, 7) Hominid, 8) Homo (e.g. Homo neanderthalensis), 9) Homo sapiens, 10) Homo sapiens sapiens* (Coren, 1998). Coren wrote that he wanted "primates" as a taxonomic level, but it would not fit his sequence. He concluded that information was the crucial factor in evolution, but "…it is difficult to ascertain just what informational property was developed during each cycle…" (Coren, 1998). He discusses chaos theory, but was unaware of the Feigenbaum Constant, and thereby narrowly missed discovering the links to chaos theory that I found.

Conclusions I may have found what Professor Coren was looking for – a unified theory of Grand Evolution. It is based on the evolution of heritable variation. Chaos theory provides an explanation, albeit top-down, with no detail. "If … universality such as Feigenbaum's constants are at work, then one can work *downwards*… to learn more about the lower level [rather] than the usual reductionist explanatory strategy of working upwards from supposed fundamental entities and dynamics." (Goldstein, Jeffrey, 2015)

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Investigating the Role of Conceptual Vagueness in Interactive Dynamics

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Abstract

This study investigates the social dynamics triggered by concepts varying in abstractness and vagueness, integrating traditional methods (norming study) with an interactive paradigm (main study). Results from the norming study suggest that vagueness is partially predicted by abstractness but represents a distinct semantic component. The main study further demonstrates how abstractness and vagueness uniquely shape how dyads evaluate the quality of their collaborative interactions.

1. Introduction

Humans possess the sophisticated ability to understand and use abstract concepts (e.g., *subtraction*, *fantasy*). Abstractness refers to concepts, from emotions to numbers to social concepts, whose members are perceptually diverse and whose meanings rely heavily on language and internal experiences (Banks et al., 2023; Reilly et al., 2024). Because abstract concepts' meaning is highly variable and generates uncertainty, interacting with other people is particularly crucial both to recur to others' expertise or to find common ground and co-build meaning (Borghi, 2022; Gandolfi et al., 2022; Mazzuca et al., 2024).

Recent proposal suggests that abstract concepts might vary in the kind of social interaction they promote, based on how well-defined and precise or oppositely vague the meaning of a concept is (Borghi et al., 2025). While determinate abstract concepts (e.g., *entropy*) are precise and often expert-defined, vaguer ones (e.g., *freedom*) remain open to reinterpretation and negotiation. As a result, people might outsource knowledge more (Rabb et al., 2019) with determinate concepts and engage socially with vaguer ones. Even if long debated in philosophy (Peirce, 1905), to our knowledge, no norms on vagueness exist, and no study investigates its influence on social interaction.

1.1 Present Work

This work explores interactive dynamics in conversations starting from concepts differing in abstractness and vagueness. A preliminary norming study quantified vagueness and examined its links with established semantic dimensions (abstractness, social metacognition (*i.e.,* need of others to learn and understand the meaning), social valence, and familiarity, Villani et al., 2019). The main study tested how abstractness and vagueness differently shape interactions within levels of shared common ground (romantic partners, *i.e.,* couples that were together for at least one year vs. strangers) using a conceptual definition task. We predicted that interactions with more abstract and vague concepts would be perceived as more difficult

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and less smooth than those with more determinate and concrete ones. The study received approval by the Ethics Committee of Sapienza University of Rome (n° 0000779).

2. Norming Study

2.1 Method

Participants. Twenty-one Italian native speakers (*M age* = 23.60, *SD* = 1.91, *range* = 21 – 29, 15 cisgender women).

Materials. Seventy-four words selected from Villani et al. (2019), split into abstract (n = 48, abstractness ≥ 3) and concrete (n = 24, abstractness < 3).

Procedure. Data was collected using Qualtrics. Participants rated vagueness on a 7-point Likert scale[1].

2.2 Data Analysis and Results

Analyses were conducted in R (v4.3.2) using lme4 (Bates et al., 2015). A linear model tested vagueness as the outcome, with abstractness, social metacognition, and social valence as predictors.

Vagueness is partially explained by abstractness. Abstractness significantly predicted vagueness (b = 0.63, R^2 = .50, *p* < .001), while social metacognition and social valence did not (*ps* > .095).

Stimuli selection for the Main Study. Based on these results, 36 concepts were chosen for the main study, balanced across three categories (Vague Abstract vs. Determinate Abstract vs. Concrete).

3. Main Study - Abstractness and Vagueness in Dyadic Interactions

3.1 Method

Participants. Sixty-eight native Italian speakers (*M age* = 23.50, *SD* = 2.55, *range* = 19–32) participated, divided into romantic couples (*n* = 17) and strangers (*n* = 17). Statistical power was estimated with G*Power (Faul et al., 2007), informed by a similar previous study (Fini et al., 2023).

Procedure. Pairs were presented with a balanced set of concepts (*n* = 9). For each, their task was to hold a 3-minute conversation while wearing eye-tracking glasses, aiming to agree on a shared definition and collaboratively write a short educational post (as part of a cover story) for students. After the writing phase, participants individually rated the overall interaction experience. The following analyses focus on Perceived Interaction Difficulty, examining the impact of gap between perceived Self vs. Other-Person Expertise and between perceived Self vs. Other-Person Contribution[2].

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[1] Instructions for Vagueness ratings were administered as follows: "*While some words have a definite meaning, not vague and determinate (e.g., "Wednesday"), other words have an open, more vague and less determinate meaning (e.g., "future"). Your task is to rate on a 7-points scale how determinate (= 1) or indeterminate (= 7) the meaning of each word is*".

[2] Gap in Contribution/Expertise Indices quantify perceived dyadic mismatch in contribution and expertise and were computed as the mean of: a) difference between the contribution/expertise estimated by participant y for participant x, and x's self-reported contribution/expertise; b) difference between the contribution/expertise estimated by participant x for participant y, and y's self-reported contribution/expertise.

3.2 Data Analysis and Results

We used Bayesian ordinal regression models with flexible thresholds (MCMC sampling: 6k iterations per chain, 3k warm-up, adapt delta = 0.99) via brms R's package (Bürkner, 2017). Two models were fitted for Perceived Interaction Difficulty, with Type of Concept (ref. level: Vague Abstract) and Intimacy (ref. level: Romantic Couples) as predictors. Gaps in perceived Self vs. Other-Person Expertise and perceived Self vs. Other-Person Contribution were included as distinct centered covariates. Random intercepts were specified for couples and concepts, with participants nested within couples.

Vagueness Influences Perceived Interaction Difficulty. Gaps in perceived Self vs. Other-Person Expertise significantly increased interaction difficulty by 40% (OR = 1.40, 95% CI: [1.06, 1.84]), with the effect being stronger for Determinate Abstract concepts, where expertise gaps increased Perceived Interaction Difficulty by 58% (OR = 1.58, 95% CI: [1.08, 2.32]). Interactions with Concrete concepts were perceived as easier than those with Vague Abstract concepts, reducing Perceived Interaction Difficulty by 38% (OR = 0.62, 95% CI: [0.40, 0.95]), (Fig 1 left panel).

Similarly, gaps in perceived Self vs. Other-Person Contribution raised Perceived Interaction Difficulty by 88% (OR = 1.88, 95% CI: [1.44, 2.43]), though Concrete concepts mitigated this effect, reducing it by 43% (OR = 0.57, 95% CI: [0.39, 0.84]). No significant effects were found for the interaction between Determinate Abstract concepts and Contribution gaps (OR = 0.85, 95% CI: [0.58, 1.24]), (Figure 1 right panel). Finally, levels of Intimacy did not impact Perceived Interaction Difficulty.
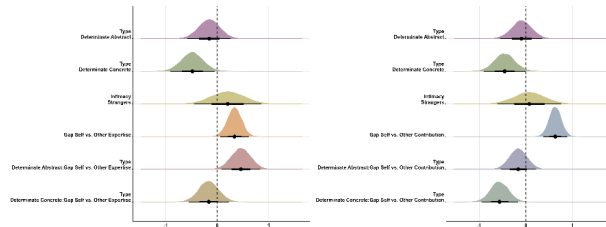

Figure 1: Posterior Distributions for the fixed effects Type of Concept, Gaps in perceived Self vs. Other-Person Expertise (left panel) and Contribution (right panel), and their interactions, and Intimacy over the level of Perceived Interaction Difficulty. The density curves depict the posterior estimates' distribution, with the black bars representing the corresponding credible intervals.

4. General Discussion

This study explores the relationship between abstractness and vagueness, and how these dimensions influence the quality of interactive dynamics. The preliminary norming study reveals that, although abstractness partially predicts vagueness, vagueness is a separate worth considering semantic component. The main study suggested collaborative interactions to be modulated by both conceptual abstractness and

vagueness. People in dyads found interactions on concrete concepts easier than those on vague abstract ones. For determinate abstract concepts, difficulty increased with gaps in perceived expertise, suggesting that expertise—and possibly knowledge outsourcing—is crucial for these concepts. While mismatch in self-other contributions had less overall impact, they mattered more for vague concepts than concrete ones. This highlights the importance of jointly negotiating meaning when dealing with vague concepts, due to their flexibility. In sum, defining concrete concepts is easier. Defining abstract concepts, instead, is more challenging—especially when they are determinate but perceived expertise is mismatched, or when vague and contributions to conversation are unbalanced. Further investigation on eye-contact and linguistic alignment will unveil the role of vagueness in shaping interactive dynamics.

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Beyond Traits: A Generative Model of Personality as Predictive and Relevance-Guided Architecture

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Contemporary models of personality, particularly trait-based approaches, have become epistemically domesticated—accepted as standardized tools for describing behavioral tendencies across individuals (Boyle et al., 2008; Fajkowska & Kreitler, 2018). While their utility in prediction and psychometrics is rarely disputed, their conceptual assumptions often go unexamined (Livesley, 2021). Predictive models tell us what tends to happen, not what kind of system is doing the acting (Lewis, 2015). When personality is merely described through scores or labels, we learn the patterns (Mõttus et al., 2020), but not the principles that organize, sustain, and transform them. Recent work urges us to distinguish between the epistemic goals of description, prediction, and explanation—each requiring different methodologies and offering distinct contributions to theory and application. Conflating these goals, particularly mistaking successful prediction for explanatory understanding, risks obstructing theoretical progress and mechanistic clarity (Mõttus et al., 2020).

This paper begins not with a new model, but with a sense of conceptual dissatisfaction. Personality is simultaneously stable enough to span a lifetime and flexible sufficient to adapt to shifting contexts. Trait taxonomies measure stability, but they do not explain how it emerges. If personality is generated, maintained, and negotiated over multiple timescales, we must ask: what architecture sustains that stability, what breaks when coherence erodes, and what permits change without collapse? What kind of system makes personality possible? Prediction is instrumental; generation is explanatory. A generative stance offers access to mechanistic levers, thresholds of coherence, and boundary conditions that determine which traits can persist and must transform (Friston, 2010; Lewis, 2015). Without this generative lens, we only measure personality shadows.

Such an architecture must be capable of regulating informational salience, precision weighting, and adaptive self-modeling—capacities central to both active inference (Bouizegarene et al., 2024; Parr et al., 2022) and relevance realization (Vervaeke et al., 2012)

We argue that resolving this dissatisfaction requires a process-based, self-organising framework grounded in relevance realisation—the capacity of an agent to determine, in real time, which internal states, external cues matter (Bouizegarene et al., 2024; Parr et al., 2022; Ramstead et al., 2021; Vervaeke et al., 2012). Without this, combinatorial possibilities explode, and explanation collapses into description (Vervaeke et al., 2012). Recent syntheses in active-inference theory (Parr et al., 2022) and narrative cognition

(Bouizegarene et al., 2024) converge on the claim that any viable architecture must: (i) learn world-models that minimise prediction error across nested timescales, (ii) continuously resolve what Vervaeke calls *relevance realisation*, and (iii) regulate precision—confidence in those predictions. This approach answers the earlier question: personality stability is not a passive trait property, but an active process of minimizing dissonance between predictions and context-dependent self-updates. It enacts coherence through dynamically adjusted beliefs, not fixed descriptions.

To move beyond descriptive models, we must treat personality not as a static configuration of traits, but as a generative, self-organizing architecture that maintains coherence under conditions of informational ambiguity and environmental flux (Bouizegarene et al., 2024; Parr et al., 2022; Vervaeke et al., 2012). Such a system must balance the demands of stability with the flexibility required for adaptation. This balance cannot be achieved through trait labels alone; it involves a form of meta-inference (Vervaeke et al., 2012) —continuous inference about which internal states and external cues matter—operating dynamically over time. This inference is not computationally explicit or symbolic, but enacted through embodied, self-organizing constraints that selectively amplify relevant predictions and attenuate irrelevant variance Bouizegarene et al., 2024; Vervaeke et al., 2012; Singer, 2004; Varela et al.,1991). As Vervaeke et al. (2012) frame this as the problem of relevance realization: the agent's capacity to dynamically determine what information is worth attending to in a combinatorially explosive space of possibilities. The cognitive system cannot represent everything or compute relevance via syntactic operations alone (Vervaeke et al., 2012). Instead, it must enact relevance through *self-organizing constraints* that modulate the salience of internal predictions and external affordances (Bouizegarene et al., 2024; Ramstead et al., 2016). This process is not peripheral to cognition—it is cognition's core. These constraints operate as precision-weighting mechanisms within a dynamic hierarchy, selecting policies and perceptions that align with long-term coherence under bounded resources Friston, 2010; Hohwy, 2014; Parr et al., 2022; Ramstead et al., 2021; Safron & Sheikhbahaee, 2023)

Within the Cybernetic Big Five Theory (CB5T), personality is described as a system of cybernetic goals modulated by affective feedback (Safron & Sheikhbahaee, 2023). However, the addition of the Free Energy Principle (FEP) and Active Inference transforms this framework into a mechanistic model (Safron & Sheikhbahaee, 2023; Parr et al., 2022). Here, personality becomes an emergent property of a hierarchical generative model that minimizes prediction error across time by updating beliefs, selecting actions, and regulating precision (Safron & Sheikhbahaee, 2023; Parr et al., 2022). Traits, in this view, are not fixed dispositions but *tendencies in policy selection (sequences of action-perception loops optimized over time)* that reflect long-term priors over goal pursuit, affective responses, and belief updating (Bouizegarene et al., 2024; Safron & Sheikhbahaee, 2023; Veissière et al., 2020; Constant et al., 2019). What appears as stability is the result of recursive error minimization over nested timescales—personality coherence as precision-weighted persistence of priors.

Bouizegarene et al., (2024) extends this architecture by introducing narrative self-models as scaffolds for temporal integration. These models operate by maintaining internal coherence—matching high-level self-representations to ongoing streams of perceptual and affective input. In this framework, disruptions to personality are not simple deviations from trait baselines, but failures of *temporal alignment* between predicted and experienced identity trajectories (Bouizegarene et al., 2024; Keven, 2016). Traits do not simply describe "what I am like"; they constrain "what I can become" within the boundaries of a generative model. Explanatory power arises not from retrospective labeling but from modeling the *generative constraints* that determine which patterns are enacted and which fade under shifting contexts. Narrative coherence is thus not a retrospective rationalization but a mechanism for precision alignment across levels of abstraction, guiding future relevance realization (Bouizegarene et al., 2024).

Together, Relevance realization, Active inference, and Narrative scaffolding converge on a shared insight: personality is a function of dynamic, relevance-guided, precision-regulated inference. Relevance realization (Vervaeke et al., 2012) governs what the system attends to and acts upon. Active inference (Bouizegarene et al., 2024; Safron & Sheikhbahaee, 2023) provides the formal machinery for policy selection under uncertainty. Narrative scaffolding (Bouizegarene et al., 2024) maintains identity coherence by integrating self-predictions over time. This triadic framework reframes stability not as statistical regularity but as *generative resistance to entropy (*Safron & Sheikhbahaee, 2023)—the system's ability to maintain form across perturbations, not by staying the same, but by *modulating how it changes*. In this view, stability is not immutability, but the structured plasticity of an agent that knows how to change without falling apart.

This reconceptualization also redefines the explanatory task of personality science. Rather than asking what traits people have, we must ask what processes sustain the self-model's viability over time. When coherence breaks down, we are not observing a personality "disorder" in trait terms—we are observing a failure in inference: relevance is misassigned, priors are hyper-precise or overly diffuse, and narratives become maladaptive. Explanation, therefore, lies not in trait structure but in *failure modes of generative models*.

Finally, this generative approach does not reject prediction; it resituates it. Predictive models (in the statistical sense) are useful to the extent that they mirror the workings of *predictive systems*. A model predicts well when it simulates how an agent negotiates uncertainty, updates beliefs, and enacts identity. This is the distinction between *predictive description* and *explanatory generation*. The former tracks outcomes: the latter reveals the architecture that makes those outcomes possible and transformable.

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Design Matters: A Screen-Based Task for Children's Probabilistic Intuition

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ABSTRACT

Measuring probabilistic intuition in children presents long-standing methodological challenges. Traditional tasks often rely on symbolic representations and are language-dependent, while more recent approaches have yet to effectively target intuitive thinking or incorporate children's perspectives in their design. We introduce the *Lucas Game*, a child-friendly, non-symbolic, and language-independent task designed to assess probabilistic intuition in children. Through a narrative-driven, game-like format, children make probability-based choices between two jars with different distributions of colored balls. The design combines congruency (intuitive vs. unintuitive cues) with numerical distance, enabling the detection of cognitive biases in numerical processing. The structure also allows for a fine-grained analysis of individual differences in reasoning profiles, making it a robust tool for future studies on probabilistic cognition in early development.

1. INTRODUCTION

How Do We Measure Probabilistic Intuition in Children?

Early research often assumed that probabilistic reasoning required formal operational thinking, which was believed to emerge only after the age of 11. Tasks were typically abstract and language-dependent, overlooking children's intuitive numerical abilities (Piaget, XX).

In recent decades, research on children's probabilistic knowledge has shifted from Piagetian views—emphasizing formal logical reasoning—to empirical studies highlighting early statistical competencies (Xu & Garcia, 2008), supporting the idea that a sense of probabilistic intuition is based on the Approximate Number System (ANS; Dehaene, 2011).

Recent studies with school children have employed game-like tasks (O'Grady & Xu, 2020; Gualtieri et al., 2022) and continuum-format stimuli (Liu et al., 2024), providing more

engaging environments for testing participants' probabilistic thinking abilities. However, these designs still face some limitations in how probabilistic intuition is operationalized and measured. In this paper, we analyze experimental designs used in these recent studies (O'Grady & Xu, 2020; Gualtieri et al., 2022; Liu et al., 2024) and suggest a novel, child-adapted, game-based task to evaluate probabilistic estimation in 6- to 9-year-old children. Table 1 summarizes our analysis, highlighting the limitations in prior research and the strengths of our task design, the *Lucas Game*.

Table 1: Limitations in prior research and strengths of our task design, the Lucas Game task.

Limitation in Prior Research	Design Feature in This Study
Demand of **manipulation of symbolic numerical information** (digits, fractions) (Lui et al., 2024)	Fully non-symbolic stimuli (jars with colored balls)
High **working memory demands** due to quantity recall (Gualtieri et al., 2022; O'Grady & Xu, 2020)	Simultaneous, visually accessible displays; reduced cognitive load
Lack of **manipulation of congruency** (Liu et al., 2024)	Systematic inclusion of congruent and incongruent trials
Perceptual biases (**color, side preference**) not controlled (Gualtieri et al., 2022)	Two target colors + counterbalanced target side

2. METHOD

The Lucas Game task was designed using PsychoPy and can be deployed via Pavlovia on iPads. The task consists of a series of trials in which a character, Lucas, asks for help choosing between two **non-symbolic stimuli** represented by two jars containing blue and yellow balls in varying proportions. Instructions are provided via audio. Children are asked to help Lucas by selecting the jar with the better chance of yielding a piece of candy hidden in the target ball (yellow or blue), without any explicit mention of probability or numerical values.

Figure 1 provides a visual representation of the task as seen by participants during the blue modality of the Lucas Game. In (A), Lucas introduces the game, showing a pair of jars with a distribution of blue and yellow balls. In (B), Lucas states that he must follow the rules and close his eyes. He tells the participants that he wants to pick a ball and asks them to help him decide which jar is better for him to put his hand into.
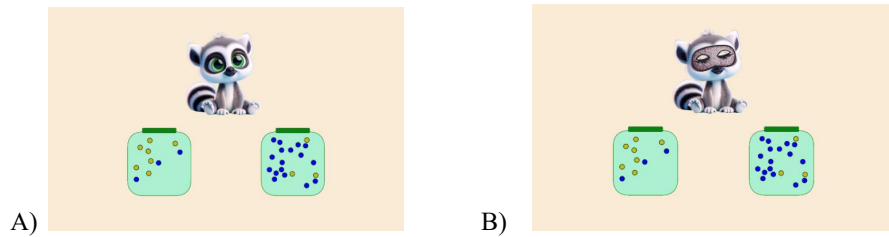
A)   B)

Figure 1: *The Lucas Game.* This illustrates the blue modality of the task, in which candies are inside the blue balls.

The design follows a 2 × 2 within-subjects structure, **crossing the factors of congruency** (congruent vs. incongruent) and numerical distance (small vs. large). Each participant must complete a total of 40 trials—10 per condition, with trial order randomized. Large distance trials are expected to be easier than small distance trials, allowing for variability in response. The stimuli are not time-limited, but children are encouraged to respond as quickly as they can. This **prevents working memory demands** due to recall activity.

To **control for color preferences**, the task is implemented in two versions: in one, blue balls are the "target," containing a candy; in the other, yellow balls serve as the target. Half of the participants are assigned to each version in a counterbalanced design. Additionally, correct responses are counterbalanced across left and right jar positions to **control for side preferences**.

3. RESULTS

The Lucas Game was designed for first- and third-grade children in Uruguay. Data from nearly 100 children were collected, and analysis is ongoing. Empirical results will be submitted for publication in a scientific journal.

4. DISCUSSION

The Lucas Game addresses key methodological shortcomings in the study of children's probabilistic reasoning. By combining age-appropriate language, non-symbolic visual stimuli, and an audio narrative context, the task avoids confounds such as symbolic demands and abstract terminology. The crossed manipulation of congruency and numerical distance enables the task to account for intuitive heuristic responses across a spectrum of trials with varying levels of difficulty.

The task is designed to engage young children in probability, allowing them to complete trials both accurately and enjoyably. The structure of the task facilitates the exploration of classical

effects in numerical cognition, such as the distance effect, as well as potential group differences in response profiles.

Data analyses will assess whether individual children exhibit systematic biases in probabilistic estimation and whether these biases are related to differential sensitivity to numerical distance—that is, differences in how children respond to varying degrees of numerical distance between options. The design also opens the door for modeling response dynamics through approaches like drift diffusion modeling, which may help uncover underlying cognitive mechanisms. Ultimately, the Lucas Game provides a promising platform for a fine-grained investigation of probabilistic intuition in childhood.

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The Implied False Effect: Reducing Credibility in Custody Disputes

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Introduction

Many factors influence our cognitive abilities. Usually, the consequences of these mistakes are minuscule. However, in custody disputes any cognitive misjudgment may have serious consequences for children and parents. A custody dispute occurs when two parents separate but cannot agree on custody (the legal decision power over the child), living (where the child should live), or visitation (in the case of living with one parent, how much the child should spend time with the other parent). Many custody disputes are very emotional and often high-conflict containing multiple accusations of various wrong-doings among parents. Judicial courts make the final rulings, but the courts typically rule in line with custody investigations that take place before the court hearings. Ratings of parental credibility are very important because custody investigations rarely have access to physical evidence to support or disbelieve accusations between parents. As such, credibility judgments often play a critical part in the custody evaluation recommendations to the judicial courts who often rule according to the recommendations. As people conduct these custody investigations, cognitive biases or effects may heavily influence the quality of the investigations. For instance, both confirmation bias (Munro, 1999) and gender discrimination (Ngaosuvan et al, 2024) have been shown to affect social service investigations. A relevant cognitive phenomenon is the implied Truth Effect, where warnings of fake news headlines on social media increase the subjective accuracy of non-rated headlines (Pennycook et al, 2020). The present study introduced and investigated a novel cognitive effect called the Implied False Effect (IFE), where high credibility judgment in one party decreases the credibility of the other party within a custody litigation context.

Method

Design & Participants: The study design comprised a 3 (IFE; Father vs. Mother vs Control condition) x 2 (position; Plaintiff vs. Defendant) experimental vignette between-subjects design with subjective ratings of parental credibility as the dependent variable. Participants (N

= 103, 64 women, 38 men, and one non-binary) were recruited via convenience sampling on social media with a mean age of 35.5 ranging from 20 to 67.

Materials: An online vignette was created inspired by an authentic Swedish custody litigation where the plaintiff accused the defendant of planning to abduct the child to a Middle Eastern country that has not ratified the Hague Abduction Convention. The vignette contained a summary of a police investigation into child abduction. In the experiential conditions, an opinion from a very experienced and decorated police investigator of an interview with one parent was concluded that the parent was considered very credible. No mention was made about the other parent.

Procedure: Participants were informed about the study's purpose (investigating factors affecting judgments in custody disputes) and ethical considerations (consent, age limitations, anonymity, data only used for educational or research purposes). Then, participants were instructed to answer questions on demographic information (gender, previous personal or professional experience of custody disputes, or relatives' custody litigation experience on seven-graded Likert scales. Subsequently, the participants were instructed to read a randomly selected vignette and subjectively rate parental credibility and worry if either parent would be awarded sole custody. Furthermore, the participants were asked to suggest court rulings about custody. Finally, a short debriefing was held where the explicit purpose of the study was explained (investigating IFE), and the participants were given the opportunity to withdraw consent from the study after learning the specific purpose.

Ethics: Mild deception (Kimmel et al, 2010) was used in line with traditional vignette methodology, and no identifiable sensitive personal or biological information was collected. The study was conducted in accordance with the Helsinki Declaration, Swedish law, and the Swedish Ethics Approval Authority, and subsequently, no ethics approval was needed.

Results

To simplify statistical analyses, we separated the results into IFE for mothers and fathers respectively.

Maternal credibility: A two-factor (TFE vs. Position) ANOVA yielded a significant main effect of TFE, $F(2.99) = 23.14$, $p < 0.001$, partial $\eta2 = 0.32$ on maternal credibility. Furthermore, a main effect of Position on credibility was revealed, $F(1.99) = 15.13$, $p < 0,001$, partial $\eta2 = 0.13$. No other effects were found.

Paternal credibility: The corresponding two-factor ANOVA yielded a main effect of TFE, $F_{(2.99)} = 28.44$, $p < 0.001$, and partial $\eta 2 = 0.37$, but no other effects were found.

Discussion

The present study investigated whether favorable external judgment by an experienced police investigator on the credibility of one parent would affect the credibility of the other parent in a custody dispute. The results were convincing. For both fathers and mothers, the favorable external judgment significantly decreased the credibility of the other parent. Thus, the present study successfully showed that the implied truth effect (Pennycook, 2010) can be reversed into an implied false effect. Furthermore, the between-subjects design of the study could be viewed as a two-experiment study where we first find indications of IFE with a vignette study using mothers as target parents, and then replicate the findings using fathers as target parents.

Limitations: The present study is the first to introduce IFE, and it needs to be replicated in other contexts, and using more skilled participants. For instance, instead of recruiting lay people using a custody dispute context, it would be interesting to investigate experienced custody evaluators or the effect's external validity in other domains. Furthermore, the present study did not have a measurement of realism, which may have affected the results. However, the story was based on an authentic custody dispute which would indicate some level of realism. Furthermore, these limitations do not strongly challenge the existence of the IFE.

Practical implications for custody evaluators

For custody evaluators, the IFE is essential to conduct a custody evaluation. Just because one parent, the plaintiff for instance, is deemed very credible, it would be a cognitive mistake to readily assume that the other parent must be less credible. The IFE indicates that a proper investigative procedure would be to interview both parents separately using different interviewers who are unaware of the credibility judgments of the other parent. For judges and jurors, the TFE is also important to evaluate the quality and usefulness of custody evaluations. Judges and jurors should ask themselves how critical the credibility judgments of the investigators are and whether the investigation has made credibility judgments on both parents. Furthermore, the gender-selective effect of position for mothers might also arise as a hypothesis that order of credibility judgments may affect the investigation when mothers are the plaintiffs.

Theoretical implications for cognitive scientists

This result is like other cognitive biases that have a reversed version such as the Horn effect which is the "evil twin" of the Halo effect (Nisbett et al, 1977). This might be a general pattern in cognitive science. That is, there might be reversed or inversed versions of multiple cognitive phenomena yet unexplored.

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Comparing Remote and Traditional Train Driving: Effects on Behavior, Perspective, and Workload

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Introduction

Rail transport offers several benefits, including reduced traffic congestion, lower pollution levels, safer travel, decreased costs, compared to road transport (Litman, 2008; Wener & Evans, 2011). The growing demand for rail passengers and freight traffic is driving the need for improvements in railway operations. Automation systems, such as Automatic Train Operation (ATO), are seen as a solution. Driverless metros are already being implemented in several cities worldwide. Although research on remote train driving is limited, it could serve as an alternative in some cases or pave the way for fully autonomous trains.

Remote driving offers several benefits, including enabling operators to manage multiple vehicles from a central hub and unlike autonomous driving, which depends on advanced sensors and complex algorithms, remote driving uses simpler systems, such as basic sensors and live video feeds (Zhang et al., 2020). For trains, this could improve scheduling flexibility, optimize driver efficiency, and reduce the need for drivers at multiple locations. This would increase train frequency and accessibility, promoting rail travel as a sustainable transportation option. Further, remote rail systems are viewed positively by potential users (Cogan et al., 2022), though future implementation plans must address concerns regarding safety, security, and trust (Cogan et al., 2022; Masson et al, 2022; Pacaux-Lemoine et al, 2020).

When exploring remote train driving, human factors must be considered. Research indicates that latency increases the operator's mental workload and decreases performance, but solutions like predictive technology can help mitigate these effects (Dybvik et al., 2021). It is also crucial to examine the differences in driving behavior and the driver's perspective between remote and on-board train operations.

Aim and research questions

This study aims to explore train operators' driving behavior and mental workload when remotely operating a train compared to manual driving, as well as their subjective experiences with both methods. The research questions are:

1. How does driving behavior differ between remote and traditional train operation?
2. How does subjective mental workload vary between traditional and remote train driving?
3. What are train operators' perspective of remote versus manual train driving?

Method

This study was conducted at the Training and Education Centre in Ängelholm and employs a mixed-methods design. It has been approved by the Swedish Ethical Review Authority (Dnr 2025-01715-01).

Participants

Participants were recruited via social media (Facebook) and invitations from the Train Driver Education School in Ängelholm to former students. The inclusion criterion was holding a train driver license. A total of 15 participants took part, including 1 female and 14 males.

Equipment

This study is part of the FUTURE project within EU Rail and involves a remote train setup featuring a prototype train vehicle equipped with Sweden's first remote control operating desk. The battery-powered train was developed by engineering students at Linköping University, with a maximum speed of 35 km/h (Figure 1). The VTI train simulator (Rosberg & Thorslund, 2025) serves as the remote control station. The setup was developed with a focus on video quality and control mechanisms. A main camera provided a clear forward view for the remote driver. Voysys video software was used to generate and decode the video stream, which was transmitted via a 5G modem to the control room. Key objectives included low latency and minimal blurriness. A secure VPN tunnel relayed control messages to the train, while the control room was connected via a fixed cable. Train speed was measured using GPS.

Figure 1: The remote-driving set-up with vehicle and control station.

Procedure

Participants received oral and written information about the study, were informed of their right to withdraw before signing consent, and were assigned a unique ID. Each completed two runs on a 700-meter track, one under remote driving and one under traditional operation, with counterbalanced order. The track included two road crossings and one pedestrian crossing. After each run, participants completed a questionnaire assessing mental workload using NASA-TLX (Hart & Staveland, 1988) and answered two open-ended questions on driver experience and preferences. How would you describe the difference between operating the train from the cab versus the remote station?, What do you believe is the most important factor to consider when developing remote-controlled trains?

Results

The results for each research question are presented below.

Driving behavior

A paired samples t-test was used to compare participants' driving speed in the two driving conditions. Results revealed a significantly lower average speed in the remote condition, $t(14) = 2.273.12$, $p = .039$. For the maximum speed, there was a tendency in the same direction, $t(14) = 1.412$, $p = 0.18$.

Workload

Three dimensions of the NASA-TLX showed statistically significant differences. A paired t-test revealed that participants reported significantly higher mental demand during remote driving (M = 12.80, SD = 5.24) compared to regular driving (M = 7.33, SD = 5.04), $t(14) = -5.01$, $p < .001$, $d = -1.29$. Similarly, participants experienced significantly greater effort in remote driving (M = 10.13, SD = 5.59) than in regular driving (M = 6.47, SD = 4.79), $t(14) = -3.49$, $p = .004$, $d = -0.90$. Regarding frustration, remote driving again yielded significantly higher scores (M = 8.20, SD = 5.21) compared to regular driving (M = 3.07, SD = 2.25), $t(14) = -4.08$, $p = .001$, $d = -1.05$.

Driver perspective

A thematic analysis revealed four key differences between traditional and remote train operation:

- Visibility and Perception: Remote operation reduced situational awareness.
- External Sensory Input: Lack of physical feedback made speed and braking harder to gauge.
- Depth Perception: Judging distances via camera increased uncertainty.
- Control: Participants felt more in control in-cab due to physical presence.

Additionally, three key considerations for remote train systems were identified:

- High-Quality Visual and Auditory Input: Clear visuals and audio are essential for safety.
- Handling Unexpected Events: Systems must manage emergencies with clear responsibilities.
- Closeness to Reality: Remote systems should replicate the sensory experience of traditional driving.

Discussion

The decreased driving speed in the remote driving condition may stem from reduced feelings of safety, security, and trust, factors that should be addressed in future implementations (Cogan et al., 2022; Masson et al., 2022; Pacaux-Lemoine et al., 2020). The subjective mental workload revealed higher mental demand, greater effort, and increased frustration during remote driving, which could be alleviated with more predictive technology, as previously suggested (Dybvik et al., 2021). From the driver's perspective, challenges such as reduced situational awareness, lack of physical feedback, and difficulty with depth perception were noted, alongside a greater sense of control in-cab. These insights underscore the importance of high-quality input, effective emergency management, and replicating real-world sensory experiences in remote systems—considerations that align with previous research and should guide future projects on remote train operation (Cogan et al., 2022; Dybvik et al., 2021; Masson et al., 2022; Pacaux-Lemoine et al., 2020).

Conclusions

This study comparing remote driving to traditional in-cab operation of a low-speed train prototype found that drivers tended to drive more cautiously in the remote condition. However, they also experienced higher mental demand, greater effort, and increased frustration. Drivers reported challenges such as reduced situational awareness, lack of physical feedback, difficulty with depth perception, and a diminished sense of control when operating the train remotely. These findings highlight the importance of keeping the driver involved in the loop during research, planning, and implementation of remote train operations.

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Driving Instructors' Perceptions and Experiences with the GDE Matrix: A User-Centered Analysis

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Introduction

The Swedish driving license syllabus is based on the GDE matrix (Goals for Driver Education), which outlines the skills and knowledge needed to become a safe driver (Hatakka et al, 2002; Keskinen, 2007). Developed by researchers and written in academic language, the GDE matrix has been thoroughly reviewed and is considered highly reliable (Bailey et al., 2020; Kiss, 2016; Molina et al., 2014). Its foundation in years of practical experience also adds to its value in driver training. While essential for ensuring high-quality training nationwide, the GDE matrix is often seen as complex and difficult to explain by traffic instructors. This is likely because the GDE matrix was not originally designed as a tool for driving instructors (N.P. Gregersen, personal communication, March 12, 2025; Keskinen, 2007). However, with appropriate clarifications and adjustments, it has the potential to serve as a valuable resource for both instructors and learner drivers.

	Knowledge and skills	Risk-increasing factors	Self-evaluation
Goals for life, skills for living (general)	Lifestyle, age, group norms, motives, self-control, personal values	Sensation seeking Group norms Complying to social pressure Use of alcohol	Risky tendencies Personal skills for impulse control Safety negative motives
Goals and context of driving (trip related)	Modal choice Choice of time Trip goals Social pressure	Alcohol, fatigue Purpose of driving Rush hours Extra motives: competing	Planning skills Typical goals Typical risky motives
Mastery of traffic situations	Traffic rules Observation Driving path Communication	Disobeying rules Information overload Unsuitable speed	Awareness of personal strengths and weaknesses
Vehicle maneuvering	Control of direction, position Tyre grip Physical laws	Unsuitable speed Insufficient automatism Difficult conditions	Strong and week points of basic maneuvering

Figure 1: The GDE-matrix (adapted from Hatakka et al., 2002).

Aim and research questions

This study aims to explore driving instructors' perceptions and experiences with the GDE matrix from a user perspective. The research questions are as follows:

- To what extent are driving instructors aware of the connection between the GDE matrix and the driver curriculum?
- To what extent do driving instructors feel confident in their understanding of the GDE matrix?
- To what extent do driving instructors consider the GDE matrix useful?

Method

This is a quantitative questionnaire study, designed and conducted in collaboration with the Swedish Driving Schools National Association (STR). Before designing the questionnaire, the authors conducted an interview with Nils Petter Gregersen, one of the creators of the GDE matrix, to gain an understanding of the ideas and concepts behind the framework.

Participants

Driving instructors were invited to participate via the STR member magazine, where information about the study's purpose was provided along with a link for those interested in contributing to the research. Data collection is ongoing, and so far, 60 respondents have taken part in the study.

Procedure

Those interested in participating were directed to an electronic questionnaire, where they were provided with more detailed information about the study. They were assured that participation was voluntary, that they could withdraw at any time, and that their responses would remain anonymous and accessible only to the research team. By starting the survey, participants provided their informed consent. The questionnaire took approximately 10 minutes to complete.

Questionnaire

Initially, the respondents were asked a background question regarding whether they are currently working as driving instructors. This was followed by five questions assessing their knowledge of the GDE matrix, which they answered on a scale from 1 (not at all) to 10 (very well).

- How well would you say the matrix corresponds to the content of the driver curriculum?
- How well do you recognize the headings in the GDE matrix?
- How well would you say the GDE matrix has been explained to you?
- How well do you feel that you understand the GDE matrix?
- How confident do you feel in explaining the GDE matrix right now?

The next section of the questionnaire included questions based on the Technology Acceptance Model (TAM; Davis, 1989). Two TAM constructs included 6 items covering perceived usefulness (PU) and 6 items covering perceived ease of use (PEU). Responses were collected on a 7-point Likert scale from 1

(extremely likely) to 7 (extremely unlikely). Each TAM construct score was calculated as the mean of its corresponding items.

Preliminary Results

Preliminary results indicate that while respondents are fairly familiar with the content and concept of the GDE matrix, they do not yet feel confident explaining it to others. Descriptive statistics are presented in Table 1.

Table 1: Descriptive statistics of the TAM scores.

Question	Mean (M)	SD
How well would you say the matrix corresponds to the content of the driver curriculum?	6,67	2.09
How well do you recognize the headings in the GDE matrix?	6.77	2.59
How well would you say the GDE matrix has been explained to you?	6.38	2.74
How well do you feel that you understand the GDE matrix?	6.45	2.74
How confident do you feel in explaining the GDE matrix right now?	5.48	3.04

Preliminary results indicate that respondents find the GDE matrix only slightly useful, rating its usefulness in terms of PU and PEU below a moderate level. Descriptive statistics are presented in Table 2.

Table 2: Descriptive statistics of the TAM scores.

TAM Construct	Number of Items	Mean (M)	SD
Perceived Usefulness (PU)	6	4.53	0.17
Perceived ease of Use (PEU)	6	4.31	0.43

Discussion and Conclusions

To be added in the final version.

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LLMs for Motif Classification in Folktales: A Prompt Engineering Approach

Introduction

Fairytales and folktales serve as humanity's oral history, with their smallest building blocks—motifs—revealing the core values and social structures of different cultures (Jorgensen, 2023). Recent computational advancements now allow researchers to trace their geographic origin and spread (Sakamoto Martini et al., 2023). However, studying these tales over time presents a unique challenge. What was once a fairy godmother might now be portrayed as a wise wizard or a helpful robot. Temporal analysis therefore requires tools capable of flexible semantic generalization—such as Large Language Models (LLMs) like ChatGPT and DeepSeek. However, LLMs may not be the most reliable tools for text classification (Rouzegar & Makrehchi, 2024). This study demonstrates that with tailored prompt engineering, LLMs can classify folktale motifs with reasonable accuracy, though challenges remain in handling abstraction, bias, and differing performance across models—highlighting both the potential of LLMs for exploring narrative and cognitive patterns, and the limitations of existing motif classification systems.

Motif Classification Framework

The Aarne-Thompson-Uther (ATU) Index (Uther, 2004) remains the dominant folktale classification system, despite notable limitations: rigidity, Eurocentrism, and gender bias (Dundes, 1997; Lundell, 1983). This study focused on overcoming the ATU's inflexibility. To standardize classification outputs, a general motif hierarchy was developed (see figure 1A). Motifs were divided into the standard categories of incidents, actors and objects (Thompson, 1946). Subcategories for actors and objects were derived from WordNet synsets, refined with the author's input and ChatGPT suggestions. Incident subcategories were based on ATU tale types, consolidated for conciseness. Additional attributes such as narrative valence, inherent attributes, and narrative role were applied where relevant.

Prompt Engineering Strategies

Optimising the endless potential of LLM application without altering model parameters is best achieved by careful prompt engineering (Sahoo et al., 2025). This project explored the strategy of example inclusion in the prompt using zero-shot (no examples), one-shot (one example) and few-shot (in this case 5 examples). Additionally, a code-style prompt was used, where instructions were formatted like code logic (e.g., looping through motif categories asking, "Is this present?"). Research suggests that few-shot prompting and code-like structures often yield improved results, although excessive prompt length can reduce performance (Chen et al., 2024).
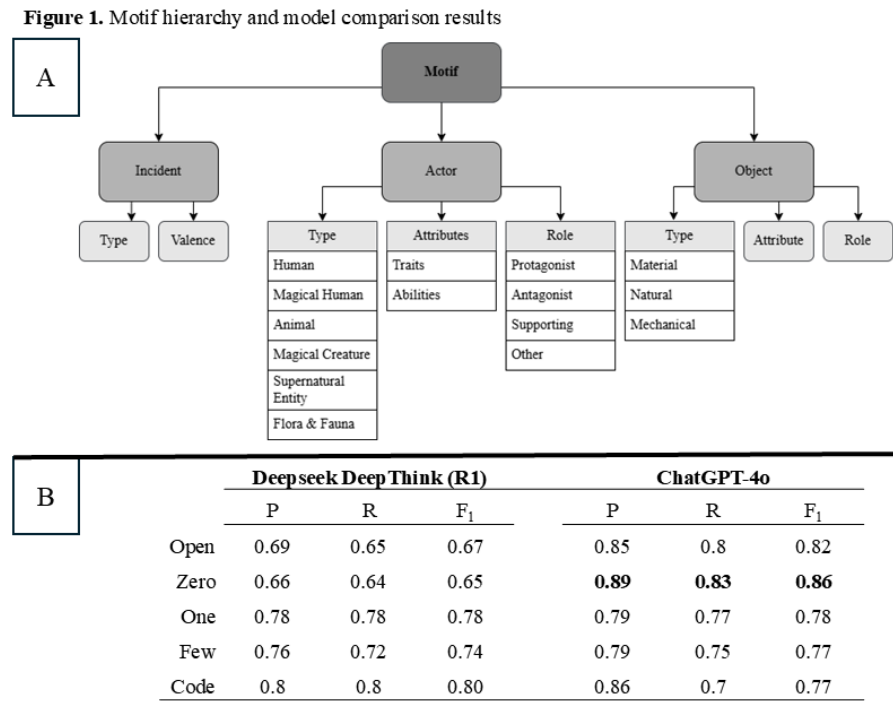
Performance Metrics

LLM performance was evaluated using both qualitative and quantitative methods. Motif identification accuracy was measured with hierarchical precision, recall, and F_1 scores, enabling nuanced assessment across levels of the motif taxonomy (Silla & Freitas, 2011). Metrics compared only the extracted and annotated motifs, excluding overextracted motifs or additional details like valence, traits, and roles.

These were omitted due to their subjective nature, which could not be reliably addressed in a single-researcher study.

Refinement Process

Initial testing began with a basic open prompt and the classification hierarchy attached. Based on suboptimal motif extraction, a revised prompt emphasized relevance, importance, and causality of motifs. Subsequent iterations tested zero-shot, one-shot, few-shot and code-style prompts, each refined based on observed shortcomings. Prompt finetuning was performed in OpenAI's ChatGPT-4o, while measurements were additionally done in DeepSeek's DeepThink (R1).

Figure 1. Motif hierarchy and model comparison results

B	Deepseek DeepThink (R1)			ChatGPT-4o		
	P	R	F_1	P	R	F_1
Open	0.69	0.65	0.67	0.85	0.8	0.82
Zero	0.66	0.64	0.65	**0.89**	**0.83**	**0.86**
One	0.78	0.78	0.78	0.79	0.77	0.78
Few	0.76	0.72	0.74	0.79	0.75	0.77
Code	0.8	0.8	0.80	0.86	0.7	0.77

Panel A: Motif hierarchy, not including the deepest levels
Panel B: Comparison of DeepSeek and ChatGPT on precision (P), recall (R) and F_1 score. The best scores are in bold.

Results

ChatGPT outperformed DeepSeek overall (see figure 1B). However, the two models showed difference in context-sensitivity. Notably, adding examples improved DeepSeek's accuracy but decreased ChatGPT's. The code-style prompt also led to similar performance across the two models, although ChatGPT's recall dropped considerably on this prompt, due to missing the subtype level classification for actors and objects (e.g., classifying "human" instead of "human – ordinary"). Another potential issue with the code-style prompt is that it led ChatGPT to over-extract motifs, which may be an issue for longer stories.

Misclassifications often involved hierarchical depth: both models repeatedly omitted the type level for actors and objects, noting only the sublevel instead (e.g. classifying 'demonic being', instead of 'supernatural entity – demonic being'). Incident categories also showed inconsistent classification, suggesting insufficient granularity. Most issues arose for the 'physical objects' category, in terms of extraction of relevant and correct physical objects. Specifically, ChatGPT identified abstract concepts as physical objects, while DeepSeek often did not extract relevant objects at all. For example, one of the test-stories involved the protagonist overhearing secrets while leaning against a tree. Both LLMs repeatedly identified the tree itself as an object. ChatGPT also identified secrets themselves as an object. Furthermore, both models frequently confused inherent and functional traits, e.g., labeling "money" as "deceptive" rather than "valuable." Actor trait classifications, in contrast, were generally more accurate—possibly reflecting the models' training on narrative human behaviour.

Discussion & Future Directions

This study demonstrates the potential of LLMs in motif classification when guided by structured prompts. However, limitations remain, particularly in recognizing abstract vs. physical categories and capturing fine-grained hierarchical distinctions. Additionally, LLM classification showed a gender bias with female characters often being overlooked or only noted in relation to male protagonists. These findings underscore the need for a more inclusive and flexible classification system, potentially combining the ATU, Propp's morphology (Propp, 2010), and Harun and Jamaludin's (2013) model.

Results also suggest that given the contextual nuance of folktales, expert human annotators remain essential. To reduce the time and cost requirements of manual annotation, combining LLMs with trained human annotators in an uncertainty-based framework should be explored as a strategy for enhancing motif classification accuracy (Rouzegar & Makrehchi, 2024). Future work might also explore statistical or clustering methods that discover motifs beyond traditional taxonomies (d'Huy, 2014; Karsdorp & Bosch, 2013), as well as identifying strings of motifs that co-occur together to form larger motifs (Ofek et al., 2013). Furthermore, the motif classification task has shown itself to be uniquely well-suited to further investigation of how LLM classification may reflect human linguistic biases or cognitive schemas.

Conclusion

While LLMs show promise for automating motif analysis in folktales, they are far from perfect. Prompt engineering can significantly improve their utility, but hierarchical depth, physicality distinctions, and cultural biases present ongoing challenges. This study lays a foundation for further interdisciplinary work between AI and folkloristics, offering new insights into both narrative structures and the capabilities of modern language models.

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