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Preface

It is a great honor to welcome you to Stockholm and the 19th SweCog meeting which is organized by the Swedish Cognitive Science Society. When Swedish people think of the capital city, “humility” is perhaps not always the first word that comes to mind. But when it comes to Cognitive Science in Stockholm, some humility is in place. The SweCog meeting has in fact never before taken place in Stockholm. But this conference might have a long-lasting impact on the cognitive science community.

As cognitive scientists, we need to create our own interdisciplinary arenas. When I began building my research team, it took a few years before my disparate collaborations with colleagues in psychology, computer science, linguistics, neuroscience and interaction design merged into a team. SweCog 2024 is about a similar pursuit, bringing the cognitive science disciplines together in Stockholm and over time establishing it as a hub for Swedish and international cognitive science research and education.

The importance of interdisciplinary cognitive science research is arguably greater than ever. We are only a couple of years removed from the COVID-19 pandemic, and many of us remember how researchers rose to its challenges by forming new, interdisciplinary constellations. Cognitive scientists provide the tools to understand human thinking and behavior, and how we can best interact with the artificial intelligence agents that play an increasing role in our lives. Whatever the urgent global challenges will look like in the future, we can be sure of one thing; addressing them will likely require some type of cognitive science knowledge.

Like all great things, cognitive science starts with people getting together. And while humility is a virtue, we are proud of having about 100 research submissions, presented by over 200 attendees, who represent 13 countries and 40 universities – 18 Swedish and 22 international. I am grateful to our organizing team members who have worked hard to make sure everyone has an exciting and stimulating conference experience. We received generous funding from the Swedish Foundation for Humanities and Social Sciences and the Stockholm University board of Human Sciences. We thank our sponsors and exhibitors. JOR AB will exhibit their exciting research technologies, including Biopac and VR equipment. The winner of our best poster award will receive a gift, an AI-powered stethoscope generously provided by StethoMe. The winner will be announced right before the closing of the conference. The leading Swedish popular science magazine Forskning och Framsteg helped us organize a panel discussion on the pressing topic of climate change and how it relates to cognition, this discussion will take place on Friday afternoon. Make sure to stay for these exciting events.

On behalf of the organizers, enjoy SweCog 2024!

Jonas Olofsson, Chair of SweCog 2024

Professor of Psychology, Stockholm University

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Oral presentations

Abstracts

O1 - Rhythmic parameters and lateralisation in the percussive behaviour of Japanese Macaques (Macaca fuscata)

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Gabriela-Alina Sauciuc[1], Tomas Persson[1], Raquel Costa[2], Ivo Jacobs[1]
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Japanese macaques (*Macaca fuscata*) exhibit a suite of stone handling behaviours (SHB, e.g. rolling, pounding, etc.) that lack an obvious instrumental function. As SHBs appear to be socially transmitted, previous research has focused on evolutionary theories of tool use and cumulative culture. It has been assumed that SHBs in general represent a form of solitary play whose function is to hone and maintain motor skills.

In contrast to this literature, we focus on a specific SHB – drumming - which we investigate from the perspective of rhythm cognition, to derive a detailed mechanistic characterisation of the behaviour. As drumming is repetitive and, occasionally, bimanual, quantifying its rhythmic properties is suited to assess motor fluency and coordination in a primate's naturalistic behaviour. In turn, this could provide a foundation for empirically informed functional inferences, given that parameters such as frequency rate, variability and lateralisation are used as measures of emotional arousal and valence, respectively.

In drumming bouts (N = 607) collected from ~30 macaques (housed at Japan Monkey Centre in Inuyama in a troop of 150 individuals), we established frequency rate (cycles / second), period, and rhythmic variability (across inter-onset intervals), as well as behavioural lateralisation and bimanual inter-limb coordination.

O2 - Children who can explain why they are skeptical about a claim can devise an efficient empirical test for that claim

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The ability to think critically is an essential skill for the 21st century learner. Part of thinking critically is identifying the information one needs to (dis)confirm a claim. What skills underlie this ability? We tested the hypothesis that being able to reflect on and justify one's belief is key to testing those beliefs. We tested this developmental account by assigning 4-7-year-olds (N= 174, Mage=68.77 months, 52.87% girls) to either a prompted or an unprompted condition. In each condition, children heard a surprising claim before being asked whether they thought the claim was true, how (un)certain they were, and how they could determine the veracity of the claim. In the prompted condition, children were also asked why they were (un)certain. Prompting children to explain their beliefs did not affect their inclination to efficiently test the claim. However, those providing a plausible reason for their uncertainty, were more inclined to suggest an efficient test—controlling for their ability to identify one when given multiple options. These data provide support for the notion that having the skills to reason scientifically is not sufficient to prompt children to follow up on their skepticism efficiently, they must also understand the cause of their skepticism.

O4 - Time and sequence as key developmental dimensions in joint actions

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Joint action (JA), generally defined as *working together towards a common purpose*, has become an important yet controversial concept in cognitive science. On the one hand, joint actions are structured and directed by the private knowledge, interests and intentions of individuals; on the other hand, they are also publicly manifest in individuals' behaviours and affective displays, available for inter-actants in social engagements. Within mainstream cognitive accounts, to engage in a joint action requires inferential processes of representing others' intentions and plans (e.g., mindreading) towards a shared goal [1, 2]. However, a growing body of contrasting embodied, situated accounts of social cognition [3] propose that joint action is better understood as a dynamic, situated interactional process where participants "roll into" joint actions without necessarily requiring reflective or representational awareness [4, 5]. The present work proposes a rethinking of how we conceive of JA and its development from early on. With particular reference to developmental studies [6], we advance an account of JA to include its temporal and sequential structures as key analytical aspects for the study of how humans learn to understand and share meaning with others through *joint interactions.*

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O8 - Encoding others' attention as implied motion: Disentangling attention-motion and action expectation effects

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We recently showed that viewing static images of agents attending to objects elicits behavioral motion aftereffects (Guterstam & Graziano, 2020), and motion-related fMRI activity patterns (Guterstam et al., 2020), suggesting that the brain encodes others' attention as an implied motion travelling from an agent toward the attended object. An alternative explanation to these findings (offered in a commentary by Görner et al., 2020) is that the observed motion signal may represent an expectation that the agent will perform an action directed towards the object. We here addressed these two alternative explanations experimentally, by dissociating the direction of attention and expected movement in the stimulus. For this, we used a spider, which is known to cause automatic withdrawal (see e.g., Chen & Bargh, 1999), as the object of attention. We found a significant motion aftereffect in the agent-to-spider direction, which was absent when the agent was blindfolded. These results directly contradict the notion that the covert motion signal observed in our previous studies is caused by an imagined action of the depicted agent. Instead, the simplest and best explanation of the results is that people implicitly code the gaze of an agent as a stream of motion emanating from the agent.

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O10 - The role of sequence representation in the evolution of human language and cognition

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Human language is unique in its compositional, open-ended, and sequential form. It has proven challenging to identify an evolutionary trajectory from a world without language to a world with language, especially while at the same time explaining why such an advantageous phenomenon has not evolved in other animals. Decoding sequential information is necessary for language, making domain-general sequence representation a tentative basic requirement for the evolution of language together with other cognitive and cultural phenomena like thinking, planning and sharing symbols. In formal evolutionary analyses of the utility of sequence representation we show that sequence representation is exceedingly costly and that current memory systems found in animals may prevent abilities necessary for language and culture to emerge. For sequence representation to evolve, flexibility allowing for ignoring irrelevant information is necessary. Furthermore, an abundance of useful sequential information and extensive learning opportunities are required, two conditions that were likely fulfilled early in human evolution. Our results provide a novel, logically plausible trajectory for the evolution of uniquely human cognition, language and culture, and support the hypothesis that human culture is rooted in sequential representational and processing abilities.

O12 - Memory in spoken and signed language interpreting: a theoretical model of memory processes in different interpreting modes

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Memory plays a crucial role in the cognitive processes of interpreting, from holding information in short-term memory, to accessing language and general knowledge in long-term memory, to solving the interpreting task in working memory. This has been theoretically acknowledged since the earliest models of interpreting (1, 2). Recent empirical studies have shown that interpreters have better memory than non-interpreter bilinguals (3, 4, 5). However, these investigations have focused almost universally on simultaneous interpreting. Other forms, such as dialogue interpreting and sign language interpreting have received comparatively little attention. This gap is notable given that dialogue interpreting is thought to be as cognitively demanding as simultaneous interpreting, though it entails different cognitive demands (6). The same is true of sign language interpreting.

In this presentation, we propose of a model of memory processes used in different interpreting modes. We interrogate the memory processes involved in the multiple components of simultaneous interpreting, consecutive interpreting, dialogue interpreting, and sign language interpreting with a focus on short-term memory, working memory, and updating. Through this model, we identify differences in how memory is used depending on interpreting mode. We conclude with hypotheses regarding memory ability in interpreters of different modes which can be tested empirically.

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O14 - No effect of additional education on long-term brain structure – a preregistered natural experiment in over 30,000 individuals

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Education is related to many beneficial health, behavioral, and societal outcomes. However, whether education causes long-term structural changes in the brain remains unclear. A pressing challenge is that individuals self-select into continued education, thereby introducing a wide variety of environmental and genetic confounders. Fortunately, natural experiments allow us to isolate the causal impact of increased education from individual (and societal) characteristics. Here, we exploit a policy change in the UK (the 1972 ROSLA act) that increased the amount of mandatory schooling to study the impact of education on long-term structural brain outcomes in a large (n∼30.000, UKBiobank) sample. Using regression discontinuity – a causal inference method – we find no effect from an additional year of education on any structural neuroimaging outcomes. This null result is robust across modalities, regions, and analysis strategies. An additional year of education is a substantial cognitive intervention, yet we find no evidence for sustained experience-dependent plasticity. Our results provide a challenge for prominent accounts of 'cognitive/brain reserve' theories which identify education as a major protective factor to lessen adverse aging effects. Our preregistered findings are one of the first implementations of regression discontinuity on neural data – opening the door for causal inference in population-based neuroimaging.

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Short papers

O3 - Job seekers' subjective experiences of credibility and motivation of three unemployment interventions

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Short paper: Introduction

Unemployment has severe consequences such as alcohol-related illness and mortality (Eliason, 2014). At the most basic level, there are two psychological reasons for prolonged unemployment; (a) competence issues or (b) motivational issues. Sweden is a relatively rich country with a strong Government that can provide a generous system to increase the competence level of the unemployed. For instance, municipalities may provide strategies to increase practical working skills for less able citizens such as supported employment (e.g., Adams et al, 2023). In addition, Sweden has one of the most generous unemployment benefits (A-kassa) in the world. Despite all these resources, the study of motivation in unemployment is neglected in Sweden. Internationally, however, there are plenty of studies investigating motivation within the field of unemployment (e.g., Atay & Güneri, 2023; Krumboltz, 1993; Van Hooft, 2018). Instead, Sweden has implemented an intervention within the context of social welfare called the Job Stimulus (JS). Noting that there are some financial obstacles for unemployed. That is, unemployed with social welfare cannot afford to work by the hour because it would reduce their social welfare creating an ironic effect. To counteract this, the JS aims to alleviate the financial consequences hoping that the unemployed will work more. The results have been disappointing as only 1.8% of the unemployed can benefit from it (The National Board of Health and Welfare, 2016). Given this result, there is a knowledge gap on how to motivate the unemployed. In particular, there is a lack of interventions based on motivational psychology theories.

Motivational psychology

Due to space limitations, a complete overview of motivational psychology is not presented. For more complete reviews (see Geen, 1995; Ngaosuvan, 2004; Ryan, 2019; Weiner, 1990). Instead, two major motivational theories, Self-Determination Theory (SDT) and Self-Efficacy (SE) were chosen. Self-Determination Theory (Deci, 1971; Deci & Ryan, 1985; Deci et al, 1999) concerns different qualities or regulations such as intrinsic (pleasure activities), identified (activities that one chooses to do to reach another goal), introjected (activities that we must do because would feel bad about ourselves if we did not), and extrinsic (activities we do because of the external rewards or avoidance of punishment) motivation. Self-Efficacy concerns the confidence a person has about being able to complete a specified task (Bandura, 1997). Within the SE framework, personal experience, vicarious experience, and encouragement from others are assumed to improve motivation.

Study aim and hypothesis

The present study aimed to investigate whether two hypothetical interventions (SDT and SE respectively) would be rated as more motivating compared to the JS intervention. We hypothesized that both SDT and SE interventions would be rated as more motivating than the JS intervention.

Method

Design and Participants

The study comprised a simple three-level (Intervention; SDT v. JS v. SE) within-subjects vignette experiment with subjective ratings of credibility and motivation as dependent measures. The participants ($N = 73$) were 54 women, 18 men, and one unidentified gender. Mean age was 39.71 ($SD = 10.01$) ranging between 20 and 61. Twenty-six participants had previous or present experience of social welfare whereas 47 had no prior or present experience.

Materials

Three (JS, SDT, and SE) vignettes were created for the sole purpose of this study. The JS vignette was a short excerpt of the present intervention, including the rules of its use and its benefits. The SDT intervention emphasized free choice of applying for jobs, but if unsuccessful the job applications will gradually become less free. The SE vignette concerned the offer of a paid internship with social welfare for six months in the hope of getting full employment. Vignette credibility was measured on a five-point Likert scale. Motivation to find work was measured by four five-point Likert scales, ranging from very low degree (1) to very high degree (5). (Full-text information on the vignettes and dependent measures are stored at https://osf.io/jkyrq).

Procedure

The participants were first informed about the ethical aspects, gave informed consent, and answered questions about gender, age, and social welfare. Then, they were instructed to read basic concepts about social welfare. Finally, the participants read each vignette, first the SDT, JS, and SE respectively, and answered questions on credibility and motivation. Participants could choose to comment on the study and its content.

Results

All inferential statistics used non-parametric tests because of non-equal distances in the likert scales. *Credibility* was measured by a Friedman test, yielding a significant effect of intervention, $X2(2) = 25{,}36$, $p < .05$. Mean scores were 2.95 (SDT), 2.07 (JS), and 3.05 (SE). Mean ranks were 2.20 (SDT), 1.59 (JS), and 2.21 (SE) respectively. Thus, we conclude that the SDT and SE interventions were rated as more credible than the JS intervention. *Motivation* was calculated as the sum of the four items. Mean scores were SDT (14.90), JS (12.26), and SE (16,63). A Friedman test yielded a significant effect of intervention, $X2(2) = 42{,}23$, $p < .05$. Mean ranks were 2.02 (SDT), 1.49 (JS), and 2.47 (SE). Subsequent analysis (Wilcoxon Sign Rank test) showed that participants rated the SDT intervention as significantly more motivating than JS, $Z = 4.03$, $p < .05$. Thus, participants rated the SDT and SE interventions as more motivating than the JS intervention.

Discussion

Ironically, the only real intervention was rated as the least credible compared to the hypothetical interventions. According to motivational theories, SDT and SE were rated as more motivating than the presently used JS. Study limitations concern (a) relatively low absolute levels of realism and motivation, (b) measurement of motivation is not based in either theory, and (c) lack of controlling for order effects. Despite these limitations, the present study provides two new promising directions for interventions to combat unemployment based on both motivational psychology as well as ratings of the unemployed.

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O5 - Machine Psychology: Integrating Operant Conditioning and NARS for Advancing Artificial General Intelligence

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Short paper: Abstract

Artificial General Intelligence (AGI) aims to create systems capable of performing any intellectual task that a human can, representing one of the hardest challenges in artificial intelligence research. Despite significant advances, the development of AGI is hindered by the lack of coherent frameworks to guide the creation of truly adaptive and intelligent systems. This paper introduces Machine Psychology as an interdisciplinary framework that integrates principles from operant learning psychology with the Non-Axiomatic Reasoning System (NARS), an AI model designed to operate with insufficient knowledge and resources. By implementing operant conditioning — a learning process where behaviors are shaped by their consequences — with the sensorimotor reasoning in NARS, Machine Psychology fosters adaptive learning and behavior in artificial agents. Experimental validation using OpenNARS for Applications (ONA) demonstrates the framework's effectiveness through several operant learning tasks. The results highlight the potential of Machine Psychology to provide robust, scalable methodologies for AGI development. This approach underscores the importance of continuous interaction with the environment and goal-driven behavior, offering promising pathways for achieving human-level AI. Future research directions include integrating additional cognitive principles, testing in diverse real-world scenarios, and refining system components to enhance performance and scalability.

Introduction

Artificial General Intelligence (AGI) aims to create systems capable of performing any intellectual task a human can, presenting significant challenges (Goertzel, 2014). Unlike narrow AI, which excels in specific tasks, AGI seeks versatility and adaptability across diverse domains, mirroring human cognitive abilities. Despite significant advances, developing AGI faces theoretical and practical obstacles, particularly the need for coherent frameworks guiding the creation of adaptive and intelligent systems. Machine Psychology, integrating operant learning psychology with the Non-Axiomatic Reasoning System (NARS; Wang, 2013), offers a promising interdisciplinary approach. This framework emphasizes continuous interaction and feedback from the environment, providing robust, scalable methodologies essential for AGI research.

The Need for Coherent Frameworks

A major impediment to AGI development is the lack of coherent theoretical frameworks (Wang, 2012). AGI research is fragmented, with various approaches often working in isolation, hindering progress without a unified roadmap. This makes it difficult to evaluate and compare systems or validate incremental advancements. Coherent frameworks are essential for providing a structured approach to understanding and developing intelligence. They offer a common language and principles for comparing models, identifying key components, and directing research efforts toward critical areas.

Machine Psychology: An Interdisciplinary Approach

Machine Psychology (Johansson, 2024) proposes an innovative framework by integrating principles from learning psychology, particularly operant conditioning, with the theory and implementation of NARS. At its core, Machine Psychology posits that adaptation is fundamental to intelligence, whether biological or artificial. This perspective is grounded in the principles of operant conditioning, which emphasize the role of environmental interactions in shaping behavior.

Operant conditioning, a concept rooted in behavioral psychology, involves learning through the consequences of actions (De Houwer & Hughes, 2020). Positive consequences reinforce behavior, making it more likely to be repeated, while negative consequences diminish the likelihood of the behavior reoccurring. This principle of learning through feedback is crucial for developing adaptive AGI systems that can modify their behavior based on experiences and interactions with their environment.

Non-Axiomatic Reasoning System (NARS)

NARS is an adaptive reasoning system designed to function under conditions of insufficient knowledge and resources (Wang, 2022). Unlike traditional AI systems that assume an abundance of data and computational resources, NARS operates effectively even with limited information. This makes it particularly suitable for real-world applications where data can be incomplete and environments unpredictable.

NARS is built on the principle of non-axiomatic logic, where all knowledge is subject to revision based on new experiences. This flexibility allows NARS to handle a variety of inference methods, including deduction, induction, abduction, and analogy. These inference methods enable NARS to reason in a manner that is both flexible and grounded in empirical evidence, a critical requirement for AGI (Wang, 2013).

This approach to AGI has been labeled as *Principle-AI*, since NARS aims to implement a single principle (Wang, 2019). It can be contrasted with approaches that aims to simulate the brain (labeled *Structure-AI*), or systems that aims to mimic human behavior in for example conversation (*Behavior-AI*), as could arguably be the approach to intelligence taken by Large Language Models (Wang, 2019).

Integration with Operant Conditioning

The integration of operant conditioning principles with NARS forms the foundation of Machine Psychology. This integration leverages the adaptive capabilities of NARS, enhancing it with mechanisms inspired by learning psychology to create a more robust AGI framework. The key idea is that AGI systems, like biological organisms, can learn and adapt through continuous interaction with their environment (Johansson, 2024). One way to describe this interaction is that NARS takes the same role as that of an organism in a psychological experiment.

Experimental Validation

To validate the Machine Psychology framework, a series of experiments were conducted using OpenNARS for Applications (ONA), a practical implementation of NARS (Hammer, 2022). These experiments involved three operant learning tasks: simple discrimination, changing contingencies, and conditional discrimination tasks (Johansson, 2024).

In the simple discrimination task, ONA demonstrated rapid learning by achieving 100% correct responses during both the training and testing phases. This experiment showed that ONA could effectively learn from positive reinforcement, a fundamental aspect of operant conditioning.

The changing contingencies task tested ONA's adaptability. Midway through the task, the conditions were reversed, requiring ONA to adjust its behavior based on the new contingencies. The system successfully adapted, illustrating its capability to handle dynamic and unpredictable environments. Figure 1 illustrates this experiment, in where the Y-axis represents both the percentage correct across trials, and one of the system's truth values called *frequency*.

The conditional discrimination task involved more complex learning scenarios, where ONA had to select the correct response based on conditional cues. Despite the increased difficulty, ONA achieved high accuracy, indicating its ability to form and utilize complex hypotheses.

Implications for AGI Research

The success of these experiments has several important implications for AGI research. Firstly, they validate the use of learning psychology principles, particularly operant conditioning, as a guiding framework for developing intelligent systems. This approach emphasizes the importance of adaptation and learning from environmental interactions, which are critical for AGI.

Secondly, the Machine Psychology framework provides a structured methodology for evaluating AGI systems. By incorporating principles from both psychology and artificial intelligence, it offers a comprehensive approach to studying and developing general intelligence.

Thirdly, the use of NARS as a model for AGI highlights its potential as a robust and flexible system. NARS's ability to learn in the form of operant conditioning principles further enhances its adaptability and learning capabilities.

Conclusion

Machine Psychology represents a promising pathway for advancing AGI research by integrating principles from operant learning psychology with NARS. This interdisciplinary framework emphasizes adaptation and continuous learning, key aspects of both biological and artificial intelligence. By leveraging the adaptive reasoning capabilities of NARS and the feedback-driven learning principles of operant conditioning, Machine Psychology offers a scalable and flexible approach to developing intelligent systems. The experimental validation of this framework underscores its potential to significantly advance the field of AGI, bringing us closer to achieving human-level artificial intelligence. Future research should focus on further integrating cognitive principles, testing the framework in diverse real-world applications, and refining its components to enhance performance and scalability.

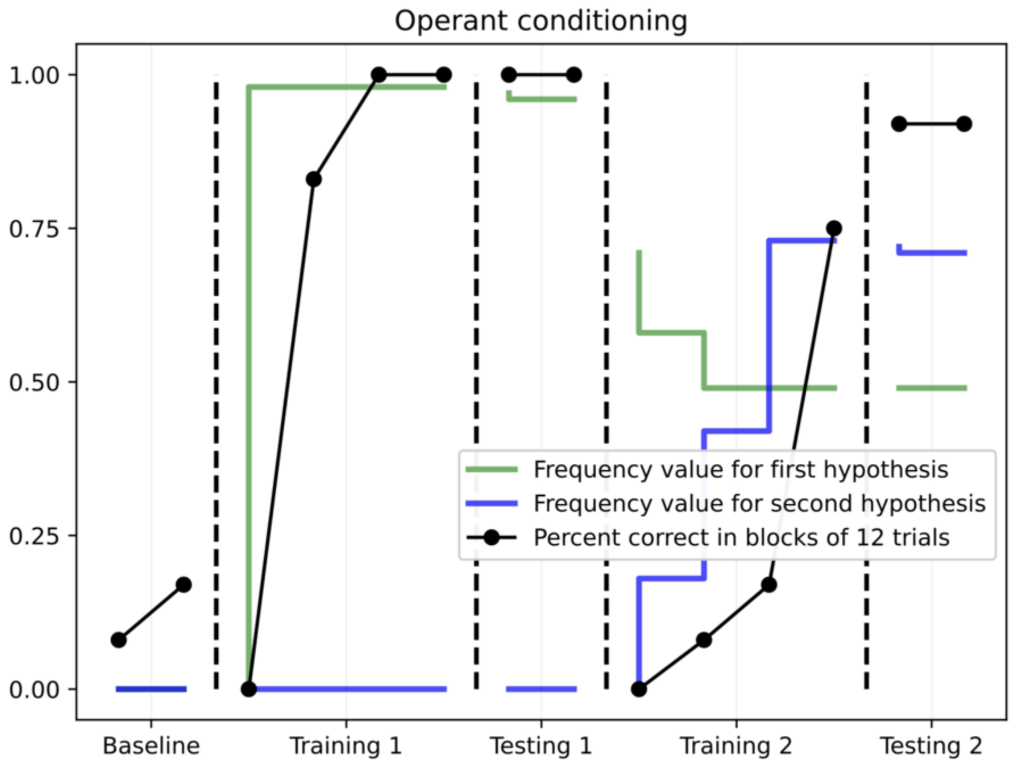

Figure 1: Operant conditioning with changing contingencies. Dots illustrate the percent of correct in blocks of 12 trials. The solid lines show the mean NARS frequency values for the respective hypotheses.

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O6 - The Impact of Artificial Intelligence on Cognitive Load in Computing Education

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Short paper: 1 Introduction

The rapid development of Generative AI (GAI) makes an impact in many fields of our society, and for higher education this is a fact that must be addressed. Research has reported on GAI creating new challenges, and GAI as a catalyst for a transformation of higher education (Chiu, 2024; Yusuf et al., 2024). According to Chiu (2024) the four most important educational domains to consider are learning, teaching, assessment and administration. This study had a focus on learning, and as pointed out by Choudhuri et al. (2024), there is a gap in the understanding of the potential and the pitfalls when using GAI in computing education. The aim of this paper is to explore the potential impact of AI technologies on cognitive load, relevant for computing education at higher education level. The research question to answer is:

What is the potential impact of AI technologies on cognitive load in computing education according to recent research?

2 Cognitive Load Theory

Cognitive Load Theory (CLT) was first developed by John Sweller and colleagues in the 1980s and has become one of the more influential theories in educational psychology (Schnotz & Kürschner, 2007). CLT describes the working memory resources that are involved in a learning task and divides the cognitive load that a learner can experience in intrinsic load, extraneous load, and germane load (Kirschner et al., 2018). Intrinsic and extraneous load are often considered to be the two main sources for cognitive load, dealing with the complexity of processed information (intrinsic) and the way that it is presented (extraneous) (Kirschner et al., 2018). While germane load covers the working memory resources used for dealing with new information to be processed, which is the intrinsic load (Kirschner et al., 2018).

Further, the theory often stresses the importance of learners' cognitive systems, and that instructions for learning needs to be adapted and designed after these (Schnotz & Kürschner, 2007). The theory has also been questioned, for example concerning its generalizability, and there is an ongoing debate on interpreting and transforming the theory (Schnotz & Kürschner, 2007). However, this study will not cover the criticism and debate concerning CLT, but use the definition outlined above.

3 Method

This study applied a scoping literature review approach for seeking available evidence in prior research (Munn et al., 2018) and identify potentials for future research and implications for practices (Tricco et al., 2016). A search was conducted in May of 2024 in databases Web of Science and Scopus that combined keywords “artificial intelligence” and “cognitive load” with “computing” or “programming” or “computer science”. The search identified 56 potentially relevant papers in Scopus and 8 in Web of Science. Papers were selected for inclusion based on the following criteria: published between 2019 and 2024, written in English, journal article or conference paper, relevant for the study’s aim and research question. After screening and removing of duplicates, 7 papers were chosen for inclusion in the study. The included papers were analyzed with thematic analysis, following the guidelines by Braun and Clarke (2006) for a thematic analysis.

4 Results

Through the thematic analysis 4 themes were identified which relates to the potential impact of AI technologies on cognitive load in computing education. These are “language learning assistance”, “intelligent support agents”, “intelligent virtual learning environments (VLE)”, and “game-based learning (GBL) strategies”. These themes, with connection to included papers, are depicted in Table 1 and further discussed in relation to Cognitive Load Theory in the next section.

5 Discussion

The theme of language learning assistance highlights that applying AI to auto-generate subtitles (Malakul & Park, 2023) and to provide speech recognition that is dynamic and assessment-based (Chen et al., 2022b) does not increase the cognitive load compared to alternative strategies for language learning in the studies. It should be important to understand this in relation to the complexity of the language content, since more complex content usually is more difficult to present and therefore increases the cognitive load. The results presented here are promising but should be investigated further.

The theme of intelligent support agents highlights that AI can be used for support in retrieving scientific articles (Cheng et al., 2022a), provide recommendations in everyday decision making (Oruç et al., 2022), and act as a conversational partner for end user developers (Asunis et al., 2021). All of the mentioned studies in this theme, discuss their designs in relation to having positive effects on cognitive load for the user. As with the previous theme, this should however be understood in relation to the complexity of information and the design of its presentation. Intelligent support agents do not reduce cognitive load automatically, it is dependent on the complexity of the information and how it is presented to the user or learner.

The last two themes, intelligent VLE and GBL strategies, differs from the previous two. Intelligent VLE highlight many of the positive aspects that it can have on students’ learning and collaboration but recognizes that there are challenges for technical cognitive load (Wei & Jia (2021). The cognitive load challenge of intelligent VLE should not be surprising given the complexity of the environments and future research could explore positive design for addressing extraneous cognitive load. A positive approach for this could be related to the theme of GBL strategies, which has been shown to enhance skills, knowledge and motivation related to computer science while also reducing cognitive load (Ma et al., 2022).

6 Conclusion

The conclusion of this study is that the potential impact of AI technologies on cognitive load in computing education, based on included papers, shows promise. However, the authors of this paper would like to stress that reduced cognitive load will not simply happen by introducing AI. The complexity of content and design of its presentation, for example through user interaction, is still very important.

7 Limitations and future research

Concerning limitations of this study, the low number of included papers needs be addressed. Future research should widen the literature review by including more databases and identifying more relevant keywords to incorporate in the query string. This could potentially increase the number of identified relevant papers to be included. An alternative for increasing the number of included papers could also be to widen the time frame for inclusion from 5 years to 10 years, and to apply backward and forward searches on identified papers.

A small but interesting theme in the findings was GBL strategies, which could be explored further in future research. A study on GBL strategies could analyze educational games involving AI and computing education to identify which game design aspects reduce or increase the cognitive load?

Table 1. Identified themes and included papers.

	Language learning assistance	Intelligent support agents	Intelligent virtual learning environments	Game-based learning strategies
Malakul & Park (2023)	Auto-generated subtitles			
Cheng et al. (2022a)		Internet articles retrieval agent		
Chen et al. (2022b)	Dynamic speech recognition			
Ma et al. (2022)				GBL for effective learning
Oruç et al. (2022)		Decision support agent		
Asunis et al. (2021)		Conversational intelligent agent		
Wei & Jia (2021)			Challenges of VLE	

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O7 - Leveraging Large Language Models for Tailored and Interactive Explanations in AI Systems

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Short paper: Abstract Over the last decade, tremendous advancements have been made in AI systems' performance, at the cost of transparency and explainability. Significant effort has been put into opening the black-box of AI systems through explainer models. Less attention has been paid to communicating these insights to users. Natural language explanations (NLEs) have been suggested as a presentation technique for explanations due to their accessibility and increased trust. Moreover, NLEs are flexible, allowing for tailored or interactive explanations. This paper introduces an approach that leverages large language models (LLMs) to generate faithful free-text NLEs for AI systems without needing human-annotated data. The approach integrates traditional explainer models with LLMs, transforming the explainer model output into natural language. We investigate whether LLMs can generate NLEs aligned with user preferences, how NLEs influence user reliance, and the faithfulness of the generated NLEs. Two preliminary studies have been conducted. The first indicates that the NLEs are faithful to the explainer model, and the second suggests that NLEs may be positive for appropriate reliance. Even though not thoroughly explored, the proposed approach introduces an interesting path toward tailored and interactive explanations.

Introduction Artificial intelligence (AI) is increasingly impacting various aspects of our lives, from personalized recommendations to critical applications in healthcare. With this expansion, the demand for transparency and interpretability grows, especially in high-stakes situations (Gunning et al., 2019). Traditional eXplainable AI (XAI) methods, such as feature importance methods, have provided insights into AI predictions. However, these methods often fail to effectively communicate these insights to non-technical users, limiting their usefulness in real-world applications (Ribera & Lapedriza, 2019).

Natural language explanations (NLEs) have been proposed as a presentation technique to increase the flexibility and accessibility of explanations (e.g., Cambria et al., 2023; Feldhus et al., 2022; Sokol & Flach, 2018). Previous approaches to generate NLEs, for instance, template-based or end-to-end generated, have had issues with flexibility (Mariotti et al., 2020) or faithfulness (Camburu et al., 2019).

This paper proposes an approach that generates faithful free-text NLEs without requiring task-specific human-annotated data. The proposed approach opens up a new path toward *tailored* and *interactive* explanations, following earlier recommendations (e.g., Cambria et al., 2023; Sokol & Flach, 2018). Both tailored and interactive NLEs can help achieve appropriate cognitive load. If users receive too much or complex information, it can be overwhelming. However, presenting information in an appropriate format or allowing the user only to seek the relevant bits can reduce cognitive load (Feldhus et al., 2022).

Methodology The proposed approach consists of three key components (Figure 1C): *(i)* task model, *(ii)* explainer model, and *(iii)* generative model.

Task Model: This component processes input data and generates predictions that need to be explained.

Explainer Model: A traditional explainer model (e.g., LIME or SHAP) extracts rationales for the task model's predictions. These rationales indicate what features of the input data influenced the prediction (Ribeiro et al., 2016).

Generative Model: An LLM, such as ChatGPT, is employed to generate NLEs based on the input data, the task model's prediction, and the rationales provided by the explainer model. Moreover, the LLM is instructed to generate explanations based on the provided information. The LLM generates NLEs for the task model predictions conditioned on the rationales provided by the explainer model.

Implementation A scikit-learn implementation of a support vector machine (SVM) was chosen as the task model. It was trained to classify texts for a subset of the 20newsgroups dataset (Lang, 1995). LIME was selected as the explainer model to generate rationales for the predictions. Lastly, ChatGPT-4 (OpenAI, 2023) was chosen as the generative model.

Evaluation and Results Two preliminary studies were conducted to evaluate the approach. First, a study evaluating the faithfulness of the generated NLEs. Second, a user study investigating user satisfaction and reliance.

Faithfulness Study: The faithfulness evaluation consisted of both quantitative and qualitative measures to ensure that the explainer model's rationales were correctly represented in the NLE. The quantitative measure compared the set of words in the generated NLEs with the set of rationales generated by LIME. The results from 100 randomly selected instances show that NLEs generated through the pipeline (Figure 1C) correctly represented 97% of the LIME rationales. Whereas the LLM-Explanations (Figure 1B) correctly represented the rationales about 11% of the time.

User Study: The user study was an online in-between-subjects experiment (n=188). Participants were recruited via Prolific and randomized into one out of four conditions. They were presented with 12 instances from the 20newsgroups and corresponding SVM predictions. For each prediction, depending on the condition, participants were presented with either a LIME explanation (Figure 1A), NLE generated by GPT-4 (Figure 1B), NLE generated via the proposed approach (Figure 1C), or no explanation. Participants were asked to indicate their satisfaction with each explanation using a Likert scale, and indicate whether they agreed with the prediction by selecting the class they thought the text belonged to.

User Satisfaction: The user study compared participants' indicated satisfaction levels depending on condition. Results indicated that overall satisfaction did not significantly differ.

User Reliance: The study examined how NLEs influenced users' reliance on AI systems. NLEs reduced over-reliance on AI compared to no explanations. That is, participants were more likely to disagree with an incorrect prediction and agree with a correct one if presented with an NLE compared to the control. No differences were found between LIME and the other conditions.

Discussion The preliminary findings indicate that the proposed approach can generate faithful free-text NLEs without task-specific human-annotated data. Since this is a work in progress, what is potentially more interesting are the future directions of this work.

Future Directions A significant advantage of the proposed approach is its potential for tailored and interactive explanations. Traditional template-based methods are static and predefined, lacking the flexibility needed for personalized explanations. The proposed approach allows for dynamic and context-aware explanations tailored to individual users' needs and preferences. This flexibility is crucial in domains where user-specific contexts play a significant role (Miller, 2019).

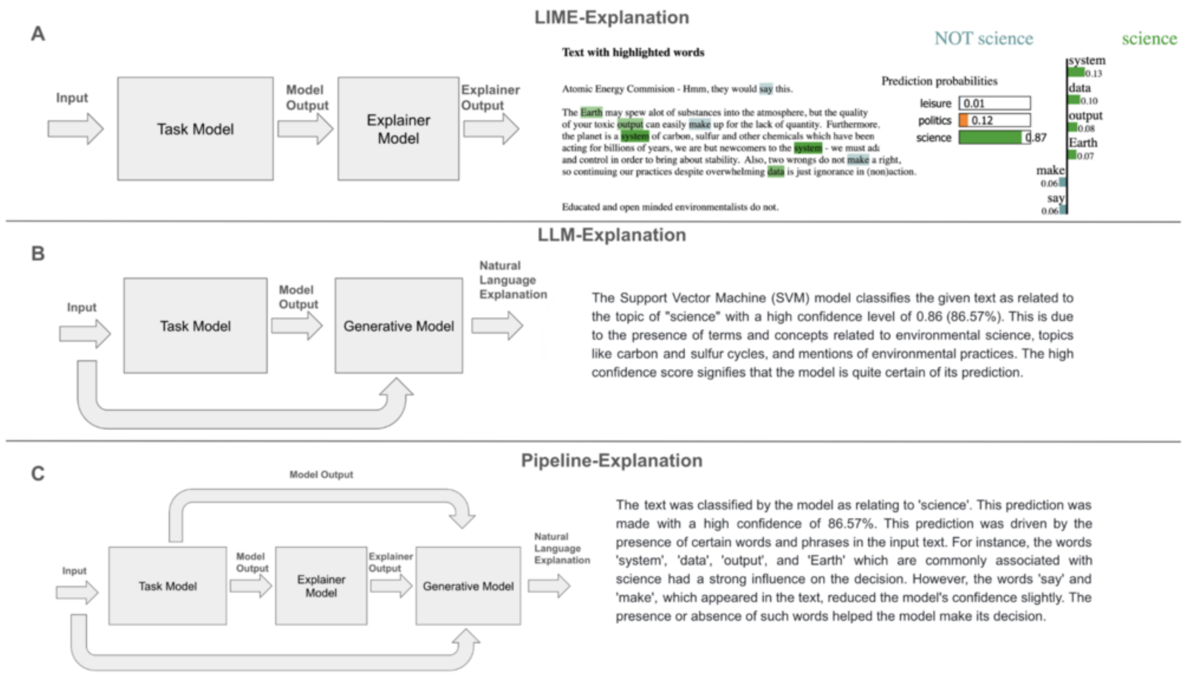
Tailored Explanations Tailoring explanations to users has traditionally been challenging to implement. However, with an LLM as the mediator, it would be interesting to investigate whether the context length could be used to add information about the user or previous interactions. For instance, one can instruct GPT-4 to explain the output to a seven-year-old or developer. Moreover, one could explore how well it can tailor explanations with different purposes.

Interactive Explanations Interactive explanations further enhance user engagement by allowing users to query the AI system for more details or clarification (Sokol & Flach, 2018). This interactivity can be achieved by keeping the generated explanation in the context length and allowing the user to prompt the system. For instance, users can ask follow-up questions, request more detailed explanations, or seek examples in directions they please rather than being provided predefined explanations. This approach aligns with how humans naturally seek understanding through conversation, thus making AI explanations more intuitive and effective (Cambria et al., 2023; Sokol & Flach, 2018).

Conclusion The proposed approach represents a significant step towards human-centered XAI, offering a solution for generating NLEs that are faithful and comprehensible. By leveraging the capabilities of LLMs, the approach addresses the limitations of traditional XAI methods, providing a foundation for tailored and interactive explanations.

Figure 1

Flowcharts and Example Explanations.



Note. On the left are flowcharts for how each condition's explanations were generated. To the right, example explanations for the same instance are shown. In this study, the task model was a SVM, the explainer model LIME, and the generative model GPT-4.

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O9 - Preferences for everyday objects are transitive

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Short paper: INTRODUCTION

To produce a choice, a mind needs to somehow represent a ranking of available options (“preferences”). A central question for cognitive psychology, but also social science, has been whether those preferences are “transitive”.

Transitivity means that some relation is inherited by subsequent elements. For example, ancestry is transitive since if Adam is an ancestor of Abraham and Abraham is an ancestor of Moses, then Adam is an ancestor of Moses . Dominance in rock-paper-scissors is on the other hand not transitive (“intransitive”): Rock beats Scissors, and Scissors beats Paper, but it is not true that Rock beats Paper. Similarly, preferences for some options a, b, c are transitive if $a \rightarrow b$, $b \rightarrow c \Rightarrow a \rightarrow c$ in pairwise choices. That is, the underlying cognition produces a ranking $a \rightarrow b \rightarrow c$ on a psychological scale.

If preferences are intransitive, it severely restricts what mathematics we may use in formal theories (for example, it rules out functions). It is also, arguably, a mark of incompetence: intransitive preferences leave one open to being exploited by other actors (“money pump”, Davidson et al., 1955).

In a seminal article, Tversky (1969) used pre-screened participants and tailored stimuli to show that there were circumstances under which preferences were intransitive. This and similar existence proofs have since been (incorrectly) interpreted as evidence that preferences are intransitive *in general* (e.g. Starmer, 2000). If we want to generalise from the laboratory to participants’ everyday lives, we should use a representative design (Brunswik, 1956) where stimuli are sampled from participants’ everyday environments. Further, overt choices will be noisy, rather than deterministic, reflections of covert preferences, which statistical methods used in previous work have not accounted for appropriately (see Regenwetter et al., 2011). We perform two pre-registered experiments that address these limitations.[1]

Our primary model of interest for how covert preferences are translated to noisy choices is the “Fechnerian” model. There is a long tradition within psychology of theories that presume that magnitudes (like strength of preference) are represented with imprecision (Fechner, 1860). When two magnitudes/preference strengths are about the same, they become difficult to discriminate and choice of which magnitude is higher is made as-if by a coin flip. As the difference between the magnitudes increases, the magnitudes become easier to discriminate and choice goes towards being deterministic. In the context of two-alternative forced choices, we get the "Fechnerian prediction" that as the distance in (covert) preference ranks between the options increases so does the probability of (overtly) choosing according to that ranking.

METHODS

We performed two experiments which were identical except for stimuli, partially different participant pools, length, and compensation. We therefore report them together.

Participants

In Experiment 1, 300 participants of UK nationality and 300 participants of US nationality (to get natural variation in stimulus familiarity) were recruited on Prolific.com. Experiment 2 recruited 400 UK participants. Participants needed to be located in the UK/USA, respectively, and were compensated with £1.50 and an incentivising bonus (one of the gambles they chose, see below, was played for real: Experiment 1) or £2.50 and an additional £1.32 due to server lag causing delays (Experiment 2).

Stimuli

In Experiment 1, we included the five gambles from Experiment 1 in Tversky (1969) as a non-everyday reference category. We also included two categories of everyday objects to choose between: UK Confectioneries to have (scraped from a poll by Yougov, the leading UK polling company) and UK political Parties to vote for.

In Experiment 2, we expanded this representative design with eight additional categories of everyday objects: (i) Movies to watch, (ii) Magazines to subscribe to, (iii) Cars to have, (iv) Holiday destinations to visit, (v) Charitable organisations to donate to, (vi) Dinners to have, (vii) Establishments to get a meal from, and (viii) Fruits to have as an afternoon snack. (i) were taken from IMDB's Top 100 list while (ii) – (viii) were taken from Yougov polls.

Stimuli were excluded if less than half of the participants in the relevant Yougov poll had heard of them (since these were not representative of most people's everyday environment) or if the accompanying image was missing or ambiguous.

Design

The main task was a series of two-alternative forced choices where participants selected the option they would prefer to play/have/vote for, etc. We also collected judgement data which will not be reported here.

In Experiment 1, participants chose between all pairwise combinations of the five monetary gambles, five randomly selected Confectioneries, and five randomly selected Parties. Each pair was presented three times, for a total of 90 trials. Experiment 2 was identical except that we used blocked randomisation to select four of the eight categories to present each participant with, for a total of 120 trials.

Analysis

We leverage recent advances in statistical methods for testing models of transitive preferences expressed with noise (see Klugkist & Hoijtink, 2007; Zwilling et al., 2019, for details). We test the Fechnerian model, some other prominent models (Random preference model; Weak stochastic transitivity, Moderate stochastic transitivity, see Cavagnaro & Davis-Stober, 2014), and a catch-all intransitive model which encompasses all possible intransitive theories. We fit them to each participant in each category separately (yielding 600 observations for monetary gambles and 600 × 2 + 400 × 4 observations for everyday objects) and evaluate them based on Bayes factors vìs-a-vìs the intransitive model.

RESULTS

We immediately note that for all everyday object categories, all group-level choice probabilities follow the Fechnerian prediction (Figure 1). As the distance between the options increases (reading the matrices in Figure 1 left to right and down to up) the probability of choosing the option with higher ranking in the best-fitting transitive preference ordering increases. On group-level, preferences for everyday objects appear transitive and Fechnerian. We proceed to investigate the individual level modelling results.

For monetary gambles, the Bayes factors favour the Fechnerian model for about 72% of observations. About 5% are best fit by the intransitive model and the rest by another transitive model. For the everyday objects across both experiments, the Fechnerian model is the best fit for about 92.6%. About 0.0014% (one participant in four different categories) are best fit by the intransitive model. It seems like intransitive preferences sometimes appear for monetary gambles but are virtually non-existent for everyday objects. These results are robust to excluding participants whose responses are completely noiseless.

There is substantial evidence (Bayes factor > $10^{0.5}$) for at least one of the transitive models vìs-a-vìs the intransitive model in 97% of all observations, never substantial evidence in favour of the intransitive model, and never for the best-fitting model over the runner-up. In sum, these data do not allow us to confidently match a specific transitive model to a specific participant, but do allow us to confidently rule out the intransitive model.

CONCLUSION

It appears possible to design stimuli – here, monetary gambles – such that at least some participants have intransitive preferences for them. As soon as we sample real-world objects, however, intransitive preferences are virtually non-existent. For the majority of observations, the best description appears to be that preference strengths for objects are represented on a psychological scale with Fechnerian imprecision. These results highlight the importance of evaluating the properties of a cognitive system in its natural ecology (Simon, 1990).

Figure 1. *Proportions of participants who chose the row option over the column option for each category. Rows/columns relabelled such that A represents the first option in each participant's best-fitting transitive preference ordering, B the second best, and so on.*

Experiment 1

Option	B	C	D	E
Lotteries				
A	0.898	0.915	0.916	0.927
B	-	0.914	0.927	0.928
C	-	-	0.905	0.904
D	-	-	-	0.923

Option	B	C	D	E
Confectioneries				
A	0.951	0.978	0.988	0.996
B	-	0.935	0.979	0.991
C	-	-	0.936	0.978
D	-	-	-	0.963
Political parties				
A	0.942	0.968	0.983	0.989
B	-	0.912	0.946	0.977
C	-	-	0.915	0.964
D	-	-	-	0.942

Experiment 2

Option	B	C	D	E
Movies				
A	0.948	0.967	0.98	0.993
B	-	0.92	0.959	0.989
C	-	-	0.915	0.958
D	-	-	-	0.923
Magazines				
A	0.956	0.972	0.985	0.992
B	-	0.924	0.972	0.982
C	-	-	0.91	0.97
D	-	-	-	0.934
Cars				
A	0.939	0.965	0.982	0.993
B	-	0.946	0.962	0.985
C	-	-	0.947	0.975
D	-	-	-	0.955
Holiday destinations				
A	0.955	0.99	0.993	1.0
B	-	0.936	0.967	0.984
C	-	-	0.926	0.976
D	-	-	-	0.936

Option	B	C	D	E
Charitable donations				
A	0.955	0.976	0.986	0.99
B	-	0.915	0.953	0.997
C	-	-	0.921	0.979
D	-	-	-	0.963
Dinners				
A	0.966	0.983	0.99	1.0
B	-	0.954	0.988	0.997
C	-	-	0.947	0.985
D	-	-	-	0.976
Establishments				
A	0.941	0.971	0.988	0.997
B	-	0.915	0.963	0.993
C	-	-	0.932	0.98
D	-	-	-	0.949
Fruits				
A	0.961	0.98	0.998	1.0
B	-	0.951	0.983	0.998
C	-	-	0.956	0.99
D	-	-	-	0.966

[1] See https://doi.org/10.17605/OSF.IO/K4PZ7 and https://doi.org/10.17605/OSF.IO/E8JPC.

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O11 - Toward a proper format of perceptual temporal representation in the dynamic snapshot view

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Short paper: How we perceptually experience temporal properties and relations of dynamic events, such as motion, is widely discussed among philosophers of temporal experience. The classical answers largely draw on the representation of a dynamic event as a series of instantaneous static contents. In particular, the specious present, a temporal unit of conscious experience, is often assumed, within which static instantaneous contents are temporally integrated and imbued with dynamic phenomenality, such as visual flow of motion. Challenging this specious present theory (SP), the dynamic snapshot theory (DS) proposes that instantaneous content appears dynamic, termed dynamic snapshot, due to preconscious and functionally specialised neural mechanisms.

The main disagreement between DS and SP lies in two aspects: 1) perceptual representation format, and 2) the involvement of consciousness in the formation of representation. The commonality is the implicit assumption that the temporal format of perceptual representation, i.e., how the representational content is structured, determines the temporal phenomenality of how temporal properties or relations are experienced.

Accordingly, DS' attempt to explain temporal experience without appealing to the involvement of consciousness does not only challenge classical phenomenology centred on the structure and act of consciousness. More interestingly, it points to a new temporal format specific to perceptual representation, drawing on the neurofunctional and neuroanatomical specificity of our perceptual system. I will more flesh out this idea and argue for its adequacy against SP.

The classical understanding of a perceptual instant is a duration-less mathematical point containing static, i.e., atemporal content, similarly to a still-cut (See review Chuard, 2020; Dobbs & Broad, 1951; Russell, 1915). Under this assumption, our perceptual experience of motion, succession, and change – which unfolds over time and exhibits certain phenomenal character – is only possible through the temporal integration of these instantaneous static contents into a succession. That is, the temporal phenomenality emerges from this temporal format of succession.

SP specifically attributes this task to consciousness. The idea that a succession of the snapshot-like static contents results in a visible dynamic flow of motion is largely inspired by cinematography. In film, "the clean, smooth motion apparent on cinema (and) television screens" arises from "static images which depict a moving object at a succession of neighbouring locations" (Dainton, 2008, p. 365). Nonetheless, differently from a film, the succession of instantaneous static contents in our mind is supposedly established by consciousness. These contents are temporally connected within a specious present, a temporal unit of conscious experience, and gain dynamic phenomenality through this temporal integration.

It should be noted that the succession of instantaneous static contents is analogous to the linguistic representation of motion, as Tylor Burge notices with respect to representation format (Burge, 2022, p. 273). Consider the propositional representation, "x moves from the location L1 at the time T1 to the location L2 at the time T2". It is decomposable into simpler representations of static images, each with a single spatial and temporal variable: x is located at the location Ln at the time Tn. We might represent each perceptual moment in this way during introspection and comprise those simple representations into a complex representation about motion.

Regarding the propositional representation with continuous spatiotemporal variables, the specious present can be also understood as a kind of mental vehicle conveying at least two simple propositional representations or still-cuts representing two motion sequences if not just a linguistic "AND" connector. This interpretation is not far-fetched, as the specious present also serves to establishing the succession of non-perceptual thought contents (Dainton, 2014) and introspection plays a relevant epistemic role to examine what is experienced (Phillips, 2008). Accordingly, it is unclear how the specious present gives rise to perceptual dynamic appearance, differently from the succession of linguistic contents in introspection.

In contrast, dynamic snapshot theorists more focus on the specificity of perceptual temporal experience. Particularly, they claim that the visual flow of a moving object is processed independently from the succession of motion sequences. For the former can be experienced without the latter, as demonstrated by several visual illusions, including waterfall illusion and pure phi motion. Furthermore, since the motion detection mechanism is known to be primitive and automatic, the dynamic feature in question is processed preconsciously (Arstila, 2016, 2018; Le Poidevin, 2007, p. 89; Prosser, 2016, pp. 123–125). Hence, there is no need for consciousness to make up the dynamic appearance of static contents by establishing succession.

DS' suggestion of instantaneous dynamic content in virtue of preconscious and functionally specialised mechanisms reflects the neuroanatomical and neurofunctional specificity of our perceptual system. Neuroscientists widely acknowledge that motion speed and direction, i.e., motion velocity are detected very early, almost simultaneously with the initial registration of visual information, and even earlier than other features when the motion velocity is very high. This occurs around 20 to 60 milliseconds after stimuli onset (Grasso et al., 2018; Zeki, 2015). By contrast, discriminating an object's shape from the background, mapping its spatial change, and conceptually identifying the object as such require feedback loops between functionally specialised neurons and take more time (philosophical review by Burge, 2022, pp. 417-418;427; Lamme & Roelfsema, 2000; Lu & Sperling, 2001).

Consequently, it is highly unlikely that instantaneous content is the static full-blown representation of a motion sequence like a still-cut image. On the contrary, every instantaneous content might appear dynamic as visual flow is almost immediately processed after motion onset, based on motion velocity. In a similar vein, these snapshots may not contain complete information about a moving object, as features such as object identity and spatial trajectory are processed later than velocity. Instead, it is more likely that some snapshots contain slightly outdated information about the object's position, while others contain incompletely processed information about its shape, resulting in blurry edges. Given that our perception of a moving object is not equally clear and distinct at every moment, this explanation is also phenomenologically plausible.

Therefore, the perceptual temporal representation format of the dynamic snapshot can be understood as a dynamic assemblage consisting of several features separately processed. The processing thereof does not always temporally coincide in a single scene; some features are more updated but others less, depending on neural processing time. Furthermore, a dynamic snapshot would contain not only dynamic features but also non-dynamic features, such as object identity that persists over time.

To conclude, the temporal representation format of the dynamic snapshot is characterised by an assemblage of dynamic and non-dynamic features. These features are processed preconsciously by separate neural mechanisms, as proposed in the original dynamic snapshot view. Additionally, the heterogeneity of the dynamic snapshot, with respect to the differing processing times of various features, has been newly illuminated. This result can be also seen as a specification of iconic temporal representation. In contrast, the temporal format in the specious present theory, namely the succession of instantaneous static contents, is suspected to be a linguistic representation format developed through cultural practices. Further elaboration on the dynamic assemblage can be made by linking perception to action, which lies beyond the scope of this paper.

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O13 - AUTONOMOUS AGENTS, COGNITION AND INTELLIGENCE

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Short paper: Abstract

This paper proposes agent-based models as a foundation for the description of nature, at different levels of abstraction, from physical to ecological. It builds on the distributed concurrent information processing performed by diverse types of agents, from elementary physical to chemical, sub-cellular to cellular, organismic, and ecological agents connected in networks of networks. It contributes an interdisciplinary synthesis of research results from a variety of research fields providing a common framework for conceptual analysis and applications to emergent levels of organization, “active matter”, cognition and intelligence, development, and evolution.

Introduction

In 1986, Marvin Minsky proposed a theory of natural intelligence titled “The Society of Mind” (Minsky, 1986). He described human intelligence (and any other natural cognitive system) as the result of interactions of simple mindless processes called agents. These processes are the basic “thinking entities” which together produce the abilities of minds. Minsky characterized the interactions between the agents as constituting a collective intelligence of a "society of mind", building on the understanding that "minds are what brains do".

The advantage of modeling the mind as a society of agents, rather than deducing its behaviors from fundamental principles or formal systems, lies in the flexibility to assign to different agents various types of processes. These agents can have different purposes, diverse ways of representing knowledge, and use different methods of problem-solving.

Over the years, agent-based models have significantly expanded their reach and are now used in a wide range of fields. Recently, during a conversation with MIT Technology Review, OpenAI CEO Sam Altman described a future where AI evolves beyond its current capabilities to present personal agents, integrated into various aspects of our lives without the necessity for new hardware or extensive additional training data. (O'Donnell, 2024)

The question is: are agents not only at the core of intelligence but also, with different degrees of capabilities, a suitable model for information processing and knowledge generation in general (Dodig-Crnkovic, 2013)? A picture from the diverse application of agent-based approaches emerges, showing them as a universal language for describing interactions in terms of information exchanges in a variety of models, ranging from fundamental physics to societies and ecologies.

The paper "A Systematic Approach to Autonomous Agents" (Dodig-Crnkovic and Burgin, 2024) discusses the critical role of agents and agent-based systems in various fields, such as artificial intelligence, ubiquitous computing, ambient intelligence, autonomous computing, and intelligent robotics.

Research has shown that autonomous agency is a feature of all living systems, from single cells to complex organisms (Dodig-Crnkovic, 2016). Biological agency involves the capacity of organisms to sense, process information, and respond to their environment, actively shaping their structures and functions. That has inspired the development of artificial agents.

Autonomous agents are increasingly used in various applications, including healthcare, education, finance, retail, manufacturing, agriculture, and more. These agents can manage tasks independently, from social media management to investment decisions and creative endeavors like writing. The programming techniques and AI technologies required for autonomous agents, such as generative models, are at the forefront of artificial intelligence research (Yaochu, 2023).

Information, computation, cognition: agency-based hierarchies of levels

The agency is the basis for linking the interconnected concepts of information, computation, and cognition for both natural and artificial systems (Dodig-Crnkovic, 2016). It posits that agents exist at various levels of organization, from elementary particles to complex organisms and ecosystems, each engaging in processes of information exchange and processing/computation. Nature is thus described as a network of informational structures, with agents at different levels of organization. Information is relational and agent-dependent, where agents are entities capable of acting and causing changes. Computation is defined as the process of information exchange between agents, effectively making the dynamics of information the core of natural computation/morphological computation.

The hierarchical organization of information within nature, (Dodig-Crnkovic, 2016), from basic physical interactions to complex biological systems is explained using Deacon's levels of natural information, which range from data patterns (syntax) to functional information (pragmatics), reflecting the increasing complexity and functionality at higher levels of organization.

Active matter as a basis for agency

Natural computation occurring at various scales, is based on properties of *active matter* from subatomic particles to entire ecosystems. In the process of complexification from the simplest structures and up, self-assembly, self-organization, and autopoiesis (self-production and self-maintaining of systems) play central roles.

The dynamics of living systems is morphological computation (Dodig-Crnkovic, 2017b), where the structure and function evolve through interactions with the environment.

The Hewitt Actor Model (Hewitt, 2010) can be used at the most fundamental level, where elementary particles and molecules are seen as computational agents exchanging messages. This model helps to explain how complex behaviors and structures emerge from simple interactions at the quantum and molecular levels.

Molecular networks exhibit a level of agency, as shown by (Mathews, Chang, Devlin, and Levin, 2023) who describe cellular signaling pathways as plastic, proto-cognitive systems with the properties of memory, problem-solving, and reprogrammability.

Cognition on sub-cellular and cellular levels – "agential materials"

Cognition is framed as a property of living agents, arising from cellular and molecular interactions (Ford, 2023). Even simple organisms like bacteria exhibit basic forms of cognition through their ability to process information and adapt to their environment. This cellular-level computation forms the basis for more complex cognitive processes in higher organisms.

The concept of *autopoiesis* is central to understanding cognition as a natural process. Autopoietic systems are self-organizing and self-sustaining, continuously regenerating their components through interactions with their environment. This process is seen as a fundamental form of cognition, applicable to all life forms. Self-organized pattern generation, i.e. morphogenetic self-organization has been studied by (Yaochu, 2023).

Morphogenesis is the development of structure in an organism and it can be described as morphological computation (Dodig-Crnkovic, 2017b). Natural morphogenetic processes may be used to understand the principles of self-organization and apply them to artificial systems.

Organismic cognition as driving force of development and evolution

The agent-based info-computational approach offers a naturalistic framework for understanding cognition, where information and computation are fundamental to all physical and biological processes. This approach bridges the gap between physical, chemical, and biological sciences, providing a unified model for studying natural and artificial cognitive systems.

It presents a comprehensive view of nature as a hierarchy of informational structures, where computation and cognition are emergent properties arising from the interactions of agents at various levels of complexity (Santosh, and Levin, 2019) (Pfeifer, Iida, & Lungarella, 2014). This framework not only enhances our understanding of biological systems but also guides the development of advanced computational technologies and cognitive robotics.

Agent-based models are suitable for systems with different components with different, even conflicting, goals (Dodig-Crnkovic 2017a, 2022). They embody parallelism, scalability, and robustness. Agent-based system is a distributed AI system used for distributed problem-solving and modeling/management of multi-agent behavior. They are especially suitable approaches to development and evolution (Walsh, 2018) (Miller, 2023) and in particular the emergence of intelligent behavior.

Conclusion

The contribution of this paper is a synthesis of up-to-date insights into a unified framework that addresses a broad range of open questions, including the emergence of intelligence in nature, the role of agency and cognition in ecosystems and evolution, the organization of matter's agency across different levels of granularity, and how advancements in artificial intelligence can extend human cognition.

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O15 - Population-based ecosystem modeling via deep reinforcement learning

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Short paper: Abstract

Population-based ecosystem models can be used for understanding ecosystem dynamics and predicting the ecological impact of human economic activities. These models typically rely on manually programmed "if-then" rules to model animal behaviors such as feeding and locomotion. As the complexity of the ecosystem grows, this method gets increasingly challenging and time consuming. Here I suggest a general strategy for population-based ecosystem modeling, which uses deep reinforcement learning instead of hand-coding.

Introduction

Ecosystem models have been used for understanding ecosystem dynamics and predicting the ecological impact of human activities like fishing, agriculture, forestry, and urban development. Population-Based Models (PBMs) (Royama, 2012) model animals at the population level, typically in terms of the biomass of each species. PBMs are frequently integrated with Geographic Information Systems (GIS) (Crooks et al., 2019), which enables models of animal populations to be tracked on a map. Many PBMs model population dynamics in terms of the relatively general concept *functional group* (FG), which can denote a species, a collection of species, or a subset of a species. PBMs have been used for modeling large ecosystems, such as Barents Sea, covering 108 marine FGs over several decades (Nascimento et al., 2023).

Animal behavior, including locomotion and feeding behavior, plays a central role in population dynamics. Accordingly, models of animal behavior are standard components of PBMs. These behavioral models are typically developed using the traditional computer programming paradigm, where the behavior is coded explicitly by a human programmer, for example by using "if-then" rules. To do this, the programmer needs to specify what the animal populations will eat and how they will move in all possible situations that might occur. Thus, they need to specify how animals of different species manage to survive and reproduce by continuously finding resources, while dealing with predators, competition, and physical obstacles.

The scope of the traditional programming paradigm is limited by the bounded rationality of the human programmers, particularly their bounded knowledge, cognitive capacity, and time (Simon, 1955). While several general mechanisms of animal behavior have been identified in ethology (like approaching food, escaping predators, and avoiding competition), this is far from enough for modeling and predicting in detail how animals of different species will behave in all situations that they might encounter (Anderson & Perona, 2014). Thus, there are *a priori* reasons to believe that hand-coded models of animal behavior are oversimplified and flawed.

Machine learning (ML) is an alternative to hand-coding that has already revolutionized several fields of science (Van Noorden & Perkel, 2023). An ML method that has been used for behavioral modeling is reinforcement learning (RL) (Sutton & Barto, 2018), in particular deep RL (Mnih et al., 2015). In ecology, deep RL has been used for ecosystem management (Silvestro et al., 2022) and for behavioral modeling in the context of agent-based ecosystem modeling (Strannegård et al., 2023). Here we will show how deep RL can be used for behavioral modeling, also in the case of population-based ecosystem modeling.

Method

A *cell property* consists of a name and a real value. Examples of cell property names could be: Depth, Temperature, Salinity, Land Cover Class, and Sea Floor Class.

Definition 1 *A static model consists of*

- *A set of m functional groups*
- *A set of cells arranged in a grid*
- *A set of n cell properties*
- *A vector in* $R^{(m+n)}$ *for each cell, specifying the properties and biomasses of the cell.*

An illustration of a static model is given in Fig. 1A.

Definition 2 *A decision function is a function from* $R^{5(m+n)}$ *to* $R^{(n+6)}$.

An illustration of a decision function is given in Fig. 1B. The observation space is given by a 5 cell environment, where the decision-making population is in the central cell. In each of the 5 cells, there are $m+n$ observations. Thus, an observation can be modeled as a point in $R^{5(m+n)}$. The action space consists of one locomotion action, one hiding action, and n feeding actions (one per FG). It also contains 4 directions of locomotion. Thus, an action can be modeled as a point in $R^{(n+6)}$. For simplicity, we consider decision functions that are implemented as *policy networks* in the form of fully connected neural networks with $5(m + n)$ inputs, n+6 outputs, and 2 hidden layers with 10 nodes in each.

Definition 3 *A dynamic model consists of a sequence of static models defined by:*

- *An initial static model*
- *A decision function for each decision-making FG*
- *Update rules for the cell properties*
- *Update rules for the biomasses*

The dynamic model might be based on data from geographic, hydrographic, meteorologic, and biological data sources. The initial static model can be based on such data, either unchanged or manipulated to reflect hypothetical human interventions such as biomass harvesting or changed land use.

For the update rules of the cell properties, one possibility is to use historic data and assume a similar temporal pattern in the future. The rules for updating biomass in a cell depend on the actions taken by the local populations. To specify these rules, one may use a set of parameters that are specific to each FG, e.g., the minimum metabolic rate, the average locomotion speed of an animal FG, or the growth rate of a plant FG.

Locomotion actions lead to biomass exchanges between neighboring cells. In our model populations can be split by simultaneous locomotion actions in different directions. We assume that no FG can move more than one cell length per time step. The amount of biomass that leaves a cell during a time step depends on the speed parameters and locomotion decisions. Feeding actions will reduce biomass of the FGs that serve as food, while increasing the biomass of the FGs that feed on it. The hiding action protects the populations from predation.

To train the policy network for a given FG with RL, one may use reward signals such as these:

- Survival reward: give reward +1 at each time step, if the given FG has not gone extinct in the grid, cf. *Heartbeat* reward in (Strannegård et al., 2024).
- Biodiversity reward: give reward +1 at each time step, if no FG has gone extinct on the grid.

Result

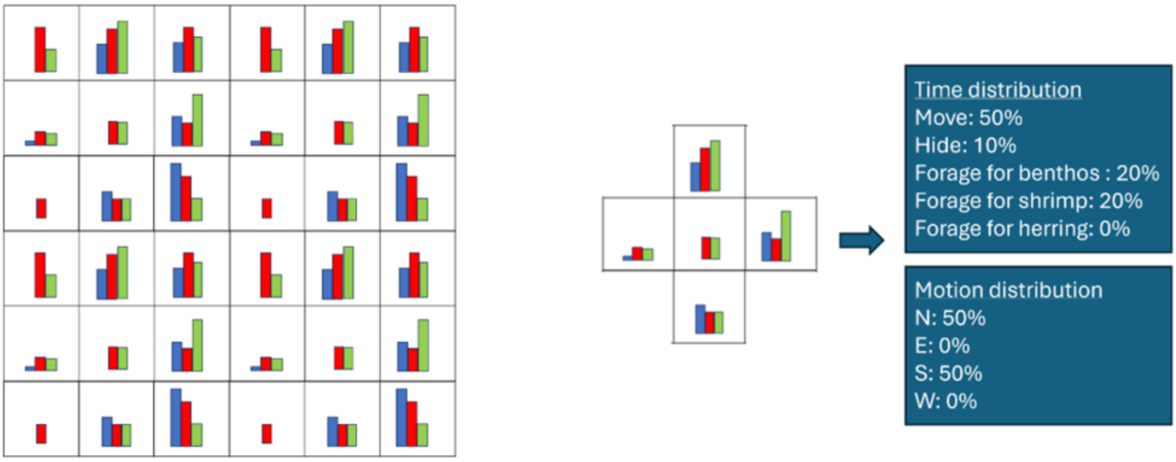
Using the framework described above, the policy networks can be trained with deep RL algorithms such as PPO (Schulman et al., 2017). Thus, a complete dynamic model can be constructed for any terrestrial or marine ecosystem, for which the relevant background data is available.

Discussion

Despite dramatically changing conditions, many animal species have co-existed in the same geographic area for hundreds of years, without any of them going extinct. Moreover, animals might come to places where they have never been before and manage to survive there. We want our behavioral models to be generalists in a similar way. To that end the behavioral models are trained in simulation runs starting from different static models derived from real maps and biomass data.

We have shown how to construct population-based ecosystem models via deep RL in theory. In the next phase, several concrete ecosystem models need to be constructed and validated.

A (left): Example of a grid representing a geographical area divided into 6x6 cells. The colored bars in the cells represent cell properties and biomasses. B (right): Example of an observation space and action space. The observations are those of a population located in cell (2,2) of the grid in A. The biomass data informs the population about the presence of food, predators, and competitors. Based on those observations, the population decides to what extent it will feed, move, and hide during the time step. In this example, one part of the population (whose size depends on the speed parameter of the FG) will move North, while another part will move South.



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Posters

Abstracts

P1 - Sound Localization Mechanics of Consciousness

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The neural basis of human consciousness is one of the greatest questions of our time. Somewhere within your brain lies the ability to generate the extraordinary experience of reality. The neural basis for this perceptual awareness remains unclear, and studies into the neural correlates of consciousness (NCCs) attempt to unravel the secrets of consciousness and map this process in the brain. In the sense of hearing, research using electroencephalography (EEG) has identified an NCC as the auditory awareness negativity (AAN), and its properties in generating conscious auditory experience are still being discovered. The AAN has been studied in recent years, and a summary of the research is presented, from its discovery to the latest revealed qualities from contemporary research.

P2 - Conceptual-level confusion in spatial memory: Misplacing sounds toward locations of smells

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Our sense of smell shows a unique integration between primary sensory areas and higher cognitive centers responsible for spatial memory[1,2]. One theory proposes that these systems coevolved to aid navigation to resources[3,4]. In contrast, hearing shows stronger separation of perceptual and cognitive processes[1,5]. Different organizations of these senses could lead to spatial memory prioritizing odors over sounds. In this study, participants memorized and recalled locations of odors and sounds in a Virtual Reality setting. We hypothesized that olfactory spatial memory representations would disproportionately interfere with auditory representations. Results of Bayesian Anova indicated a memory decline over time and a general retroactive interference effect, but no olfaction-specific interference. However, results from an exploratory Bayesian logistic regression showed that in the error trials, participants tended to misplace sounds in the vicinity of odors related to the same concepts. For example, when presented with a sound of popcorn popping (concept: popcorn), participants misplaced that sound to the location of the smell of popcorn. There was no similar interference from auditory stimuli on olfactory misplacements. Therefore, we propose that the hypothesized unique olfactory retroactive interference in spatial memory tasks might manifest subtly in the type of errors, rather than in overall performance.

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P4 - The Association between Memory Strategies and Working Memory Training Performance in Older Adults

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Working memory (WM) training for older adults, aimed at addressing cognitive decline, has primarily focused on visual and auditory stimuli, while the potential of olfactory stimuli remains underexplored. Additionally, the influence of memory strategies on WM training performance, particularly how these strategies vary across different sensory modalities, is not well understood. The aim of this study is to explore the relationship between memory strategies and performance on working memory training with different sensory modalities in healthy older adults. We randomized participants (n=34, aged 65-75) to perform a spatial, adaptive working memory training task with either olfactory or visual stimuli. The participants visited the lab for 45-minute sessions, five days a week, over four weeks (20x45 min in total). Performance on the training task was measured by the WM load, increasing and decreasing with correct and incorrect responses, respectively. No strategy instructions were given in advance; instead, we collected data after the training period through open text forms. The responses will be coded according to strategy to explore associations between training performance and memory strategies in olfactory versus visual WM training.

P5 - What can Socially Assistive Robots bring to quality of life for older adults?

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Socially Assistive Robots (SAR) has been suggested as an important technology in the shift of care from institution to home environments, and has been shown to nr effective in addressing loneliness and social isolation among older adults (Lee et al. 2023., Lorenz et al., 2016, Shishehgar et al., 2018). In a newly started research project RO-LIV, we employ a user experience design approach, involving older adults as co-designers and engaged actors, in order to identify needs, solutions, and obstacles for integrating socially assistive robots into older adults' homes. The research is organized into three work packages: *Needs Analysis, Current Situation Analysis*, and *Conditions and Obstacles for Integration into the Home Environments*. The expected results include a road map for the integration of socially assistive robots into older adults' homes, informed by a nuanced understanding of user needs and preferences. Overall, we emphasize the importance of adopting a user-centered approach in human-robot interaction research, particularly when designing solutions for older adults. By involving older adults in the design process and addressing their diverse needs, researchers can develop robotic systems that are address real user needs, are socially acceptable, and has a increased potential for adoption and impact on quality of life.

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P8 - Emoji-Text Mismatches: Stirring the Pot of Online Conversations

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Emojis and emoticons are pervasive in social media platforms (Hasyim, 2019). However, their usage and response patterns remain largely unexplored. This paper presents a pilot study for a larger experimental project on the reactions to emojis and emoticons in text-based conversations. Data were collected on three triadic conversational groups on the messaging app Telegram. The participants were instructed to discuss a moral dilemma named the Balloon Task (Howes & Lavell 2023). Each conversations lasted 20 minutes (M=782 words). 16 instances of emojis and emoticons were found. This paper provides a qualitative analysis of the patterns.

We found that the emojis/emoticons can have either consistent or inconsistent emotional valence with the text, highlighting matches or mismatches between the two. An example of matched cases is the greetings "hej :)" (positive text + a positive emoji). An example of mismatched cases is "this experiment is not supposed to make us feel comfortable \emoji{face-with-tears-of-joy}" (negative text + a positive emoji). A special case of mismatches is contributed by emojis that are incongruent with the text, like \emoji{see-no-evil-monkey}. These patterns will be used to develop experimental stimuli in a follow-up study to investigate online interlocutors' reactions to different emoji-text patterns.

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P9 - Daily Sleep Variations and Next-Day Cognitive Performance in Young and Older Adults: A 21-Day Mobile Experience Sampling Study

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Experimental studies on sleep deprivation demonstrate that insufficient sleep worsens cognitive performance, and more so in young than in older adults. However, the impact of daily sleep variations on cognitive performance in real-life contexts remains less understood. This study explored the impact of daily sleep variations on next-day cognitive performance, in 308 young (18-30 years) and older adults (55-75 years) who participated in a 21-day mobile experience sampling method study. Participants performed the momentary Digit Symbol Substitution Test (mDSST), a measure of processing speed, daily via a mobile phone app. Actigraphy, a wearable accelerometer sensor that measures wrist activity, was used to monitor sleep duration and efficiency. Mixed-model regression analysis revealed that nights with shorter sleep duration than usual were associated with decreased next-day mDSST performance in both age groups ($p < 0.001$), while variations in sleep efficiency had no significant impact. Although older adults generally showed significantly lower cognitive performance in the mDSST ($p < 0.001$), the effects of sleep duration variations were similar across age groups, emphasizing that adequate sleep duration is crucial for maintaining cognitive performance. In contrast, day-to-day variations in sleep efficiency may be less impactful.

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P10 - Implicit learning of sound sequences

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Implicit learning is the ability to learn without awareness and is important for aspects of daily life including noticing perceptual patterns, motor learning and language abilities (1, 2, 3). We use a modified version of the Serial Reaction Time Task (4) to investigate whether people implicitly can learn sequences of sounds presented from different locations. Additionally, we investigate factors such as mind-wandering and sleepiness that possibly affect the level of implicit learning as well as task reliability.

Our data from three data collections, show that implicit learning of sound sequences is possible, at least for some individuals (35-79% participants). We also observe that a majority of the participants get sleepier over the course of a testing session and that many of the participants report high levels of mind-wandering during task performance (m = 5, rng = 1-7).

That some individuals show implicit learning of sound sequences while others do not deserves further investigation on why this is so and if it affects daily life. Given the observed high levels of mind-wandering and sleepiness as well as known problems with task reliability, one important question is whether individual trait-level ability or situational factors are the most important factor for implicit learning.

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P11 - Inside-out: Thought-Experiments, Scientific Simulations, and the Economy of Extended Cognition

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I introduce a new alternative for extended cognition. Narrow processes take place within an intuitive boundary given by 'skin and skull' (Clark and Chalmers 1998), while broad processes at least partly go beyond that boundary. There is a tendency within cognition towards making cognition more efficient by mutually substituting narrow and broad processes. There are two directions of substitution, outside-in, and inside-out. My example is thought-experimental simulation.

Outside-in: some thought-experimental simulations manifest a tendency to temporally replace a paradigmatically broad process, the process of empirical (material) experimenting, by a narrow imaginative process that is more readily available.

Inside-out: some thought-experimental simulations in turn manifest a tendency to expand the originally narrow process of thought-experimenting so as to implement some part of it on external devices, as in certain computer simulations that perform the same task more efficiently.

I propose a sufficient condition of extended cognition that covers the two directions:

REPLACEMENT:

Some process *P* is an extended cognitive process if either

(i) *P* is narrow and *P* replaces a broad cognitive process *Q* in approximating the outcome of *Q*,

or

(ii) *P* is broad and *P* replaces a narrow cognitive process *R* in approximating the outcome of *R*.

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P12 - Res Cogitans – The Evolution of Thinking

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A somewhat prominent view in the literature is that language provides opportunity to program the brain with ‘cognitive gadgets’, or ‘virtual machines’. Here, I explore the possibility that thinking itself – internal symbolic responses to stimuli that are either intrinsic or extrinsic, and computational procedures that operate on these internal symbolic representations – is such a software product rather than just an emergent phenomenon of the brain’s hardware being ‘complex enough’, or the brain processing information in a manner that is ‘integrated enough’. I also present a testable hypothesis that would indicate the presence of such a thought-gadget, and briefly overview some evolutionary pre-requisites for its existence. Further, I explore some consequences the existence of such a gadget would entail for our understanding of consciousness. The nature of the gadget is left unspecified as the article is not a blueprint for the thinking gadget, but an argument in favor of its existence.

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P13 - Resolving Quantifier Scope Ambiguity: The Influence of Context and Grammatical Gender

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The sentence "every road leads to a town" is ambiguous. It can be interpreted in at least two different ways: there is either one town (singular) or several towns (plural). This ambiguity arises from the interaction between the universal quantifier "every" and the indefinite article “a”. Typically, speakers resolve such quantifier scope ambiguities using their lexical-pragmatic knowledge, but syntactic or morphological factors can influence how easily and consistently these ambiguities are resolved (Kurtzman & MacDonald, 1993; Sayeed, et al., 2019). In this experimental study, we explore how the grammatically gendered Swedish indefinite articles — which are themselves ambiguous with counting words — impact a language user's ability to use context to resolve quantifier scope ambiguities. Participants read quantifier scope ambiguity sentences preceded by context sentences prompting either a singular or plural interpretation, with the trials framed as being spoken by a friend to simulate a more dialogic context. The findings reveal that contextual information strongly affects quantifier scope ambiguity interpretations, although grammatical gender shows a trend in the opposite direction from our initial hypothesis. We discuss these results in terms of cognitive load and the contextual floor.

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P14 - Physiological responses during gaze avoidance in children with autism

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Eye tracking studies of reduced eye gaze in autism spectrum condition (ASC) mainly follow two hypotheses; *gaze avoidance* and *gaze indifference*. The former is consistent with the sensory overload and hyperarousal theories of abnormal social orientation in ASD, while the latter is more in line with the social motivation hypothesis. In order to investigate the complex interplay between arousal and face processing, we combined an eye tracking approach with biomarkers of autonomic nervous system arousal; heart rate variability (HRV) and GSR. The idea is to analyze the relationship between eye gaze avoidance and autonomic arousal, as well as dimensional measures of autistic traits and other symptomatic ratings. If the results support the gaze avoidance hypothesis, we expect to find a meaningful correlation between the latency to look away from the eye region of face stimuli, high scores on the symptomatic measures and high measures of arousal. Another variable of interest is a proportional measure of trials with initial gaze shifts toward the eyes divided by the number of valid trials. In line with the gaze indifference hypothesis, we would expect lower arousal for higher proportions of fast gaze shifts to the eyes in individuals with high symptomatic autism scores.

P15 - Large-scale oscillatory networks characterize cognitive states

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The temporal patterns in functional neuroimaging data are key for understanding whole-brain dynamics. This study used Independent Component Analysis in the theta and alpha bands to unveil networks in MEG data from three visuospatial working memory (WM) tasks in the Human Connectome Project and a second independent dataset. Four distinct networks, two in each band, were found and were input into a non-supervised clustering algorithm, which produced four states that may be related to different cognitive states. The posterior theta network was linked to an encoding state, while a dorsal alpha network was associated with maintenance of information in WM. This study highlights the reliability and validity of using electrophysiological networks, which showed a systematic switching between states throughout various task phases.

P16 - Challenges in neural self-regulation: insights from EEG-based Neurofeedback training

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With feedback, people can learn to self-regulate neuronal activity in specific brain regions and frequencies. The utility of neurofeedback (NFB) becomes apparent when we consider that many neuropsychiatric disorders are characterized by atypical brain activity. Tuning the brain to a more normalized state could reduce symptoms. One open challenge in NFB research is that many participants cannot learn to self-regulate their neural activity. In four sessions, we investigated non-performance in EEG-based real-time NFB training. Specifically, twenty participants trained for 32 minutes in four sessions to upregulate frontal Theta (Fmθ) and occipital Alpha and down-regulate centrotemporal SMR and central Beta.

We found that all participants could self-regulate at least two features, and twelve participants learned to regulate three features. However, none of the participants could upregulate the Fmθ, a feature typically associated with cognitive control. The results suggest that non-performance in NFB is not a general disability; instead, some neural features are more challenging to learn to regulate. Another unexpected finding was that Fmθ systematically decreased throughout the session for most participants. This phenomenon was consistent across all trained features. Since past neurofeedback research hasn't shown a decrease in Fmθ, more effort is needed to clarify theta changes in NFB experiments.

P19 - Affective polarization effects on political judgment in vague political contexts

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Research on polarization effects on political judgment is fairly extensive in bipartisan systems, like US presidential elections (e.g. Dias & Lelkes, 2022, Iyengar & Westwood, 2015), but less is known about these effects in multi-party systems, like many European parliamentary elections. In this study, 195 Swedish subjects were randomly assigned to evaluate three fabricated political suggestions without any established partisan ties. Each suggestion was paired with a fictitious survey result indicating left-wing, right-wing, or no preference. Participants reported their favorability towards each suggestion, and we collected data on their political (left-right) preference and strength of political identification. Results showed a small to medium negative effect from outgroup preference, but no significant effect from ingroup or neutral preferences. The negative outgroup effect was stronger among those with a stronger political attachment. This indicates that even in a context with less defined ingroups and outgroups, significant negative outgroup bias, suggesting affective polarization, can still occur.

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P20 - Expectation Priming Through Linguistic Framings When Introducing Social Robots: An Empirical Study of Students' UX in an Educational Context

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The field Human-Robot Interaction (HRI) involves new forms of social interactions that are dependent on the many and different earlier expectations of humans. In this study, the impact of linguistic framing on students' expectations and user experiences when being introduced to social robots in an educational setting were investigated. An empirical case study involved the social robot Pepper and 10 students aged 16–19. The introduction to Pepper utilized two forms of linguistic framing: positive and negative terms. Pre- and post-interaction interviews were conducted to assess the students' expectations and experiences. Assessments to measure negative attitudes toward robots and user experiences were conducted using the NARS and Godspeed questionnaires. Furthermore, filmed observations of the students' interactions with Pepper were used to provide additional insights. Results of the study showed that students' expectations and experiences varied depending on the type of introduction and linguistic framing utilized. While none of the differences among the questionnaire responses were statistically significant, the trends were in line with the clear results from the interviews and observations.

P21 - Can Robot Cats Help Children with Autism Spectrum Disorder in Dental Care?

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Children with Autism Spectrum Disorder (ASD) often face various difficulties with visiting a dental hygienist (e.g. collaborating), which can lead to stress and anxiety connected to participation in dental care. Therefore, some children get remitted to a specialist pedodontics unit that is 'schooling' children for dental visits by using an individual treatment plan. They work with different tools, such as stress reduction tools (e.g. stress ball) and the so-called 'tell-show-do' method.

Behavioral and psychosocial interventions are the main approach to help children with ASD, which seek to facilitate development and adjustment by teaching children appropriate social and communication skills. Previous research has shown promising results with the use of companion robots for psychosocial support, and therefore, we investigated through two studies the usage of a cat robot for 6-10-year-olds with ASD during dental visits. The first study was conducted over the course of one year (3-5 visits) with the collection of video and observation data of the interaction, while the second study measured the effect of the stimuli being a cat robot or a stuffed animal. Preliminary results show that most of the participants connect with the robot while posing new challenges for the dental hygienist.

P22 - Investigating How Olfactory Processing Is Affected By Visual vs. Gustatory Priming Stimuli via EEG

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Majority of the sensory information gathered in a natural context is multisensory. Thus, it is crucial to investigate multisensory interactions in controlled lab environments. This study explores the effects of priming stimuli from two different sensory modalities, gustation and vision, on olfactory processing. Specifically, integrative processes of olfactory perception are studied in the presence of congruent or incongruent, taste or visual stimuli (e.g. sweet taste or the word ”sweet” followed by peach odor). Total of thirty participants will be presented with an odor while being subjected to a priming stimulus in one of the two modalities, as a taste or a written word, and asked if the odor matches the priming stimulus or not. Through this setup, reaction time and accuracy data will be collected. Via EEG, an N400 electrocortical activity, measured by contrasting processing of predicted vs unpredicted stimuli, is expected to be obtained. Because of the close integration between taste and odor systems, the hypothesis is that the response-times will be shorter, and the N400 cortical responses will be larger, for taste-odor pairs than for visual-odor pairs.

P23 - Individuals with remitted depression show a normative attention to social stimuli at an early time stage – an eye-tracking study

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Ongoing and remitted depression (RD) is prevalent and linked to functional impairment and attentional difficulties. While prior research has investigated early-stage attentional biases towards emotional social stimuli among depressed, formerly depressed, and healthy controls (HC), a gap remains in understanding orienting towards social stimuli per se. This study examined whether adults with RD (n=22) show distinctive attentional patterns to whole faces (WF), isolated eyes (IE), and color deviants (CD) compared to HC (n=21). Depression diagnoses were confirmed through clinical interviews, and attentional processes were assessed using the pop-out paradigm in eye-tracking tasks. Aligning with previous research, the study confirmed that WF and CD elicited a pop-out effect. Additionally, IE, also, elicited preferential visual orienting, akin to other salient stimuli. No significant differences were found between RD and HC in the speed of attention directed toward the target, as measured by target hit and gaze shift latency. Similarly, no differences in dwell time were observed in the WF or IE conditions, indicating that remitted depression does not affect the duration of engagement with social stimuli. These findings imply that the pop-out effect in adults is not influenced by RD. Longitudinal studies including larger samples are encouraged.

P24 - Social Robots that Handle the Unreal: What? When? Where? Why? How?

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Events involving the unreal are ubiquitous in people's lives in the forms of movies, novels, computer games, pretend play, and role playing. People process the distinction between real and unreal in comprehension, encoding and retrieval of information. I argue that social robots need the ability to handle the unreal to be fully integrated in human environments. Otherwise, they may show inappropriate behaviour, such as that a household robot may incorrectly alert emergency services when perceiving an threat coming from a fictional action movie, or when seeing the family's children playing with toy guns. Among the challenges when equipping social robots with this ability are, a) to identify in which contexts, functions, and tasks the ability is most relevant (such as learning companion, healthcare intervention assistance, or safety monitoring), b) to establish a desideratum for what robots would need to be able to do on a behavioural level, and c) explore technical implementation (such as sensory systems and neural network architectures). These challenges could be addressed in relation to existing frameworks in social robotics and further perspectives, such as ethics, could be applied. These challenges require interdisciplinary collaboration, involving areas such as psychology, media studies, computer science, engineering, design, and philosophy.

P25 - Hello Trivia Friend: Understanding Human-Agent Dynamics Through Design Provocation

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This study leverages a critical provocation design approach to examine user interactions with intelligent agents, specifically focusing on how non-conventional agent behaviours impact user perceptions. By embedding playful, challenging, and mischievous elements into the user experience, the research aims to uncover insights traditional methods might miss. Participants interacted with a trivia game agent named Trivia Friend, which provided false feedback to provoke reactions and gain insights on user perceptions. Key findings highlight the emotional spectrum elicited by the agent's behaviour, ranging from frustration and mistrust to amusement and engagement. The study reveals that user perceptions of fairness and communication style are influenced by the agent's provocations. Furthermore, the research underscores the importance of managing user expectations. A provocative design can stimulate engagement. However, real world implementations of intelligent agents must be designed with fairness and transparency to ensure positive user experiences. The study calls for efforts towards emotional understanding, clear communication, and ethical considerations when implementing socially capable intelligent agents. This research contributes to the development of adaptive, user-friendly, and ethically sound intelligent AI based agents by offering valuable insights into the complex dynamics of human-agent interactions.

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P26 - Metacognition during sleep deprivation

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There is a negative effect of sleep loss on many cognitive functions (Lim & Dinges, 2010). Less is known about the extent to which individuals are aware of their cognitive abilites after insufficient sleep. This awareness, known as metacognitive accuracy, was assessed in a group of healthy participants (N=182) either after three nights of sufficient sleep or after one night of total sleep deprivation, in a randomised, between-subjects study. Participants performed several cognitive tests, measuring simple attention, arithmetic ability, working memory, episodic memory, and inhibition (using a Stroop task). After each test, with no feedback about answers, they rated how well they thought they performed. We estimated the difference between the two groups regarding participants' probability of correctly rating themselves as having performed above or below the median. Across the different tests, this probability was close to 50% for both groups, indicating poor metacognitive accuracy with this measure. The probability that there was a noteworthy difference between the two groups is very small. In other words, cognitive ability declined after sleep deprivation, and metacognitive accuracy remained practically constant across conditions, but low overall.

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P27 - Pragmatics partially segregated from theory of mind: evidence from resting state functional connectivity

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Pragmatics and Theory of Mind (ToM) are at play during conversational interaction, but the relationship between the two, in the conversational context, is a matter of debate. Using resting state fMRI-data, we investigate a potential segregation of the two domains by considering functional connectivity within the ToM network and between the ToM and language networks and their relation to pragmatic measures. We also studied the connectivity of two cortical clusters: a left superior parietal and a bilateral dorsal precuneal cluster. These clusters are located outside both the ToM and language networks and were previously found to covary with individual pragmatic variability. The results show that these two clusters are functionally connected at rest, and that the degree of connectivity is related to pragmatic behavior. On the other hand, there was no relation between pragmatic behavior and the degree of connectivity involving the ToM network. Furthermore, the ToM network and the two clusters were not connected. Approaches such as cognitive spaces/maps could provide new perspectives on pragmatics and related domains. In conclusion, we suggest that the domain of pragmatics is partially segregated from ToM, and provide further support that the two clusters outside the ToM and language networks are pragmatically relevant.

P28 - Visual Mental Imagery is Not Evidently Separable from Episodic Memory Recall

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While previous research on episodic memory vividness aims at measuring episodic memory, such cognitive tasks also involve visual mental imagery since vividness is primarily a property of visual mental imagery. Literature also shows that subjective measurements of visual mental imagery (e.g., the Vividness of Visual Imagery Questionnaire; VVIQ) are confounded by demand characteristic effects. Therefore, this study examines whether subjective vividness ratings are interpreted differently between a "visualize" and a "recollect" version of the VVIQ. One hundred and thirty-nine participants filled out online either one of the versions of the questionnaire, which also included an additional manipulation on demand characteristics (i.e., instructional cues). Eighty-nine participants self-described with aphantasia; those who cannot voluntarily form visual mental imagery. Results showed that irrespective of self-describing with aphantasia or not, participants scored comparably on the two versions of the questionnaire (with aphantasic participants scoring overall lower than control participants), favouring the interpretation that episodic memory vividness involves visual mental imagery. However, instructional cues did not affect scoring patterns as predicted. Different interpretations of such results are discussed, highlighting the idea that it is a difficult methodological exercise to discern the two theoretical constructs: visual mental imagery and episodic memory.

P29 - “Give skin coldness to us”: temperature-based metaphors across the world’s languages

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This talk will focus on the uses of temperature terms (such as *warm, hot, cold, cool*) outside of the temperature domain proper (Koptjevskaja-Tamm 2015, Koptjevskaja-Tamm & Nikolaev 2021), e.g., the well-known cases like *warm people* and *hot temperament*, and the more “exotic” cases like ‘give skin coldness to us’ = ‘give us peace’ in Ewe (a Kwa language spoken in Ghana). We will look at the areal and genetic patterns in such uses and their absence across a sample of about 100 languages from all around the world, and discuss to what extent the findings provide evidence for the allegedly universal conceptual metaphors "AFFECTION IS WARMTH” and "ANGER IS HEAT" (Lakoff & Johnson 1999, Grady 1997, Kövecses 2003, etc.). Linguistic manifestations of the former show a surprisingly limited areal and genetic distribution, as opposed to the latter, whose linguistic manifestations are much more frequent. The study demonstrates once again the dramatic influence of the Anglocentric, Standard Average European, and WEIRD perspective on many of the central concepts and conclusions in linguistics, psychology and cognitive studies, and emphasizes the necessity to bring in linguistic diversity into this research (cf. Piirainen & Sherris 2015, Wnuk & Ito 2021, Blasi et al. 2022).

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P30 - A qualitative study on parent's perception of their child's developing critical thinking skills and their own role in this development

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In a world where most information is open and easily accessible, a key educational challenge is to scaffold children's ability to navigate this information and think critically about what they are told. Past work has shown that, given careful guidance, preschoolers can reason logically and identify an efficient test of a surprising claim. However, when left to their own devises, they struggle to detect the need for and to engage in such critical thinking activities. Cultivating a disposition to think critically might thus be a goal of not only formal, but also informal educational settings, such as family interactions. A key component of these interactions is parent's ideas about critical thinking. In this qualitative study, we interview 10 parents on their beliefs about critical thinking and its development in their child, as well as their role in, and propensity to seek advice on, this development. Our thematic analyses suggests that most parents believe in teaching their child critical thinking skills, but few mentioned having clear strategies and want advice. Interestingly, many parents converged on the idea that critical thinking, or skills supporting such activities, may in fact be best played out in collaboration with their child during everyday activities.

P31 - Peripartum Depressive Symptoms and Development of Child Emotion Regulation: The Roles of Temperament, Attachment and Sleep Quality

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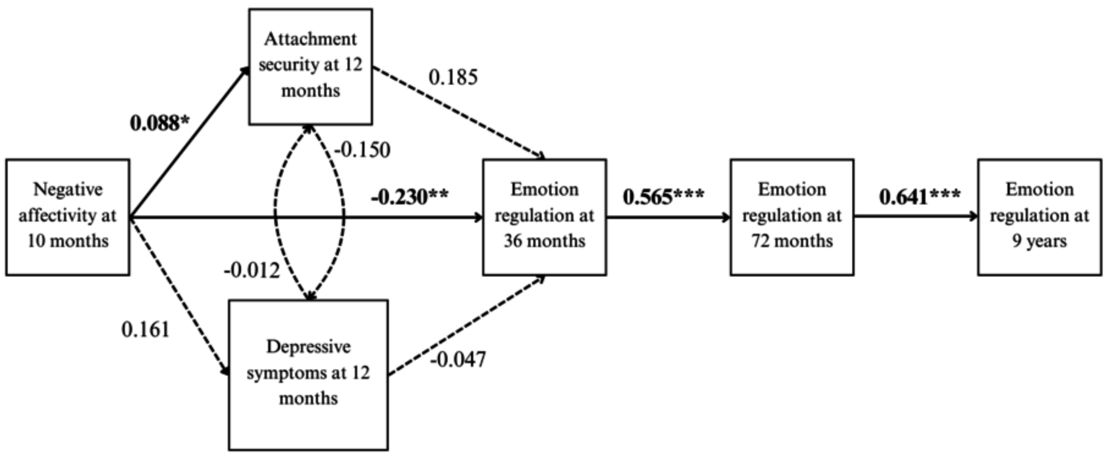
While the detrimental effect of peripartum depression on child socioemotional development and psychopathology is well-researched, less is known about the effect on emotion regulation ability. The relationship between peripartum depressive symptoms and child emotion regulation, was examined through path analysis. Further, an exploratory analysis model investigated the effect of maternal sleep quality, a common predictor of maternal depressive symptoms, on emotion regulation. The models included a moderation analysis with two known correlates of both peripartum depression and emotion regulation: child temperamental negative affectivity and attachment security. For 127 typically developing children, negative affectivity was measured at 10 months of age (IBQ-R VSF), child attachment (Strange Situation Procedure) and maternal Depressive symptoms (MADRS-S) and sleep quality was collected at 12 months; and Emotion Regulation at 36 and 72 months, and 9 years (Emotion Questionnaire). No statistically significant effects of depressive symptoms and sleep quality on child emotion regulation were observed and no moderation effects were found. Exploratory analysis indicated that negative affectivity significantly affected attachment security (positively) and emotion regulation development (negatively). The findings emphasize the importance of considering child internal characteristics when predicting child mental health outcomes.



P32 - Virtual Reality Full-Body Ownership Illusions: A Study on the Role of Perspective

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Feeling ownership over the body of a virtual avatar is achievable by inducing a full-body ownership illusion in virtual reality. Previously, researchers have used the first-person perspective and synchronous tactile stimulation to elicit this illusion. The strength of the illusion can then be measured by averaging ownership and referral of touch scores from a questionnaire. In the present study, ownership and referral of touch scores were analyzed together and independently to determine the roles of perspective and timing of tactile stimulation on the full-body ownership illusion. To compare each factor, participants experienced four 90-second conditions in virtual reality combining the first- and third-person perspectives with synchronous and asynchronous tactile stimulation. Based on the average ownership and referral of touch scores together, the first-person synchronous condition elicited the highest overall illusion scores. However, separately analyzing these components revealed that the first-person perspective conditions elicited the highest ownership scores, regardless of visuotactile synchrony, whereas the synchronous stimulation conditions elicited the highest referral of touch scores, regardless of perspective. These findings suggest that ownership and referral of touch are separate components of the illusion which may be impacted by conditions differently.

P33 - The Relationship between self-reported Sleep Quality and Executive Functions among Swedish upper-secondary school pupils

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Reports suggests that Swedish adolescents sleep quality might challenge the cognitive demands that schooldays require to acquire knowledge. Such cognitive demands would be expected to rely on executive functions including working memory (WM) and inhibition.

Here, we assessed self-reported sleep quality and executive functions in a sample of Swedish upper secondary-school pupils (N= 106, M_{age} = 16.14 yrs). Sleep quality and the item "too little sleep" (frequency of < 6 hours sleep) were assessed by the Karolinska Sleep Questionnaire (KSQ) and executive functions (WM and inhibition) by the Teenage Executive Functioning Inventory (TEXI).

Results showed that worse sleep quality was associated with the perception of more severe cognitive problems (sleep quality and WM: r = 44, p < .001, sleep quality and inhibition: r = .39, p < .001). The more often sleep was reported as "too little" was associated with the perception of more severe cognitive problems ("too little sleep" and WM: r = .24, p = .012, ("too little sleep" and inhibition: r = .30, p = .002).

In sum, the association between sleep quality and duration with cognitive functions warrants further investigation with the inclusion of objective measurements and other important variables important for learning in school.

P34 - Three-way Interaction of Reading, Aptitude, and Education Predicts Grammatical Proficiency in Turkish as First Language (L1)

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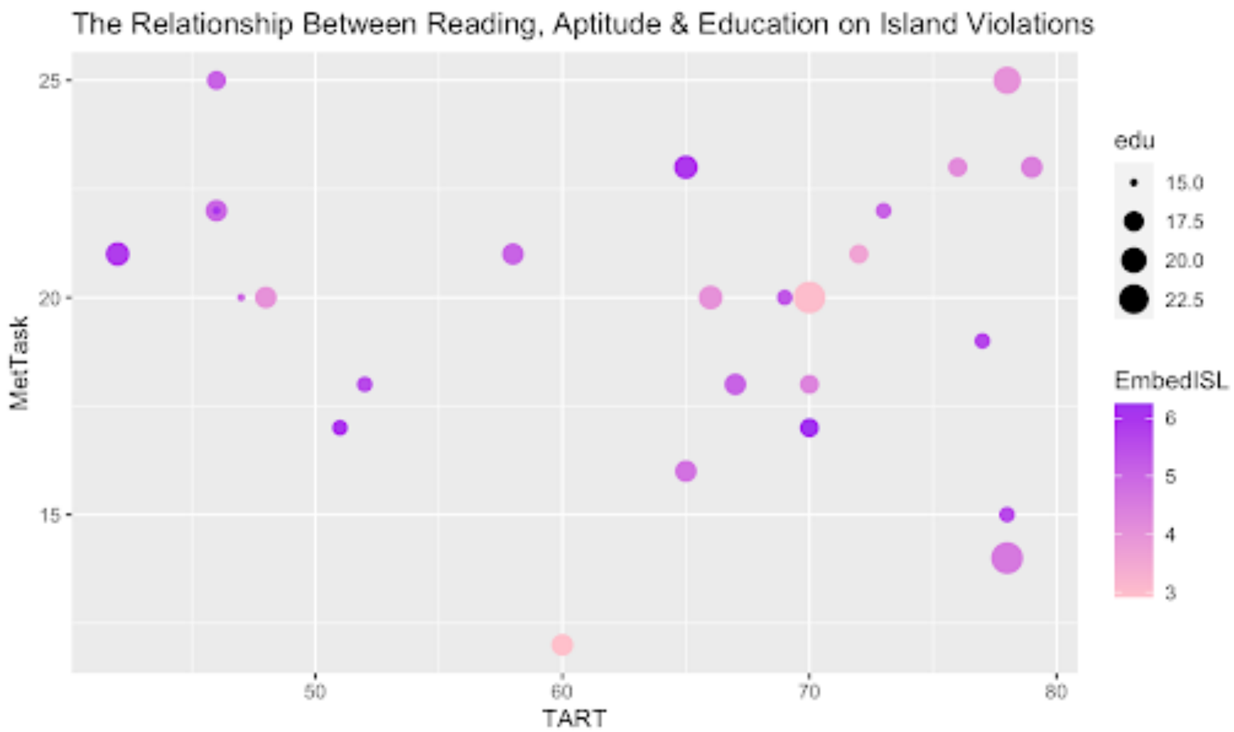
Language aptitude predicts success in L2 learning, but its relevance to L1 learning is controversial. Recent studies suggest that L1 learning involves explicit mechanisms (Llompart & Dabrowska 2020, 2023), such as aptitude (Li 2016) and print exposure (Dabrowska 2018). Despite numerous English aptitude tests, there is none available for Turkish. This ongoing study outlines the development and the piloting of the Turkish Sentence Pairs Test (TSPT), akin to its English version (Llompart & Dabrowska 2023), based on the MLAT (Modern Language Aptitude Test) words in sentences subtest (Carroll & Sapon 1959). The TSPT is based on the MLAT "Words in Sentences" subtest. We investigate if the TSPT and PLAB (Pimsleur Language Aptitude Battery) predict island adjunct violations in Turkish using a grammaticality judgment task (Çakır 2017). Reading is measured using the Turkish Author Recognition Test (Gedik 2024). Results reveal a strong correlation between PLAB and the TSPT ($n = 26$, $r = .43$, $p < .05$). Though neither measure independently predicts island adjunct violations, time spent in formal education as a main effect and the TSPT show a significant interaction with reading and education. These findings suggest good metalinguistic skills, reading, and education can complement ultimate L1 acquisition.



CRediT authorship contribution statement

Yağmur Ece Ergün: Writing - review & editing, Formal Analysis, Data Curation, Development and Piloting of Tasks & Stimuli. **Fırat Can Erişgin**: Writing - review & editing, Formal Analysis, Data Curation, Development and Piloting of Tasks & Stimuli. **Sueda Şahin**: Writing - review & editing, Formal Analysis, Data Curation, Development and Piloting of Tasks & Stimuli. **Su Öy:** Writing - review & editing, Formal Analysis, Data Curation, Development and Piloting of Tasks & Stimuli. **Deren Yayar**: Writing - review & editing, Formal Analysis, Data Curation, Development and Piloting of Tasks & Stimuli. **Tan Arda Gedik**: Conceptualization, Methodology, Formal Analysis, Supervision, Project Administration, Data Curation, Writing - review & editing.

The TSPT is freely accessible at this link:
https://osf.io/5r6jt/?view_only=6efaafdb3ffb450bb295bbb386828922

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P35 - Constructing and deconstructing a human judgment rule

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The so-called conjunction fallacy (judging A&B in combination as more probable than A in isolation) is one of the most emblematic, (in)famous errors in the research literature. In a series of studies involving 312 participants, we show that rephrasing the task in the supposedly more favorable format of natural frequencies does not amend them. Providing allegorical hints about the underlying structure (the “nested-set”) of the task does diminish the conjunction fallacy in both artificial tasks, and symptom judgments made by clinical psychologists. However, several hints are needed for substantial improvement. Previous experience, and stereotypical cues in the response alternatives hinders the application of the correct judgment rule, which may be seen as interference due to salient representations. We further argue that the rule constructed through the allegorical examples provides a local and malleable rather than normative rule on which people base their judgments.

P36 - Retrieval Practice in the Classroom Boosts Knowledge of Mathematical Concepts: An Implementation Study in Middle School

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Mathematics as a subject in primary school spans several domains and refers not only to numerical and procedural skills but also to conceptual understanding of mathematical concepts. A pedagogical learning method for concept learning, based on cognitive principles (i.e. repeated successful memory retrieval), is "*retrieval practice*" (RP). In the current intervention study, we implement RP in middle-school classrooms (5th grade; N=40; M_{Age}=10.9) across four subject areas in mathematics, spanning a total of four months. We evaluate (i) whether RP strengthen primary school pupils' knowledge of mathematical concepts compared to a control condition (S = study/re-read the material) and (ii) whether this effect can be observed independent of cognitive proficiency (CPI; composite score based on six cognitive ability tasks). The sample was divided by median-split of CPI to a LOW and HIGH cognitive ability group. A repeated measurements ANOVA on concept learning-gain (post vs pre) revealed a significant main effect of learning method (RP > S) as well as a significant interaction between learning method and CPI group. Learning gain with RP was significantly greater compared to S among LOW compared to HIGH cognitive ability pupils. Further investigations should focus on identifying mediating and moderating factors for these effects.

P38 - Visual mnemonics as a tool for learning in upper secondary school

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Visual mnemonics are millennia-old tools for supporting human memory. They have been used throughout history in a large range of settings where there has been a need for remembering large amounts of information. By visualizing a well-known environment, such as one's own home, and placing pictures representing the information to be remembered at specific places within that imagined environment, episodic memory performance can be greatly aided. The techniques utilize the fact that we easily can bind spatial locations in memory with information encountered there.

An area where the need for remembering arguably is paramount is within schools, and while several studies have shown that visual mnemonics can be effective for remembering word lists or shorter textbook paragraphs, there is a paucity of studies taking an applied stance with a larger range of study material and extensive practice. In this ongoing study, we investigate the effects of partaking in an elective course in a Swedish upper secondary school, in which visual mnemonics are taught in an applied fashion by an experienced teacher. We present pilot data showing large increase in episodic memory performance among the students, and we discuss the students' perceptions of the mnemonics as expressed in course diaries.

P39 - Investigating The Editing's Effect of Advertising Photos On the Virtual Purchase Decision Based On the EEG Parameters

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Decision-making is an important cognitive function that can be defined as the process of choosing an option among available options to achieve a specific goal. Human decision-making while buying products online is subject to various factors, one of which is the quality and effect of advertising photos. Advertising photo editing can have a significant impact on people's virtual purchase decision. A group of 30 participants were asked to react to 24 edited and unedited images while their EEG recorded. Analysis of the EEG data revealed increased alpha wave activity in the occipital regions (O1, O2) for both edited and unedited images, which is related to visual processing and attention. Additionally, there was an increase in beta wave activity in the frontal regions (FP1, FP2, F4, F8) when participants viewed edited images, suggesting involvement in cognitive processes such as decision-making and evaluating advertising content. Gamma wave activity also increased in frontal and parietal regions, which are associated with higher cognitive functions such as attention, memory, and perception, when viewing the edited images. These Findings suggest that photo editing could potentially influence consumer perceptions during virtual shopping experiences by modulating brain activity related to product assessment and purchase decisions.

P40 - Infinity Problems: Considering the Implications of a Lightweight Inverse Kinematic for Understanding Human Motion Planning.

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The human musculoskeletal system's inherent redundancies allow for infinite potential configurations for any given task. While sometimes seen as a problem for cognitive control systems, motor redundancy also fosters adaptability, learning, and resilience, making it essential for effective motor functioning (Latash, 2012). While many features of human motion and pose production have been identified, it remains unclear how cognitive systems quickly identify and enact motions given the scale of challenges introduced by motor redundancy. This study introduces an inverse kinematics solver, the Forward and Backward Reaching Inverse Kinematics solver (FABRIK) (Aristidou et al., 2016; Lamb et al., 2022). FABRIK uses a novel and lightweight approach to overcoming degree of freedom redundancy in multi-joint systems and may provide insights into human motor control. Initial validations of FABRIK for predicting human motion and pose data, demonstrate strong alignment with recorded data and are comparable to more computationally intensive state-of-the-art methods. We consider the implications of this relatively simple inverse kinematics solver for understanding how cognitive systems might deal with the challenges of motion planning in real time.

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P41 - Examining the Impact of Camera Control on Collaborative Problem-Solving

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Remote design reviews are often carried out using video conferencing apps and are limited by the lack of immersive interaction, which is believed to be addressable by using extended reality (XR). It is argued that giving design review participants control over their viewpoint through XR might enhance the design review process. This study investigates whether enhancing camera control can improve collaborative problem-solving without XR. We propose that the ability to create one's own cognitive map of a space through self-navigation is the basis for improvement, not XR technology specifically.

The experimental setup involves a collaborative puzzle-solving task with two distinct conditions: one with fixed camera perspectives and another allowing personal camera control. Teams of three engage in a task requiring the assembly of a 3D puzzle, where two of them have half of the solution and work to guide a third individual in a puzzle assembly task.

We aim to measure outcomes in terms of completion time, the number of errors, and user satisfaction. Preliminary results indicate a complex interaction between camera control and collaborative dynamics. I intend to discuss our methodology, share initial observations, and explore the implications of these findings.

P42 - Identifying Thought Patterns in Major Depressive Disorder by Using Variational Inference and Large Language Models Integrated with Concept Space

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Tracking thought patterns in patients with **Major Depressive Disorder (MDD)** is essential in psychotherapy. While patient-therapist interactions provide valuable insights into patients' cognitive states, no definitive model exists to fully capture the link between conversations and thought patterns. Psychologists often face challenges in accurately identifying disordered thinking, requiring detailed reviews of conversations for deeper analysis.

Recent advancements in **Artificial Intelligence (AI)** , especially in **large language models (LLMs) ,** offer potential solutions. LLMs' ability to process large text datasets can help psychologists detect disordered thoughts and negative concept formation. **Concept spaces**—internal model representations capturing distinct cognitive concepts—provide a new approach. Thought patterns, represented as vectors in a concept space, can be used as inputs to LLMs alongside conversational data.

By training these models on question-response pairs from healthy individuals and patients, we can create generative models that simulate conversations reflective of individuals' cognitive patterns. **Variational inference techniques** can then be applied to infer these thought patterns from conversations, helping track cognitive changes during therapy and providing insights into therapeutic effectiveness.

P44 - Individually tailored retrieval practice influences the magnitude of the testing effect independent of variations in fluid intelligence

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Retrieval practice is known to enhance memory more compared to other learning methods (i.e. *the testing effect*). However, it is unclear how an individually tailored retrieval practice (IRP) enhances long-term performance, and its relation to individual cognitive prerequisites. Utilized IRP was criterion-based such that five successful retrievals/item during learning was required during the learning phase. Here, we provide novel evidence for how IRP benefit upper-secondary school students (N=29; M_{age}=16.44) related to individual variations in fluid intelligence (*g*f). In the classroom, using a within-subject design, pupils learned a Swedish vocabulary (word-pairs) from three conditions: IRP with feedback, repeated study matched to IRP exposure, and non-tailored retrieval practice (six repetitions) day 1. A follow-up test of the to-be-learned material was performed day 7. First, there was a positive correlation between *g*f and performance overall (day 7). Second, a repeated ANCOVA on long-term performance (condition: study, non-tailored retrieval practice, IRP) with *g*f as a continuous covariate demonstrated a main effect of performance, with significantly better performance after IRP compared to the other two conditions. No significant interaction between *g*f and condition was identified. Thus, IRP similarly enhanced the magnitude of the testing effect independent of individual variations in *g*f.

P45 - Blame: What is it Good For?

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An emerging strand of research claims that emotive blame is justified on the basis of its functional role in cultivating moral agency in those to whom it is directed. On these instrumentalist accounts, our actual collective responsiveness to moral considerations is largely explained by the scaffolding or cultivating force of emotive blame as directed at us. We believe that there is some reason to be sceptical of the functional role assigned to emotive blame on these accounts. This is because there is evidence from the psychology literature on prosocial behaviour and moral development that *direct* emotive blame may be *ineffective* in inculcating moral norms in the children and young adults to whom it is directed. We concede that emotive blame may have the direct functional role in scaffolding moral behaviour in adults, however we believe that such accounts overlook what we think is likely the more central functional role of emotive blame. This is the role emotive blame plays in the moral ecology: the models, narratives, scripts, and cultural frameworks that we internalize. The most central functional role of emotive blame, we claim, is to *indirectly* foster moral considerations responsive agency through modelling behaviour observed in the moral ecology.

P46 - Wrong, try again: Outcome feedback improves performance on base-rate fallacy tasks

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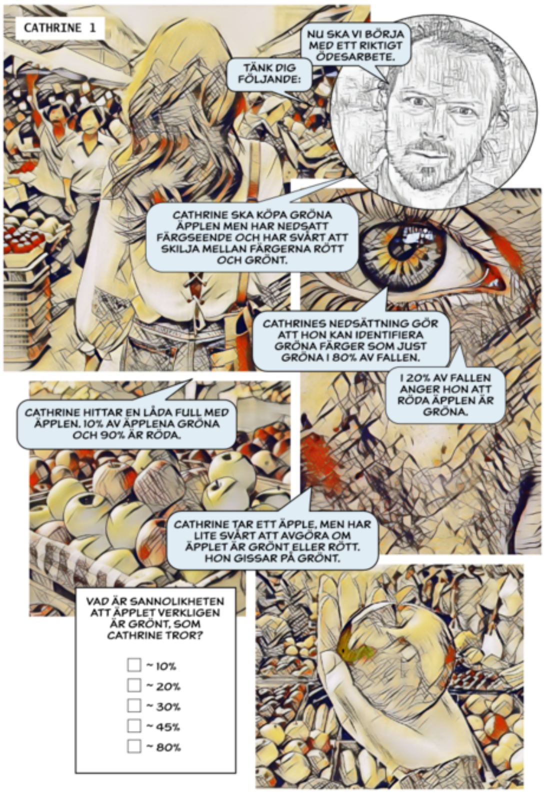
The base-rate fallacy is a phenomenon where people underestimate information about prevalence or prior probability and instead base judgments primarily on individuating information (e.g., character descriptions or test accuracy). Results from previous attempts to mitigate base-rate fallacies through e.g., educational initiatives have been mixed. We investigated whether performance on base-rate tasks can be improved through training with outcome feedback, i.e., whether the chosen response alternative was correct or incorrect. The training consisted of 30 five-alternative forced choice tasks, while pre- and post-training measurements comprised ten probability point-estimation tasks. To make the training more engaging, we created an interactive comic book with base-rate tasks embedded in the narrative. The study was designed as a randomized controlled trial where 28 participants trained with, and 30 participants trained without feedback. Results revealed that RMSE decreased from pre- to post-training for the feedback group only, indicating that it is possible to learn how to avoid the base-rate fallacy through repeated training with feedback. Additionally, the comic book format was well-received and can serve as inspiration for researchers who either want to make their studies more motivating to participate in or need a method of disseminating effective interventions to the public.



P47 - Subject-specific frontal-midline theta during cognitive tasks and relation to non-performance during single-session neurofeedback

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Frontal-midline theta (fm-θ) oscillations are linked to higher-order cognitive functions and control, such as inhibitory control. Despite its potential, fm-θ extraction at an individual level remains challenging due to high inter-subject variability, complicating its use in neurofeedback (NFB) applications. In this study, twenty healthy participants performed the Sternberg and Stroop tasks, followed by a session of fm-θ NFB training, while their EEG activity was recorded. Both tasks are known to elicit fm-θ, but the subject-level interactions between these tasks and NFB training are not well understood. Preliminary results suggest a small but significant group-level increase in fm-θ during the maintenance phase of 6-letter trials compared to 2-letter trials in the Sternberg task. Similarly, a significant increase in fm-θ was observed for incongruent versus neutral trials in the Stroop task. Nevertheless, no participants could voluntarily increase fm-θ through a single NFB session. This work focuses on individual subjects, presenting findings on the correlations between fm-θ during cognitive tasks and NFB training in terms of band-specific magnitude and possible changes in Θ peak frequency. We believe this study will provide insights into the mechanisms of fm-θ related to working memory and inhibitory control, enhancing our understanding of non-performance during fm-θ NFB.

P48 - Crosslinguistic interactions in real-time L3 Swedish spoken sentences

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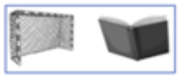
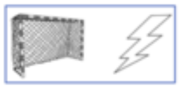
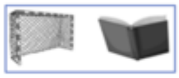
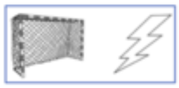
Multilinguals' word recognition can be affected by non-target language coactivation driven by word form similarity to the input, resulting in crosslinguistic competition. Sentence-level findings, however, diverge for bilinguals and are scarce for trilinguals, whose both non-target languages might compete (Bartolotti & Marian, 2018). This study investigated whether first (L1) and second (L2) language lexical competition affected third language (L3) sentence processing, and whether sentence context modulated single and double crosslinguistic competition. Forty-four Russian-English adult Swedish learners did a lexical selection task while listening to L3-Swedish sentences, which were low or highly constraining towards target nouns, and seeing the target and competitor's pictures. The competitor's Russian and the target's Swedish phonological onsets could overlap, the competitor could be a Swedish-English cognate or an overlapping cognate. Shorter reaction times (RTs) and higher accuracy were found in high- compared to low-constraint sentences. However, L1-competition significantly reduced the overall accuracy and increased the RTs even in the high-constraint sentences. L2-English and double L1-Russian-L2-English competition was not significant. Longer Russian-speaking country stay (or delayed L3-immersion) slowed the RTs. Thus, top-down context information could not significantly modulate bottom-up driven L1-competition, which can be explained within BLINCS (Shook & Marian, 2013), by language order/acquisition contexts and a competition type.

Table 1. Eight experimental conditions for the target noun MÅL, [ˈmoːl] (goal, [vɐˈrotə] in Russian).

Condition	Competition: L1-Russian phonological	Competition: L2-English cognate	Sentence context	Experimental sentence for MÅL (competitors' Russian equivalents are provided as IPA-based transcriptions in […])	Visual display
1.Low constraint, no competition	no overlap	non-cognate	low constraint	Han har frågat om MÅLET / AND. he.3SG.have-PRS.ask-PTCPabout-ABTgoal-DEF.SG.N./ duck-SG.C. He has asked about the goal / duck, [ˈutkə].	
2. Low constraint, English competition	no overlap	cognate	low constraint	Han har frågat om MÅLET / BOK. he.3SG.have-PRS.ask-PTCPabout-ABTgoal-DEF.SG.N./ book-SG.C. He has asked about the goal / book, [ˈknʲigə].	
3. Low constraint, Russian competition	overlap	non-cognate	low constraint	Han har frågat om **MÅL**ET / BLIXT. he.3SG.have-PRS.ask-PTCPabout-ABTgoal-DEF.SG.N./ lightning-SG.C. He has asked about the goal / lightning, [**moɫ**nʲɪjə].	
4. Low constraint, Russian and English competition	overlap	cognate	low constraint	Han har frågat om **MÅL**ET / HAMMARE. he.3SG.have-PRS.ask-PTCPabout-ABTgoal-DEF.SG.N./ hammer-SG.C. He has asked about the goal / hammer, [**məɫ**ɐˈtok].	
5. High constraint, no competition	no overlap	non-cognate	high constraint	Han har stått i MÅLET / AND. he.3SG.have-PRS.stand-PTCPin-INgoal-DEF.SG.N./ duck-SG.C. He has stood in the goal / duck, [ˈutkə].	
6. High constraint, English competition	no overlap	cognate	high constraint	Han har stått i MÅLET / BOK. he.3SG.have-PRS.stand-PTCPin-INgoal-DEF.SG.N./ book-SG.C. He has stood in the goal / book, [ˈknʲigə].	
7. High constraint, Russian competition	overlap	non-cognate	high constraint	Han har stått i **MÅL**ET / BLIXT. he.3SG.have-PRS.stand-PTCPin-INgoalDEF.SG.N./ lightning-SG.C. He has stood in the goal / lightning, [**moɫ**nʲɪjə].	
8. High constraint, Russian and English competition	overlap	cognate	high constraint	Han har stått i **MÅL**ET / HAMMARE. he.3SG.have-PRS.stand-PTCPin-INgoal-DEF.SG.N./ hammer-SG.C. He has stood in the goal / hammer, [**məɫ**ɐˈtok].	

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P49 - Compensatory semantic processing in adverse hearing situations

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When bottom-up processing of speech is compromised, such as in a noisy environment, semantic context can give cues that help identifying words. In children with cochlear implants (CI) such compensatory semantic processing has been linked to large responses in the N400 component (Kallioinen et al., 2023), an ERP component reflecting semantic processing. However, in experiments using speech-in-noise in typically hearing populations, the N400 effects are diverse and are sometimes small, suggesting that successful compensatory semantic processing is sensitive to a number of factors such as level of noise, strength of semantic cues, semantic skills and effort. Comparing ERP results and experimental factors in studies with children and adults with CI and typically hearing adults in adverse hearing situations we discuss the limits of successful compensatory semantic processing and accommodate some of the diverse N400 effects.

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P50 - Morphosyntactic Constructions As A Means Of Distributing Attention In News Text Headlines

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The aim of the presentation is to reveal the attention-attracting potential of morphosyntactic constructions, i.e. form-meaning pairings fixed in long-term memory (Croft, 2022) schematically denoting various relations of the surrounding world. Constructions are used in three positions of a headline: attention-grabbing, attracting readers by naming referents close to the target audience; attention-keeping, filled with predicative constructions, and attention-nudging, stimulating the audience to turn to the text itself (Potapenko, 2021). Agentive constructions, filling the attention-attracting position in the headlines, have a high potential due to the representation of the event participants. Predicative constructions in the attention-keeping position exert a significant influence on the addressee, characterizing the referents named by agentive pairings. In the attention-nudging position, locative, temporal, causative, and quantitative constructions compel the addressee to read the news text. Locative pairings draw audience's attention by denoting the place of the event approximately, forcing the readers to refer to the text body, and quantitative constructions add persuasiveness to the content of the headline by representing statistical data. Temporal and causative constructions have a low impact on the audience due to their infrequent use in news headlines.

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P51 - Coordination of Languages in the Encounter Between Subjective Worlds

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Humans are continuously discovering the nature of their world through interactions with it. What the individual has access to is based on their specific morphology, sensorimotor properties, personal history, current needs and goals, and more. This subjectively constructed world is the individual's Umwelt. However, when two humans meet, they will have different Umwelten in which the other human will be a part.

Predicting the behaviours of another human is comparatively difficult. It is rarely enough to understand other humans as physical objects; they are intentional agents. A mitigating circumstance is, however, that humans can attempt to intentionally coordinate through social interaction. The languages of such interaction have been discovered by the respective individual and, much like the Umwelt, that which is discovered is not the absolute and objective Truth, but rather a subjective construction based on the individual's history of experience, properties, and more. Understanding social interaction as such coordination of unique languages between agents with unique access to the world provides a perspective that highlights meaning for the respective individual rather than meaning as something abstract and general. Such a perspective can, in addition, be useful for improving interaction with technology in a thoroughly user centred way.

P52 - Moving towards, moving forwards: investigating interpersonal synchrony in human-robot interactions

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Interpersonal synchrony, namely the reciprocal coordination of movements in time, is often referred to as "social glue", supporting social interactions and engagement between humans [1]. Is this true for interactions with artificial social agents, i.e. social robots (SRs)? SRs are increasingly participating in human's daily ecologies, our study aims to investigate the influence of interpersonal synchrony on human intersubjective engagement with social robots.

In this study, we draw from work by Galbusera et al.[2], on spontaneous interpersonal synchrony between humans. Through the use of a Motion Capture system, we collected kinematic data (e.g., speed, tempo, and directions of bodily movements) to measure interpersonal synchrony in human-robot and human-human (control condition) dyads engaged in a joint mirroring task. To investigate the impact of interpersonal bodily synchrony on humans' affective experience and perception of the robot, different qualitative assessment tools were used, e.g. PANAS [3], Godspeed [4], Comfortability self-report [5], NARS [6] and then combined with interpersonal synchrony data. Preliminary results indicate a statistical significance between the dyads, we expect that further analyses will broaden our understanding of which factors contribute to or hinder humans' affective and intersubjective perception of robots as social partners.

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P53 - In-silico brain model simulates cognitive control of information by synchronized networks

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For information processing, it is crucial that the brain can be both flexible and stable. In working memory (WM), flexibility is needed to encode or update new information and stability is needed to maintain information. Using two magnetoencephalography datasets acquired during WM task performance, we found that cognitive states were formed by large-scale synchronized networks in the theta and alpha band: an encoding state dominated by posterior theta and a maintenance state dominated by dorsal alpha synchronization.

These networks could be recreated in an in-silico model consisting of a spiking and an oscillating cortical layer, with biologically realistic cortical connectivity and controlling input from basal-ganglia-thalamus. The encoding state facilitated flow of information from visual areas, whereas a maintenance state facilitated parietal information flow. Maintenance state also facilitated flow of information from frontal and temporal cortex. These results suggest a mechanism by which large-scale synchronization creates cognitive brain states which control the flow of information.

P54 - Exploring the impact of disgust sensitivity on cognitive abilities: the mediating role of cognitive style.

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Prior research highlighted a relationship between disgust sensitivity and cognitive abilities (CA), however many aspects remain unclear. Previous findings suggest that disgust sensitivity can interfere with reflective thinking, resulting in heuristic data processing and reduced cognitive performance.

To shed light on these aspects, we conducted a study to examine how cognitive abilities are influenced by disgust sensitivity through the mediating role of cognitive style. A mediation analysis was conducted on 268 participants (215 women; mean age = 25.79 yrs, ± 13.36), who completed measures of cognitive abilities (ICAR16), disgust sensitivity (BODS), and reflective thinking (CRT). Our findings indicate that higher levels of disgust are associated with less reflective cognitive styles, which, in turn, negatively impact CA. Specifically, disgust sensitivity has a negative association with CA, and this effect is partially mediated by reflective thinking style. Our results show the significant role of cognitive style in the emotional influences on cognitive functioning.

These results may support the notion that the Behavioral Immune System, evolved to avoid pathogen threats, may increase reliance on cognitive heuristics at the expense of more deliberative processes.

P55 - Concurrent curiosity affects primary task performance but not primary task learning: evidence from a two-armed bandit task

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Curiosity may distract from prescribed learning when the targets of curiosity are off the primary task and the informational outcomes are task-irrelevant. But what happens when curiosity is directed off-task but the revealed information is coincidently task-relevant? We tested this in an online study (N = 151) using a temporal two-armed bandit task with an embedded masked image distractor task. Participants were instructed to minimize time by selecting the arm with probabilistically faster inter-trial intervals. Bandit arms were represented by masked images and the chosen image was unmasked. Prior individual curiosity ratings for the masked images allowed us to manipulate the potential to satisfy curiosity orthogonally to the bandit task. Performance in two conditions where high curiosity images were aligned with ("aligned") or against ("misaligned) the time-minimizing bandit choice were compared to a neutral condition. We found that curiosity integrated with the values of the bandit arms to improve performance in the aligned condition and had a clear negative effect on performance in the misaligned condition. Despite this, learning rates and post-test confidence in the best arm-choice across the conditions did not differ reliably. Our results suggest that curiosity can be pursued simultaneously with a primary task without impeding prescribed learning.

P56 - Odor identification and odor naming errors are informative about olfactory-perceptual and olfactory-semantic processing

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Olfactory abilities are often assessed with identification tasks (e.g., Doty, 2019), and odor naming is used to evaluate theories about olfaction and language (e.g., Pellegrino et al., 2021). In these tasks, a binary scoring model is frequently used, which is based on whether odors are correctly identified/named, or not (e.g., Nordin et al., 1998). I will argue that we should not only focus on correct responses, but also investigate both odor identification and odor naming errors (i.e., *misidentifications* and *misnamings*). I will present results showing that both misidentifications (Raj et al., 2023) and misnamings (Hörberg et al., submitted) contain important information about olfactory-perceptual abilities. Both misidentifications and misnamings are more prevalent for odor labels that are frequent in language use, semantically close to the target odor name, and more strongly associated to olfaction and gustation. For misidentifications, these biases weaken by age. Whereas misidentifications tend to be specific, misnamings often are unspecific and vague. Misnaming properties associated with specificity are also directly related to olfactory perfomance: High performers tend to use more specific and concrete terms in their misnamings. Both odor misidentifications and misnamings can thus provide plenty of information about olfactory-perceptual abilities as well as semantic odor knowledge.

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P58 - Exploring effects of temporal attention on the neural correlates of visual consciousness

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Imagine sitting in your electric car, lost in thoughts, waiting for a traffic light to turn green. Suddenly a car behind you honks and you realize the light is already green. That shift of attention allowed you to become conscious of the green light. Similarly, an example of temporal attention is attending the traffic light to be able to drive away quickly. These examples illustrate the close relationship between attention and consciousness. The neural correlates of consciousness (NCCs) are commonly investigated with electroencephalography (EEG). Research in vision suggests that one promising candidate for the NCC is the Visual Awareness Negativity (VAN): a negative wave recorded over occipital, visual cortex about 200 ms after a stimulus. The present study examines whether VAN is confounded by temporal attention. On each trial, after a warning tone and either a short or a long interval (600 ms or 2200 ms), a weak visual stimulus is presented. Temporal attention should be more focused in the short than long interval. Continuously, the visual stimulus is adjusted to the awareness threshold. If results show that VAN is unaffected by the manipulation of temporal attention, then its position as an NCC is strengthened.

P59 - On-scalp MEG - a closer look at the brain

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Magnetoencephalography (MEG) directly measures neural firing with highest temporal and spatial resolution making it ideal for studying neural processes involved in cognition[1]. Using optically pumped magnetometers (OPMs), a novel type of MEG sensors, we can further improve the method. Since they operate at less extreme temperatures compared to the cryogenic sensors used in conventional systems, OPMs can be placed much closer to the head – and the neural sources therein – leading to higher signals and better spatial precision[2]. Less thermal insulation also makes systems much smaller and lighter, with individually packaged sensors that enable maximal flexibility. The low weight also allows for wearable systems where the participants can move their head or even stand/walk[3] – opening a range of new possibilities in experimental design. Finally, the flexibility means that sensor arrays can be adjusted to the individual head size and shape of the participants, benefitting especially children whose recording quality has previously suffered from the one-size-fits-all sensor arrangement in conventional MEG systems[4]. First recordings with smaller systems have hinted at the potential of the technology for studing cognition[5]. Now, for the first time, dense whole head systems are available that will allow us to study brain activity in unprecedented detail[6].

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P60 - Effects of body language during conversation with socially assistive robots

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It has been shown that interaction methods such as body language and gestures in socially assistive robots (SAR) contribute to engagement, attention, and entertainment value. Studies in social cognition emphasize the significance of body language for facilitating interaction in social exchanges. Inspired by these results, an independent group experiment (*N*=45) was designed to investigate how body language, as an interaction method in SAR, affects perceived social presence. Participants engaged in semi-structured conversations with the social robot Pepper, equipped with an ChatGPT-based dialogue system with, or without, body language. Perceived social presence was retrieved through the Almere questionnaire. Contrary to our hypothesis, the results did not show any significant differences in perceived social presence. Detailed analysis did however show that the interactive condition enhanced the feeling of being seen and tended to make the robot more entertaining. The lack of support for the hypothesis suggests that the robot's body language might be less significant than previously thought, possibly due to method and design factors, as well as the robot's advanced dialogue system. This study highlights the potential of large language models for SAR and could indicate that some aspects of the robot’s design might overshadow other aspects.

P61 - Burstiness of Communication as a Moderating Variable in Team Cognition: Insights from a C3Fire Microworld Experiment

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Short paper: Abstract

Cognitive systems, including teams, function as dynamical systems characterized by interdependent elements that evolve together over time. Further, groups differ in their ability to transform resources into performance (Hackman & Katz, 2010; Mayo & Woolley, 2021). Having access to a wider diversity of competencies (skills, knowledge and abilities) in a team should enable teams in dynamic environments to better adapt and develop the requisite internal variety to match the complexities of the demands of the environment (Goldstone et al., 2024), yet being able to integrate and make use of the diversity is a necessary condition to enable this higher performance. Groups exhibiting more "turn-taking" behavior are often faster and more efficient (Almaatouq et al., 2024). Studies by Riedl and Woolley (2017) and Mayo and Woolley (2020) demonstrate that a latent, general ability to make more effective use of resources is associated with more coordinated attention, as measured by "burstiness" (Barabási, 2005) in group email communication.

Embracing this perspective, our study investigates the role of communication burstiness in team cognition within dynamic environments using the C3Fire microworld (Granlund, n.d.) —a functional simulation of command and control in forest firefighting. Specifically, we explore how communication burstiness mediates the relationship between critical changes and team performance. We are organizing 24 four-person teams into High Variety (specialists) and Low Variety (generalists) structures, assessing their performance across various scenarios.

Our hypothesis is that performance of diverse, HV, teams will depend more on their communication process, so that when it works well they may perform best but when it works poorly they will likely perform worse, while LV teams may be less affected by the communication process due to higher ability for independent action by its members.

Our anticipated results aim to highlight the importance of synchronous attention patterns in team cognition. We suggest that burstiness of communication following scenario critical changes (such as new fires) can enhance situational awareness and coordination, thereby influencing team effectiveness. This study contributes to the theoretical understanding of interactive team cognition and offers practical implications for designing and training high-performing teams in dynamic settings. Our study is also an attempt at a proof-of-concept for using the C3Fire microworld to study concepts from collective intelligence, such as burstiness, and invigorating the literature of C2 (command & control) with newer theories of collective intelligence.

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P62 - Towards an Understanding of Neural Mechanisms of Production of Code-Switches: From Conceptualization to Activation

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The human language production apparatus is undoubtedly a highly complex cognitive system. This system gets even more complicated when more than one language exists in the mind of a person.

Existing models of bilingual language production start their consideration from the perspective of the results, suggesting that the elements, which have received highest activation finally make it to the articulated surface. What remains to be explained is how activation across more than one language can be integrated in the process of language production resulting in a seamless sequence of elements from different languages.

Hence, we developed a model, which sketches core neural processes of incremental bilingual language production including Code-Switches. We hypothesize that the linguistic elements required for a message can only be activated when an adequate large signal initiates the process of excitability of the networks that represent the respective elements. With this model, we aim to exemplify the locus of generation of the “adequate signal” within the language production apparatus. Furthermore, this model attempts to illuminate the nuanced orchestration of excitatory and inhibitory action potentials when activating and connecting the associated networks of the linguistic representations intended by the bilingual speaker.

P63 - The effect of prosody on listening comprehension: Immediate and delayed recall

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Previous studies have shown that children's listening comprehension improves when the information is delivered with positive emotional prosody compared to neutral prosody. Additionally, natural speech (human voice) enhances listening comprehension more than speech synthesis (text-to-speech). In this study, we investigated how prosody affects listening comprehension and memory performance across four conditions: natural speech (control), speech synthesis, and two altered human voice conditions (modifying lexical stress and prosodic phrasing). We assessed both immediate and delayed (one-week follow-up) recall using a recognition task. Forty participants listened to four audio recordings of different texts narrated in each prosody condition and answered content-based questions both immediately and one week later. The findings revealed that unaltered human voice led to better immediate memory retention compared to the other conditions, but no significant differences were observed after one week. This suggests that while unaltered human voice initially aids comprehension more than synthesized speech (and manipulated human prosody), its benefits may not last over time.

P64 - Does retrieval practice improve motor-skill retention?

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The *testing effect* is a phenomenon that seems to reward retrieval practice with better long-term memory retention over passive study alone. Although the effect has been studied for 20 years, there is no consensus theory for why this difference between passive and active learning is consistently found. There are even fewer studies about how the testing effect applies to, for example, the learning and retention of motor skills. To date, almost all literature on the testing effect investigates more academically oriented contexts, such as learning foreign word pairs or recalling images. A new project is now underway to investigate whether the benefits of retrieval practice over passive study holds in other modalities, such as motor-skill learning. The literature suggests the testing effect might generalize this way. The purpose of this project is to better understand what amount of cognitive support is appropriate when learning tasks in, for example, extended reality, human-robot interaction, and human-in-the-loop applications. With the dawn of Industry 4.0, companies are increasingly using extended reality and human-robot collaboration to minimize errors and improve productivity. The literature suggests that there may in fact be downsides to providing limitless, on-demand information during task performance via reduced retention.

P65 - Sex Differences in Dopamine D1 Receptor Availability and Episodic Memory in Adults over 40: a Longitudinal Imaging Study

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Given the established link between dopamine, cognition, and ageing, this study aimed to explore whether the level or change in dopamine D1 receptor (D1DR) played a role in sex differences in episodic memory (EM). We analysed changes in D1DR availability in the caudate and putamen regions and EM at two measurement points to determine longitudinal sex differences in healthy adults over 40. A longitudinal correlation study was conducted (n = 69, M = 37, F = 32, 40-82 years) using neuroimaging (MRI, PET) and cognitive data from the DyNaMiC project. We found support for female advantages in ageing-related decline in D1DR availability but not EM. Specifically, previous findings on cross-sectional advantages for women were not maintained longitudinally. While linear mixed-effects models showed that D1DR availability in the right caudate and right putamen could moderate sex-related interactions associated with EM performance, mediation analysis exploring the change-change association of EM and D1DR revealed that left putamen D1DR availability could account for 25.8% of sex-related EM variations. Overall, the study found that cross-sectional sex differences in EM performance were not entirely consistent with the longitudinal counterparts.

P67 - The activation of metaphorical thought as a function of stimulus saliency

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The automatic activation of spatial representations of affect has mainly been studied using stimuli at the extreme ends of the valence continuum, such as happy and angry facial expressions (e.g., Damjanovic & Santiago, 2016). It remains unclear whether the 'up = good' metaphor can also be triggered by stimuli with subtle valence. This issue was investigated in the current series of visual search tasks. In these tasks, pictures of neutral faces (Experiment 1) or car targets (Experiment 2) were presented in the top, bottom, left, and right locations on a computer screen, surrounded by competing distractors. A meta-analysis (Study 3) using each target's position along the valence continuum revealed a significant linear increase in the activation of the 'up = good' metaphor, with the strongest attentional gains found for happy facial expressions and the weakest for cars. This indicates that activation is most potent for socially relevant stimuli, such as faces. These findings demonstrate the gradual manner in which low-dimensional conceptual structures are engaged in recognizing everyday object categories.

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P68 - Simulating Embodied Singers by Combining Vocal and Auditory Models with Cognitive-Motivational Architectures

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The field of articulatory phonetics has produced a variety of computer-implemented vocal models (see e.g. Kröger, 2022), just like the field of auditory perception has provided us with various models of human hearing (see e.g. Lyon, 2017). When these models are paired together, they form a minimal sensorimotor infrastructure. In combination with a cognitive-motivational architecture they could be used to simulate (minimally) embodied singers. Just such an architecture is described by Leman (2016). He explains how predictive sensorimotor processing synergizes with the human endowments for expressive communication in order to interact in intentional ways with the biosocial music signal. He also hypothesizes that several aspects of this interaction with music mutually reinforce each other's empowering effects.

We investigate how these ideas can be implemented in singing agents so that these concepts can be studied through simulation. Therefore we develop a software stack based on vocal and auditory models and explore which computational learning frameworks can support the cognitive processing and motivational drives, e.g. data-driven deep learning, reward maximisation in reinforcement learning (Sutton & Barto, 2018) or free energy minimization in predictive processing and active inference (Parr et al., 2022; Sprevak & Smith, 2023). At SweCog we will present our work in progress.

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P69 - The Cognitive Gender Interaction of Driver Monitoring Systems and Driver Traffic Safety

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Some drivers engage in secondary activities that contribute to decreased traffic safety. User Experience can inform and help people make safer and more conscious choices in traffic. Previous research on self-reported mobile phone use shows that a ban on mobile phone use while driving has not led people to completely cease the behavior. The study investigated whether a driver monitoring system contributes to safer driving when different gender drivers are distracted by mobile phones and whether the system affected their sense of safety. Is there a difference between male and female drivers' behavior and perception of the driver monitoring system? This was investigated using an experimental mixed-method design with a simulator, surveys, and an interview.

The experiment tested three different monitoring situations: group A was a control group without mobile or driver monitoring system, group B received distracting SMS messages, and group C received distracting SMS messages and were warned by the driver monitoring system. The total gender differences in the traffic offenses revealed significantly lower traffic offenses for women. This is also in relation to previous research publications.

P70 - The Impact of Time Delays on Gaze Behavior in Human-Robot interaction

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The ability to perceive and refer to physically present objects is often seen as a key competence for robots to be perceived as social agents capable of engaging in meaningful interaction. However, the role of timing during actions is frequently overlooked. How can we address the interplay between timing and sociality when designing robotic interactions? This question guided a recent study we conducted, examining the impact of time delays in robotic movements during a turn-taking game with a humanoid robot (n=17). Participants showed more hand-tracking behavior with no delay and tended to look away more often during short delays, indicating greater engagement without delays. Surprisingly, no significant difference in engagement was found between no delays and long delays, with more hand-tracking observed during long delays than short ones. This suggests that not all delays disrupt participant engagement. Additionally, participants looked at the robot's face more when they perceived the interaction as less fluent, likely seeking social cues to interpret the disruption. Interestingly, subjective ratings did not vary across delay conditions, underscoring the importance of behavioral measures, as some effects of interaction disruptions may not be captured by self-report scales.

P72 - How much can and should we automate for philosophical health?

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Philosophical health is the process of reflective self-discovery revealed by a person's actions in the world and their alignment with worldviews, values, and beliefs. Psychology and sociology rightly suggest that much of what we do or say is socially or cognitively automated (autopilot, habitual or cultural behavior). Yet, we are not mere automata: according to the Philosophical Health approach, the democratic subject can cultivate a personal or autonomous core, a singular biography. Nevertheless, the coherence of our singular biography is not guaranteed by default; it is an action, a practice of self-care. I have proposed and tested a method, SMILE_PH (Sense-Making Interviews Looking at Elements of Philosophical Health) to help persons become aware of and act upon their philosophical health. I am currently engaged in exploring the automation of such a method, via AI-enhanced counselling (with human-in-the-loop). How much can and should we automate to help individuals in their philosophical care for the self and the world?

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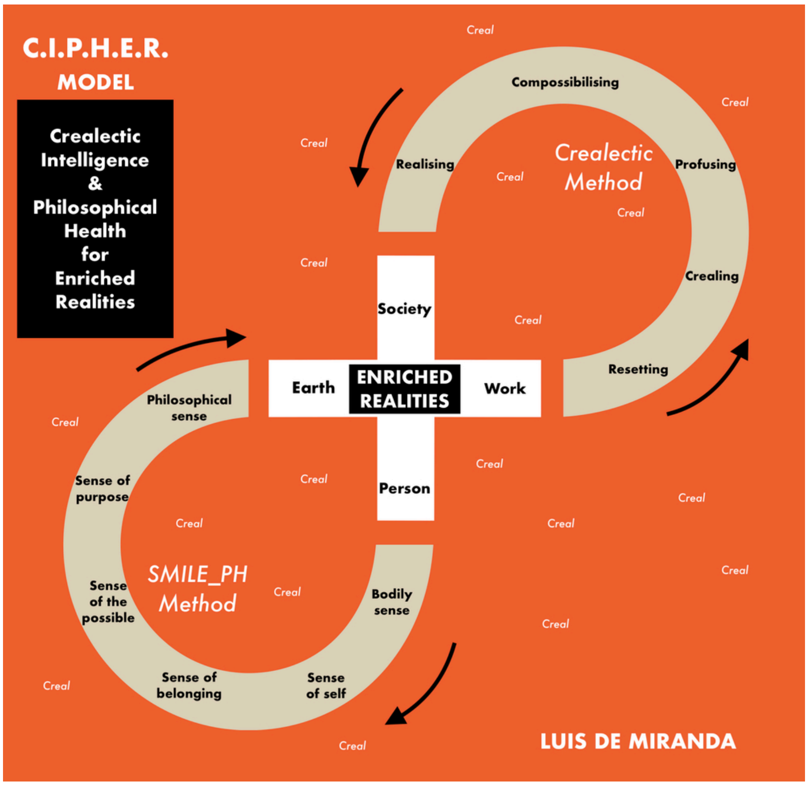
C.I.P.H.E.R.
MODEL
Crealectic Intelligence & Philosophical Health for Enriched Realities
Compossibilising
Realising
Crealectic Method
Profusing
Crealing
Resetting
Society
Earth
ENRICHED REALITIES
Work
Person
Philosophical sense
Sense of purpose
SMILE_PH Method
Sense of the possible
Sense of belonging
Sense of self
Bodily sense
Creal
LUIS DE MIRANDA

Short papers

P3 - Experiences from the driving license process test for Adolescents with ADHD and ASD: Pre-driver education issues and test situations

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Short paper: Introduction

About 10–15 percent of Sweden's population has a neuropsychiatric disability (NPD), leading to various cognitive challenges (The Swedish National Board of Health and Welfare, 2024). Two common NPD diagnoses are ADHD (Attention Deficit Hyperactivity Disorder) and Autism Spectrum Disorder (ASD), having both ADHD and ASD together is not uncommon (American Psychiatric Association, 2013).

Young drivers are often involved in traffic accidents due to inexperience and an underdeveloped frontal lobe, which affects risk awareness (Diamond, 2013; Romer et al., 2017). Since driving poses even greater cognitive challenges for adolescents with NPD (Huang et al., 2012; Reimer et al., 2010), it's important to find ways to support them during the driving license process.

ADHD is characterized by inattention, impulsivity and /or hyperactivity, while ASD is characterized by deficits in social communication and interaction, repetitive behaviors, and varying cognitive abilities (American Psychiatric Association, 2013), which may affect driving. For instance, impulsivity and hyperactivity in adolescents with ADHD can lead to risky driving behaviors like speeding and frustration with other drivers, raising collision risks (Groom et al., 2015).

ASD driving-related challenges are anxiety, processing speed, and executive function (Bishop et al., 2018). Additionally, they are less confident in their driving abilities, possibly due to anxiety (Daly et al., 2014).

In driver education, individuals with ASD often struggle with practical components, while those with ADHD face challenges with theoretical aspects (Almberg et al., 2015; Patrick et al., 2018). Driver training for individuals with ASD highlights the need for structure and clarity (Ross et al., 2018; Patrick et al., 2018), along with individualized and strength-based approaches (Myers et al., 2021; Vindin et al., 2021).

Swedish authorities are examining the driver education system and are considering the use of driving simulators in training and assessment (Thorslund et al., 2024). Understanding the specific challenges individuals with NPD face in driving and training, is essential for making effective and inclusive adjustments to the education system. A PhD project funded by the Swedish Transport Administration will investigate the challenges. As part of the project, a questionnaire study examined the experiences of those with ADHD and ASD and their willingness to communicate with educators or driving examiners (Thorslund & Lidestam, 2024). This paper outlines the challenges reported during the pre-driver education phase and the driving tests.

Method

An online- questionnaire was administered to individuals with and without neurodevelopmental conditions, who were either in the process of obtaining their driver's license or had recently obtained it. The first section of the questionnaire included background questions:(age, gender, current status in the driver's license process (an ordinal scale ranging from just received a learner´s permit to possessing a driver's license), geographical information (region of Sweden and size of town), and any diagnosed NPD or other conditions. Respondents who reported a NPD diagnosis were asked to specify their diagnoses.

For the challenges encountered during the pre-driver education phase, the questions were phrased as follows: "*Compared to an average driving license aspirant of the same age, how easy is it for you to...*: *1. …obtain a medical attestation, 2. …apply for a learner's permit, 3. find a suitable driving school, 4. know when to tell about diagnosis or challenges*". All respondents rated the level of difficulty on a scale from 0 (Much harder! For me, it's impossible, no matter how much I would practice it!) to 100 (Much easier! For me, no further training is needed on it!).

Those who had obtained their driver's licenses were also, asked about their experiences during the theoretical and practical test situations. These questions assessed test content and treatment during the tests, with responses ranging from worst experience (0) to best experience (100).

Given the distribution of diagnoses among respondents, three groups were relevant for comparison with the control group: ADHD, ASD, and combined ADHD and ADHD (ADHD&ASD). The section on challenges during the pre-driver education phase was completed by 105 respondents 62 (60%) without any diagnosis, 19 (18%) with ADHD, 11 (10%) with ASD, and 13 (12%) with ADHD&ASD. Among respondents who had got their driving license, 38 (24 %) belonged to the controls, 14 (41%) had ADHD, 4 (29%) had ASD, and 12 (50%) had ADHD&ASD.

Results

The pre-driver education phase was more challenging for the NPD groups ($p < .01$, see Table 2). Post-hoc tests revealed that all three diagnosis groups experienced more challenges than the control group in *Applying for a learners permit* and *Finding a suitable driving school*. Compared to the control group, both the ADHD group and the ADHD&ASD group experienced more challenges in *Obtaining medical attestation*. Additionally, the ADHD group and the ASD group experienced more challenges than the control group in *Knowing when to tell about diagnosis or challenges* (Table 1).

Table 1 Means for the different groups and *F*-value, *p*-value, and partial $\eta 2$ for the group comparison of experienced challenges at during the pre-driver education phase. Significances are highlighted with asterisks as follows (< .05 = *, < .01 = **, < .001 = ***).

		Diagnosis M (SD)	*Control M (SD)*	*F(3, 98)*	η_p^2
Obtain a medical attestation	*ADHD*	45.00 (25.45)	68.57 (28.96)	6.58***	.17
	ASD	53.09 (31.15)			
	ADHD&ASD	34.77 (33.44)			
Apply for a learner's permit	*ADHD*	46.63 (33.03)	80.10 (28.60)	9.67***	.23
	ASD	58.45 (30.86)			
	ADHD&ASD	41.46 (35.32)			
Find a suitable driving school	*ADHD*	47.21 (34.58)	69.54 (28.72)	4.96**	.13
	ASD	46.09 (34.80)			
	ADHD&ASD	42.31 (34.18)			
Know when to tell about diagnosis or challenges	*ADHD*	41.84 (34.15)	62.00 (30.53)	3.99**	.11
	ASD	33.27 (32.34)			
	ADHD&ASD	46.23 (30.55)			

Table 2 Means for the different groups and *F*-value, *p*-value, and partial η^2 for the group comparison of experience at the test situations. Significances are highlighted with asterisks as follows (< .05 = *, < .01 = **, < .001 = ***).

		M (SD)	*Control M (SD)*	*F(3, 63)*	η_p^2
Layout and content theoretical test	*ADHD*	44.86 (24.44)	71.84 (23.67)	3.64*	.15
	ASD	63.00 (29.67)			
	ADHD&ASD	59.67 (21.45)			
Treatment theoretical test	*ADHD*	61.21 (30.96)	86.47 (20.42)	6.66***	.24
	ASD	90.00 (9.20)			
	ADHD&ASD	58.50 (25.95)			
Layout and content practical test	*ADHD*	52.57 (26.08)	69.47 (29.55)	1.51	.07
	ASD	74.75 (23.63)			
	ADHD&ASD	63.17 (18.72)			
Treatment practical test	*ADHD*	64.29 (29.93)	79.53 (29.40)	2.00	.09
	ASD	95.50 (9.11)			
	ADHD&ASD	69.33 (29.73)			

There was a group effect on the experience of the layout and content of the theoretical test, and on the treatment; this effect was not observed in the practical test (see Table 2). Post-hoc tests revealed that the ADHD group, compared to the control group, had a significantly worse experience with the layout and content of the theoretical test ($p = .002$). The ADHD group also reported worse treatment experiences at the theoretical test compared to both the control group ($p = .002$) and the ASD group ($p = .039$). The ADHD&ASD group reported worse treatment experiences at the theoretical test compared to the control group ($p < .001$) and the ASD group ($p = .025$).

Discussion

The heightened difficulty reported by all three diagnostic groups compared to the control group, particularly in obtaining a learner's permit and finding a suitable driving school, aligns with previous studies suggesting improvements like accessible information and simplified language to support the early stages of the driving license process (Bishop et al., 2018; Lanzi, 2005).

The ADHD group and the ASD group experienced more challenges in *Knowing when to tell about* *diagnosis or challenges, compared to* the control group. Due to the large individual variability within specific diagnoses, highlighted also in previous research (Myers et al, 2021; Vindin et al, 2021), a functioning communication is essential to be able to tailor the driver education process. Thus, further research is needed on alternative communication methods suitable for driver training and assessment.Related to social aspects and rules is the experience of the treatment at the theoretical test. The ADHD and the ADHD&ASD group reported significantly worse treatment during the theoretical test compared to both the control group and ASD group. Interestingly, the ASD group had a more positive view of the treatment at the theoretical test than the control group, possibly due to social procedures being suitable for them. This study was conducted in Sweden, hence focuses on challenges in the Swedish driver's license process. As with similar studies, there is a risk of bias since only those willing to share their experiences participate. The small sample size also limits the ability to divide respondents into subgroups.

Respondents with diagnoses, particularly those in the ADHD & ASD group, expressed a strong interest in contributing to improvements even after completing the driver's license process. The next phase will involve interviews with driver educators and examiners to explore alternative communication methods, along with planned register studies on license prevalence and traffic incidents among individuals with NPD.

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P6 - Emotion Recognition and Adult Aging: No Effect of Intranasal Oxytocin, but Sensory Modality Matters

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Short paper: Abstract

Emotion recognition abilities tend to decline with age, but the experimental stimuli used in most studies lack ecological validity. A single dose of intranasal oxytocin has been found to improve emotion recognition, but this effect is understudied in older adults. Therefore, the effect of a single dose of intranasal oxytocin (40 IU) was tested in 38 younger adults (aged 20-30 years) and 38 older adults (aged 64-76 years) using a randomized double-blinded, placebo-controlled, within-subjects experimental design. Dynamic, multimodal (audiovisual) and unimodal (auditory, visual) stimuli were used to better simulate real-life emotion recognition situations. Contrary to our prediction (Hypothesis 1), intranasal oxytocin had no effect on emotion recognition in older or younger adults. As predicted (Hypothesis 2), the age-related difference in emotion recognition accuracy was greatest for auditory stimuli, followed by visual, with the smallest difference for multimodal stimuli. Older adults exhibited a greater multimodal benefit than younger adults. These findings have implications for understanding socioemotional aging.

Introduction

Adult aging has a well-documented association with declining emotion recognition abilities (Gonçalves et al., 2018; Ruffman et al., 2008). However, most studies have used static emotional expression stimuli, which lack ecological validity. Moreover, most studies on emotion recognition have focused on younger adults, despite accumulating evidence that these findings cannot be generalized to older adults. A single dose of intranasal oxytocin has been found to improve emotion recognition (Leppanen et al., 2017; Shahrestani et al., 2013), but few studies have examined this effect in older adults. The present study addressed this gap using a randomized double-blinded, placebo-controlled, within-subjects experimental design. Age-related effects on emotion recognition have practical relevance because older adults who can accurately recognize emotions self-report a higher quality of life (Phillips et al., 2010).

Present Study

The first aim of this study was to assess the differences in how a single dose of intranasal oxytocin (40 IU) affects emotion recognition in older and younger adults, relative to placebo. The second aim was to investigate the effect of adult aging on emotion recognition accuracy using dynamic auditory, visual, and multimodal stimuli. Based on findings from previous studies (Cortes et al., 2020, 2021), the difference in emotion recognition accuracy between older and younger adults was expected to vary by stimulus modality. Intranasal oxytocin was expected to improve emotion recognition—despite past mixed findings—because participants received a higher dose and were exposed to more naturalistic, difficult facial and vocal stimuli, thus avoiding ceiling effects. A better understanding of intranasal oxytocin effects has potential implications for pharmacological or psychological interventions for emotional functioning (Ebner et al., 2013; Horta et al., 2020).

Hypotheses

Overall, older adults were expected to have lower emotion recognition accuracy than younger adults. Within age-groups, emotion recognition rates were expected to vary by stimulus modality (auditory < visual < multimodal). Hypothesis 1 (H1) predicted that intranasal oxytocin treatment would improve emotion recognition accuracy, with the greatest effect in the group with lowest performance, i.e. older adults. Comparing older with younger adults, Hypothesis 2 (H2) predicted that the age-related difference in emotion recognition would differ between stimulus modalities; the largest difference was expected for auditory stimuli, followed by visual, with the smallest difference for multimodal (audiovisual) stimuli.

Methods

Data was collected from 93 participants. However, 13 participants were excluded due to missing age data, and 4 were excluded because of incorrect coding of the treatment condition. Therefore, the final sample for analysis consisted of 76 participants: 38 younger adults (M_{age} = 26 years, SD = 3, range 20-30 years, 20 female) and 38 older adults (M_{age} = 71 years, SD = 3, range 64-76 years, 18 female). Data was collected in an MRI (magnetic resonance imaging) scanner at the Karolinska Institute, Huddinge as part of a larger study, but this poster will focus on behavioural outcomes.

Participants attempted to correctly identify emotion expression stimuli following administration of either oxytocin (40 IU) or placebo nasal sprays during two sessions. The order of treatment (oxytocin or placebo) was counterbalanced by randomization in both age groups. The nine-alternative forced choice task was a modified version of the Emotion Recognition Assessment in Multiple modalities, or ERAM (Laukka et al., 2021). There were 40 trials in each of the audio, visual, and multimodal blocks (120 trials per session). This study was approved by the Ethical Review Authority (Dnr: 2012/1511-31/2).

We modelled the number of correct responses using binomial regression (n = number of attempts) with a logit link function and the following predictors: time (1, 2), oxytocin (yes, no), age-group (younger, older), modality condition (auditory, visual, multimodal); and three interaction terms: age-group × time, age-group × oxytocin, and age-group × modality condition. In addition, we estimated varying effects for individuals (intercept and coefficient for time), to account for the multi-level structure of the data involving repeated measures in participants. The model point estimates were the predicted percentage of correct responses for each condition. Regression coefficients were expressed on the log-odds scale.

Results

As expected, older adults generally performed worse than younger adults in recognizing emotions. Across all modalities, the average accuracy for older adults was 46%, which is 4.2 times higher than chance level (for nine alternatives, chance level is 1/9 = 11%). For younger adults, the average accuracy across modalities was 60%, which is 5.5 times higher than chance level. Data from Time 1 and Time 2 were aggregated for the following analyses, as no clear training effects were observed.

Hypothesis 1 predicted that intranasal oxytocin treatment would improve emotion recognition accuracy, with the greatest effect in the group with lowest performance, i.e. older adults. Unexpectedly, oxytocin had no effect on emotion recognition accuracy for older (b = -0.050, CI [-0.14, 0.043]) or younger (b = -0.00082, CI [-0.060, 0.059]) adults.

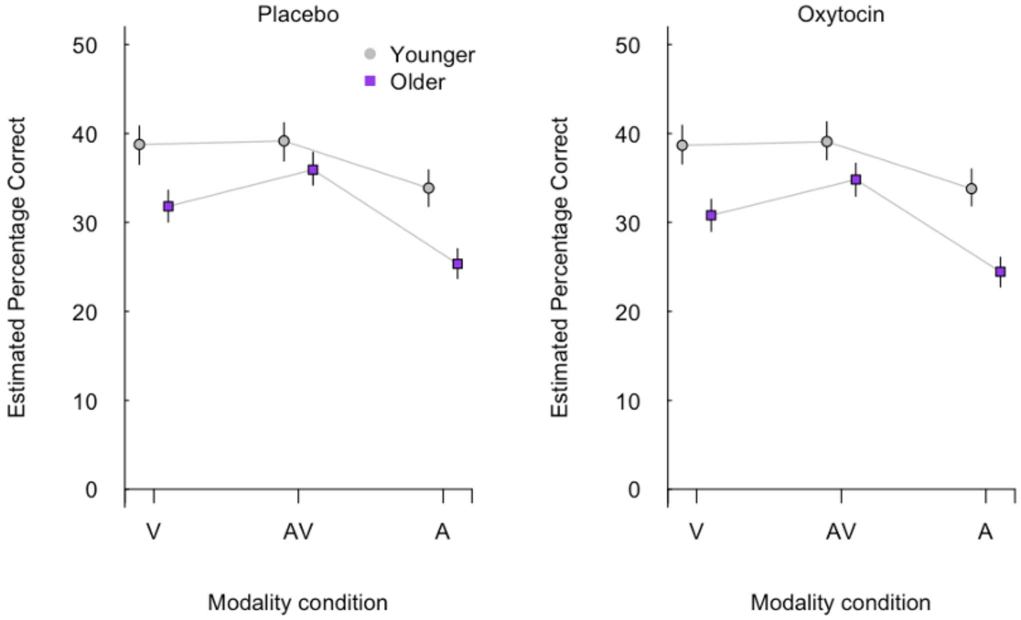
Hypothesis 2 predicted that the age-related difference in emotion recognition would vary by stimulus modality. Indeed, younger adults outperformed older adults in all three stimulus modality conditions, for both placebo and oxytocin treatment (Figure 1). As predicted, the age-related difference in emotion recognition accuracy was largest for auditory at 8.4% [6.2%, 11%], followed by visual at 6.9% [4.5%, 9.5%], and with the smallest age-related difference for multimodal stimuli at 3.2% [0.72%, 5.7%].

Discussion

Contrary to expectations (H1), intranasal oxytocin had no effect on emotion recognition. There is an inonsistent literature with evidence of both positive effects (Leppanen et al., 2017; Shahrestani et al., 2013) or no effect (Cortes et al., 2020; Grainger et al., 2018) of intranasal oxytocin. There are several potential explanations for the absence of intranasal oxytocin effects in this study. These include lack of statistical power (Quintana, 2020), ineffective dosage (Quintana et al., 2021), and individual variation masked by group-level analysis (Fischer et al., 2023), among others which will be further discussed in the poster.

As predicted (H2), the age-related difference in emotion recognition was largest for auditory stimuli, followed by visual, with the smallest difference for multimodal stimuli. Older adults exhibited a *multimodal benefit* compared to recognition of unimodal stimuli. Unexpectedly, younger adults did not exhibit a multimodal benefit; they performed equally well in the visual and multimodal conditions. Potential explanations for these findings will be discussed. The present study's findings have implications for understanding socioemotional aging, and help form the basis for informing practical applications to improve lifelong well-being.

Figure 1
Effect of Age by Sensory Modality



Note. Model point estimates for emotion recognition rates comparing older with younger adults are shown for placebo and oxytocin conditions. Emotion recognition rates (estimated percentage correct) are shown by stimulus sensory modality (V = visual, AV = multimodal audiovisual, A = auditory). Error bars represent 95% compatibility intervals.

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P7 - Differences in the attention network between deaf and hearing individuals

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Short paper: Abstract

Evidence suggests that large-scale brain network organization may differ between individuals with limited sensory input (e.g. deaf individuals) and those without sensory impairment. These neural differences may manifest as behavioural differences, such as enhanced visual attention in deaf individuals. Using independent component analyses (ICA) on resting-state fMRI data, we showed that the attention network was more widespread in the hearing compared to the deaf group. This suggests that the organization of the attention network is different in deaf and hearing adults.

Introduction

Visual attention, including top-down selection and visual orientation, is processed within the attention network, also known as the dorsal frontoparietal network (Uddin et al., 2019). This network covers the superior parietal lobule extending into the intraparietal sulcus, the middle temporal complex, middle frontal (frontal eye field), and ventral premotor regions in hearing adults. However, the organization of this network in deaf signers, a group in which altered visual attention has been identified (Merabet & Pascual-Leone, 2010), is not described in the literature.

Deafness leads to reorganization of cortical structures. In particular, auditory cortices are reorganized to respond to preserved senses (Cardin et al., 2020), which has been related to altered visual processing in deaf individuals (Merabet & Pascual-Leone, 2010). For example, studies have found visual attention for stimuli presented in the periphery to be enhanced in deaf compared to hearing individuals, while such differences are absent in the central visual field (Bosworth & Dobkins, 2002) . Differences in visual attention performance between populations have further been related to cortical reorganization (Bavelier et al., 2001).

In a study from our lab, we showed differences in the involvement of auditory cortices in the left control, the default mode, the ventral somatomotor, and the attention networks in deaf individuals (Andin & Holmer, 2022). Further, altered network organization beyond auditory cortices has also been identified, i.e., Bonna et al. (2020) found reduced network segregation in deaf compared to hearing individuals as well as an enlargement of the default mode network. Large-scale brain network differences between populations indicate that we cannot assume that available parcellations of brain networks based on hearing individuals applies to deaf individuals. In the present study, the aim was to investigate the attention network, where behavioural group differences are commonly described in the literature, of deaf individuals in comparison to hearing individuals.

Method

Fifteen deaf early signers and 24 hearing non-signers were included in the present study. The groups were similar on gender distribution and education level but the deaf group was significantly older, $t(37) = 3.4$, $p = .002$. Deaf participants used Swedish Sign Language as their primary language, and non-signers were native Swedish speakers. The study was approved by the regional ethical review board in Linköping (Dnr: 2016/344-31).

MRI data acquisition was performed on a Siemens Magnetom Prisma 3T scanner (Siemens Healthcare, GmbH). Resting-state data were preprocessed and analyzed using default pipeline settings in the CONN functional connectivity toolbox (Version 20.b; www.nitric.org/projects/conn, RRID: SCR_009550). The preprocessing included functional realignment and coregistration, slice-timing correction, outlier detection, normalization and segmentation, smoothing (8 mm FWHM) and denoising (bandpass filtering: 0.0008 – 0.09 Hz). Quality measures (displacement, motion, global signal change and number of scrubbed slices) were added as second-level covariates.

To identify the attention network in the two samples, independent component analyses (ICA) were performed separately for the two groups using the G1 FastICA algorithm at group-level, followed by subject-level back-projection using GICA3 (dimensionality reduction = 64). A 24-component solution rendered the best overall solution for both groups (compared to 8, 16 and 32 components) as well as the best fit with the template for the dorsal attention network ($r = .45$ for the deaf group and $r = .54$ for the hearing group). The size and group overlap of the identified networks were determined using MRIcron (McCausland Center for Brain Imaging, Columbia, USA).

Results

The dorsal attention network (see Figure 1) was larger in the hearing group (164.4 cc) compared to the deaf group (83.5 cc). The overlap between groups (62.6 cc) included bilateral post- and precentral gyrus, parietal, occipital and temporooccipital regions as well as the cerebellum and the brainstem. For the hearing group, the network extended anteriorly into frontal regions and posteriorly into parietal and temporal regions. Exclusive regions in the deaf group were limited to small parts of the right planum temporale, right central opercular cortex, and the caudate nucleus.

Discussion

We investigated the attention network in deaf individuals and found it to be almost half the size compared to hearing individuals. Overall, the attention network in the hearing group better matched the established anatomical definition (Uddin et al., 2019), e.g. for the hearing group the network included expected middle temporal complex and intraparietal sulcus which was not included in the network for the deaf group. We suggest that the observed group difference indicate reorganization of the attention network in deaf populations, not reflected in existing network templates.

Previous studies indicate that there is reorganization of cortical regions beyond primary sensory cortices in deaf individuals (Cardin et al., 2020). Differences in brain activation related to attention processes suggest that the attention network is reorganized in deaf individuals, aligning with behavioral findings that attentional processes differ between deaf and hearing populations (Bavelier et al., 2001; Dye et al., 2007). Our findings of attention network differences suggest that this network in deaf individuals is reorganized in a way not captured by existing brain network templates. This reorganization may be linked to behavioral differences in attentional processes between deaf and hearing individuals, as previous research has shown. Thus, the mismatch between current templates and the deaf population is unsurprising, reinforcing the need for tailored templates that reflect the unique neural organization in deaf individuals.

By using data-driven analyses we have identified general differences in the attention network. However, future studies should focus on identifying attention networks in deaf compared to hearing individuals during tasks and/or by investigating brain-behavior correlations, mapping attention performance to network organization.

One potential caveat when interpreting these results is that brain imaging in deaf populations typically show greater individual differences and less extensive activation at the group level compared to hearing populations (e.g. Andin et al., 2019). This is likely to stem from differences in residual hearing and variations in communication mode within deaf populations. The larger heterogeneity leads to less robust activation patterns, which might lead to less robust outlining of large-scale networks. However, the core of the networks that are displayed in Figure 1 shows a large overlap across groups (yellow and orange colors), whereas peripheral parts of the network are less likely to be included in the deaf group. Another potential limitation is that the deaf group was smaller than the hearing group, which might contribute to a decreased likelihood of reaching thresholds for inclusion of regions in the network. Thus, heterogeneity and sample size possibly lead to a smaller network distribution in deaf compared to hearing individuals.

To conclude, our findings suggest that the organization of the attention network differs between deaf and hearing adults. This difference might represent effects of cross-modal cortical reorganization and should be considered when applying large-scale network templates on deaf samples.

Supplementary material

Details on methodology and brain imaging results can be found on https://osf.io/bkv9u/.

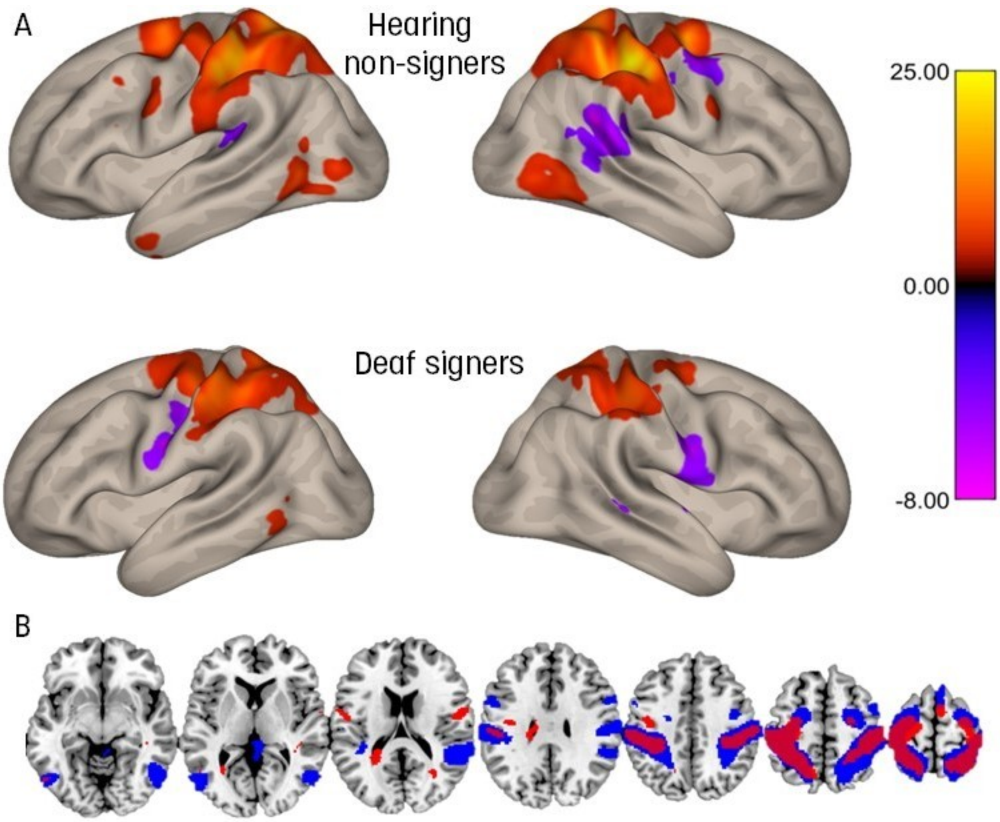

Figure 1. The dorsal attention network in hearing and deaf individuals. A) Surface display of the attention network component with hot colors representing positive correlation and cool colors negative correlation with the independent component time course. B) The extent of the dorsal attention network for hearing (blue) and deaf (red) individuals.

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P17 - Towards a Self-Driving Future – A study on the factors influencing behavioral intentions to use autonomous buses

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Short paper: Abstract

Autonomous buses promise to improve safety and accessibility in our traffic systems. Because it is a new technology it can be challenging to achieve good adoption rates. In one experiment we examine how psychological factors linked to general adoption of new technology relates to adoption of autonomous buses. Participants ($N = 89$) report their curiosity and expectations on the behavior of an autonomous bus approaching a pedestrian crossing. Performance expectancy and trust towards autonomous buses are also measured. Results indicate that Performance expectancy and trust are important factors for stimulating behavioral intention to use autonomous buses.

Autonomous buses (ABs) are designed to function without direct human intervention and have seen advancements in recent years. ABs offer many benefits, including increased traffic safety by reducing human error and better accessibility for individuals unable to drive (Fagnant & Kockelman, 2015). They can transport multiple passengers efficiently, providing accessible and economical transportation options (Nenseth et al., 2019).

However, technical advancements alone do not ensure public acceptance and usage. We must also study people's reactions and attitudes toward this relatively new technology to understand the factors influencing acceptance and usage. Behavioral intention (BEI) captures the strength of intentions to engage with technology (Nenseth et al., 2019). This study investigates how curiosity, performance expectancy, expectations, and trust affect BEI to use ABs.

Research suggests that higher levels of trust are associated with an increased likelihood of using autonomous vehicles and that trust also influences perceptions of usability, safety, and acceptance of technology (Choi & Ji, 2015; Zmud et al., 2016; Nordhoff et al., 2021; Zhang et al., 2021).

Performance expectancy (PE) is a component of the Technology and Acceptance Model (Davis, 1989) and describes how the user perceives the usefulness of the technology. PE has positively influenced BEI to use autonomous vehicles (Zhang et al., 2021; Sweet et al., 2023; Ribeiro et al., 2021).

How well expectations of behavior match the actual behavior of a technology also influences acceptance and usage. Congruent expectations have been shown to impact BEI to use technology positively and are emphasized as a dominant factor for promoting positive attitudes and behavior toward technology (Zhang et al., 2021; Miller et al., 2022).

Studies by Acikgoz et al. (2023) and Hill et al. (2016) indicate that curiosity – the motivation to gain new knowledge – can influence adoption of technological innovations, like smartwatches. We expand on this research by examining how curiosity in the moment relates to BEI to use ABs.

Based on the research reported above, we hypothesize that trust, PE, expectations, and curiosity positively predict BEI.

Methodology

The study recruited 101 participants. Twelve were excluded due to failing to comply with instructions, leaving 89 participants (38 women and 51 men aged 18 – 81). Fifty-two were recruited through convenience sampling and 37 via Prolific. Participants were divided into a test group subjected to curiosity manipulation and a control group.

Trust (TRUST), behavioral intention to use (BEI), and performance expectancy (PE) were based on items from Nordhoff et al. (2021) and were measured on a six-point rating scale from 1 (strongly disagree) to 6 (strongly agree). The items chosen were those with the highest factor loadings. EXPECTATIONS were measured on a rating scale of 1 – 7 (How well did the self-driving bus's braking match your expectations? From "Not at all well" to "Very well"). Curiosity was also measured on a rating scale, 1-7, (How curious do you feel? ("Not at all" to "Very much").

Data was collected online using the PsychoPy (Peirce, 2007) and Pavlovia platforms. All participants were informed about the study, and consent was obtained through the process. The test group underwent a curiosity manipulation by being shown the question, "Can autonomous vehicles 'see' me as a pedestrian?". Both groups were then shown a photo of an AB approaching a crosswalk from a pedestrian's perspective. Participants were then asked to rate their general state of curiosity and expectations of whether the bus would stop safely. The ratings were followed by a film sequence, showing the AB braking as a pedestrian crossed the road. After the film, participants rated how well the bus's braking behavior met their expectations, trust, and intentions to use ABs. The experiment group was then shown the answer to the curiosity manipulation question. Finally, both groups answered the BEI, PE and TRUST questionnaire.

Results

A Mann-Whitney U test indicated that the curiosity manipulation failed to produce a difference between the two groups in both curiosity ratings ($Mdn_{test} = 5.00$, $Mdn_{control} = 5.00$, $p = 0.61$). and BEI ($Mdn_{test} = 3.70$, $Mdn_{control} = 3.80$, $p = 0.99$). Therefore, we decided to use the curiosity ratings as an independent variable to explore the role of curiosity on BEI. We performed a multiple regression with the dependent variable, BEI ($M = 3.60$, $SD = 1.02$). The independent variables included TRUST ($M = 3.82$, $SD = 1.04$), PE ($M = 3.65$, $SD = 1.16$), EXPECTATIONS ($M = 4.65$, $SD = 1.65$), and CURIOSITY ($M = 4.93$, $SD = 1.69$).

TRUST showed a significant positive relationship with BEI, $b = 0.280$, $p < .001$. Similarly, PE showed a significant positive relationship with BEI, $b = 0.525$, $p < .001$. Finally, neither EXPECTATIONS nor CURIOSITY showed a significant relationship with BEI ($p = .260$ and $p = .935$, respectively). See Table 1 for detailed results.

Discussion

This study examined how trust, performance expectancy, expectations, and curiosity shape the BEI to use ABs and has three main findings. First, trust influences intentions to use ABs, corroborating previous research (e.g., Nordhoff et al., 2021; Marsja et al., 2024). This suggests that users who trust ABs are more inclined to intend to use them. Second, performance expectancy was the strongest predictor of BEI to use ABs. This underscores the importance of emphasizing the advantages of ABs to boost acceptance and usage. Third, expectations and curiosity did not predict BEI to use ABs. A study by Acikgoz et al. (2023) did find that curiosity predicts BEI to use smartwatches. An explanation for the difference in findings may be that Acikgoz used the construct curiosity rather liberally, focusing on tendency towards exploratory behaviors in a shopping context (e.g. "I often read advertisements just out of curiosity", "I like to shop around and look at displays"), while the present study probed participants' current state of mind. Future studies should develop instruments and methods that are consistent with the theoretical definition of curiosity, while still maintaining a close connection to the specific technology (e.g. using ABs).

These findings may be interpreted as trust and performance expectancy are important as they reflect technology's perceived usefulness and reliability. On the other hand, expectations may be influenced by other factors, such as trust, perceived risk, and perceived safety, which may moderate or mediate the relationship between expectations and BEI. The study's limitations encompass potential biases in participant recruitment and formulation of survey questions. Despite these limitations, the study offers insights for future research. Understanding factors like trust and performance expectancy can inform strategies to promote acceptance and usage of autonomous buses. Additionally, further exploration of curiosity and expectations could deepen understanding of technology acceptance. In conclusion, the study highlights the importance of trust and performance expectancy in promoting the behavioral intention to use ABs.

Table 1

Results from the regression model using behavioral intention to use as dependent variable.

			95% Confidence interval					95% Confidence interval	
Predictor	*b*	*SE*	Lower	Upper	*t*	*p*	*β*	Lower	Upper
Intercept	0.392	0.303	-0.209	0.994	1.296	0.199			
TRUST	0.28	0.08	0.117	0.444	3.409	0.001	0.286	0.119	0.452
PE	0.525	0.072	0.380	0.670	7.203	<.001	0.596	0.431	0.761
EXPECTATIONS	0.045	0.039	-0.034	0.123	1.135	0.260	0.071	-0.054	0.197
CURIOSITY	0.003	0.038	-0.072	0.079	0.082	0.935	0.005	-0.119	0.129

Note. TRUST and PE show significant positive relationships with behavioral intention to use.

b = unstandardized coefficient, β = standardized coefficient, PE = performance expectancy,

and SE = standard error.

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P18 - Rule of Law in Swedish Health Insurance Assessments: Maximizing Ecological Validity using Vignette Methodology

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Short paper: Abstract

A functional society must adhere to the rule of law. For instance, a court cannot arbitrarily yield a guilty or non-guilty verdict given the exact same information. The study tested professionals' ability to react to an authentic sickness benefit 180-day rule investigation with different outcomes. A vignette was used where an authentic and anonymized investigation was manipulated into two versions; approved or denied in a simple experimental between-subjects design. Dependent measures were subjective ratings of agreement with the decision, transparency, and logical stringency. The results showed high levels of participant agreement of the decision across the two conditions even though half had the opposite decision. The results are discussed in terms of cognitive overload or retroactive selective memory process. The legal implications are serious. If the result is valid, then one could simply take a sickness benefit 180-day rule investigation, change decisions, and professionals would be none the wiser. However, this result must be replicated using varied investigations in terms of typicality, complexity, and professionals' experience and education before generalization.

Introduction

Rule of law is hard to prove. Research has focused on proving the opposite such as gender discrimination (e.g., Kübler et al, 2018) using vignettes. Vignette studies are conducted as traditional experiments except that the participants imagine hypothetical situations (Jergeby, 1999). Participants are asked how they would act if the imaginations would be real. A classic vignette procedure uses a between-subjects design where the participants are asked to rate the competence of job applicants with name changes of the applicants (e.g., Kübler et al, 2018). Recent developments have focused on improving sequential randomization and allocation of subvignettes (Kim & Yang, 2024). However, the main challenge is creating realistic stories. One strategy would be to use actual cases, remove the assessment (i.e., the actual decision that took place in real life), let the participants suggest their assessments, and measure subsequent reproducibility (Wilkins & Meindl, 2023). This is a powerful strategy to test the rule of law, but the ecological validity is still limited because professionals rarely read investigations without assessments.

New strategy

To increase ecological validity, we developed a new type of vignette, where the entire investigation is presented but with two different assessments (approved or denied) in a between-subjects design followed by subjective measures of quality aspects. If the entire sample of participants show strong agreement with each other, despite the fact that half of them had the assessment approved and the other denied, then rule of law is put in serious question.

Setting

The Swedish social insurance system is relatively generous. Sick or injured workers may receive sickness benefits. However, after 90 days, workers must show inability to do any task at the employer. After 180 days, workers must prove inability work altogether. If there are considerable reasons to believe that the worker will return to work within a year from the first sick day, eligibility for continued sickness benefits is allowed up to 365 days. The application is assessed by professionals at the Swedish Social Insurance Agency.

Aims & hypotheses

The present study introduced a new strategy to increase ecological validity in vignette studies. We hypothesized high levels of consistency among the participants across conditions.

Method

Design and Participants

The study comprised a simple experimental between-subjects design with Decision (Approved vs. Denied) as the independent variable with quality, agreeing, transparency, and stringency as dependent variables. Thirty-seven active legal professionals (28 women, 8 men, and one other) with a mean age of 42.25 (9.58) ranging from 27 to 57 participated in the study. They were recruited from one Swedish Social Insurance Agency unit in the Mälar Valley, Sweden. All participants were professionals assessing 180-day investigations regularly. One participant did not reveal age and was excluded from this analysis only. Mean working experience was 8.97 (8.09) years with a range from 2 to 35.

Materials

The entire study took place online. Two versions (Approved or Denied) of a complete authentic sickness benefit investigation were anonymized for the sole purpose of this study. Furthermore, the online form included questions on age, gender, and working experience. Dependent variables were measured with 5-point Likert scales where the participants were asked to either disagree a lot (1) to agree a lot (5) with the following statements; (a) I agree with the *decision* of considerable reasons, (b) the investigation has high *transparency*, that is, the reader understands how the outcome was concluded, and (c) the investigation has high *stringency*, that is, the assessment follows logically from the given information.

Procedure

The participants were randomly assigned a condition; approve or deny. Participants were then informed of the standard ethical aspects of research, then asked about age, gender, and working experience. Then, the participants read an investigation concerning the assessment of work ability deficit days 181- 365 of illness, except for considerable reasons. After that, participants rated the degree of overall quality, agreement with the given assessment, transparency, and logical stringency.

Ethics

The study was conducted in accordance with the Helsinki Declaration, Swedish Law and Swedish Ethical Review Authority. There was no need for an ethics approval because it consisted of no identifiable or sensitive information, any physical manipulation, biological material or a potential risk for the participants. Also, the relevant person in the sickness benefit 180-day rule investigation has opted not to allow us upload the vignettes as an open science framework.

Results

A Kruskal-Wallis test revealed no significant difference for overall quality (Mean ranks 19 (approved) and 19 (denied)), assessment (20.89 (approved) and (17.21 (denied)), transparency (20.81 (approved) and (17.29 (denied)), and stringency (22.03 (approved) and 16.13 (denied)). Furthermore, descriptive data illustrated that the independent variable (Decision; approved or denied) did not affect the subjective ratings. Due to the small sample size, the five-graded Likert scales were transformed into three-graded scales (disagree, neither, or agree).

	Neither low or high	Low	High
Condition	*Decision agreement*		
Approved	0	3	15
Denied	2	4	13
	High transparency		
Approved	1	0	17
Denied	4	1	14
	High stringency		
Approved	2	1	15
Denied	5	3	11

Table 1. Frequencies of ratings (n = 37)

Discussion

The results showed that subjective ratings of 180-day rule investigation quality measures were virtually unaffected by the different outcomes. If this result is valid, then one could simply replace a denied sickness benefit 180-day rule investigation decision for an approved one or vice versa, and professional investigators would be none the wiser. However, study limitations must be addressed; typicality, complexity, and retroactive selective memory effects. The study did not include measures of typicality and complexity of the investigation. If the investigation was very rare and complex, there is less reason to believe that the overall performance in terms of the rule of law would be heavily affected. The results are not surprising because the human mind is susceptible to memory overload (van Merriënboer & Sweller, 2005). The method used provided central information (approved or denied) that may have caused a retroactive memory selection process. The participants in the approved condition may have started to selectively recall the aspects that lean towards approval and vice versa in the denied condition. Future studies may benefit from adding conditions where the participants are asked to make their own decisions and using memory tests.

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P37 - Investigating Probabilistic Reasoning in Young Children: Insights from the Lucy Task Pilot Study.

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Short paper: Abstract

This pilot study explores children's ability to integrate visual probabilistic information using the *Lucy task*. Eight children (ages 6-8) completed tasks involving happiness estimations and game choices based on probabilities. Results showed no significant preference for specific probabilities, and children demonstrated consistency between their initial estimates and choices. These findings suggest that young children can effectively process probabilistic information presented visually, providing a basis for further research on probabilistic reasoning development.

Introduction

Decision-making often requires an understanding of frequencies and probabilities. Investigating how children process probabilistic information is increasingly relevant in our data-driven world. Children's ability to understand probabilities is crucial for their development as decision-makers in an environment where numerical information and uncertainty are widespread.

In 2001, Schlottmann introduced the Lucy Lemur test, a game-like method for testing children's intuition about probabilities (Schlottmann, 2001). This method involves children evaluating a puppet's happiness with game outcomes involving marbles stopping on different colored sections of a tube with varying probabilities and associated prizes. The approach effectively engaged children and elicited meaningful responses about their probabilistic reasoning without verbalization. Schlottmann and Wilkening's study in 2011 reported that even 6-year-olds could integrate probabilistic and deterministic concepts to make judgments about expected outcomes, which indicates that children consider both probability and the magnitude of potential outcomes in their assessments.

In a recent study, Gualtieri et al. (2022) investigated how children combine two probabilistic concepts when making decisions in a game-like task. The study examined how children choose between machines (claw/crane) with different probabilities of dispensing target items from a mixed distribution of target and non-target objects. Gualtieri (2022) found a persistent preference for one of the concepts, suggesting that base rates play a critical role in children's decision-making from an early age.

Our study investigates children's understanding of probability, specifically their capacity to interpret visually presented probabilistic information. We predicted that when children are presented with equally accessible visual representations of probabilistic elements, they will not exhibit a specific preference, leading to a more integrated understanding of these concepts.

In the Lucy task, inspired by Schlottmann's method, participants help Lucy win a prize by solving two task blocks on a screen. The first task tests children's abilities to integrate probabilistic information, while the second involves a two-alternative forced-choice (2AFC) task where children choose which game would make Lucy happier.

We also examined age differences in probabilistic reasoning, comparing first- and third-grade students' abilities to integrate probabilistic information and use their estimations consistently.

Method

Participants and Context

The pilot study involved eight students, equally divided between first and third grades, aged 6 to 8 years, from Suecia School in Montevideo, Uruguay. This serves as the initial phase of a larger project that will include 100 first-to-third-grade students, and be conducted in collaboration with the Interdisciplinary Center for Cognition, Education, and Learning (CICEA).

Task and Procedure

Participants completed the Lucy task in a 5-minute session. In the first block (see Image 1A), children saw two roulettes with green (winner) and red sections and used a slider to estimate Lucy's happiness. In the second block (see Image 1B), the same games reappeared (two per trial), and children chose which game would make Lucy happier. They solved nine games in the first block (see Image 1C) and 33 game combinations in the second block (2AFC format). Combinations where both games' probabilities were equal were excluded.

Familiarization

Children were introduced to a fully green roulette in a demo stage, understanding how happy Lucy would be with different combinations of green and red sections. They interacted with the slider, asked questions, and familiarized themselves with the task before starting the test blocks.

Results

Balanced Integration of Probabilistic Elements

To evaluate our hypothesis, we compared participants' happiness estimations across different games. In each trial, children evaluated games with varying winning (green) and losing (red) sections. Statistical analysis revealed no significant preference for the roulettes' order in any game ($p > 0.05$), as presented in Table 1. This supports our hypothesis that when visual probabilistic information is equally accessible, children do not favor one over the other.

The heatmap (see Image 1D) visually represents these results, showing average happiness estimations for all games. The x-axis and y-axis represent the number of green sections in the left and right roulette of each game. As expected, happiness estimations increased proportionally with the number of green sections, reflecting that participants effectively integrated probabilistic information. The color scale, ranging from red (lower happiness) to green (higher happiness), highlights balanced responses with no extreme outliers or clear preference for a specific game configuration.

Coherence between Blocks 1 and 2

We calculated the "match" and "mismatch" counts to assess the consistency between the children's choices in Block 2 and their initial happiness ratings from Block 1. A "match" occurred when a child's choice aligned with their higher Block 1 rating. Both first and third graders showed high match rates, with first graders matching 78% of the time and third graders matching 80%. Image 1E displays this comparison visually, showing similar patterns across age groups. A z-test for proportions confirmed there was no statistically significant difference between the groups ($Z = -0.45$, $p = 0.65$), indicating consistency in probabilistic reasoning across the two blocks, regardless of age.

Age-related Differences in Probabilistic Thinking

We further analyzed the score of first and third graders in Block 2, defined as the fraction of correct choices. The results showed a slight advantage for third graders (Mean = 0.92, Std.Dev = 0.05) over first graders (Mean = 0.86, Std.Dev = 0.13), though this difference was not statistically significant ($p > 0.05$). Image 1F illustrates the average scores, with error bars representing the standard error of the mean. This suggests that while older children performed marginally better, both age groups displayed similar competencies in integrating and applying probabilistic reasoning.

Discussion

Our findings align with Schlottmann and Wilkening (2011), supporting the notion that even young children possess functional probabilistic intuitions, integrating and applying probabilistic information in tasks without needing verbal explanations.

The high consistency between initial probabilistic judgments and subsequent choices suggests young children can recall and apply probabilistic information effectively.

Although older children performed slightly better, our results support the idea that children of different ages integrate probabilistic information similarly when presented visually.

Suggestions for the next study

The pilot study offers valuable insights for our larger study. Expanding the age range and grade levels will offer a more detailed understanding of probabilistic reasoning development.

As a limitation, we acknowledge that children may rely on a 'more-green-more-happy' bias. To address this, the larger study will introduce congruent and incongruent conditions to assess the role of this bias in probabilistic reasoning

Conclusion

This pilot study demonstrates that young children can integrate and manipulate probabilistic information when presented visually. The Lucy task effectively elicits meaningful responses about children's probabilistic reasoning without verbal explanations. Our findings suggest that visual accessibility is key to facilitating balanced information integration. The high coherence between initial judgments and subsequent choices indicates that children consistently apply probabilistic reasoning. Age-related analyses provide a foundation for future research with larger samples to explore developmental trends in probabilistic thinking.

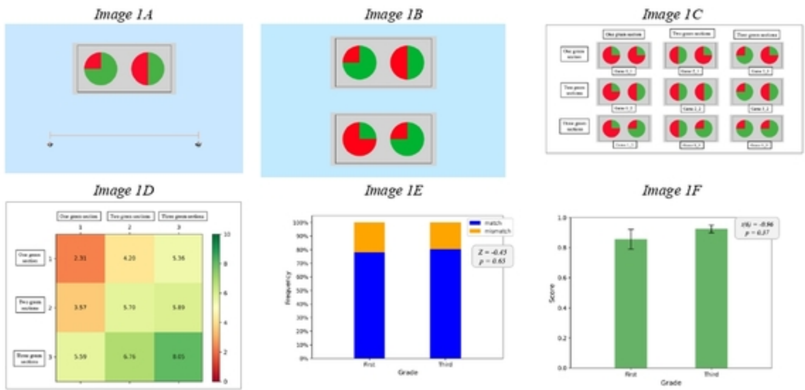

Table 1

	Game A	Mean (M) Game A	Std.D (σ) Game A	Game B	Mean (M) Game B	Std.D (σ) Game B	T value (t)	Sig. (p)	Degree F (df)
Pair 1		4.20	2.44		3.57	1.29	0.60	0.55	14
Pair 2		5.36	2.10		5.59	2.02	-0.22	0.83	14
Pair 3		5.89	2.39		6.76	2.10	-0.78	0.45	14

Image 1A: *Representation of block one of the Lucy task. In the image, the game 3-2 is illustrated together with the scale of happiness.*
Image 1B: *Representation of the second block of the Lucy task. In the image, the games 3-2 (on top) and 1-3 (bottom) are illustrated.*
Image 1C: *Set of games included in the Lucy task. In block one, each of these games corresponds to one trial, and participants are instructed to estimate Lucy's happiness for each. In block two, participants are presented with pairs of games – in a format of two Alternative Forced Choice (2AFC) task – and must choose the one that can make Lucy happier. Combinations where both games have equal probabilities are excluded.*
Image 1D: *Heatmap displaying the average happiness estimations for Lucy across different game combinations. The games are categorized by the number of green (winning) sections. The color scale ranges from red (lower happiness) to green (higher happiness), with values increasing as the number of green sections grows. This visual representation highlights the balanced integration of probabilistic elements by participants, as no extreme outliers or preference are evident.*
Table 1: *Comparative analysis of participants' happiness estimations for Lucy across pairs of games. The table presents the means (M) and standard deviations (Std.D) for Game A and Game B in each pair. A t-test was conducted to assess whether the differences in means were statistically significant. None of the comparisons reached significance ($p > 0.05$), indicating that participants did not consistently prefer one game over the other within each pair.*
Image 1E: *Proportion of match and mismatch choices in block 2, by grade. The blue sections represent "match" choices, where participants selected the game that aligned with their higher ratings from block 1. The orange sections represent "mismatch" choices, where participants' selections did not align with their earlier ratings. Both first and third graders show a high proportion of matches, indicating consistency in applying their probabilistic reasoning across tasks. A z-test for proportions showed no statistically significant difference between the grades ($Z = -0.45$, $p = 0.65$), reinforcing the idea that both age groups exhibit similar reasoning patterns*
Image 1F: *Average score for correct game choices in block 2, displayed by grade. Participants in third grade performed slightly better than those in first grade, although the difference is not statistically significant ($t(6) = -0.96$, $p = 0.37$). Error bars represent the standard error of the mean, showing the variability within each group. The score reflects the proportion of games chosen correctly out of the total number of games.*

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P43 - Substantial Motion View to the Conscious Mind: A Hierarchical Reinforcement Learning Model of Mental Processes

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Short paper: What is the **conscious mind**? Despite extensive efforts to understand its nature, much remains undiscovered. The conscious mind can be seen as the agency responsible for mental faculties such as imagination, knowledge representation, and thinking, uniquely characterizing these abilities in each individual. These faculties function as dynamic processes shaped by the conscious mind. But what, fundamentally, is the conscious mind?

Drawing inspiration from Mullā Ṣadrā's theory of **substantial motion**, which posits that matter is inherently dynamic, we conceptualize the conscious mind as a higher-order motion regulating and shaping the dynamics of mental abilities. Each mental process represents a lower-level motion under the conscious mind's control. Moreover, human interaction with the environment reciprocally influences this control mechanism, adding complexity to its operation.

A promising framework for modeling these hierarchical dynamics and their environmental interaction is **hierarchical reinforcement learning (HRL).** Within this framework, the conscious mind is analogous to a **higher-level Markov Decision Process (MDP)**, governing the lower-level MDPs, each representing distinct mental faculties. This model offers a powerful tool for understanding the conscious mind's hierarchical structure and function.

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P57 - Proactive eye-gaze for predicting repetitive worker behavior

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Short paper: Abstract Proactive eye-gaze (PEG) is a behavioural pattern where eye fixations precede actions, such as reaching. With the proliferation of eye-tracking technology, PEG shows promise for predicting human actions, which has many applications, for example, within industrial human-robot collaboration (HRC). This study investigates PEG in repetitive assembly tasks. Eye-tracking data from four experienced workers were recorded and analysed. The study recorded 57 assembly sessions, identifying 3793 fixations, of which 35% were proactive gazes. The mean PEG interval was 795 ms. Contrary to the hypothesis, PEG was found to be as strong, if not stronger, in repetitive tasks compared to previous studies investigating PEG in other contexts. These findings suggest PEG could be a reliable predictor of worker actions in repetitive tasks, enhancing coordination in HRC.

Background Proactive eye-gaze (PEG) is a behavioural pattern where many types of human actions, including reaching actions, are preceded by eye-fixations on the target. The phenomenon has been studied extensively (e.g. Johansson et al., 2001; Land & Hayhoe, 2001; von Hofsten, 2004), revealing a PEG of several hundred milliseconds (Gredebäck & Falck-Ytter, 2015). As eye-tracking technology becomes increasingly ubiquitous, PEG could potentially constitute a powerful cue for predicting human action. Action prediction has a wide range of application areas, including industrial settings where prediction of worker behaviour could increase safety and improve interaction with automation technology, such as collaborative robots (Billing et al., 2019).

One of the main application areas for industrial human-robot collaboration (HRC) lies within assembly tasks that today are executed manually. Many assembly tasks within industries are very repetitive, where the same action may be executed in almost exactly the same way hundreds of times each day. One example is manual assembly of wire harnesses inside cars. Wire harness assembly is difficult to automate due to the flexible nature of cables and therefore performed manually by workers. However, these installations are also challenging for human workers, often comprising high load forces on arms and hands, resulting in wear and tear injuries. Along with the electrification of vehicles, both the number of cable assemblies and the involved load forces are expected to increase dramatically, making wire harness installations among the most common causes of ergonomic issues in car manufacturing.

If wire harness assemblies are to be executed collaboratively between human workers and robots in a way that is both efficient and safe, PEG could be a key component in implementing coordination mechanisms between human workers and robots. While PEG has been investigated in a range of tasks, including cooking (Hayhoe et al., 2003), sports (Land & McLeod, 2000), and driving (Land & Lee, 1994), less is known about PEG in highly repetitive tasks such as assembly. While assembly is similar to many everyday activities in that it comprises pick and place actions, it also differs in that the environment is much more predictable and that tasks are executed in a similar way, over and over again.

In the present work, we aim to assess the usefulness of PEG as a predictive queue for human worker actions in repetitive tasks, such as assembly. As a starting point, we ask to what extent PEG is present also in these repetitive tasks. We hypothesise that the predictable environment, in combination with the worker's extensive experience, could make forward looking redundant, leading to declining, or even disappearing, PEG.

Method Eye-gaze of four industry workers (age 23-43) at Volvo Cars (Torslanda, Sweden) were recorded during manual assembly operations as part of their typical workday. Data was collected at the bumper assembly line, where cables are mounted onto the bumpers using connectors and clips. Participants were recruited through the local team leader among the team members who happened to be working during the scheduled data collection. Since participants were required to wear eye-tracking glasses during data collection, full vision or corrected to full vision using lenses constituted inclusion criteria. All participants were experienced workers with two or more years of experience as Volvo employees and nine or more months of experience working at the precise workstation.

Workers that showed an interest in participating were verbally informed about the study, asked to sign written informed consent, and thereafter asked to wear a pair of eye-tracking glasses (Pupil Labs Invisible). After a quick calibration of the eye-tracker made by one of the researchers, the data recording was initiated, including both eye-gaze data and the front-facing camera on the glasses. Each recording session lasted for about 15 minutes during which the participant was asked to continue working as usual.

Results and Discussion 57 assemblies, about 30 seconds each, were recorded, comprising a total of 1340 high-phased assembly operations such as reach to grasp, placement of components, screwing, and finger press. For each operation, the time of first fixation on the target and the time of hand contact with target was manually annotated by the second and forth author, using the ELAN video annotation tool. In order to assess reliability, 30 recordings were annotated by both annotators, revealing very high reliability (Krippendorff Alpha > 0.99). An example frame from the front facing camera is presented in Figure 1A.

The 57 analysed assemblies comprised a total of 3793 fixations, identified by velocity threshold (IVT) using the Pupil Cloud software. 35% of these fixations were directly associated with a specific annotated hand action, and thus identified as proactive gazes.

The distribution of PEG intervals is presented in Figure 1B, revealing a pattern of very stable proactive eye-movements towards the target location, mean = 794 ms, median = 707 ms, std = 524 ms. The vast majority (97.4%) of all fixations appeared at least 200 ms before of the first hand contact with the target. A large proportion of the remaining 2453 fixations that were not identified as proactive gazes were also related to the task, and many of these fixations preceded the hand actin in close proximity of the target.

Individual variations were also small. As visible in Figure 1C, each of the four participants produced a similar PEG distribution, with means ranging from 743 ms to 852 ms. Acknowledging that the number of participants were very small, the general implications of these findings should however be taken with care.

Contrary to our hypothesis, these results show similar, or possibly even stronger, proactive eye-gaze than found in previous investigations, suggesting that PEG is at least as prominent in repetitive actions as in other contexts. These results indicate that PEG could constitute a reliable queue for upcoming actions also in very repetitive situations, with high phased actions.

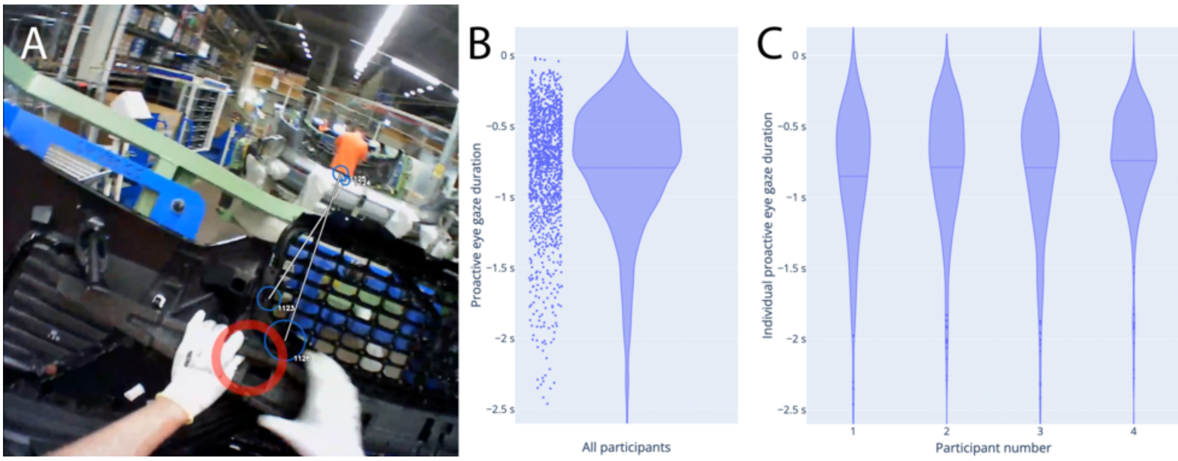

Figure 1: (A) The workers view during assembly captured with the front-facing camera of the eye-tracking glasses. Courtesy of Volvo Cars. (B) and (C) Temporal distribution of proactive eye-gazes, in relation to first hand contact with target.

Acknowledgements This work was financially supported by the Swedish innovation agency Vinnova through the research and innovation programme Produktion2030, grant #2022-01279: *Empowering Human Workers for Assembly of Wire Harnesses (EWASS)*. Parts of this work has previously been presented at the International Conference on Perception and Action (Billing et al., 2024).

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P66 - An Evaluation of Driver Education Goal Fulfillment in a Simulator-Based Driver Screening Test

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Short paper: Introduction

Young drivers are overrepresented in traffic accidents, partly due to lack of driving experience and an underdeveloped frontal lobe, which impairs risk awareness (Diamond, 2013; Romer et al., 2017). The higher-order cognitive skills involved in driving are challenging to train and assess in a driving test. Consequently, the Swedish Transport Agency and the Swedish Transport Administration are investigating ways to improve the driving license process to enhance risk awareness among new drivers (The Swedish Transport Administration & The Swedish Transport Agency, 2019).

The Swedish driver's license curriculum is based on the Goals for Driver Education (GDE) framework (Hatakka et al., 2002), which specifies four hierarchical levels of driver behavior: *vehicle maneuvering*, *mastering traffic situations*, *goals and context of driving*, and *goals for life and skills for living*. The higher levels of driving behavior are the most difficult to assess, and it has been suggested that an on-road driving test alone is insufficient for evaluating safe driving performance (Vetter et al., 2018).

Driving simulators offer a safe, controllable environment for education and training (Ābele et al., 2019; de Winter et al., 2012) and can effectively test drivers' perception, risk-awareness, and performance in rare but critical traffic situations (Thorslund et al., 2024). Thorslund et al. (2024) proposed a simulator-based screening test designed by traffic safety experts to complement the driving test by assessing aspects of driving performance related to risk awareness. A second version of the test, developed in collaboration with the simulator manufacturer Skillster, includes traffic situations where the hazard is explicit and in the driver's view, explicit but in the periphery, or obscured, requiring the driver to predict potential hazards. However, the relationship between these test situations and the GDE framework has not been investigated.

This questionnaire study aimed to evaluate the simulator screening test situations in relation to the GDE framework by answering the research question: To what extent are the various levels of the GDE framework represented in the test situations?

Method

Driver education professionals with at least one year of experience working with the GDE framework were invited to complete the questionnaire. Among the 89 respondents, 63 were driving instructors, 19 were driving inspectors, and 7 were other professionals involved in driver education.

The mean professional experience was 16.4 years (*SD* = 12.3), with a range from 1 to 44 years. The questionnaire consisted of 15 depicted and described traffic situations, presented in a randomized order for each participant. Each situation was accompanied by the following questions, representing various levels of driving behavior specified by the GDE framework, to be answered on a scale of importance (0-100 %):

***Level 1* (*vehicle maneuvering*):** To be able to handle the vehicle, the driver must have sufficiently good maneuvering skills and knowledge of how things such as speed, brakes, and road conditions affect, for example, the vehicle's braking distance. How important do you think this is for the driver to handle the situation well?

***Level 2* (*mastering traffic situations*):** To be able to handle a situation, it is necessary that the driver detects other road users, understands the obligations of both other road users and the driver himself, and interprets their behaviour in a correct way. How important do you think this is for the driver to handle the situation well?

***Level 3* (*goals and context of driving*):** To handle a situation, a driver should predict possible scenarios during the journey and manage stress and fatigue. How important do you think this is for the driver to handle the situation well?

***Level 4* (*goals for life and skills for living*):** Resisting temptation and peer pressure makes it easier to make wise decisions in different traffic situations. At the same time, your goals in life affect when, where and how you choose to drive. How important do you think this is for the driver to handle the situation well?

Results

Descriptive analysis of the ratings for each situation is presented in Table 1, showing mean values, standard deviation (*SD*), and number of respondents (*n*). The skills at GDE level 2 were rated as the most important in every situation, except for situation 14. GDE level 3 skills were consistently rated as the second most important in nearly all situations.

Table 1. Screening test situations, presented with mean ratings and standard deviations for each GDE driving behavior level.

Situation	Rating per GDE- level: Mean (*SD*) Max = 100	Situation	Rating per GDE- level: Mean (*SD*) Max = 100
 1: Left turn with oncoming traffic	1: 79.6 (24.1) 2: 92.3 (10.9) 3: 79.8 (22.5) 4: 70.8 (27.4) *n* = 68	 2: Traffic queue with pedestrian	1: 77.0 (25.5) 2: 92.6 (13.6) 3: 91.2 (12.3) 4: 71.5 (28.5) *n* = 67
 3: The driver must give way to the bus	1: 68.8 (27.1) 2: 92.0 (13.4) 3: 86.3 (17.1) 4: 68.51 (28.6) *n* = 63	 4: Child is running towards crossing	1: 79.7 (25.2) 2: 96.1 (8.9) 3: 86.4 (19.6) 4: 71.3 (30.8) *n* = 62
 5: Bicycle crossing the road in junction	1: 71.1 (28.8) 2: 94.5 (10.7) 3: 83.6 (18.4) 4: 63.4 (31.8) *n* = 64	 6: Pedestrian partially hidden	1: 72.1 (29.8) 2: 93.1 (12.8) 3: 87.1 (18.6) 4: 67.7 (31.4) *n* = 65
 7: Child runs out from in front of a bus	1: 84.6 (22.8) 2: 93.8 (11.0) 3: 89.2 (14.0) 4: 75.1 (27.8) *n* = 67	 8: Adapt speed to highway traffic	1: 89.3 (15.2) 2: 92.3 (11.3) 3: 81.7 (22.7) 4: 71.6 (30.2) *n* = 66
 9: Bicycle crossing and oncoming traffic	1: 71.1 (26.1) 2: 94.1 (10.5) 3: 86.0 (19.4) 4: 67.7 (31.1) *n* = 62	 10: Truck parked behind a small hill	1: 80.9 (21.8) 2: 88.5 (16.4) 3: 85.9 (18.8) 4: 70.5 (28.9) *n* = 67
 11: Car is hidden behind turning bus.	1: 63.2 (33.4) 2: 92.1 (12.7) 3: 88.1 (17.1) 4: 72.9 (28.4) *n* = 66	 12: Slow vehicle enters the road	1: 86.3 (17.2) 2: 88.3 (16.1) 3: 80.8 (20.6) 4: 73.2 (26.7) *n* = 67
 13: Adapt speed to highway traffic	1: 86.7 (16.6) 2: 92.7 (11.8) 3: 81.6 (19.0) 4: 69.8 (29.0) *n* = 67	 14: Moose enters the road	1: 84.8 (24.5) 2: 67.8 (33.4) 3: 90.9 (14.3) 4: 67.7 (33.0) *n* = 68
 15: Left turn from a high-speed road	1: 85.9 (19.1) 2: 93.8 (10.3) 3: 87.1 (16.8) 4: 76.2 (29.1) *n* = 63		

Discussion

The high ratings (over 63%) on all GDE levels of driving behavior indicate that every level is represented in each situation, regardless whether the hazard present in the situation is explicit or obscured. Even level 4, which is considered the most challenging to assess in a driving test, received relatively high ratings in most situations.

With one exception, all situations were rated highest on level 2 (mastering traffic situations) compared to the other levels, which includes skills like detecting other road users, understanding obligations, and interpreting behavior. The exception was the situation in which a moose enters the road (14), which requires good scenario prediction (level 3) and maneuvering skills (level 1). The three situations involving speed adjustment (8, 12, 13) stand out with higher ratings on level 1 compared to level 3.

A limitation of the study is the risk of respondent fatigue from repeatedly answering the same questions for each of the 15 situations, potentially leading some participants to quit before completing the questionnaire. To mitigate this effect, the situations were presented in a randomized order for each participant. The next step in this project will investigate how to generate a sufficient amount of variations of the test situations to ensure that test takers cannot predict what situations will occur.

Conclusion

All driving behavior levels of the GDE framework are well represented in the simulator screening test situations, suggesting the test is a suitable complement to the on-road driving test.

Acknowledgments

This work was founded by the Swedish Transport Administration (TRV), grant (2022/31998) on "Simulators for Driver Education and Assessment". The authors also wish to thank Victor Nyberg for collecting the data and adding clarifications in the images of the test situations.

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P71 - Strategic Interactions Under Conformity Pressures: An Agent-based Model

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Short paper: This paper combines agent-based modeling with concepts from game theory to explore the strategic aspects of conformity and resistance as an ideological norm is introduced to a population of agents. The norm propagates through local interactions between neighboring agents and reaches a high level of collective conformity, despite most agents privately remaining non-believers. As the percentage of non-believers who choose to initiate interactions about the norm increases, collective conformity and the number of true believers both decrease, suggesting that one way to counteract the influence of ideological norms is to encourage open conversation and debate.

Introduction

Ideological norms can lead to infringements on individual freedom, harassment of non-conformers and censorship of dissenting voices (Centola et al., 2005; Feldman, 2003; Haidt, 2012). Some examples illustrating this include morality laws policing women's behavior (Sullivan, 2022), discrimination against homosexuality (Agence France-Presse, 2024), and, in some Western societies attempts to suppress debate on biological sex (Siddique, 2024).

Feldman (2003) proposed the social conformity-autonomy dimension as a conceptualization of the internal conflict between the need for social order upheld by social conformity, and the desire to maximize personal autonomy. Individuals who have a predisposition towards prioritizing social conformity are more likely to support authoritarian tactics such as governmental action against dissenters, and are more likely to punish dissent themselves when they perceive social cohesion to be threatened. The connection between prioritizing social conformity and intolerance for dissent may explain why, even in free societies, the consequences of resisting ideological norms can be significant.

Asch's (1951, 1955) line-judgment experiments showed that individuals do not passively succumb to conformity pressures caused by an incorrect majority. Both conformers and resistors actively processed the information and analyzed the actions of the confederates making up the majority. This suggests that there is an active decision-making aspect of conformity and resistance, particularly in situations where an unambiguous falsehood is presented as the truth.

Concepts like the spiral of silence (Noelle-Neuman, 1974) and pluralistic ignorance (Allport, 1933, as cited in Prentice & Miller, 1996) help explain why individuals sometimes choose to endorse opinions they privately disagree with, often leading to a high level of collective conformity and an incorrect perception of the true majority opinion. But while people's fear of social isolation can be leveraged into public norm compliance, changing people's private beliefs is more challenging – especially if the emerging norm conflicts with reality. Abrams et al. (1990) suggest that informational influence occurs when there is disagreement between ingroup members, with individuals exhibiting greater uncertainty when disagreeing with people they categorize as similar to themselves. This suggests that while ideological conformity pressures may influence phenomena like the spiral of silence and pluralistic ignorance in the outgroup, they might lead to belief change within the ingroup.

The pervasiveness of ideological norms along with their significant societal impact make ideological conformity pressures and how we respond to them a highly relevant topic. Furthermore, understanding the role of individual decision-making in the propagation and enforcement of these norms is important for developing strategies for resistance.

Method

Using agent-based modeling in combination with concepts from game theory I examine how the trade-off between conformity and resistance affect the decision-making and strategies of agents as well as the overall outcome in terms of collective conformity and number of true believers. Feldman's (2003) social conformity-autonomy dimension serves as the basis for agents' behavior, meaning agents vary in their relative prioritization of social conformity versus autonomy. The strength of this prioritization is normally distributed among agents.

Agents are randomly distributed in cells on a toroidal grid and interact with other agents within Moore neighborhoods. These interactions resemble a social influence game where the preferences of agents compete to influence other agents' decisions to publicly conform to or resist the norm. The extent to which an agent's decision is influenced by a partner depends on the strength of both agents' preferences and on various conformity pressures.

The ideological norm is introduced to the population by a single true believer and, analogous to Asch's line-judgment experiments, represents an unambiguous falsehood contradicting the private beliefs of agents. Agents decide whether to conform to or resist the norm in interactions with other agents and are classified based on their behavior as:

- **True believers:** agents who consistently conform.
- **Resistors:** agents who consistently resist.
- **Mixing strategies:** agents who sometimes conform and sometimes resist.

True believers initiate interactions about the norm at each time step, while the percentage of non-believers (i.e., all other agents) who choose to initiate interactions is determined by λ. Belief change occurs when κ, the proportion of an agent's last n public decisions aligning with its private belief, falls below a set threshold. Because the behavior of agents is influenced by peer pressure, social punishments, and other conformity pressures occurring over time, agents may change classification before the model stabilizes.

Results

The model shows that the norm propagates through the whole population via local interactions between neighboring agents. A sensitivity analysis reveals several consistent patterns. Most agents, regardless of preference for social conformity or autonomy, prefer to mix strategies. This means that most agents' decisions are, to varying degrees, influenced by their partners. A smaller number of agents conform or resist consistently and are classified as "true believers" and "resistors" respectively. True believers and resistors generally have stronger preferences than agents who mix strategies, and their decisions are much less influenced by other agents.

A simulation experiment varying the percentage of non-believers who choose to initiate interactions about the norm (λ) shows that collective conformity and the number of true believers both decrease as λ is increased. As Table 1 shows, collective conformity decreased from 83.09% at λ = 1%, to 60.26% at λ = 100%. Further analysis revealed that agents who prioritize social conformity were more affected by changes in λ, with fewer of these agents becoming true believers as λ increased.

Discussion

Despite few agents becoming true believers, a high level of collective conformity is reached, mirroring the phenomenon of pluralistic ignorance. Similar to Asch's findings with human participants, agents who consistently conform or resist are in the minority. As the percentage of non-believers choosing to initiate interactions about the norm increased, collective conformity and the number of agents becoming true believers decreased. The largest effect of this was observed on agents who prioritize social conformity, suggesting that the absence of dissent might have a more direct negative impact on individuals who prioritize social conformity compared to individuals who prioritize autonomy.

There is often a trade-off between publicly conforming to or resisting ideological norms that we privately disagree with. When the cost of resistance is too high, many individuals respond by either complying or keeping silent. The culture of "no debate" surrounding many ideological norms helps explain why people are unwilling to make their dissent public, leading to pluralistic ignorance and spirals of silence. But this absence of dissent might also lead to belief change in individuals who, due to their prioritization of social conformity, are likely to become harsh enforcers of ideological norms they personally agree with. Encouraging conversation may prevent these individuals from becoming true believers in unpopular or harmful ideological norms in the first place, reducing the conformity pressures they are able to exert on others.

Table 1

Conformity and strategy groups across simulations

Non-believers (λ)	Conformity (%)	Mixing Strategies (%)	True Believers (%)	Resistors (%)
1% Initiating Interactions	83.09	59.95	32.15	7.90
5% Initiating Interactions	77.86	62.00	30.22	8.08
10% Initiating Interactions	73.28	63.71	28.18	8.11
25% Initiating Interactions	66.33	65.68	26.12	8.20
50% Initiating Interactions	62.82	66.00	25.54	8.46
75% Initiating Interactions	60.95	66.91	24.44	8.65
100% Initiating Interactions	60.26	66.44	24.75	8.81

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Conference Schedule

Thursday 10 October 2024

09:00 - 12:00 **Pre-conference workshops, site-visits, and social sessions**, *Aula Magna*

12:00 - 12:50 **Conference Registration**, *Aula Magna*

12:50 - 13:00 **Conference opening**, *Aula Magna*

13:00 - 13:50 **What does sleep do for brain and cognition? - John Axelsson**, *Aula Magna*

13:50 - 15:15 **Oral presentations (session 1)**, *Aula Magna*

13:50 - 14:10 O1 - Rhythmic parameters and lateralisation in the percussive behaviour of Japanese Macaques (Macaca fuscata)
***Marcus Lindelöf*[1]**, *Gabriela-Alina Sauciuc*[1], *Tomas Persson*[1], *Raquel Costa*[2], *Ivo Jacobs*[1]
[1] Lund University, Department of Philosophy, Sweden
[2] Japan Monkey Center / University of Lisbon, Primate Cognition Research Group

14:10 - 14:30 O2 - Children who can explain why they are skeptical about a claim can devise an efficient empirical test for that claim
***Tone Hermansen*[1]**, *Kamilla Mathisen*[1], *Samuel Ronfard*[2]
[1] University of Oslo, Department of Psychology
[2] University of Toronto Mississauga, Department of Psychology

14:30 - 14:50 O3 - Job seekers' subjective experiences of credibility and motivation of three unemployment interventions
***Leonard Ngaosuvan*[1]**, ***Frida Söderlund*[1]**, ***Stina Johansson*[1]**
[1] Division of Social Work, Department of Culture and Society, Linköping University

14:50 - 15:10 O4 - Time and sequence as key developmental dimensions in joint actions
***Valentina Fantasia*[1]**, *Jonathan Delafield-Butt*[2]
[1] Department of Philosophy and Cognitive Science, Faculties of Humanities and Theology, Box 192, 221 00, Lund University, Lund, Sweden
[2] Laboratory for innovation in autism, Faculty of Humanities and Social Sciences, University of Strathclyde, Glasgow, Scotland, UK

15:15 - 15:45 **Coffee break**, *Aula Magna*

15:45 - 16:50 **Oral presentations (session 2)**, *Aula Magna*

15:45 - 16:05 O5 - Machine Psychology: Integrating Operant Conditioning and NARS for Advancing Artificial General Intelligence

Robert Johansson[1, 2]
[1] Department of Psychology, Stockholm University, Stockholm, Sweden
[2] Department of Computer and Information Science, Linköping University, Linköping, Sweden

16:05 - 16:25 O6 - The Impact of Artificial Intelligence on Cognitive Load in Computing Education

Niklas Humble[1], *Peter Mozelius*[2, 3]
[1] Uppsala University, Department of Information Technology, Sweden
[2] University of Gävle, Research Program of Digitalization, Technologies, Media, and Learning (DTML), Sweden
[3] Mid Sweden University, Department of Communication, Quality Management and Information Systems (KKI), Sweden

16:25 - 16:45 O7 - Leveraging Large Language Models for Tailored and Interactive Explanations in AI Systems

Linus Holmberg[1, 2], *Maria Riveiro*[2], *Serge Thill*[3]
[1] Linköping University
[2] Jönköping University
[3] Donders Institute for Brain, Cognition, and Behaviour, Radboud University Nijmegen

16:50 - 17:30 **Poster session 1**, *Aula Magna*

1 P1 - Sound Localization Mechanics of Consciousness

Billy Gerdfeldter[1], *Mingaile Greiciute*[1], *Annika Andersson*[1], *Stefan Wiens*[1]
[1] Stockholm University, Department of Psychology, Sweden

2 P2 - Conceptual-level confusion in spatial memory: Misplacing sounds toward locations of smells

Malina Szychowska[1], *Jonas Olofsson*[1]
[1] Department of Psychology, Stockholm University, Stockholm, Sweden

3 P3 - Experiences from the driving license process test for Adolescents with ADHD and ASD: Pre-driver education issues and test situations

Birgitta Thorslund[1], ***Lina Hertzberg***[1], *Helena Selander*[2, 3], *Björn Lidestam*[2]
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4 P4 - The Association between Memory Strategies and Working Memory Training Performance in Older Adults

Ottilia Andersson[1], ***William Fredborg***[1], *Jonas Olofsson*[1]

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5 P5 - What can Socially Assistive Robots bring to quality of life for older adults?
Erik Billing[1]***,****Beatrice Alenljung*[1]*,Catharina Gillsjö*[2]
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[2] School of Health Sciences, University of Skövde

6 P6 - Emotion Recognition and Adult Aging: No Effect of Intranasal Oxytocin, but Sensory Modality Matters
Marie Low[1]***,****Mats E. Nilsson*[1]*,Natalie C. Ebner*[2]*,Amirhossein Manzouri*[1, 3]*,Diana Persson*[1]*,Petri Laukka*[1, 4]*,Håkan Fischer*[1, 5, 6]
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[6] Aging Research Center, Department of Neurobiology, Care Sciences and Society, Karolinska Institutet and Stockholm University, Sweden

7 P7 - Differences in the attention network between deaf and hearing individuals
Josefine Andin[1]***,****Emil Holmer*[1]
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8 P8 - Emoji-Text Mismatches: Stirring the Pot of Online Conversations
Chara Soupiona[1]*,****Vanessa Vanessa***[2]***,****Amy Han Qiu*[2]*,Fahima Ayub Khan*[2]*,Christine Howes*[2]
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9 P9 - Daily Sleep Variations and Next-Day Cognitive Performance in Young and Older Adults: A 21-Day Mobile Experience Sampling Study
Jade Silfverling[1]***,****Wessel van Leeuwen*[1]*,Malin Freidle*[1]*,Torbjörn Åkerstedt*[1]*,Göran Kecklund*[1]*,Johanna Schwarz*[1]
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10 P10 - Implicit learning of sound sequences
Malin Freidle[1]***,****Mats Nilsson*[1]
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11 P11 - Inside-out: Thought-Experiments, Scientific Simulations, and the Economy of Extended Cognition

Daniel Dohrn[1]
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12 P12 - Res Cogitans – The Evolution of Thinking
Patrik Lindenfors[1, 2]
[1] Institute for Futures Studies
[2] Centre for Cultural Evolution, Stockholm University

13 P13 - Resolving Quantifier Scope Ambiguity: The Influence of Context and Grammatical Gender
David Pagmar[1]**,***Asad Sayeed*[1]
[1] University of Gothenburg

14 P14 - Physiological responses during gaze avoidance in children with autism
Viktoria Klein Moberg[1]**,***Jakob Åsberg Johnels*[2]*,Nouchine Hadjikhani*[2]*,Johan Lundin Kleberg*[1]*,Martyna Galazka*[2]
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[2] Gothenburg University

15 P15 - Large-scale oscillatory networks characterize cognitive states
Nieves Ruiz Ibáñez[1]**,***Julia Ericson*[1]*,Torkel Klingberg*[1]
[1] Department of Neuroscience, Karolinska Institutet

16 P16 - Challenges in neural self-regulation: insights from EEG-based Neurofeedback training
Elmeri Syrjänen[1]**,***Joana Silva*[1]*,Elaine Astrand*[1]
[1] Mälardalen University

17 P17 - Towards a Self-Driving Future – A study on the factors influencing behavioral intentions to use autonomous buses
Freja Turén[1]**,***Gustaf Wadenholt*[2]*,Erik Marsja*[1]
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[2] Department of Psychology, Umeå University, Umeå, Sweden

18 P18 - Rule of Law in Swedish Health Insurance Assessments: Maximizing Ecological Validity using Vignette Methodology
Leonard Ngaosuvan[1]**,***Ligia Larsson*[2]
[1] Linköping University
[2] Eskilstuna Municipality

19 P19 - Affective polarization effects on political judgment in vague political contexts
Gustaf Lindblad[1]

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20 P20 - Expectation Priming Through Linguistic Framings When Introducing Social Robots: An Empirical Study of Students' UX in an Educational Context
Emma Hjälm[1]*,* ***Martina Quach***[1]***,*** *Erik Lagerstedt*[2]*,Erik Billing*[1]*,Kajsa Nalin*[1]
[1] University of Skövde, School of Informatics, Sweden
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21 P21 - Can Robot Cats Help Children with Autism Spectrum Disorder in Dental Care?
Sofia Thunberg[1]***,*** *Anna Lena Sundell*[2, 3]
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22 P22 - Investigating How Olfactory Processing Is Affected By Visual vs. Gustatory Priming Stimuli via EEG
Samet Albayrak[1]***,*** *Jonas Olofsson*[2]
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[2] Psychology, Stockholm University, Stockholm, SE

23 P23 - INDIVIDUALS WITH REMITTED DEPRESSION SHOW A NORMATIVE ATTENTION TO SOCIAL STIMULI AT AN EARLY TIME STAGE – AN EYE-TRACKING STUDY
Dimitar Krastev[1]***,*** *Ida Fjellström*[2]*,Charlotte Willfors*[3, 4]*,Ann Nordgren*[5, 3, 6, 4]*,Johan Lundin Kleberg*[7, 8]
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[7] Department of Psychology, Stockholm University, Stockholm, Sweden
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24 P24 - Social Robots that Handle the Unreal: What? When? Where? Why? How?
Pierre Gander[1]
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25 P25 - Hello Trivia Friend: Understanding Human-Agent Dynamics Through Design Provocation

Kevin C. Dalli[1]**,***Charlotte McNulty*[1]

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26 P26 - Metacognition during sleep deprivation

Tina Sundelin[1, 2]**,***Andreas Jemstedt*[1]*,Alvin Gavel*[2]*,John Axelsson*[1, 2]*,Bennett L. Schwartz*[3]

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[3] Florida International University

27 P27 - Pragmatics partially segregated from theory of mind: evidence from resting state functional connectivity

Christoffer Forbes Schieche[1]**,***Manu Mahal*[2]*,William Hedley Thompson*[3, 4]*,Julia Uddén*[1, 2]

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28 P28 - Visual Mental Imagery is Not Evidently Separable from Episodic Memory Recall

Dániel Pénzes[1]

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29 P29 - “Give skin coldness to us”: temperature-based metaphors across the world’s languages

Maria Koptjevskaja Tamm[1]

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30 P30 - A qualitative study on parent’s perception of their child’s developing critical thinking skills and their own role in this development

Mari Stavsholt[1]**,***Karine Viana*[2, 3]*,Tone Hermansen*[2]

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[3] OsloMet, Department of Social Work, Child Welfare and Social Policy

31 P31 - Peripartum Depressive Symptoms and Development of Child Emotion Regulation: The Roles of Temperament, Attachment and Sleep Quality

Mattias Engel[1]

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32 P32 - Virtual Reality Full-Body Ownership Illusions: A Study on the Role of Perspective

Kristina Stenström[1], *Maria Pyasik[2], Andreas Kalckert[1]*
[1] University of Skövde
[2] University of Udine

33 P33 - The Relationship between self-reported Sleep Quality and Executive Functions among Swedish upper-secondary school pupils

Carola Wiklund-Hörnqvist[1, 2], *Anna-Maria Johansson[3], Linnea Karlsson Wirebring[1, 2], Sara Stillesjö[1, 2], Linda Olsson[4], Erika Olofsson[4]*
[1] Department of Psychology, Umeå University, Sweden
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[3] Department of Health, Education and Technology Luleå University of Technology, Sweden
[4] Upper secondary school, municipality in Northern Sweden

34 P34 - Three-way Interaction of Reading, Aptitude, and Education Predicts Grammatical Proficiency in Turkish as First Language (L1)

Yağmur Ece Ergün[1], Fırat Can Erişgin[1], Sueda Şahin[1], Su Öy[1], Deren Yayar[1], ***Tan Arda Gedik[2, 1]***
[1] Bilkent University, Department of Psychology, Turkey
[2] FAU Erlangen-Nürnberg, Chair of Language & Cognition, Germany

35 P35 - Constructing and deconstructing a human judgment rule

Linus Andersson[1], *Sara Stillesjö[1], Gustaf Wadenholt[1], Linnea Karlsson Wirebring[1]*
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Friday 11 October 2024

09:00 - 09:50	**Cognition and the social dimensions of knowledge - Åsa Wikforss**, *Aula Magna*
09:50 - 10:10	**Coffee break**, *Aula Magna*
10:10 - 11:50	**Oral presentations (session 3)**, *Aula Magna*
10:10 - 10:30	O8 - Encoding others' attention as implied motion: Disentangling attention-motion and action expectation effects ***Christian Renet[1]***,*Arvid Guterstam[1]* [1] Department of Clinical Neuroscience, Karolinska Institutet, 171 77 Stockholm, Sweden
10:30 - 10:50	O9 - Preferences for everyday objects are transitive ***Mattias Forsgren[1]***,*Gustav Karreskog Rehbinder[2]*,*Peter Juslin[1]* [1] Department of Psychology, Uppsala University [2] Department of Economics, Uppsala University
10:50 - 11:10	O10 - The role of sequence representation in the evolution of human language and cognition ***Anna Jon-And[1]***,*Markus Jonsson[1]*,*Johan Lind[1]*,*Stefano Ghirlanda[1]*,*Magnus Enquist[1]* [1] Centre for Cultural Evolution, Stockholm University
11:10 - 11:30	O11 - Toward a proper format of perceptual temporal representation in the dynamic snapshot view ***Haeran Jeong[1, 2]*** [1] Department of Philosophy, Faculty of Arts and Humanities, Heinrich Heine University Düsseldorf, Germany [2] Department of Philosophy, Faculty of Social Sciences, University of Turku, Finland
11:30 - 11:50	O12 - Memory in spoken and signed language interpreting: a theoretical model of memory processes in different interpreting modes ***Elisabet Tiselius[1]***,*Laura Babcock[1]* [1] Stockholm University
11:50 - 13:00	**Lunch**, *Aula Magna*
13:00 - 14:00	**Oral presentations (session 4)**, *Aula Magna*
13:00 - 13:20	O13 - AUTONOMOUS AGENTS, COGNITION AND INTELLIGENCE ***Gordana Dodig-Crnkovic[1, 2]*** [1] Chalmers Universityy of Technology [2] Mälardalen University

13:20 - 13:40 O14 - No effect of additional education on long-term brain structure – a preregistered natural experiment in over 30,000 individuals

Nicholas Judd[1]

[1] Donders Institute for Mind, Brain and Behaviour

13:40 - 14:00 O15 - Population-based ecosystem modeling via deep reinforcement learning

Claes Strannegård[1, 2]

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[2] Department of Molecular Medicine and Surgery, Karolinska Institutet

14:00 - 15:00 **Structuring experiences in cognitive spaces - Christian Doeller**, *Aula Magna*

15:00 - 15:20 **Coffee break**, *Aula Magna*

15:20 - 16:00 **Poster session 2**, *Aula Magna*

1 P36 - Retrieval Practice in the Classroom Boosts Knowledge of Mathematical Concepts: An Implementation Study in Middle School

Linnea Karlsson Wirebring[1, 2]*,Anna-Maria Johansson*[3]*,Carina Granberg*[4]*,Carola Wiklund-Hörnqvist*[1, 2]*,Sara Stillesjö*[1, 2]*,Peter Bergman*[5]*,Stina Ericson*[5]

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[3] Department of Health, Education and Technology, Luleå University of Technology, Sweden

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[5] Primary school, municipality in Northern Sweden

2 P37 - Investigating Probabilistic Reasoning in Young Children: Insights from the Lucy Task Pilot Study.

Maybí Morell Ruiz[1]*,Federico Abraham Ceruti*[2]*,Magnus Haake*[1]*,Agneta Gulz*[1]

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[2] Universidad de La República, Montevideo, Uruguay.

3 P38 - Visual mnemonics as a tool for learning in upper secondary school

Petra Sandberg[1]*,Martin Nilsson*[2]

[1] Department of Psychology, Umeå University, Umeå, Sweden

[2] Katedralskolan, Lund, Sweden

4 P39 - Investigating The Editing's Effect of Advertising Photos On the Virtual Purchase Decision Based On the EEG Parameters

Maryam Habibifar[1]*,Paria Tabie*[2]

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[2] Master Student in Media and Cognitive Science, Cognitive Science Department, Tabriz Islamic Arts University, Tabriz, Iran

5 P40 - Infinity Problems: Considering the Implications of a Lightweight Inverse Kinematic for Understanding Human Motion Planning.

Maurice Lamb[1]***,***_Estela Pérez Luque_[1]
[1] Högskolan i Skövde

6 P41 - Examining the Impact of Camera Control on Collaborative Problem-Solving

Francisco Garcia Rivera[1]***,***_Maurice Lamb_[1]
[1] University of Skövde

7 P42 - Identifying Thought Patterns in Major Depressive Disorder Using Variational Inference and Large Language Models Integrated with Concept Space

Mariam Marlen Mirström[1]***,***_Mohammad-Hossein Heidari Beni_[2]_,Shima Rezai_[2]
[1] Lund University
[2] Sharif University of Technology

8 P43 - Unlocking the Power of the Conscious Mind: Integrating Concept Space & Agent-Environment Interaction

Mariam Marlen Mirström[1]***,***_Mohammad Matin Mazaheri Kouhani_[2]_,Mohammad-Hossein Heidari Beni_[3]_,Yousef Javaherian_[3]_,kamyab hossain pour_[3]
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[2] Shahid beheshti university
[3] Sharif University Of Technology

9 P44 - Individually tailored retrieval practice influences the magnitude of the testing effect independent of variations in fluid intelligence

Sara Stillesjö[1, 2]***,***_Linnea Karlsson Wirebring_[1, 2]_,Anna-Maria Johansson_[3]_,Carola Wiklund-Hörnqvist_[1, 2]
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10 P45 - Blame: What is it Good For?

Kristoffer Moody[1]***,***_Makan Nojoumian_[1]
[1] University of Edinburgh

11 P46 - Wrong, try again: Outcome feedback improves performance on base-rate fallacy tasks

Nils Olofsson[1]_,Anne Winquist_[1]_,_***Gustaf Wadenholt***[1]***,***_Linnea Karlsson Wirebring_[1]_,Linus Andersson_[1]
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12 P47 - Subject-specific frontal-midline theta during cognitive tasks and relation to non-performance during single-session neurofeedback

Joana Silva*[1]*, *Elmeri Syrjanen[1],Elaine Astrand[1]*
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13 P48 - Crosslinguistic interactions in real-time L3 Swedish spoken sentences

Yulia Kashevarova*[1]*, *José Alemán Bañón[2]*
[1] Umeå University
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14 P49 - Compensatory semantic processing in adverse hearing situations

***Petter Kallioinen*[1, 2]**
[1] Department of Linguistics, Stockholm university
[2] Sci-lab, Department of Psychology, Stockholm university

15 P50 - MORPHOSYNTACTIC CONSTRUCTIONS AS A MEANS OF DISTRIBUTING ATTENTION IN NEWS TEXT HEADLINES

***Nataliia Talavira*[1]**
[1] Nizhyn Mykola Gogol State University

16 P51 - Coordination of Languages in the Encounter Between Subjective Worlds

***Erik Lagerstedt*[1]**
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17 P52 - Moving towards, moving forwards: investigating interpersonal synchrony in human-robot interactions

Johannes Rosenfrost*[1]*, *Trond Arild Tjøstheim[1],Valentina Fantasia[1]*
[1] Lund University, Department of Philosophy, Sweden

18 P53 - In-silico brain model simulates cognitive control of information by synchronized networks

Julia Ericson*[1]*, *Nieves Ruiz Ibanez[1],Torkel Klingberg[1]*
[1] Karolinska Institutet

19 P54 - Exploring the impact of disgust sensitivity on cognitive abilities: the mediating role of cognitive style.

Eva Tolomeo*[1]*, *Cristiana Colacino[2],Luna Giada Mazza[2],Alessandro Vecchi[2],Marco Tullio Liuzza[2]*
[1] Department of Health Sciences, “Magna Graecia” University of Catanzaro
[2] Department of Medical and Surgical Sciences, “Magna Graecia” University of Catanzaro, Catanzaro, Calabria, Italy

20 P55 - Concurrent curiosity affects primary task performance but not primary task learning: evidence from a two-armed bandit task
Gustaf Wadenholt[1]*,Ronald van den Berg*[2]*,Paul Schrater*[3]*,* ***Linus Holm***[1]
[1] University of Umeå
[2] University of Stockholm
[3] University of Minnesota

21 P56 - Odor identification and odor naming errors are informative about olfactory-perceptual and olfactory-semantic processing
Thomas Hörberg[1]***,*** *Murathan Kurfalı*[1, 2]*,Maria Larsson*[1]*,Erika Jonsson Laukka*[3, 4]*,Pawel Herman*[5]*,Jonas Kristoffer Olofsson*[1]
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[4] Stockholm Gerontology Research Center, Stockholm, Sweden
[5] Computational Brain Science Lab, Division of Computational Science and Technology, KTH Royal Institute of Technology, Stockholm, Sweden

22 P57 - Proactive eye-gaze for predicting repetitive worker behavior
Erik Billing[1]***,*** *Raquel Quesada Díaz*[2]*,Malin Eklund*[2]*,Anna Brolin*[2]
[1] School of Informatics, University of Skövde
[2] School of Engineering Science, University of Skövde

23 P58 - Exploring effects of temporal attention on the neural correlates of visual consciousness
Mingaile Greiciute[1]***,*** *Sergej Engström*[1]*,Stefan Wiens*[1]
[1] Stockholm University, Department of Psychology, Sweden

24 P59 - On-scalp MEG - a closer look at the brain
Christoph Pfeiffer[1]
[1] Karolsinka Institutet

25 P60 - Effects of body language during conversation with socially assistive robots
Malin Eklund[1, 2]*,Julia Forslund*[2]*,* ***Erik Billing***[3]
[1] School of Engineering Science, University of Skövde
[2] Department of Applied IT, University of Gothenburg
[3] School of Informatics, University of Skövde

26 P61 - Burstiness of Communication as a Moderating Variable in Team Cognition: Insights from a C3Fire Microworld Experiment
Gisela Bäcklander[1]***,*** *Ulrik Spak*[1]*,Isabell Andersson*[1]
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Sweden

27 P62 - Towards an Understanding of Neural Mechanisms of Production of Code-Switches: From Conceptualization to Activation
Gülay Cedden[1],*Christiane von Stutterheim[1]*
[1] Heidelberg University

28 P63 - The effect of prosody on listening comprehension: Immediate and delayed recall
Alexandra Dylman[1],*David Glarén Diaz[2]*,*Andreas Blysa[2]*,*Billy Jansson[2]*
[1] Mälardalen University
[2] Mid Sweden University

29 P64 - Does retrieval practice improve motor-skill retention?
Patrick Oden[1]
[1] University of Skövde

30 P65 - Sex Differences in Dopamine D1 Receptor Availability and Episodic Memory in Adults over 40: a Longitudinal Imaging Study
Georgina W Chu[1],*Alireza Salami[2, 3, 4, 5]*,*Jarkko Johansson[6, 2]*
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[5] Wallenberg Centre for Molecular Medicine, Umeå University, Umeå, Sweden
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31 P66 - An Evaluation of Driver Education Goal Fulfillment in a Simulator-Based Driver Screening Test
Birgitta Thorslund[1],*Sam Thellman[1]*,*Helena Selander[2, 3]*
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[3] Department of Clinical Neuroscience, Institute of Neuroscience and Physiology, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden.

32 P67 - The activation of metaphorical thought as a function of stimulus saliency
Ljubica Damjanovic[1]
[1] Department of Psychology, Lund University, Lund SE-221 00, Sweden

33 P68 - Simulating Embodied Singers by Combining Vocal and Auditory Models with Cognitive-Motivational Architectures

Joris Grouwels[1]
[1] KTH Royal Institute of Technology - Department of Speech, Music and Hearing - Stockholm, Sweden

34 P69 - The Cognitive Gender Interaction of Driver Monitoring Systems and Driver Traffic Safety
Paul Hemeren[1]
[1] University of Skövde

35 P70 - The Impact of Time Delays on Gaze Behavior in Human-Robot interaction
Samantha Stedtler[1]
[1] Lund University

36 P71 - Strategic Interactions Under Conformity Pressures: An Agent-based Model
Sarah Mc Shane[1]
[1] University of Gothenburg, Cognitive Science

16:00 - 16:40 **Panel discussion**, *Aula Magna*

16:40 - 16:50 **Closing**, *Aula Magna*

Authors Index

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