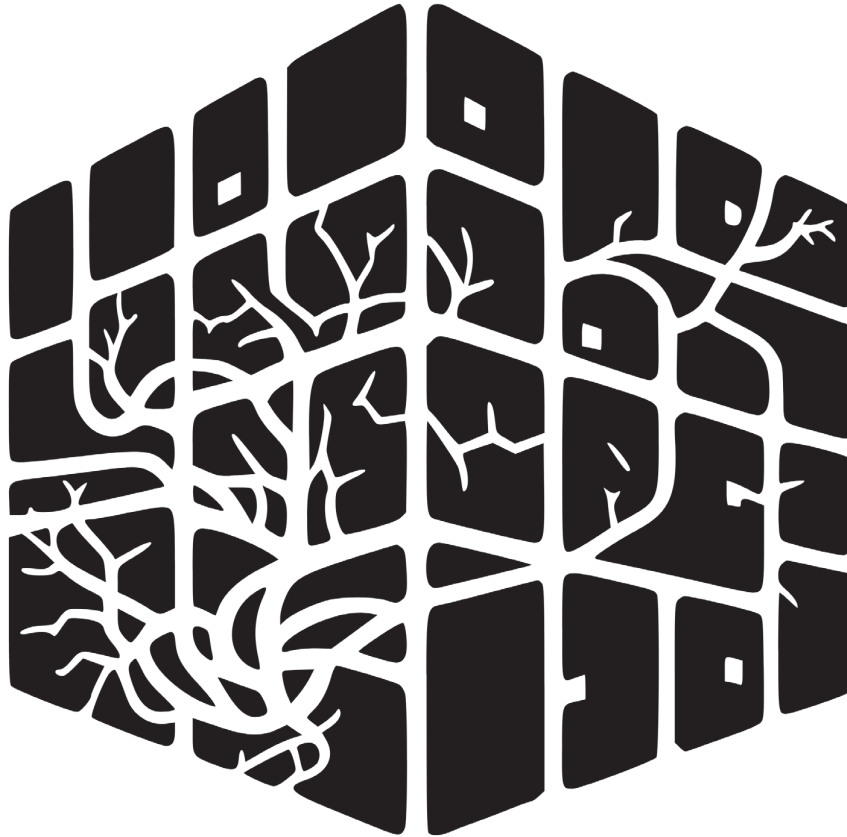


Middle European  
interdisciplinary  
master's programme in  
Cognitive Science



***Puzzled by the Mind***  
***MEi:CogSci Conference 2023***  
***Budapest***

# Proceedings of the MEi:CogSci Conference 2023

The conference took place at the Faculty of Education and Psychology, Eötvös Loránd University in  
Budapest Hungary , on 15-17 June, 2023.

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# Welcome!

**Dear Coxies, dear MEi:CogSci partners and friends, dear guests,**

Welcome to our 17th MEi:CogSci Conference; this year hosted by the Eötvös Loránd University in Budapest.

While still reflecting on challenges and chances that the years of the COVID-pandemic brought to us, being students, teachers, scientists, being friends, partners, parents, children, etc., technological developments of the past months impact our lives again in a profound manner. Old questions such as *what it means to be intelligent, what it means to reason and to understand* are all over the media. Cognitive science deals with the theoretical foundations, the mathematical models, as well as the societal impacts of (artificial) intelligent systems. This particular topic is but one among the broad range of contributions to this conference. MEi:CogSci aims to educate not only experts in cognitive science, but also humans acting in an ethically and socially responsible manner.

We want to express our gratitude to the Faculty of Education and Psychology for hosting the conference this year. We thank all student volunteers, faculty, and staff of the Eötvös Loránd University, who helped to support this event. A big thank you to Márton Nagy, who took over the overall organisation of this conference in Budapest!

We want to welcome our invited speakers Kristína Malinovská (Comenius University in Bratislava, Slovakia), Péter Simor (Eötvös Loránd University in Budapest, Hungary), and Toma Strle (University of Ljubljana, Slovenia). Thank you for joining us this year and for sharing your knowledge with us.

We also welcome our graduates, who join this event and provide insights into possible careers after MEi:CogSci. Thank you for supporting MEi:CogSci even after graduation!

We thank Luka Kovač for creating the cover art for the conference proceedings.

Thank you, Igor Farkaš, for organising the publication of these proceedings under an ISBN number.

We also want to thank all reviewers and supervisors, who provide the foundations for this event.

And last but not least, it is you, Coxies, who make this conference happen. Your posters, talks, and initiatives will make the MEi:CogSci Conference 2023 an exciting and joyful event!

Thank you all for coming! Enjoy the 17th MEi:CogSci Conference!

Elisabet Delgado Mas, Evelyn Fischer, Martyna Meyer, Udo Schimanofsky, Mariette Soulat, Elisabeth Zimmermann

## **Editors' Note**

We, the editors, thank all MEi:CogSci students/authors for submitting their work to the MEi:CogSci Conference 2023. We are happy to present your work in the conference proceedings and to contribute to the field of cognitive science by covering such a variety of interesting topics.

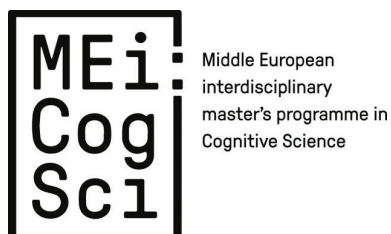
The MEi:CogSci conference and its proceedings are a joint effort. The editors ensure that the work submitted to the conference is in accordance with the conference guidelines for authors. Thus, the editors revise the submissions in respect to formal criteria and formatting issues. Participating students/authors are expected to adhere to good scientific practice and to honour the regulations relating to good academic conduct. The students'/authors' responsibilities include the usage of references and citations in a transparent, precise, and correct manner, as well as issues regarding style, spelling, and grammar of their abstracts. Despite our best efforts to meet our responsibilities as editors, the MEi:CogSci Conference 2023 proceedings may contain errors and we apologise for any inconveniences.

Thank you all for allowing us to represent MEi:CogSci and our programme's understanding of cognitive science through your submissions of original work.

## **Seventeenth Middle European Interdisciplinary Conference in Cognitive Science (MEi:CogSci Conference 2023)**

Budapest, Hungary

15 -17 June, 2023



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# Plenary Talks

# **Towards Biologically Plausible Learning in Artificial Neural Networks**

**Kristina Malinová**

*Comenius University Bratislava*

Standard error backpropagation is the most prominent supervised learning algorithm for artificial neural networks, although it has been shown to be biologically implausible. Learning in the brain is local and makes a use of bidirectional flow of information. We propose Universal Bidirectional Activation-based Learning, a novel neural model based on the Contrastive Hebbian learning and recirculation algorithms. Our model extends the existing work as it implements two mutually dependent, yet separate weight matrices for different activation propagation directions and a learning rule with novel hyperparameters that drive the contribution of target-based and self-supervised learning. This allows our model to master qualitatively different tasks such as auto-encoding, denoising, and classification. Our results show that UBAL is comparable with a standard multi-layer perceptron as well as with the related biologically motivated state-of-the-art models. Due to its heteroassociative nature, UBAL is able to generate images of the learned classes as an emergent phenomenon, without being explicitly trained to do so.

# The Wandering Mind in Sleep and Wakefulness

**Péter Dániel Simor**

*Eötvös Loránd University*

Mind-wandering is a mental state in which attention shifts from the present environment or current task to self-referent thoughts about past experiences, future events, or planned actions. A variety of studies estimated that humans spend at least one-third of their waking hours lost in such self-generated mental content. Although mind-wandering seems to reflect a default state of the brain and putatively serves a variety of cognitive functions such as autobiographical memory, creative/divergent thinking, mindreading, or anticipation of future scenarios, excessive mind-wandering comes with high cognitive and emotional burdens. Since mind-wandering is characterized by sensory disengagement and by immersion in internally driven mental processes, it is assumed to be at least partly akin to dreaming experienced during sleep. Accordingly, mind-wandering during attention-demanding cognitive tasks is coupled with neurophysiological indicators of local sleep, supporting the assumption that attentional lapses, sensory disengagement, and spontaneous thoughts are underlined by transient sleep-like neuronal activity. In the present talk, I will summarize two recent studies that build on the above view. The first study examined if daytime mind-wandering could be predicted from the previous night's sleep, specifically the amount spent in sleep stages when intense dreaming occurs. The second study examined the potential benefit of mind-wandering in automatic, implicit learning, opening future avenues to study mind-wandering in relation to information processing and memory consolidation.

# Nudging Choice?

**Toma Strle**

*University of Ljubljana*

Behavioural science shows that we are susceptible to many biases and influences that can, in certain contexts, lead to erroneous judgments and disadvantageous choices. As a result, various strategies have been proposed to improve human decision-making, such as debiasing, entrusting choice to algorithmic systems, or changing choice environments. In my talk, I will focus on the latter strategy, in particular the nudge programme and similar interventions. I will first present the basic claims of the nudge programme, which aims to modify people's behaviour by changing choice environments without eliminating freedom of choice. I will then discuss some challenges and open questions related to the design and implementation of nudges. Should we put more emphasis on examining how (individual) decision-makers relate to the environments within which they make choices? What implications does the complex nature of decision-maker-environment interaction have for the design (and implementation) of nudges? How ethically problematic is deliberate steering of peoples' behaviour, and when should we support it, if at all?

# Opening Workshops

# MEi:CogSci Walk&Talk

**Udo Schimanofsky**

*University of Vienna*

Get to know each other, make new friends with people from other universities and have a chat about exciting CogSci topics at our topical sightseeing sessions!

To kick off the conference in style, the organizing team has planned - in addition to an exciting opening workshop by Toma Strle - a part social part stimulating learning event with an open space structure. YOU decide what is on the program and what you want to do! Whether you want to explore ideas, the city of Budapest or just have a relaxed chat in the park (the walking aspect is very open to broad interpretation). How about a stroll down the riverbank while discussing your personal CogSci passion topic or something you always wanted to know more about? What is a body for an artificial agent? How does feeling and thinking relate? WTF is consciousness?! Like the old saying goes: even a sightseeing tour of three thousand seconds starts with a single question!

We will meet at 9:00 AM and gather some exciting topic ideas, then depart for our first little Walk&Talk sessions. Suggestions for scenic routes and/or sightseeing destinations (a leisurely walk away from the conference venue) will be prepared. Reconvening and fresh opportunities to join a new round of Walk&Talks every full hour (10:00, 11:00, 12:00). The event is flexible, adaptable to all requirements and fully accessible. Wrap-up at 13:00. Bring sunscreen, walking shoes and a curious mind :)



# How Do I Experience Choosing?

**Toma Strle**

*University of Ljubljana*

In the workshop, we will explore how we experience decision-making in everyday life situations. First, a brief introduction to the phenomenology of decision-making will be given. In groups, participants will then explore how they experience their own choices — the process leading up to the choice, the final choice, and the strategies they might use when deciding. Groups will present and discuss their findings. Through the workshop, some of the challenges of investigating decision-making within contemporary cognitive science will also be explored.

# Talks

# Dialogical Nature of Narrative Identity: A Meta Analysis

**Aljaž Andolšek**

*University of Ljubljana*

## Introduction

McAdams defines narrative identity as the internalized and evolving story of the self, that people construct to make meaning out of their lives [1]. As such it is often assumed in research, that there is a single, centralised narrative frame, which organizes and integrates a person's life story into one of unity and purpose. However, an alternative perspective advocated in dialogical self-theory, suggests that life stories are several, smaller and less integrative, instead of being as individualised, whole, and self-contained. The I here is seen as a de-centred multiplicity of positions with dialogical relationships at its core.

The concept of the dialogical self was inspired by the work of James [2], who coined the distinction between I and me. The I is equated with the self-as-knower and has three features: continuity, distinctness, and volition. On the other hand, me is equated with self-as-known and is composed of the empirical elements considered as belonging to oneself. Inspired by this distinction, Hermans, Kempen and Van Loon [3] have conceptualised the self in terms of a dynamic multiplicity of relatively autonomous I-positions. These I-positions manifest themselves in terms of voices in accordance with changes in situation and time. These shifts between these positions or voices establishes dialogical relations that exchange information about their respective Me's, which results in a complex, narratively structured self.

## Research Goals and Results

The understanding of the narrative self is very different in various relevant research fields (such as psychology, philosophy, anthropology, neuroscience) and there is no clear understanding, how it fits and relates to cognitive science. The goal of the research will be to compare the dialogical self-theory to other contemporary theories of the narrative self and accurately identify the concept across different disciplines (if that is even possible), to outline its function and structure and possibly construct a unifying model of the narrative self, that could be integrated into the broad field of cognitive science.

## Methods

The main method of research will be a systemic literature review, stemming from the dialogical self-theory and compared to relevant literature from the fields of philosophy, cognitive and developmental psychology, neuroscience and anthropology.

## References

- [1] D. McAdams and K. McLean, "Narrative Identity," *Current Directions in Psychological Science*, 2013, doi:10.1007/978-1-4419-7988-9\_5
- [2] M. Woźniak, "'I' and 'Me': The Self in the Context of Consciousness," *Frontiers in Psychology*, vol. 9, 2018, doi:10.3389/fpsyg.2018.01656
- [3] H. J. M. Hermans, "The Dialogical Self: Toward a Theory of Personal and Cultural Positioning," *Culture & Psychology*, vol. 7, no. 3, pp. 243–281, 2001, doi:10.1177/1354067X0173001

# User and Stakeholder Acceptance Analysis of Automated Road Transport Logistics Systems

Zoja Anžur

*University of Ljubljana*

Role of humans in industry is changing due to novel automated vehicles [1]. Technology acceptance (TA) refers to the user's motivation to use a technological solution. Technology Acceptance Model [2] proposed perceived usefulness and ease of use as important factors in TA. Expanding on that, the latest model ARTLAM [3] was constructed. It will be the foundation of our work, with slight adjustments made by my colleagues. As it has not yet been used in a study where participants would be exposed to a technological solution, this will be one of the contributions of this thesis. Perceived usefulness, ease of operation, supporting conditions, safety, security, reliability, and public acceptance are proposed as factors of TA. I will explore underlying factors of TA based on data from employees who were faced with a technological solution (experiences of usage) and compare it with underlying factors based on data from employees who were not (expectations before usage).

## Method

I will conduct a survey measuring factors of TA in two groups of participants. The target population will be various employees in the logistics industry. Data for the first group (expectation) was already gathered and analyzed. Second group (experience) will be exposed to a Fleet Management System (FMS), which is a software for remote operation (scheduling tasks and resolving issues) of logistics vehicle fleets. Interviews will be carried out. I will perform

multiple regression analysis on the data, thus identifying underlying factors of TA based on experiences and compare them with expectations. Interdisciplinarity will be ensured by researching a psychological construct (TA) and embedding the results in predictive processing framework.

## Expected Results

I expect to identify usefulness and ease of use as significant antecedents of experience as they have already turned out to be important factors of TA [2]. I expect that reliability and supporting conditions will not be significant antecedents of experience as they refer to aspects of TA that will not be brought to participants' attention. I hope that this framework will have implications in introduction of novel technologies.

## References

- [1] C. Cimini, A. Lagorio, D. Romero, S. Cavalieri, and J. Stahre, "Smart Logistics and the logistics operator 4.0," IFAC-PapersOnLine, vol. 53, no. 2, pp. 10615–10620, 2020.
- [2] F. D. Davis, "A technology acceptance model for empirically testing new end-user information systems: Theory and results," dissertation, Massachusetts Institute of Technology, 1985.
- [3] P. Fröhlich, M. Gafert, L. Diamond, M. Reinthaler, M. Neubauer, F. Hammer, and S. Koskinen, "Towards a Comprehensive Understanding of Stakeholder Requirements for Automated Road Transport Logistics," In Proceedings of the Workshop on Automation Experience at the Workplace co-located with the ACM Conference on Human Factors in Computing Systems (CHI 2021), 2021.

# Maybe “Diable”, But Not “Carrotable”: How Pseudowords Can Trick Colombian Spanish Speakers’ Brains?

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It has been shown that morphologically complex words are decomposed when processed. According to Schreuder, R., & Baayen, R. H. (1995) there are two separate sub-processes after decomposition, namely licensing (checking stem category), and composition (checking semantic compatibility of stem+affix combinations). This has been evidenced by Manouilidou, C., & Stockall, L. (2014) showing that pseudowords (PWs) containing argument violations (morible “diable”) are more likely to be accepted than those with category violations (zanahoriable “carrotable”), and they are rejected at a slower rate. We investigate whether the two sub-processes are distinguishable for Colombian Spanish native speakers when suffix attachment rules of Spanish are violated. Contrary to previous studies, here suffix productivity is manipulated. Additionally, we compare verb-attaching to noun-attaching affixes, while previous research has mainly focused on verb-attaching affixes. The experiment involved a 2 x 2 factorial design with two factors: suffix productivity (low, high) and base category (nouns, verbs). For noun bases, we used: 1. suffix -udo (=low productivity) which attaches to nouns that refer to body parts, so we created semantic violations (SemViol) PWs by attaching it to object nouns; 2. suffix -ano (=high productivity) that attaches to proper nouns, so concrete nouns were used for SemViol PWs. In both cases, we created category violations (CatViol) PWs by attaching the

suffixes to verbs. For verb bases we used: 1. -ble (=high productivity) and 2. -dizo (low productivity) that attach to various verbs, but they seem not to attach to verbs of growing, change of state, or existence, which we used as bases for SemViol PWs. CatViol PWs were created by attaching -ble and -dizo to nouns. We also added Grammatical existing words for the four suffixes, 40 fillers, and 40 nonwords, and created a lexical decision task with 310 items in total.

Preliminary Linear mixed-effects models analysis [accuracy/RTs~Condition (CatViol, SemViol, Gramm) x Suffix (udo,ble,diz,ano)+by-item and by-subject random intercepts] show the expected pattern for BLE and DIZO, with SemViols eliciting higher acceptability, higher RTs (BLE  $z=-2.31$ ,  $p=0.09$ , DIZO  $z=-2.90$ ,  $p=.02$ ) and more errors (BLE  $z=9.09$ ,  $p<.0001$ , DIZO  $z=4.14$   $p=.0002$ ). The effect was not found for ANO and UDO. The results show that the pattern does not seem to depend on affix productivity, but they suggest dependence on base category: with noun-attaching affixes, violations of category and violations of semantics seem to be equally bad, fast, and accurate. Further research is needed to show if this pattern is triggered by differences in processing noun vs. verb-attaching affixes, or specific semantic restrictions.

## References

- [1] C. Manouilidou and L. Stockall, “Teasing apart syntactic category vs. argument structure information in deverbal word formation: A comparative psycholinguistic study,” *Italian Journal of Linguistics*, vol. 26, no. 2, pp. 71–98, 2014.
- [2] R. Schreuder and R. H. Baayen, “Modeling morphological processing,” in L. B. Feldman (Ed.), *Morphological aspects of language processing*. Lawrence Erlbaum Associates, 1995, pp. 131–154

# Enactive Cognition in an Organizational Context: Individual Capabilities in Fostering Resonance

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This study explores how stakeholders' perception of an organization can influence and foster individual engagement and the experience of work as meaningful. Key concepts to describe these reciprocal mechanisms are resonance (RE) and aesthetic experience (AE). RE in organizations can be defined as a state of alignment between an individual's values, emotions and actions with the organization's purpose. This alignment leads to a sense of shared meaning and motivation among stakeholders and is important for sustainable and future-oriented organizations [1]. The concept of AE in an organizational context allows to integrate the sensory and emotional qualities of an organization, such as its visual design, architecture, organizational culture and communication style, into a cohesive whole. These qualities can shape the way people experience the organization and influence their attitudes and behaviours towards it [2]. This study uncovers prerequisites for employees to experience RE, AE and purpose in organizations by examining their roots in the organizational context and exploring their reciprocal mechanisms with individual attributes including capabilities, personality traits, mindset and previous learning experience. It aims to understand how the experience of these concepts can be fostered to enhance shared meaning and motivation among stakeholders. In organizational theory, the concept of enactive cognition highlights the

significance of creating a supportive environment that fosters co-creation between individuals and organizations. This process involves a dynamic interaction where individuals' cognitive capabilities and organizational structures mutually influence each other, generating new knowledge and value.

## Method

To achieve the research objectives, this study adopts an iterative grounded theory approach, facilitating open exploration of questions and theory generation [3]. The research methodology involves conducting 10–15 semi-structured narrative interviews with individuals from an organization, as well as administering personality questionnaires. The interviews aim to uncover prerequisites for stakeholders' experiences of RE, AE and purpose, while the questionnaires provide additional insights into relevant individual attributes. This study aims to provide valuable insights on cultivating conditions for innovation, growth and their promotion and application in organizations.

## References

- [1] C. Kerschbaum and M. F. Peschl, "The Power of Resonance and Aesthetic Alignment in Future-Oriented Organizations - the Case of Patagonia," in *Proceedings of ENTRENOVA*, September 7–9, 2023.
- [2] A. Strati, "Aesthetic Understanding of Organizational Life," *The Academy of Management Review*, vol.17 no. 3 pp. 568 – 581, 2006.
- [3] A. Strauss and J. Corbin, *Basics of qualitative research: techniques and procedures for developing grounded theory*. Sage Publications, 2014.

# A Neuro-Phenomenological Review of Object Recognition

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Object recognition is the process of detecting and classifying an object in our visual experience, it is a part of „sense making” of our perpetual experience. The visual processing of detection and classification is done in a matter of milliseconds and may seem seamless in our daily experience.

There are a few gaps in our understanding of this process. First, the issue of generalizing the different data items to create categories for classification, the main issue in this process is the huge variability between appearances of the same item, due to lighting or viewpoint for example. The second gap is explaining how the high specificity in assigning a category to an object is achieved, for example, different specificity levels could be a building, a home and my home. Thus, it is required to distinguish between very close categories [1].

Further, studies have described some intriguing phenomena related to object recognition, for example, becoming conscious of an object after already doing a reflexive action related to it, such as avoiding a car that comes towards you suddenly while driving [2, 3].

In this project I would like to study the topic of object recognition from a few angles. First, how is object recognition perceived in experience? Second, how neurophysiological research describe the mental process of object recognition?

I would also like to find parallels between the neurophysiological processes and our experience of object recognition. I expect there will be parallels between both disciplines, so that the neurophysiological description could explain the phenomenological description.

In addition, I might find parts of the phenomenon that have not yet been studied well in a neurophysiological experiment.

I would like to perform a meta-analysis on the topic, with two main concentration topics: the phenomenological aspect, neuroscientific and physiological aspect. Using my conclusions, I would like to formulate suggestions for future research.

## References

- [1] M. Riesenhuber and T. Poggio, “Models of object recognition,” *Nature Neuroscience*, vol. 3, no. S11, pp. 1199–1204, Nov. 2000. doi:10.1038/81479
- [2] R. Gregori-Grgič, M. Balderi, and C. de’Sperati, “Delayed Perceptual Awareness in Rapid Perceptual Decisions,” *PLoS ONE*, vol. 6, no. 2, p. e17079, Feb. 17, 2011. doi:10.1371/journal.pone.0017079
- [3] J. Jolij, H. S. Scholte, S. van Gaal, T. L. Hodgson, and V. A. F. Lamme, “Act Quickly, Decide Later: Long-latency Visual Processing Underlies Perceptual Decisions but Not Reflexive Behavior,” *Journal of Cognitive Neuroscience*, vol. 23, no. 12, pp. 3734–3745, Dec. 01, 2011. doi:10.1162/jocn\_a\_00034



# Retrospective Analysis of Causal Perception

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The human brain distinguishes between two types of causality: inferential causality and perceptual causality. The first kind refers to rational procedures. In contrast, the perception of causality seemingly relies on a perceptual module devoted exclusively to recognizing direct causes and effects in the environment. From this perspective, humans perceive causality as they perceive colors, sizes, shapes, orientations, etc. Nevertheless, the assumption that the perception of causality does not require intricate inferences has not been sufficiently demonstrated. Numerous researchers had focused on investigating the psychophysical conditions required for perceiving causality, e.g., Michotte's [1] temporal-spatial parameters required to perceive causality. The principal aim of my master thesis is to prove one hypothesis that might explain the psychophysics and plausible modularity of perceptual causality. This is because the perception of causality depends on a retrospective process in the brain. Two other subsequent hypotheses will be tested as well: 1) the retrospective process is based on a specific module, 2) the perception of causality is independent of other visual properties such as shapes, sizes, colors, etc. Three visual launching-effect [2] experiments are being implemented to prove these hypotheses, which are recorded with EEG equipment as well. The first one consists of a classical launching effect in real motion. The participants have to rate how strong was the influence of the launcher on the target's movement. In a second experiment, two screens are shown to the participants creating an apparent

motion illusion. In the third, the target moves in a real motion sequence, either vertically or horizontally. The participants have the additional task of choosing the direction (horizontal or vertical) of the target's movement. The third experiment follows the previous scheme, but six variables are modified: the target's speed and size, the launcher's size and direction, the collision temporary delay, launcher-target spatial gap. The participants have the same tasks as in the second experiment.

In the apparent motion experiments, the participants do not know the target's direction of movement. Thus, only after the impact, the visual system reconstructs the preceding directions. If the perceptions about the target's movements coincide with the target movement presented, it is presumable the retrospective reconstruction. Comparing the event-related potentials among the apparent motion and the real motion experiments, it will be possible to localize temporarily and spatially the perception of causality [3], and the influence of other visual properties.

## References

- [1] A. Michotte, *The Perception of Causality*, Adfo Books, 1963.
- [2] T. Hubbard, *Launching, Entraining, and Representational Momentum: Evidence Consistent with an Impetus Heuristic in Perception of Causality*, Springer Science + Business, 2012.
- [3] S. Blackmore, "A psychological theory of the out-of-body experience," *Journal of Parapsychology*, vol. 48, 1984.



# Exploring the Impact of Virtual Reality on Secondary School Mathematics Education

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The integration of innovative technologies, such as virtual reality (VR), in education has gained considerable attention from researchers and educators. VR technology offers an immersive and interactive learning environment that can enhance engagement, motivation, and learning outcomes [1]. However, while some studies have shown the potential benefits of VR learning for adult learners, there remains a scarcity of research on its impact on secondary school students, particularly in comparison to traditional classroom teaching [2].

This research aims to address this research gap by exploring the impact of VR learning on secondary-school student engagement, motivation, and learning outcomes, compared to traditional classroom teaching. The study will use a mixed-methods approach that includes a quasi-experimental design and qualitative analysis of student and teacher feedback. The research questions will examine the advantages and disadvantages of VR learning, as well as the factors that may affect its effectiveness.

To conduct the study, a sample of 50 students enrolled in a traditionally taught math course will be recruited, with one section receiving instruction via VR. Data will be collected on student engagement, motivation, and learning outcomes, including academic performance

and knowledge retention. The anticipated outcomes suggest a positive influence of VR on student engagement and motivation, possibly enhancing mathematical learning outcomes.

The findings of this research will enrich the understanding of VR's role in education and fill the current literature gap regarding its effectiveness for secondary school students. The insights gathered could shape educational practices and policies, guiding the incorporation of VR technology in teaching, particularly for math and other suitable subjects.

Emphasizing the significance of innovative technologies in education, this study points towards the potential benefits for academic success. As VR technology evolves, its continuous assessment becomes vital. Future research should delve into the long-term effects and other influencing factors of VR learning. This continuous scrutiny assures the optimal utilization of VR and similar technologies in education, potentially enhancing learning experiences and outcomes for the coming generations.

## References

- [1] N. Pellas, S. Mystakidis, and I. Kazanidis, "Immersive virtual reality in K-12 and higher education: A systematic review of the last decade scientific literature," *Virtual Reality*, vol. 25, no. 3, pp. 835–861, 2021. doi:10.1007/s10055-020-00489-9
- [2] P. Araiza-Alba, T. Keane, J. L. Beaudry, and J. Kaufman, *Immersive virtual reality implementations in developmental psychology*, 2020. doi:10.31234/osf.io/ga8sz

# Use of Electroencephalography -based Neurofeedback in People with Parkinson's Disease

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## Introduction

Parkinson's disease (PD) is the second most common neurodegenerative disease and one of the leading causes of disability. Around 10 million people have this condition worldwide [1]. It is a progressive disease characterized by gradually worsening symptoms. Individuals with PD develop different motor and non-motor symptoms. Some of the non-motor symptoms can appear years before a person is diagnosed with PD. Each year, PD diagnoses increase by 1 % [1]. Most commonly, the motor symptoms are treated using levodopa, which is absorbed by the brain cells and transformed into dopamine, a neurotransmitter that controls movement [1]. However, there are currently no other effective drugs available to treat PD. An alternative non-invasive and non-pharmaceutical technique is neurofeedback (NFB), a type of biofeedback that measures neuron activity. We know different NFB methods that work according to different principles. In my dissertation, I will focus on electroencephalography-based NFB (EEG NFB), which has a high temporal resolution and provides real-time feedback to participants [2]. It is also cheaper and easier to transport compared to other systems. Patients are shown the feedback that they can use to change their brain waves according to the cues given by an expert [2]. Such training is known as neurofeedback training (NFT).

## Aims and Methods

The aim of my master's thesis is to systematically review experimental articles in which NFT was used as a method to treat patients with PD.

Additionally, I aim to check experimental articles where the NFT was used to improve the motor skills of healthy participants. One of the main goals of the thesis is also to determine the possibility of implementing EEG NFT in clinics or everyday life, without the need for the presence of an expert or clinician. With this, the ecological validity of the NFT method can be improved.

For a systematic review, I will follow the PRISMA-S strategy [3]. Articles will be collected from PubMed, Google Scholar, and Frontiers web pages.

## Expected Results

I expect, to find EEG NFT leading to improvements in motor deficits in PB patients. Additionally, I expect to develop a protocol for the application of the EEG NFT that can be utilized without the need for clinician supervision.

## References

- [1] M. J. Armstrong and M. S. Okun, "Diagnosis and treatment of parkinson disease," JAMA, vol. 323, no. 6, p. 548, 2020. doi:10.1001/jama.2019.22360
- [2] R. Sitaram et al., "Author correction: Closed-loop brain training: The science of neurofeedback," Nature Reviews Neuroscience, vol. 20, no. 5, pp. 314–314, 2019. doi:10.1038/s41583-019-0161-1
- [3] M. L. Rethlefsen et al., "Prisma-S: An extension to the PRISMA statement for reporting literature searches in systematic reviews," BioMed Central, 2019. doi:10.31219/osf.io/sfc38

# Is the Discrete Semantic System Part of the More General Conceptual or Linguistic Network?

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The ubiquity of numbers in our culture confers especial importance on the cognitive mechanisms enabling numerical processing and comparison. When asked to identify the smaller/larger one of two Arabic numbers in comparison tasks, participants' performance improves with increasing numerical distance between the stimuli [1]. This so-called symbolic distance effect can be attributed to the Discrete Semantic System (DSS), a network in which numbers vary in their strength of association with concepts such as "small" or "large" [2]. Similar distance effects also occur when letters or months are compared [3]. This poses the question whether these distance effects might rely on a more general conceptual or linguistic network of associations or, in other words, whether the DSS is part of this domain-general network. If the numeric and non-numeric distance effects rely on the same mechanism, their slopes may correlate. Hence, to address our research question, we subjected adult participants ( $n = 65$ ) to three different comparison tasks, using Arabic numbers, letters of the alphabet, and months of the year as stimuli. Subsequently, we calculated the reliability-adjusted correlations of the distance effect slopes for participants' error rate and reaction time across the three domains. In line with previous studies, significant distance effects were observed in all three domains for both error rate and reaction time. The distance effect

slopes correlated moderately to strongly between numbers and months (error rate) and between letters and months (error rate and reaction time). Further, we found weak correlations between the error rate distance effect slopes for numbers and letters as well as for the reaction time distance effect slopes for numbers and months. These results partly support the idea that the DSS drives symbolic comparisons beyond the number domain, at least in ordered lists as closely associated with numbers as months. However, the assumption that similarly-appearing distance effects indicate a single mechanism might have been flawed as participants might combine different strategies. In our case, number and letter comparisons might rely on two distinct mechanisms, with month comparison partly drawing on both of them. Future studies should therefore aim to disentangle the properties of different ordered lists to elucidate how the human mind processes numeric and non-numeric symbolic comparison.

## References

- [1] R. S. Moyer and T. K. Landauer, "Time required for judgements of numerical inequality," *Nature*, vol. 215, no. 5109, pp. 1519–1520, 1967.
- [2] A. Krajcsi, G. Lengyel, and P. Kojouharova, "The source of the symbolic numerical distance and size effects," *Frontiers in Psychology*, vol. 7, 2016.
- [3] B. A. Fairbank Jr., "Experiments on the temporal aspects of number perception." Doctoral Thesis, The University of Arizona, USA, 1969.

# Predicting Dementia Based on Wearable Digital Devices Data

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## Introduction

Dementia is a progressive neurodegenerative brain disorder and the most severe expression of cognitive impairment. Research has shown that preventive interventions targeting lifestyle and vascular risk factors early on can slow down the neurodegeneration process. In a previous lifestyle intervention study a prediction model based on clinical and demographic data was built, predicting a high or a low risk of developing dementia. While these data have been found to be good predictors of dementia, this study aims to utilize wearable digital devices data with the goal of using machine learning (ML) methods to predict dementia. Mobile devices and wearable digital consumer technology could help detect the disease specific changes earlier in the disease course. Cognitive, sensory, and motor changes could be detected 10–15 years prior to the diagnosis of dementia.

## Methods

160 participants aged 60–77 are included in the 2-year study. Disease-relevant features are collected with a smartphone and a smartwatch. The features we will include in the prediction model are metrics which reflect movement (phone acceleration, relative location), phone usage, levels of exercise (steps, activity log, calories) and sleep metrics. From these features symptoms of dementia will be extracted based on literature review. Also, an ML prediction model with the outcome of high or low risk of developing dementia will be built. Outcomes

of this model will be compared with the ones of the prediction model based on clinical and demographic data. The specific ML approach (supervised or unsupervised learning) is yet to be determined after comparative analysis of both ML techniques. We hypothesize that digital devices data alone are not enough to accurately and precisely predict whether a participant has a high or a low risk of developing dementia. However, by adding digital devices data to the already existing prediction model, its prediction accuracy and precision would likely improve.

## Discussion

The goal of this project is to build a prediction model for dementia based on digital biomarkers. An important benefit of digital devices for both researchers and patients is the widespread use of phones and other digital devices in daily life, which eliminates additional expenses for collecting data. Measurements could be collected for longer periods instead of sporadically. This could improve detecting and predicting dementia early on, enabling interventions, which can slow down the disease progression.

## References

- [1] S. Hanke et al., “AI-based predictive modelling of the onset and progression of dementia,” *Smart Cities*, vol. 5, no. 2, pp. 700–714, 2022. doi:10.3390/smartcities5020036
- [2] L. C. Kourtis, O. B. Regele, J. M. Wright, and G. B. Jones, “Digital biomarkers for alzheimer’s disease: The mobile/wearable devices opportunity,” *npj Digital Medicine*, vol. 2, no. 1, 2019. doi:10.1038/s41746-019-0084-2

# Approaching Exposure Therapy as a Sequential Decision-making Problem

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## Background

Exposure Therapy (ET) is a variant of cognitive behavioral therapy (CBT) whose theoretical foundations have been widely explored in the domain of psychology to treat anxiety disorders. ET treatment regimens rely on correcting the maladaptive beliefs [1] of patients and adjusting the therapy conditions accordingly. However, the learning-based experimental designs [1] in ET have not yet been studied in detail for improving therapy protocols and remain suboptimal in practice. Theory of Mind (ToM) which refers to the human ability of inferring the intentions and beliefs of others, is a principal constituent of human cognition [2]. An extension of ToM in the machine learning (ML) field has been the involvement of meta learning [2] for multi-agent reinforcement learning (MARL) [3] to discover latent variables in simulation environments. Disruptions in ToM parameters such as the failure of a belief update function result typically in aberrant behavior [1]. ET protocols, therefore, are essentially founded on finding solutions for sequential decision-making problems. RL in the psychology literature has been identified as (i) habituation and (ii) goal-directed learning [3]. The difference between each type is the feedback from the environment with which humans can adapt to update their action-state pairs [3]. In ML, the corresponding behavior is formulated in terms of (i) model-based and (ii) model-free RL algorithms.

## Methods

Our in silico MARL study is grounded on the premise of model-based and model-free RL algorithms which will be deployed in an RL therapist for adaptive design optimization (ADO). The therapist agent will function as a stand-in for the human therapist in agent-to-agent therapy sessions. The actions of the patient agents will be parameterized on the prediction error (PE) estimation capability of a mathematical model such as the Rescorla-Wagner model (RWM) while the actions of the therapist agent will be investigated with algorithms such as Dyna-Q or DQN [3] for learning control policies.

## Expected Results

We hypothesize that an RL therapist agent with ToM capabilities [3] will be able to learn to accurately predict the mental states of patient agents and fine-tune the therapy environment. The results of the previously mentioned ML methods are expected to demonstrate viable insights to optimize ET and allocate quantifiable intervention components for affected populations.

## References

- [1] M. Moutoussis, N. Shahar, T. U. Hauser, and R. J. Dolan, "Computation in Psychotherapy, or How Computational Psychiatry Can Aid Learning-Based Psychological Therapies," vol. 2, no. 0, Art. no. 0, Feb. 2018.
- [2] N. C. Rabinowitz, F. Perbet, H. F. Song, C. Zhang, S. M. A. Eslami, and M. Botvinick, "Machine Theory of Mind." arXiv, Mar. 12, 2018.
- [3] R. S. Sutton and A. G. Barto, Reinforcement Learning: An Introduction. Cambridge, MA, USA: MIT Press, 2018.



# Exploration of Subjective Experiences During Hypnosis and Hypnoanalgesia

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Hypnosis has been increasingly used as a non-pharmacological intervention for pain management (hypnoanalgesia). However, the mechanisms behind hypnoanalgesia are not yet fully understood. The current study is part of a broader research aimed at improving our understanding of the role of response expectancy in hypnoanalgesia [1]. To achieve this, the research aims to explore the expectancies and subjective experiences associated with both sham and conventional hypnosis inductions and to compare the effectiveness of suggestions for pain reduction when coupled with these inductions.

While previous research has examined the differences in behaviour between sham and conventional hypnosis, little attention has been given to the subjective experiences associated with sham hypnosis. This study seeks to fill this gap by analysing the subjective experiences reported by participants during both inductions. Descriptive data from some studies suggest that hypnotic responses elicited by sham inductions are slightly lower than those elicited by conventional inductions [2]. Although this difference is not statistically significant in most individual studies, the pattern is consistent across several studies.

During the experiment, participants were asked to report their experiences in free-text

format. However, limitations of this method were identified, prompting the testing of a phenomenological interview as an alternative. The phenomenological interview is predicted to provide greater insights into the subjective experiences associated with hypnosis and to expose differences in experiences between sham and conventional hypnosis. The interview is a combination of several phenomenological approaches and is expected to provide richer and more detailed data [3]. The study's results may offer new avenues for future research on hypnosis and pain management.

## References

- [1] Z. Kekecs, Y. Farahzadi, and K. Giran, "The effects of sham hypnosis techniques—PLB HYP - OTKA Study 2," *osf.io*, March 22, 2022. [Online]. Available: <https://osf.io/dskby> [Accessed: May 4, 2023].
- [2] C. Kendrick, L. Koep, A. Johnson, W. Fisher, and G. Elkins, "Feasibility of a sham hypnosis: Empirical data and implications for randomized trials of hypnosis," *Contemporary Hypnosis & Integrative Therapy*, vol. 29, no. 4, pp. 317–331, 2012.
- [3] F. J. Woodard, "Phenomenological contributions to understanding hypnosis: review of the literature," *Psychological Reports*, vol. 93, no. 3, pp. 829–847, 2003.

# **Towards a Physics-based Cognitive Science: Reconceptualising the Problems of Consciousness**

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Explaining consciousness has been one of the biggest challenges of human existence. In over 3,000 years of documented thinking, not much progress has been made in finding a satisfying definition. The ever-advancing increase in scientific disciplines has not made it easier, as each field has come up with its own definitions. This is especially relevant in the field of cognitive science.

The thesis aims towards the analysis of the most important conceptions of consciousness in the wider field of cognitive science, providing a theoretical, foundational meta-synthesis of consciousness, focussing on physical concepts. Since the leading disciplines are not yielding fully comprehensive frameworks, a physics-based approach is chosen to widen the discussion of consciousness into one of the most important natural sciences, possibly providing a more comprehensive approach to consciousness. First, the most important conceptions of consciousness and their different ‘problems’ within the field of cognitive science are investigated. Afterwards, psychedelic-research-inspired brain-theories, such as the entropic brain hypothesis [1] are scrutinised, emphasising the potential of implementing physical concepts into consciousness and brain research. The thesis thus provides a theoretical conceptual framework that introduces terminologies from the field of physics into cognitive

science, allowing a reconceptualisation of consciousness with an added physical dimension. Third, theoretical and physical concepts of resonance are discussed to shift the focus to a neurophenomenological conception of resonance. Other physical frameworks are presented and contrasted to phenomenological states, among which there will be the ‘connectome-harmonics’ [2] and the ‘resonance theory of consciousness’ [3]. The former reports that the functional networks of the human brain are predicted by harmonic wave patterns which are ubiquitous throughout nature. The latter suggests that consciousness is a product of various shared resonance frequencies.

The thesis concludes with an integration of these conceptions in the form of a physics-inspired cognitive science and its implications on different phenomenological states as well as providing possible empirical research suggestions to test these new theories.

## **References**

- [1] R. L. Carhart-Harris, “The entropic brain - revisited,” *Neuropharmacology*, vol. 142, pp. 167–178, 2018. doi:10.1016/j.neuropharm.2018.03.010
- [2] S. Atasoy, I. Donnelly, and J. Pearson, “Human brain networks function in connectome-specific harmonic waves,” *Nature Communications*, vol. 7, p. 10340, 2016. doi:10.1038/ncomms10340
- [3] T. Hunt and J. W. Schooler, “The Easy Part of the Hard Problem: A Resonance Theory of Consciousness,” *Frontiers in Human Neuroscience*, vol. 13, p. 378, 2019. doi:10.3389/fnhum.2019.00378

# The Prediction Value of EEG in Neuromarketing: Advertising Videos and Consumer Engagement

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## Introduction

Neuromarketing techniques can improve the prediction of consumer behavior by measuring implicit physiological consumer responses unobservable through traditional methods. Neural measures have the potential as unbiased predictors, overcoming the limitations of subjective measures used in marketing research [1]. Many findings attempt to predict preference based on various features of the EEG signal. Alpha frequency suppression is a recognized indicator of mental activity and engagement, e.g., when paying close attention to any kind of stimulus [2]. EEG shows promise for predicting consumer response, but its contribution to preference prediction beyond traditional measures requires further research.

## Methods

A total of 40 university students will be recruited for the study. In a within-subjects design, participants will be presented with a set of video ads from a video advertisement database with performance metrics selected from the Golden Drum advertising festival. Video ads will be divided into two major groups depending on whether they have received an award at the festival or not and further divided into groups based on the year of production and content. The videos will be displayed on a computer screen, and the participants' EEG oscillations will be recorded simultaneously to measure the neural correlates of the engage-

ment with presented audiovisual stimuli. Engagement with each video will be rated using a 5-point Likert scale. We presume to see a difference in engagement between selected groups of videos. EEG data will be pre-processed and frequency analyses will be performed to calculate power change in alpha frequency for each subject. A multiple regression analysis will be conducted to evaluate the predictive value of different models. Additional analysis will be performed on subgroups.

## Expected Results and Discussion

It is expected that the awarded videos will lead to higher levels of engagement, as measured by both EEG and self-reported responses. We expect the relative power change in the alpha frequency band will be greater for winning videos than for non-winning videos compared to the average alpha power across all videos. This interdisciplinary study's results will add valuable insights to the growing research on consumer neuroscience and examine the impact of audiovisual stimuli on engagement and associated neural processes.

## References

- [1] A. Hakim and D. J. Levy, "A gateway to consumers' minds: Achievements, caveats, and prospects of electroencephalography-based prediction in neuromarketing," *WIREs Cognitive Science*, vol. 10, no. 2, article e1485, 2019, doi: 10.1002/wcs.1485
- [2] G. Pfurtscheller and A. Aranibar, "Event-related cortical desynchronization detected by power measurements of scalp EEG," *Electroencephalography and Clinical Neurophysiology*, vol. 42, no. 6, pp. 817–826, 1977, doi: 10.1016/0013-4694(77)90235-8



# **The SOS of Experience: A Dialectic Approach to the Relationship Between Sense of Self and Experience**

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Our experience is all we have, illuminating itself and the world. Our endeavors, including the scientific enterprise, are characterized by a perspective taking in the form of background assumptions including but not limited to how we make distinctions and indications. But how does experience arise at all, and why? Would it be possible to trace back the origins of experience in the evolutionary framework (cf. natural drift)? If so, what should be considered the mark of experience?

The aims of this thesis are manyfold: (1), it is to judge the applicability of the autopoiesis framework developed by Maturana and Varela [1] on what they term “higher order autopoietic systems” by trying to include experience in the autopoiesis framework. This amounts to, at face value, a change in the domain of explanation and poses certain difficulties and dangers. Furthermore, additional aims are: (2) by using the framework of “meshwork of selfless selves” [2], to identify the relationship between self, sense of self, and experience, (3) to test the applicability of the idea of tracing the mark of experience back to the mark of sense of self, (4) to develop a firm understanding of the “knotty dialectic” [2] of the organism, and look at what consequences a dialectical approach has on the mind-body problem, (5) to develop a framework of experience and sense of self with the understanding of the active role

played by the knower (scientist or the philosopher) in developing explanations that are valid in their domain of inquiry.

Keeping the above-mentioned points in mind, the main hypothesis is, stated loosely, that the mark of experience is the sense of self, which seems to have developed in organisms that can be put in the category of “cognitive self” in the Varelian framework [2]. The task will then be shifted towards languaging beings and how a “socio-linguistic self” [2] may provide a qualitative shift which may (or may not) pose a problem for the life-mind-continuity thesis.

The frameworks mentioned above may resist interpretations that take them outside of their proposed domain of explanation. For example, trying to expand the “meshwork of selfless selves” framework onto the historical (evolutionary) domain is bound with problems. Thus, this thesis should be viewed as a dynamic process characterized by a situated sense of learning by doing.

## **References**

- [1] H. R. Maturana and F. J. Varela, *Autopoiesis and Cognition: The Realization of the Living*, Springer Science & Business Media, 1980.
- [2] F. J. Varela, “Organism: A Meshwork of Selfless Selves,” in *Organism and the origins of self*, Springer, 2013, pp. 79–107

# Enacting Prepositions: Internalising Spatial Relations

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Meaning is considered to be grounded in ongoing interaction with the environment, i.e. lived experience in three dimensional space and real time (enactive cognition) [1]. This is reflected in language use, e.g., in terms of spatial relations that are regarded as basic for acquiring the semantics of locative and directional prepositions (image schema theory) [2]. From a neuroscientific perspective of brain function, the body is considered to execute brain-initiated action based on previous experience. This comprises of actively sampling the world while concurrently reporting the consequences of these actions. This information is then integrated to serve as basis for future use (inside-out framework) [3]. Theoretical research and empirical evidence appear to not always be congruent, however. The level of efficacy of current therapy approaches for Broca's aphasia, e.g., do not always yield the expected results. This may be based on a misconception in terms of the nature of the deficit that underlies the loss of prepositional use in aphasia.

## **Synergy**

This theoretical account aims at fleshing out how disciplines, theories and empirical evidence may complement one another to shed new light on the interrelationship of spatial cognition and prepositions. This will involve identifying level congruent correlations factoring in concerns regarding a potential granularity problem. Thus, it likewise seeks to contribute to bridging the gap between philosophy, linguistics and neuroscience on a person level, i.e. the whole body (including the brain). An

empirical pilot case study on English spatial prepositions previously conducted will be argued to exemplify how theories may be combined and applied in a clinical context (chronic Broca's aphasia). The observed effects, including sustained effects, indicate an efficacious approach. Relevant observations made will be integrated and (cor)related to brain function.

## **Outlook**

The findings may, e.g., encourage testing the enactive approach suggested on a wider scale of individuals with Broca's aphasia. This may have an impact on how impairment-based therapy is administered in terms of spatial prepositions. Potential future projects such as 'aphasia meets preschool/kindergarten' (where participants may be on the same level preposition-wise) may decrease afflicted individuals' awareness of deficits and enable social interaction between the two groups that may both benefit from the experience. Finally, this perspective may also influence approaches in foreign language teaching concerning spatial prepositions.

## **References**

- [1] F. J. Varela, E. Thompson, and E. Rosch, *The Embodied Mind: Cognitive Science and Human Experience*. Cambridge, MA: MIT Press, 1991.
- [2] M. Johnson, *The body in the mind: The bodily basis of meaning, Imagination, and reason*. Chicago: University of Chicago Press, 1987.
- [3] G. Buzsáki, *The brain from inside out*. New York: Oxford University Press, 2019.

# Personality Traits and Driving Behaviour: Slovenian Drivers

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Personality plays a crucial role in driving behavior, as it can considerably impact a driver's actions on the road [1]. Therefore, knowing how personality traits influence driving behavior can help individuals become more aware of their behavioral tendencies and make conscious changes in their behavior that can contribute to improved safety on the road.

Intrigued by this notion, we would like to explore the existence of a correlation between personality traits and driving behavior, primarily focusing on young drivers. To achieve this goal, we have designed and want to validate a questionnaire called "Slovenian Driving Behaviour Questionnaire of Novice Drivers (SN-DBQ)". The questionnaire is an adaptation of the widely used Driver Behavior Questionnaire (DBQ) [2]. The Big Five Inventory (BFI-2) [3] will be used to classify participants' personality traits, encompassing openness, conscientiousness, extraversion, agreeableness, and neuroticism. By analyzing the questionnaire responses, we will explore the effect of these traits on the frequency of driver errors.

Our research will seek to address two key research questions: firstly, whether the SN-DBQ is a valid measure of novice drivers' behavior compared to established metrics such as the DBQ, and secondly, whether a correlation between personality traits and driving behavior exists.

Data processing will involve conducting Pearson's correlation analysis between personality

traits identified with the BFI-2 and error tendencies identified with the DBQ, as well as correlations between the results from the DBQ and the SN-DBQ. The internal reliability of all three questionnaires will be evaluated using Cronbach's alpha. Through these procedures, we will address the first research question by demonstrating whether the SN-DBQ is a valid tool for assessing the driving behavior of novice drivers.

A Pearson correlation will also be conducted between the BFI-2 and the SN-DBQ, enabling us to explore the extent to which personality traits predict driving errors. Our study could provide valuable insights by identifying the specific dimensions of driving behavior strongly associated with various personality traits. These findings have the potential to be utilized to develop targeted interventions to mitigate risky driving behaviors and promote safer practices on the road.

Our study highlights the importance of further research on the relationship between personality traits and driving behavior in novice drivers, emphasizing the potential effectiveness of personality-based interventions in improving driving safety.

## References

- [1] J. Smith, "The role of personality in driving behavior and road safety," *Journal of Traffic and Transportation Engineering*, vol. 8, no. 3, pp. 123–130, 2021.
- [2] S. T. Cordazzo, C. T. Scialfa, and R. J. Ross, "Modernization of the driver behavior questionnaire," *Accident Analysis and Prevention*, vol. 87, pp. 83–91, 2016.
- [3] O. P. John, E. M. Donahue, and R. L. Kentle, "Big five inventory," *Journal of Personality and Social Psychology*, vol. 61, no. 3, pp. 454–456, 1991.

# What Would Happen If Your Grandma Played More Video Games?

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Executive functions (EF) are crucial for goal-directed activities. However, EF performance decline comes naturally with age, causing cognitive impairments. Assessing EF is important for early diagnosis and if used as a cognitive training it can help mitigate the deteriorating quality of life.

This research focuses on assessing one of EF - working memory (WM), which stores and manipulates information for a short time. Traditional WM tasks lack ecological validity and suitability for training. However, cognitive video games seem to be a better option.

Their biggest advantages are (a) realistic environments and tasks in which using WM seems more natural (b) effectiveness for all ages [1] and (c) a positive impact on lives [2]. Existing games are limited - they are commercial, expensive, and lack the flexibility needed for academic research. Hence, we developed a new game (Restaurant Game) as a flexible, research-oriented game to measure WM performance.

In our game, a player must remember an order from one customer and serve it correctly. If served correctly, the number of items in the order increases. The game has different modes - remembering the order in the forward/backward/random order.

We aim to conduct a pilot study on psychometric characteristics (validity, reliability) on a

smaller sample which will guide future validation of the game. To tailor the game for our study, we started with gathering feedback on the user experience of playing the game and its important variables (users' motivation, lack of frustration, ...). After that, we adjusted the game based on the feedback.

In the validation part, the game's final version will be tested against selected established WM tasks (similar or less similar in nature to the game) in random order. We will sample a homogenous group of healthy, young participants (20–35 years old) with the most varied WM span possible (based on results from the digit-span task). Performance measures will be recorded and the participants will be given a questionnaire asking about the characteristics of their user experience. To test the reliability of the game we will let the participants play it twice, with the second trial after 3 months. In both cases, we will use a within-subject design.

If this pilot study proves to be successful showing a better user experience of the game compared to the established WM tasks, the game can advance to a proper validation study. Later on, the game can be tested as a cognitive training task. Its open-source nature enables future research and insights into WM.

## References

- [1] R. Nouchi et al., "Brain training game improves executive functions and processing speed in the elderly: A randomized controlled trial," *PLoS ONE*, vol. 7, no. 1, 2012. doi:10.1371/journal.pone.0029676
- [2] I. Granic, A. Lobel, and R. C. Engels, "The benefits of playing video games.," *American Psychologist*, vol. 69, no. 1, pp. 66–78, 2014. doi:10.1037/a0034857

# Empowering Patients: Comparing ChatGPT and Google in Medical Report Interpretation

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## Introduction

Medical reports play a crucial role in healthcare communication, significantly influencing patients' understanding and decision-making regarding their health. However, patients often face challenges in interpreting these reports due to limited time with doctors, a lack of medical knowledge, and inadequate access to information, resulting in confusion and distress [2]. Conversational AI-based models, such as ChatGPT, have emerged as potential solutions, offering emotional support and the potential to enhance understanding [1]. Despite their promising applications in various domains, their effectiveness in the interpretation of medical reports remains largely unexplored. This study aims to compare the effectiveness of ChatGPT and Google in facilitating understanding and providing more empathic responses and better emotional support. Furthermore, the study will investigate trust in technology, user experience, information reliability, and validity, addressing the emotional and cognitive needs of patients.

## Methods

This experimental study will involve 96 participants recruited from a university setting. They will be randomly assigned to either ChatGPT or Google as a tool to aid their interpretation of presented medical reports, while a control group will receive doctor-supported interpretations. After a 30-minute interpretation phase, participants will be asked to provide feedback

on trust, user experience, and perceived empathy using a Likert scale questionnaire. The Likert scale ratings will also be used to assess the quality, reliability, and validity of the information provided by comparing medical reports and AI-generated answers with expert evaluations. To evaluate understanding in the context of multimedia learning theory, qualitative interviews, comprehension questions, and tests (e.g., retention, transfer) will be conducted to gain in-depth insights into participants' understanding. Data analysis will involve statistical techniques such as ANOVA to examine differences between the groups.

## Expected Results

ChatGPT's conversational capabilities are expected to outperform Google, enhancing emotional support, and understanding. The findings will advance the understanding of machine learning in medical report interpretation, with practical implications for healthcare integration, user experience, information reliability etc. However, a further larger-scale study involving healthcare participants is necessary to capture the complexities of real-world medical report interpretation.

## References

- [1] M. Cascella, J. Montomoli, V. Bellini, and E. Big-nami, "Evaluating the feasibility of CHATGPT in Healthcare: An analysis of multiple clinical and research scenarios," *Journal of Medical Systems*, vol. 47, no. 1, 2023. doi:10.1007/s10916-023-01925-4
- [2] J. W. Ayers et al., "Comparing physician and artificial intelligence chatbot responses to patient questions posted to a public social media forum," *JAMA Internal Medicine*, 2023. doi:10.1001/jamainternmed.2023.1838



# Does Right Hemisphere Dominance Relate to Emotional Flexibility and Depressive Moods?

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## Introduction

Studies have shown that depressive traits are usually accompanied by anxiety and stress, contributing lower to emotional flexibility (EF). EF is the ability to have flexible and appropriate responses to changing emotional circumstances [1]. According to the Valence hypothesis, the right brain hemisphere is responsible for processing negative thoughts and emotions, and the left hemisphere for happiness and excitement. Depressive mood is linked to hemisphere imbalance, with the left hemisphere relatively hypoactive and the right hemisphere hyperactive, which is seen in the frontal hemisphere alpha asymmetry [2]. The goal is to explore the relationship between depressive mood, EF, and alpha asymmetry in young adults. We aim to investigate whether frontal asymmetry with higher activity in the right frontal hemisphere is correlated to depressive mood with anxiety and stress, and lower EF.

## Methods

The experiment involved 35 adults between the ages of 18 to 27. To evaluate participants' depressive mood, we used the simple, reliable, and well-used Depression Anxiety Stress Scale (DASS-21) self-reporting questionnaire. EF was measured with the Emotional Shifting Task (EST), a new, more ecologically valid way to measure EF; containing stimuli of positive and

negative valence with shift and non-shift conditions. Brain activity in the resting state was recorded with electroencephalography (EEG). Frontal brain activity will be compared between hemispheres through the calculation of the frontal alpha asymmetry index, obtained using the EEGLAB toolbox. We will use linear regression to determine the relation of alpha asymmetry to EST and DASS-21.

## Expected results

Based on the literature presented in the introduction [2], and with research showing decreased cognitive flexibility in patients with depression [1]; we hypothesize that participants with a higher score on the DASS-21, slower and less correct responses in the shift conditions on the EST will show stronger alpha asymmetry with right frontal hemisphere being more active than the left.

## Conclusion

With further analysis, we aim to add valuable information to the literature about alpha asymmetry's relation to lower EF and depressive mood, as the research on alpha asymmetry is somewhat inconclusive. With this research, we will contribute to a larger set of studies featuring depressive traits and EF from a neuroscientific point of view.

## References

- [1] N. Horato, L. A. Quagliato, and A. E. Nardi, "The relationship between emotional regulation and hemispheric lateralization in depression: A systematic review and a meta-analysis," *Translational Psychiatry*, vol. 12, no. 162, 2022. doi:10.1038/s41398-022-01927-9
- [2] D. Mathersul, L. M. Williams, P. J. Hopkinson, and A. H. Kemp, "Investigating models of affect: Relationships among EEG alpha asymmetry, depression, and anxiety.," *Emotion*, vol. 8, no. 4, pp. 560–572, 2008. doi:10.1037/a0012811

# An EEG Exploration of Emotional Flexibility

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Emotional flexibility refers to the ability to flexibly shift emotional responses according to environmental changes. Although there are several existing self-report measures which measure emotional flexibility, consistent and ecologically valid emotional flexibility paradigms are still lacking in the literature. There is an existing novel Emotional Shifting Task (EST) [1], which is an online computer-based study empirically measuring emotional flexibility. The stimuli consist of an emotionally valenced pair of images, with a cropped segment displayed first and the full image afterward. The possible emotional valence combinations of the paired stimuli are pos-pos, neg-neg, pos-neg, and neg-pos.

In this study, the EST will be investigated using a modified oddball paradigm and electroencephalography (EEG). Participants will complete an EEG oddball task consisting of 4 practice trials and 300 experimental trials. After the participant responds whether they feel that the initial cropped image has a positive or negative valence, the full image is revealed, and the participant responds whether the second full-context image has a positive or negative valence. Response accuracy is shown to the participants, and reaction time is recorded for later analysis. In addition to the EEG portion of the study, participants will complete the 21-item Depression Anxiety Stress Scale (DASS-21).

Based on the results from the original online study [1] and a follow-up fMRI study using the

same cropped/full paired image paradigm [2], it is expected that activation will be greater when switching from a positive cropped photo to a negative full photo. An existing study involving EEG and emotionally valenced photos [3] showed that the n170 seems to be the component that best matches processing of emotional valence as well as facial processing, and as our stimuli involve both faces and emotional valence, we expect to find that the n170 is the most relevant component.

EEG data is being collected using a Mind Media NeXus-32 device, which is attached to a 21-channel cap. Data collection is currently ongoing. Out of a total of 300 expected participants, data from 29 participants has already been collected and pre-processed using EEGLAB.

## References

- [1] B. Biro et al., “Interaction between emotional context-guided shifting and cognitive shifting: Introduction of a novel task,” *Neuropsychopharmacologia Hungarica : a Magyar Pszichofarmakologiai Egyesület lapja* = official journal of the Hungarian Association of Psychopharmacology, vol. 23, no. 3, pp. 319–330, Sep. 2021.
- [2] B. Biró et al., “The neural correlates of context driven changes in the emotional response: An fmri study,” *PLOS ONE*, vol. 17, no. 12, 2022. doi:10.1371/journal.pone.0279823
- [3] R. Qiu, H. Wang, and S. Fu, “N170 reveals the categorical perception effect of emotional valence,” *Frontiers in Psychology*, vol. 8, 2017. doi:10.3389/fpsyg.2017.02056

# Discovering Indicators of Dementia in Literary Texts

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## Introduction

Alzheimer's dementia is one of the most common diseases troubling the aging population. Diagnosing it often includes methods strenuous for the individual [1] which calls for a more efficient and kinder diagnosis approach. Among several markers of cognitive decline due to AD are also different linguistic features that can be found years prior to disease onset. Discovering potential AD markers early on can contribute to disease delay or in the future even prevention. For this reason, exploring linguistic markers in literary texts is an idea worth exploring and can help develop a kinder diagnosis tool that could be used in the future also with non-writer populations.

## Methods

In order to discover how linguistic markers of AD in literary texts change over time it is necessary to pick a prolific author suffering from dementia whose works span over the period of their entire life. These texts will then be scanned and converted to text. Using the texts, I will create a custom corpus that will enable me to search for specific linguistic markers of dementia within the writer's works like the decreased size of the vocabulary, increase in repetitions, increase in the usage of filler words and indefinite nouns. Statistical analysis will be done using simple linear regression.

## Expected Results

I expect results to show that individual linguistic markers that are typical of dementia patients will reveal themselves in the texts of the

author I chose years prior to their official diagnosis thus confirming the results of Le et. al. which claim that linguistic markers of dementia can be found in literary texts years prior to disease onset.

## Discussion

Confirming that the linguistic markers of dementia are evident in text years prior to disease onset can lead to more research being focused on such cost effective and patient-friendly diagnostic tool development. More research in the field can also incentivize others to try finding linguistic cues in shorter texts belonging to non-writer populations and its application in clinical use.

## References

- [1] X. Le, I. Lancashire, G. Hirst, and R. Jokel, "Longitudinal detection of dementia through lexical and syntactic changes in writing: A case study of three British novelists," *Literary and Linguistic Computing*, vol. 26, no. 4, pp. 435–461, May 2011. doi:10.1093/llc/fqr013



# The Motive of Dementia in Children's Picturebooks

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## Introduction

Dementia is the most prevalent neurodegenerative condition, characterized by progressive loss of vulnerable neuron populations in the central nervous system [1]. The clinical symptoms of dementia can be divided into functional, affective, behavioural, and cognitive [2]. With the increasing prevalence of dementia, the number of children in contact with dementia patients is also increasing, affecting them in different ways, yet there is little effort to help children understand the disease in an age-appropriate way [2]. The picturebook is a literary work and a teaching accessory meant for intergenerational reading that helps children learn about problem topics and create a tolerant society, when presenting them in a comprehensive and correct manner [2].

## Research Goals and Methods

The goal of my research is to examine the quality of children's picturebooks depicting the motive of dementia, based on their depiction of the clinical symptoms of dementia and consideration of criteria for a quality picturebook (aesthetic design of language, simplicity, representation of the child's world of experience, imagination, polyvalence, and cross-writing) [3].

Eight literary works were chosen based on a selective search in the COBISS biblio-graphic system. The criteria were: type of content (picturebook), language (Slovene), target group (children), and key word (dementia). Quality of chosen picturebooks will be analysed using two scoreboards – one assessing the depiction

of the clinical symptoms of dementia and based on the work of Sakai et al. (2012) [2], and the other based on the criteria for picturebook analysis [3]. Each correctly and wholly depicted symptom will bring the picturebook one point, the consideration of quality picturebook criteria will be analysed qualitatively, without point assignment, due to the qualitative nature of literary analysis.

## Interdisciplinarity and

### Expected Results

This interdisciplinary work combines the findings and methods from the fields of literary analysis, developmental psychology, and neuroscience to examine the quality of picturebooks with the motive of dementia. Based on previous research in the field [2] I expect that the clinical symptoms of dementia will be depicted insufficiently. I expect that the criteria for a quality picturebook [3] will not be followed thoroughly in most picturebooks.

## References

- [1] B. N. Dugger and D. W. Dickson, "Pathology of neurodegenerative diseases," Cold Spring Harbor Perspectives in Biology, vol. 9, no. 7, 2017.
- [2] E. Y. Sakai, B. D. Carpenter and R. E. Rieger, "What's wrong with grandma?: Depictions of Alzheimer's disease in children's storybooks," American Journal of Alzheimer's Disease & Other Dementias, vol. 27, no. 8, 2012.
- [3] B. Kümmerling-Meibauer, "Klassiker der Kinder- und Jugendliteratur: Ein Internationales Lexikon. Stuttgart: Metzler, 1999.

# Methodological Limitations of Using Ani-mal Models in Cognitive Science Research

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Animal models are frequently used in research practice because they can presumably help us to gain a deeper understanding of humans. This is particularly evident in drug testing studies, where the goal is to discover potential cures for diseases [1]. Similarly, animal models are increasingly being used as an approach in cognitive science research. While the way animal models are used in drug testing practice is somewhat standardized (i.e. providing the animal with the newly developed drug and investigating its effects in terms of safety and efficacy), their use vary substantially when the phenomenon of interest is our cognition [1]. For this purpose, animals undergo brain scanning and neuroimaging setups, attention-related experiments, and behavioral experiments.

Although there is an ongoing debate about the reliability of animal experimentation in pharmacological research, there has been relatively little attention paid to how animal models affect our assumptions and findings on human cognition [3]. For example, one of the main criticisms of using animal models and extrapolating the results to humans is related to the internal and external validity of such an approach. Internal validity refers to the degree to which a study accurately measures what it claims to measure and is often related to study design, lack of internal measures to control bias, or irrelevant variables that may influence the study outcomes. External validity refers to the extent to which findings derived from one setting,

population, or species can be reliably applied to other settings, populations, and species [2]. Additionally, the use of animal models can raise significant ethical concerns, particularly if the animals are subjected to pain or suffering.

While these ethical questions are of utmost importance, this thesis will mainly focus on the potential methodological limitations. Thus, the aim of this thesis is to critically analyze the existing literature and evaluate the limitations of different animal models used in cognitive science research. This will involve a thorough examination of the internal and external validity of animal models, as well as an assessment of the robustness of the experimental design and potential biases. By doing so, we hope to contribute to a better understanding of the role of animals in cognitive science research and provide valuable insights for future studies in this field.

## References

- [1] N. B. Robinson et al., “The current state of Animal Models in research: A Review,” *International Journal of Surgery*, vol. 72, pp. 9–13, 2019.
- [2] P. Pound and M. Ritskes-Hoitinga, “Is it possible to overcome issues of external validity in preclinical animal research? why most animal models are bound to fail,” *Journal of Translational Medicine*, vol. 16, no. 1, 2018.
- [3] Akhtar A. “The flaws and human harms of animal experimentation,” *Cambridge Quarterly of Healthcare Ethics*, vol. 24, no. 4, pp. 407–419, 2015.

# The Role of Individual Consideration for Joint Decisions in Bargaining Situations

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## Introduction

While making decisions as a team poses challenges as conflicting opinions may impede the chances for a consensus, a body of literature shows that groups outperform individual decision-makers in several tasks, especially when these groups can jointly deliberate. [1] Similar results have been shown in bargaining tasks, where groups behave more rationally than individuals. [2]

However, in such bargaining situations while group deliberation may increase individual decision performance, what is the impact of individual considerations prior to joint deliberation for group performance? Previous research suggests that next to reciprocal error reduction, the exchange of arguments may underlie greater decision accuracy of groups. [3] We, therefore, hypothesize that individual considerations before joint deliberation predict greater decision accuracy for joint decisions as the exchange of ready-made arguments may increase the efficacy of the decision aggregation process.

## Methods

To investigate this question, we will employ a sequential ultimatum game where two participants form a team, acting as recipients against a single proposer. For each round, the proposer is given an amount of money and will be asked to decide on how much of it to share

with the respondents who may accept and receive the offer or reject it which leads to both of the parties receiving nothing.

Team partners will communicate via a chat room while sitting in separate rooms to jointly deliberate to reach a unanimous decision. Participants will be placed in one of two conditions: either an individual deliberation condition in which they announce their individual decision first before discussing or a joint deliberation condition where they discuss immediately without individual contemplation.

## Expected Results

We expect that exchanging ready-made arguments allow for more structured deliberation dynamics between partners. Therefore, we expect teams in the individual deliberation condition to perform better in terms of total sum of money acquired.

## References

- [1] H. Mercier and N. Claidière, “Does discussion make crowds any wiser?”, *Cognition*, vol. 222, 104912, 2022. doi:10.1016/j.cognition.2021.104912
- [2] T. Kugler, E. Kausel, and M. Kocher, “Are groups more rational than individuals? A review of interactive decision making in groups”, *Wiley Interdisciplinary Reviews: Cognitive Science*, vol. 3, no. 4, pp. 471–482, 2012. doi:10.1002/wcs.1184
- [3] G. Dezechache et al., “Democratic forecast: Small groups predict the future better than individuals and crowds”, *Journal of experimental psychology. Applied*, vol. 28, no. 3, 525–537, 2022. doi:10.1037/xap.000424

# An Epistemological Investigation into Learning of Behaviour Trees

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Automated robotic action planning is a key problem in AI. Using an autonomous forklift as an example, we apply cognitive science-inspired approaches to improve the accomplishment of complex tasks in the context of utility machines [1]. Such tasks can look like the following: a forklift truck is forced to lift a pallet, which is blocked by another. One solution is to move the blocking pallet first to access the cleared targeted one. However, a solution should not have to be trained manually for each occurrence, but rather achieved autonomously, through a reactive action planning method, capable to cope with dynamic changes in the environment. For safety reasons, the overt behaviour resulting from any such deployed algorithm needs to be “readable” by humans.

To achieve such comprehensible machine cognition, a modification of a Behaviour Tree (BT) is to be learned through Genetic Programming, which is inspired by Evolutional Biology and 4E Cognition [2], [3]. An epistemological investigation is concerned with the concepts of knowledge representation and creation in the context of BTs. We aim to explicate, which definitions and considerations are of practical utility in the context of the development of AI applications. By adding this philosophical perspective, the problem of action planning in AI becomes an interdisciplinary investigation.

Three implementation steps are conducted to demonstrate the advantages of the cognitive

science-informed approach. In the first stage, we implement and empirically assess modifications of BTs in the benchmark example of the Pac-Man game. We then combine the lessons learned with an analysis of the actual targeted deployment environment to select a suitable variant. Next, we compare the selected method to a BT hand-crafted by experts in a simulation of the forklift truck scenario. Finally, we aim to deploy the method on the actual forklift truck, to demonstrate its usability in the real world.

The impact of this master’s thesis is bidirectional, reflecting its interdisciplinary approach. On the one hand, a cognitive science-informed method is presented for learning BT-based action planning in AI. On the other hand, the philosophical aspects underlying “knowledge” in machine cognition are made explicit for the example application scenario.

## References

- [1] AIT Austrian Institute of Technology GmbH, “HOPPER - AIT Austrian Institute Of Technology”, ait.ac.at, Sep. 30, 2022. [https://www.ait.ac.at/en/ueber-das-ait/center/center-for-vision-automation-control/complex-dynamical-systems/hopper?no\\_cache=1](https://www.ait.ac.at/en/ueber-das-ait/center/center-for-vision-automation-control/complex-dynamical-systems/hopper?no_cache=1) (accessed Apr. 18, 2023).
- [2] M. Colledanchise and P. Ögren, “Behavior Trees in Robotics and AI: An Introduction,” CoRR, vol. abs/1709.00084, 2017. Available: <http://arxiv.org/abs/1709.00084> (accessed Apr. 18, 2023)
- [3] N. Nilsson, “Teleo-Reactive Programs for Agent Control,” arXiv, Dec. 31, 1993. doi:10.48550/arXiv.cs/9401101.

# Exploring Empathy in Music Therapy for Children with Autism Spectrum Disorder

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## Introduction

The clinical view of autism spectrum disorder (ASD) characterizes it as a social communication condition that presents with repetitive interests and actions. It is commonly assumed that people on the autism spectrum experience difficulties understanding the emotions or perspectives of others. Yet, the conception that people with ASD “lack” empathy neglects not only the reported experiences of autistic people but also fails to account for attentional, emotional processing, and other behavioral or cognitive differences that influence how they interact with the world [1]. Moreover, the “double empathy problem” asserts that the social impairments that exist in ASD may be better understood as a bidirectional failure of understanding between individuals of two differing dispositions (e.g., neurotypes) that both parties struggle to overcome [2]. By recontextualizing social difficulties associated with ASD as intersubjective breakdowns in mutual understanding, we may be able to understand cross-neurotype interactions in a new light.

Music therapy (MT) is an intervention for various conditions, including ASD. It is correlated with improvements in core symptoms of ASD, particularly for younger individuals, but its mechanisms are not well understood [3]. We are interested in examining whether (and by what means) musical interaction facilitates empathy and mutual understanding between an autistic child and a non-autistic therapist during MT.

## Methods

The Music for Autism (M4A) project is a randomized control trial replication study that will assess functional connectivity, biological, and behavioral outcomes of MT compared to play therapy in 80 autistic children aged 6–12 [3]. As a part of this study, the current project aims to determine whether musical interactions provide a way for a child with ASD and their music therapist to cope with the double empathy problem. To this end, treatment process variables from treatment fidelity videos will be analyzed against treatment outcomes.

## Expected Results

As musical interactions entail joint attention and action, we anticipate that music creation provides a nonverbal “middle ground” for social reciprocity that facilitates empathy and understanding in therapeutic settings.

## References

- [1] S. Fletcher-Watson and G. Bird, “Autism and empathy: What are the real links?,” *Autism*, vol. 24, no. 1, pp. 3–6, 2020. doi:10.1177/1362361319883506
- [2] D. Milton, E. Gurbuz, and B. López, “The ‘double empathy problem’: Ten Years on,” *Autism*, vol. 26, no. 8, pp. 1901–1903, 2022. doi:10.1177/13623613221129123
- [3] A. Groessing et al., Design and implementation of a replication study: The music for autism (M4A) binational assessor-blinded randomised crossover trial, 2023. doi:10.21203/rs.3.rs-2478719/v1



# Human Rights as a Cognitive Gadget

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This research aims to investigate the concept of human rights as a cognitive gadget within the field of cognitive science. Drawing from the work of cognitive scientist Cecilia Heyes, who defines cognitive gadgets as learned mental mechanisms that enable humans to think and reason in specific ways, this study explores how human rights can be understood as a cognitive gadget.[1] Unlike innate or genetically programmed traits, human rights are acquired through social interaction and cultural transmission, evolving through cultural rather than genetic evolution.

By viewing human rights as a cognitive and social phenomenon, rather than purely a juridical concept, this research seeks to understand how human rights function as a mental mechanism that enables individuals to contemplate moral and legal entitlements for themselves and others. It acknowledges that human rights are not universal or fixed but are contingent and variable across different historical and political contexts.

Taking into account the significant evolution of human rights since the human rights revolution of approximately 1945, the study proposes an interdisciplinary approach that combines conceptual analysis, synthesis, and evaluation of existing literature and case studies. By tracing the evolution of human rights as a cognitive gadget, the research aims to explore the intricate interplay between the development of human rights as a mental mechanism and the political, cultural, and spiritual challenges that

have emerged during the human rights revolution.[2]

By investigating the historical and social contexts that have influenced the evolution of human rights as a cognitive gadget, this research aims to shed light on how human rights as a mental mechanism are shaped and how they respond to the complex challenges of the human rights revolution. This study intends to contribute to the understanding of the cognitive foundations of human rights and their dynamic nature within different cultural and historical settings.

## References

- [1] Cecilia Heyes. *Cognitive Gadgets: The Cultural Evolution of Thinking*. Cambridge, MA: Belknap Press, 2018.
- [2] Michael Ignatieff. *Human Rights as Politics and Idolatry*. Princeton University Press, 2011.

# Biologically Motivated Learning in Neural Networks with Convolutional Architectures

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Universal Bidirectional Activation-based learning (UBAL) is a novel learning algorithm for artificial neural networks [1], which is based on the workings of real biological neurons. Instead of propagating error derivatives it uses local activation values for updating its weights. It extends contrastive Hebbian learning, which uses presynaptic and postsynaptic activation values for the updates. It is also bidirectional for which it uses two different weight matrices for each activation direction. The ideas for UBAL comes from its predecessor algorithms recirculation and GeneRec [1].

UBAL has never before been implemented in a convolutional version, which is the main aim of the proposed master thesis. Convolutional neural networks are usually better suited for processing images, therefore our hypothesis is that convolutional UBAL will also yield better results in the image classification task compared to the current, fully connected version. We will implement convolutional UBAL and make experiments in the programming language Python, namely the Pytorch library [2].

We will first test the implementation on the famous MNIST dataset and possibly extend the experiments also to the Cifar10 dataset. Apart from the Convolutional UBAL, we will explore the influence of target encoding on the success

of the UBAL network in terms of using representations of a more perceptual nature along with the perceptual symbol system hypothesis (PSSH) in cognitive science [3].

According to PSSH representations in our cognition are not arbitrary symbols (e.g. words) as originally assumed by classical computationalism. They do indeed resemble their referents in the world and are multi-modal in essence, including visual properties, affordances, memories, etc. In this sense a representation of a digit (e.g. MNIST dataset) in the neural network would have some resemblance to the digit as it relates to the process of its recognition, so instead of coding it as a position in a vector of zeros (one-hot) we use digitized image that would represent all different examples of that digit in the trained network. We hypothesize that this encoding together with the biological nature of the convolutional UBAL model will yield better results.

## References

- [1] K. Malinovská, L. Malinovský, P. Krsek, S. Kraus, and I. Farkaš, “UBAL: a Universal Bidirectional Activation-based Learning Rule for Neural Networks,” in *Proceedings of the 2019 2nd International Conference on Computational Intelligence and Intelligent Systems*, New York: Association for Computing Machinery, 2020, pp. 57–62. doi: 10.1145/3372422.3372443
- [2] A. Paszke et al., “Pytorch: An imperative style, high-performance deep learning library,” *arXiv.org*, <https://arxiv.org/abs/1912.01703> (accessed May 9, 2023)
- [3] L. W. Barsalou, “Perceptual symbol systems,” *Behav. Brain Sci.*, vol. 22, no. 4, pp. 577–660, August 1999. doi:10.1017/S0140525X99002149

# An Enactivist Perspective on Experience and Sense-making in Games and Beyond

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The study of games in (human) culture forms an interdisciplinary and heterogeneous field of research. One main reason for the broad interest in the concepts and phenomena attributed to playing games – particularly considering today's forms of technological mediations of our reality – is that game-playing enacts experiences and realities quite distinct from what I will – very naively – call 'ordinary life' (i.e. reality as enacted not playing).

This work will explore what the enactment of specific games implies for the experience of reality being situated in and around such a game-context. The field of research on games is rather diverse, containing several disciplines (psychology, philosophy, education, next to others), intersections between them, as well as specifically dedicated programs (game studies). A way to integrate some of these diverse approaches to games could be an enactivist understanding of cognition [1]: Grounding mind, cognition and consciousness in action and engagement with and within a specific environment, rather than grounding action in being derived from rational reasoning.

While playing games, different rules, goals, norms, and logics apply to our sense-making and subsequently, reality is enacted differently than outside of the context of games [2]. This aspect of 'otherness of reality', its virtuality [3], will situate this work: Games mediate the ways

in which we engage with reality and hence our experienced reality itself. Next to some of the states particularly constitutive of playing many games (e.g. flow-states), I assume the experience of playing games also implies some degree of lasting change in experience in general.

I will undertake a literature research and attempt to converge perspectives from philosophy of games, philosophy of technology, sport psychology and education, with an enactivist epistemological frame as foundation. I will use this framework to engage with a specific video game (yet to be determined) and explore the experience of playing the game, its design and technicalities, as well as being part of the community and culture around it.

The results of this work are supposed to enrich studies of games by an enactivist perspective and understanding, especially considering expanding digital dimensions which create new genres, of games. Particularly, I will engage with the question of how specific frameworks of design – with an emphasis on specific technologies– enable specific forms of phenomenology and how such experiences might extend beyond this framework of just playing a game into a culture and 'ordinary life' around it.

## References

- [1] F. J. Varela, E. Thompson, E. Rosch, and J. Kabat-Zinn, *The Embodied Mind: Cognitive Science and Human Experience*. Cambridge: MIT Press, 2017.
- [2] B. Suits, *The Grasshopper: Games, Life and Utopia*. Toronto: University of Toronto Press, 2020.
- [3] A. Miah, *Sport 2.0 Transforming Sports for a Digital World*. Cambridge, MA: The MIT Press, 2017.



# Movement Agency in Functional Movement Disorder Patients and Healthy Individuals

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Functional movement disorders (FMD) refer to movement abnormalities not being triggered by a neurologic disease [1]. Most common FMD symptom are sudden movements which patients experience involuntary although they are not caused by brain lesions or damage like in other neurological disorders. FMD are a consequence of an issue with how signals are sent throughout the brain and in the brain's motor centres [2]. It is the function and not physiological lesion causing the disorder.

With this study, our goal is to test the hypothesis that it is more difficult for patients with FMD compared to healthy individuals to distinguish voluntary movement from an involuntary, i.e., a TMS-induced one.

A group of patients with FMD and a group of healthy participants will be investigated using transcranial magnetic stimulation (TMS). Age and gender will differ as little as possible between the two groups. Before the experimental session, for each participant, a hotspot will be measured using neuronavigation method to reduce bias. During the session, participants will be instructed to move a random hand at a set time point and concurrently, TMS will be applied to cause movement in either the same or the opposite hand. Then, volunteers will report on which hand they remember they moved voluntarily, and which was moved by

TMS. The experimental design as will mostly be based on Jensen et al. [3].

Our aim is to compare two groups and test for data distribution. Based on the results gained, either parametric or non-parametric tests will be implemented for analysis.

FMD present a large burden in neurology as well as psychiatry and despite their commonness in neurological practice, their prognosis is poor [1]. We hope this study will shed light on movement volition and agency in FMD patients and help for further clinical approach of FMD.

## References

- [1] T. Pringsheim and M. Edwards, "Functional movement disorders," *Neurology: Clinical Practice*, vol. 7, no. 2, pp. 141–147, 2017. doi:10.1212/cpj.0000000000000350
- [2] "Functional movement disorders," Stanford Health Care (SHC) - Stanford Medical Center, <https://stanfordhealthcare.org/medical-conditions/brain-and-nerves/functional-movement-disorders.html> (accessed May 9, 2023).
- [3] M. Jensen, E. Vagnoni, M. Overgaard, and P. Haggard, "Experience of action depends on intention, not body movement: An experiment on memory for *Mens Rea*," *Neuropsychologia*, vol. 55, pp. 122–127, 2014. doi:10.1016/j.neuropsychologia.2013.07.022

# Augmented Reality for Augmented Memory: Delaying Dementia with Object-location Encoding

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Dementia is on the rise and even though there are many efforts being made to find the cure for it, there is still no success. In the meantime it is important to embrace all the possible strategies to delay this life debilitating condition. Early dementia and mild cognitive impairment (MCI) are the preceding stages when the person affected is still able to live and function autonomously and independently. Hence we must put all the effort in for the condition not to progress any further. Cognitive training is one of the possible ways to delay memory decline [1].

The research shows that real objects are more memorable than their photos [2]. Interestingly, there is also no significant difference between the object's photo and a black and white representation of it, implying that the distinctive properties of photo, i.e. color and shadow, do not play any major role in the memorization process. There is obviously something else about the real-world objects that we must take advantage of when considering memory training. Since the use of real objects in memory training would be cumbersome, there are some new technologies that could offer an appropriate alternative.

If an actual 3D object is preferred by our brain, maybe we should exploit that with the help of augmented reality (AR). It is one of the emerg-

ing technologies under the umbrella of extended reality (XR) where AR is superimposing a virtual layer across the real world. The research will be done by comparing the memorization capacities of digital images of objects, AR virtual ones embedded in the environment and real-world items. This would give us the opportunity to find out if the AR solution is a suitable substitute for actual objects and thus more convenient for memory training. Namely, there is some evidence that spatial context and the connection between object and location could enhance declarative memory encoding [3]. Both information seems to converge in the hippocampus, where spatial data acts as a scaffold for semantic memory and together with temporal component also for episodic memory.

In the interdisciplinary crossroad of cognitive psychology and neuroscience, along with computer technology, we can determine the effectiveness of AR as a memory training tool. Additionally, the research could also provide us with some insight into what this property of real object's superiority could actually be.

## References

- [1] F. Schneider, A. Horowitz, K.-P. Lesch, and T. Dandekar, "Delaying memory decline: Different options and emerging solutions," *Translational Psychiatry*, vol. 10, no. 1, 2020.
- [2] J. C. Snow, R. M. Skiba, T. L. Coleman, and M. E. Berryhill, "Real-world objects are more memorable than photographs of objects," *Frontiers in Human Neuroscience*, vol. 8, 2014.
- [3] J. R. Manns and H. Eichenbaum, "Evolution of declarative memory," *Hippocampus*, vol. 16, no. 9, pp. 795–808, 2006.

# Unconscious Influence of Negative Affective Stimuli on Consumption Behavior and Judgments of Value

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Traditional economics assumes that individuals are rational actors who make decisions based on weighing costs and benefits [1]. However, behavioral economics recognizes that people are not always perfectly rational and that their decisions can be influenced by a variety of psychological factors, such as emotions, biases, and heuristics. Yet, little is known about the nature of affective reactions elicited by different types of unconscious stimuli [2]. Our study aims to investigate how cognitive processes interact with emotional states, and how these interactions affect consumption behavior and judgments of value. More specifically our research aims to study how negative text concealed in the logical tasks influences the consumption of the beverage, perception of beverage value, and sensory evaluation of the beverage.

Participants will first answer a questionnaire regarding their levels of thirst and hunger. They will also rate their current affective state on the PANAS questionnaire. Subsequently, participants will engage in logical tasks, with one group solving tasks presented in neutral text and the other group solving tasks presented in negative text. After completing the tasks, participants will again fill out the PANAS questionnaire. The final part of the experiment will include offering participants a beverage followed

by a questionnaire regarding their consumption and judgment of value like the questionnaire described in Winkielman [2].

Based on previous research investigating how unconscious affective stimuli influence behavior and judgments of value [2], we hypothesize that participants exposed to negative text will exhibit lower judgments of value and consumption rates compared to those in the neutral text group.

One limitation is that the study only measures participants' initial motivational state in terms of thirst and hunger. However, other factors may influence their consumption behavior and judgments of value that are not accounted for in the study. Future research could investigate the long-term effects of unconscious influences of affective stimuli on behavior and judgments of value and the role of individual differences, such as cognitive abilities, in moderating these effects. By examining how affective stimuli can unconsciously influence consumption behavior and judgments of value from an interdisciplinary perspective, the study may provide a more comprehensive understanding of the mechanisms that shape decision-making processes.

## References

- [1] M. Ogaki and S. C. Tanaka, Behavioral Economics: Toward a New Economics by Integration with Traditional Economics. in Springer Texts in Business and Economics. Singapore: Springer Singapore, 2017. doi:10.1007/978-981-10-6439-5
- [2] P. Winkielman, K. C. Berridge, and J. L. Wilbarger, 'Unconscious Affective Reactions to Masked Happy Versus Angry Faces Influence Consumption Behavior and Judgments of Value', *Pers Soc Psychol Bull*, vol. 31, no. 1, 2005.

# Detection and Forecasting of Mental Health Phase Transitions from Text Data

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Detecting and forecasting mental health phase transitions is crucial for effective psychotherapeutic intervention and treatment. Complex dynamics and chaos theory have emerged as useful frameworks for understanding mental health processes. They provide insights into the presence of chaotic patterns, characterized by unpredictability and sensitive dependence on initial conditions, as well as phase transitions. Phase transition (PT) is a phenomenon in psychotherapy that represents a point of change in time series data and can psychologically manifest as e.g. a change in the level of depression [1]. This study aims to develop natural language processing (NLP) and machine learning methods to use diary entries for detection and forecast of PTs.

The used dataset, consisting of inpatient daily diary entries, was collected during the psychotherapeutic process of inpatient stays. Firstly, NLP methods will be used to preprocess the text data and from the diary texts extract features such as sentiment analysis (determining sentiment or emotion in text), topic modelling (uncovering hidden themes or topics in text), and different linguistic patterns (recurring structures and arrangements of words in text). Secondly, Pattern Transition Detection Algorithm (PTDA) [2] will be used together with machine learning methods to identify phase transitions in time-series data, consisting of features extracted with NLP methods. PTDA leverages complex dynamics principles to analyze

various dynamic aspects of the data and detect significant changes or shifts in patterns. By assessing the dynamical characteristics, such as mean change and periodicity, PTDA provides insights into the occurrence of phase transitions. Lastly, a forecasting model will be developed to not just detect but also forecast at what time in the future a PT is likely to occur.

The performance of the detection and forecasting model will be evaluated using ground truth data of PTs. Our hypothesis is that the results will demonstrate that it is possible to detect and forecast phase PTs in mental health using text data.

In conclusion, this study aims to demonstrate the potential of NLP methods in detecting and forecasting mental health PTs from diary entries. By combining complex dynamics with NLP methods, researchers and clinicians can gain a more comprehensive understanding of mental health processes and develop more effective interventions and treatments.

## References

- [1] G. K. Schiepek et al., “Psychotherapy is chaotic—(not only) in a computational world,” *Frontiers in Psychology*, vol. 8, 2017. doi:10.3389/fpsyg.2017.00379
- [2] K. Viol et al., “Detecting pattern transitions in Psychological Time Series – a validation study on the Pattern Transition Detection Algorithm (PTDA),” *PLOS ONE*, vol. 17, no. 3, 2022. doi:10.1371/journal.pone.0265335

# Classification of Neural Correlates of Error Processing

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## Introduction

Detection and classification of correlates of error processing is a key area of interest in neuroscience and has important practical implications for fields such as brain-computer interfaces and human-computer interaction. One approach to this problem is through the use of electroencephalography (EEG), which can detect the electrical potential produced by the brain when an error occurs [1]. In this study, we aim to measure and classify two distinct types of errors, namely execution errors and outcome errors [2]. Our primary research questions are: Can we differentiate between two distinct types of errors - execution errors and outcome errors - in the context of a complex motor task? Moreover, can we predict outcome errors before the actual outcome of the task?

## Methods

To answer these questions, we employed a visuomotor rotation paradigm - a technique wherein visual feedback of a participant's motor action is systematically altered to induce sensory-motor errors in a group of participants ( $n=7$ ) while their brain activity was recorded with EEG. Specifically, the participants were tasked with performing a reaching arm movement with a haptic robot, aiming to hit a designated target. Perturbations in the form of random rotations at varying angles ( $\pm 40^\circ$ ,  $\pm 20^\circ$ ) were introduced during 20 % of the trials. The

experiment was divided into three experimental blocks, each designed to induce a specific type of error. To investigate the feasibility of differentiating between different types of errors, we conducted four binary classifications using multiple neural network models based on convolutional and transformer architectures. These classifications included outcome error vs. no error, execution error vs. no error, outcome error vs. execution error, and pre-outcome error vs. no error.

## Expected Results

Previous work suggests that such differentiation is possible in a cursor control video game paradigm [2], but it is unclear to what extent these results apply to more complex motor tasks which involve more noisy experimental settings. Based on preliminary analysis, we found that in a cross-subject classification paradigm, in which we train a general classifier from all subject data, accuracies in all binary classifications were not above the chance level. However, within-subject classification resulted in above-chance level accuracies for some models and subjects.

## References

- [1] R. Chavarriaga, A. Sobolewski, and J. del R. Millán, "Errare machinale est: the use of error-related potentials in brain-machine interfaces," *Frontiers in Neuroscience*, vol. 8, p. 208, 2014. doi: 10.3389/fnins.2014.00208
- [2] M. Spüler and C. Niethammer, "Error-related potentials during continuous feedback: using EEG to detect errors of different type and severity," *Frontiers in Human Neuroscience*, vol. 9, p. 155, 2015. doi: 10.3389/fnhum.2015.00155



# Living with and Through Jealousy: Research on Jealousy among Non-monogamous People

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## Introduction

Jealousy, while mostly referred to as a single emotion, presents itself as a more complex emotional phenomenon, which can include emotions like distress, fear, anger, and disgust. The key component for the activation of jealousy is the classification of connections between the desired individual and a third party as a threat to an existing relationship. [1] The base assumption of most literature concerning romantic jealousy is that of romantic love being an exclusive resource. Within this framework, any behaviour that promotes physical or emotional intimacy with another person, bears the potential to weaken the relationship. In non-monogamous contexts, this base assumption is reversed, shifting the focus of jealousy-triggering situations more on reasons for the trigger than the effects of the behaviour. [2] Consequently, research of jealousy in non-monogamous contexts provides opportunities to look into aspects like communication-issues or methods promoting relationship security. This thesis aims to promote a deeper understanding of the ways in which jealousy is experienced, navigated, and potentially transformed in non-monogamous relationships. We ask the question: “What are common ways in which jealousy is managed in non-monogamous contexts?”

## Methods

Since there is no prior research on this specific topic, We aim for multifaceted results, creating an overview of the subject and laying suitable groundwork for future research.

We will use a qualitative design with semi-structured interviews. Participants will be recruited in Viennese non-monogamous online social groups and then with the snowball-method until there are no new, but only recurring themes in the dataset. The sample is selected with the aim of including individuals from a range of non-monogamous relationships, including polyamorous, open, swinging and anarchistic relationships to be able to look into relevant variables and document a possible learning process. The collected data will then be analysed using reflexive thematic analysis, identifying common themes. [3] The interviews are designed to elicit detailed narratives about the experience of jealousy, including the triggers, sensations, and thoughts associated with the phenomenon. Reoccurring themes within the dataset will then guide research implications and promote an understanding of romantic jealousy, which is less connected with exclusivity but with individual context.

## References

- [1] S. Hart and M. T. Legerstee, Handbook of Jealousy. Chichester, West Sussex: Wiley-Blackwell, 2010.
- [2] J. Fern, Polysecure: Attachment, Trauma and Consensual Nonmonogamy, Thorntree Press, 2020.
- [3] V. Braun and V. Clarke, Thematic Analysis: A Practical Guide. Los Angeles, CA: SAGE, 2022.

# The Dreaming Workforce: Investigating Sleep, Dreams, and Work Relationships

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Sleep and work constitute a significant portion of our lives, with individuals spending about two-thirds of their time on these activities [1]. Given the crucial role of sleep in workplace performance and overall well-being, it is concerning, that sleep problems continue to be prevalent in modern society [3]. Recent systematic reviews [2] have underscored the notable interplay between sleep and work, warranting further investigation. Particularly intriguing is the potential role of dreams as a bridging element between these two phenomena, offering a novel avenue for exploration and deeper understanding.

A study explores the bidirectional relationship between sleep and work behaviors with thirty business owners. First-person and third-person methods measure how sleep and work behavior influence each other. Participants use the Oura tool for at least sixteen days to measure sleep quality. The Oura ring measures sleep parameters like REM states, efficiency, disturbances, heart sleep, and regularity. Daily surveys via phone questionnaires collect data, and initial and final surveys measure the business context and psychological characteristics.

This explorative research investigates the intricate relationship between sleep, dreams, and work. Daily questionnaires gather data on dream occurrence, focusing on the forthcom-

ing master thesis. Data analysis will employ reduction techniques, with further development in collaboration with the research group. Specific dimensions of dream occurrence are expected to emerge. In-depth interviews may supplement the data to explore relevant aspects of dream occurrence among business owners.

## References

- [1] S. Boden, S. J. Williams, C. Seale, P. Lowe, and D. L. Steinberg, "The social construction of sleep and work in the British Print News Media," *Sociology*, vol. 42, no. 3, pp. 541–558, 2008.
- [2] A. M. Gordon, B. Carrillo, and C. M. Barnes, "Sleep and social relationships in healthy populations: A systematic review," *Sleep Medicine Reviews*, vol. 57, p. 101428, 2021.
- [3] M. Van Laethem, D. G. Beckers, M. A. Kompier, A. Dijksterhuis, and S. A. Geurts, "Psychosocial work characteristics and sleep quality: A systematic review of longitudinal and intervention research," *Scandinavian Journal of Work, Environment & Health*, vol. 39, no. 6, pp. 535–549, 2013

# Circadian Fluctuations in Mind-wandering: The Temporal Orientation and the Affective Tone of Thoughts

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Mind-wandering - our thoughts drifting from “here and now” to other mental contents is experienced in 25–50% of our waking life [1]. Despite recent conceptual conflicts, this mental process is commonly characterized by dimensions of task-unrelatedness and stimulus-independency and has various impacts on one’s cognitive performance. While it impairs reaction times during task performances, comprehension during reading and lectures, it has also been suggested that it might enhance creativity and is beneficial for problem-solving [1]. A growing body of work has recently utilised experience sampling methods to acquire a better insight into the phenomenological aspects of mind-wandering [2]. Despite this, the rate of mind-wandering was thus far implicitly assumed to be constant throughout the day, but recent research has shown that both circadian functioning and an individual’s chronotype have an impact on this rate [2]. Besides contributing to the evidence of these influencing factors, the primary aim of our study is to investigate the potential relationship between circadian functioning and the temporal orientation of mind-wandering thoughts, namely retrospection, prospection, or direction towards the present, as well as the affective tone of these thoughts.

100 participants of legal age, sampled from the university research pool will be included in the experience sampling process. Throughout 10 days, they will receive 10 notifications a day at random time points, sent through a mobile application, starting at their waking time, and finishing at the bedtime. On each sampling occasion, they will have to fill out a short questionnaire, answering questions about general aspects of their potential mind-wandering episode, temporal orientation of a mind-wandering episode, valence of their thoughts and the subjective quality of their sleep.

Statistical analysis will be performed by utilising mixed linear models with data nested within each participant. We hypothesise that the influence of circadian functioning will result in an increased relative ratio of future oriented thoughts in the morning. We additionally expect to observe the influence of circadian functioning and chronotype on the rate of mind-wandering itself, more precisely a greater rate in the morning for evening types and greater rate in the evening for morning types.

## References

- [1] J. Smallwood and J. W. Schooler, “The Science of Mind Wandering: Empirically navigating the stream of consciousness,” *Annual Review of Psychology*, vol. 66, no. 1, pp. 487–518, 2015.
- [2] G. K. Smith, C. Mills, A. Paxton, and K. Christoff, “Mind-wandering rates fluctuate across the day: Evidence from an experience-sampling study,” *Cognitive Research: Principles and Implications*, vol. 3, no. 1, 2018.



# Emotion Inference in Artificial Social Intelligent Agents

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Advances in computational cognitive modeling have enabled researchers to formulate and evaluate precise hypotheses regarding how individuals make social inferences (Ong et al., 2019). One of the key concepts underlying these studies is the theory of mind, which refers to the ability to attribute mental states (such as beliefs, desires, intentions, and emotions) to oneself and others, as it enables people to make predictions about others' behavior, understand their intentions, and coordinate their actions (Chen et al., 2021).

Despite recent advancements in computational cognitive modeling, emotions have often been neglected in these models (Ong et al., 2019). This signifies a significant limitation in comprehending a crucial aspect of human psychology, as emotions have a pivotal impact on social interactions, decision-making, and overall mental and emotional health.

One area where the theory of mind and computational cognitive modelling intersect is in the development of artificial social intelligence (ASI). ASI aims to create intelligent agents, that can interact with humans in a socially intelligent way (Williams et al., 2022).

The objective of this research endeavour is to construct a comprehensive framework, drawing inspiration from the work of Ong et al. (2019), aimed at facilitating the precise prediction and recognition of emotions expressed in written natural language. The proposed

model employs a probabilistic methodology that entails the calculation of the likelihood associated with a particular emotion, based on variables encompassing actions, outcomes, beliefs, and desires present within the textual input.

The effectiveness of the model is going to be compared to a baseline language model text generator that does not use the emotion recognition algorithm however it is trained with various datasets.

It is hypothesized that the model with emotion inference algorithm provides better predictions of emotions in written natural language.

## References

- [1] D. C. Ong, J. Zaki, and N. D. Goodman, "Computational Models of Emotion Inference in Theory of Mind: A Review and Roadmap," *Topics in Cognitive Science*, vol. 11, no. 2, pp. 338–357, Jul. 2018. doi:10.1111/tops.12371
- [2] J. Williams, S. M. Fiore, and F. Jentsch, "Supporting Artificial Social Intelligence With Theory of Mind," *Frontiers in Artificial Intelligence*, vol. 5, Feb. 2022. doi:10.3389/frai.2022.750763
- [3] I. Delis, C. Chen, R. E. Jack, O. G. B. Garrod, S. Panzeri, and P. G. Schyns, "Space-by-time manifold representation of dynamic facial expressions for emotion categorization," *Journal of Vision*, vol. 16, no. 8, p. 14, Jun. 2016. doi:10.1167/16.8.1

# The Strange Loop of Creative Origination: Toward a Theory of Enactive Resonance

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At the heart of enactivism lies the idea of a fundamental circularity of mind and world, which codependently originate through the mechanism of structural coupling. Conclusions strikingly similar to this mutually transformative mode of relation have emerged across various disciplines in terms of correspondence in ecological anthropology [2], resonance in social philosophy [3], and congruence in humanist psychology. The significant degree of isomorphism between these theories is what motivates their systematic triangulation within the context of this master thesis.

Guided by the central research question of how enactive theory can be enlightened by insights from other fields, the aim is to crystallise an integral conceptual framework of enactive resonance. Furthermore, the theory of strange loops [1], i.e. self-referential cyclic level-crossing processes, is explored as a unifying principle for establishing interdisciplinary common ground. The thesis is structured as a multi-voiced text which employs three distinct narrative styles in counterpoint: theoretical meta-synthesis, musical examples, and mathematical illustrations. Grounded in the premise of a life-mind continuum, special attention is afforded to the interwoven relation of *epistêmê* and *technê*, elaborating the argument for an epistemogenetic ordering principle at the core of self-organisation that drives morphogenesis

via enactive resonance. Exemplified by the image of the loop station, a musical device to record cyclic patterns and polyrhythmic substrates, I argue that the phenomenology of real-time creative origination through autopoietic self-expression enables an embodied mind to enter into resonance with itself by attuning to the latent potentials arising from the affordance-scape of its lifeworld. Illustrated by the image of the Möbius strip, a mathematical object that transcends common sense dualities, I then develop the hypothesis of an enantiodromic homeostatic function that self-regulates dissonant energy gradients via dissipative structures.

Operationalising concrete decision-making strategies with hypersensitivity to critical cues could inspire novel resonance-based enactive approaches to complex problems such as neurocognitive, somatosensory, sociocultural and ecological alienation. A future musiconeurophenomenological research program is envisioned to explore the epistemogenetic potential of creative strange loops in autopoietic musical improvisation, i.e. *musicopoiesis*.

## References

- [1] D. Borgo, "Strange loops of attention, awareness, action, and affect in musical improvisation," *Music and Consciousness* 2, pp. 113–124, 2019, doi: 10.1093/oso/9780198804352.003.0007.
- [2] T. Ingold, "On human correspondence," *J Roy Anthropol Inst*, vol. 23, no. 1, pp. 9–27, 2017, doi: 10.1111/1467-9655.12541.
- [3] S. Susen, "The Resonance of Resonance: Critical Theory as a Sociology of World-Relations?," *Int J Politics Cult Soc*, vol. 33, no. 3, pp. 309–344, 2020, doi: 10.1007/s10767-019-9313-6.

# Regulating Future Emotional Outcomes Using Theory of Mind

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## Introduction

Emotion regulation refers to the different ways humans influence their emotions when they have them and when that emotion materializes to be experienced at a given time and in the social context [1]. There are two types of emotion regulation. Intrapersonal emotion regulation deals with the regulator's self-concept, while interpersonal emotion regulation is when people try to modulate other people's emotions [1]. There are different strategies to regulate our emotions, which have been extensively studied. Those strategies include some form of cognitive reappraisal, distraction, and suppression of the emotions we experience in certain situations [1]. Planning, on the other hand, refers to a mechanism that is used for action selection to induce or influence future outcomes to potential regulatory interventions to maximize the expected outcome of the user [2]. Other studies have studied action selection causal models in terms of model re-enforcement learning and other causal models; however, Ho [2] proposed that the prediction model of theory of mind can also be used as an action selection model for planning interventions.

## Methods

The study aims to test whether planning uses Theory of Mind as both a prediction and action selection model for interpersonal emotion regulation to understand how the planning would

work within affective mental states. We hypothesize that participants will anticipate the following action if it lines up with the given context but fail if what is expected does not correspond with the context. They will also exhibit slower reaction times when doing the task. The task is a modified version of Caillaud [3] fMRI task, which sets out to measure participants' responses to emotional stimuli to expected and unexpected action in a social context. The paradigm should reveal if people can anticipate an upcoming action or reaction from in a situation. Participants will be first shown expression photos and context videos that provide the social context. Participants will then be shown the slide of an expected or unexpected expression stimulus and will have to predict which one will come next. Eye tracking will also be used to measure pupil dilation. Psychopy and R programming will be used for data collection and analysis respectively.

## References

- [1] K. Niven, "The four key characteristics of interpersonal emotion regulation," *Current Opinion in Psychology*, vol. 17, pp. 89–93, 2017.
- [2] M. K. Ho, R. Saxe, and F. Cushman, "Planning with theory of mind," *Trends in Cognitive Sciences*, vol. 26, no. 11, pp. 959–971, 2022.
- [3] M. Caillaud, A. Benjanin, M. Laisney, P. Gagnepain, M. Gaubert, A. Viard, P. Clochon, V. de La Sayette, P. Allain, F. Eustache, B. Desgranges, "Influence of emotional complexity on the neural substrates of affective theory of mind," *Human Brain Mapping*, vol. 41, no. 1, pp. 139–149, 2019.

# Neural Correlates of Anosognosia in Dementia: A Systematic Review and Meta-analysis

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Dementia is a condition in which a person experiences a decline in cognitive abilities, including remembering and reasoning, which can interfere with their ability to perform daily activities. It is a general term that covers a variety of diseases including Alzheimer's disease (AD), Frontotemporal dementia, Lewy body dementia, Vascular dementia, etc. Anosognosia, characterized by the lack of awareness of one's own cognitive deficits, is a prominent feature of many neurodegenerative diseases, such as Alzheimer's disease and frontotemporal dementia.

Magnetic Resonance Imaging (MRI) studies have been used to investigate the neural correlates of awareness impairment in various neurodegenerative diseases [1]. Several studies have shown that anosognosia in AD and behavioral variant frontotemporal dementia (bvFTD) is associated with structural changes in the prefrontal cortex, posterior cingulate cortex, and hippocampus, as well as decreased activation in the prefrontal cortex and increased activation in the default mode network [2], [3]. These findings suggest that awareness impairment in different neurodegenerative diseases is associated with specific structural and functional changes in distinct brain regions [1]. This knowledge is important for developing targeted interventions to improve awareness in patients with neurodegenerative diseases. Nonetheless, more research is needed to fully

comprehend the underlying neural mechanisms.

The aim of this study is, first, to systematically review studies on the association between anosognosia and measures of brain structure or function using MRI scans, in different neurodegenerative diseases. A comprehensive search of a major database, PubMed, will be conducted to identify relevant studies. Based on exclusion and inclusion criteria, data on study and participant characteristics, anosognosia measures, and brain imaging measures will be extracted. Later, depending on the findings, an activation likelihood estimation (ALE) meta-analysis will be conducted. The primary objective of the analysis is to investigate the correlation between anosognosia and measures of brain structure or function, while secondary outcomes will include the effect of disease type, disease severity, and cognitive domain on the observed associations.

## References

- [1] M. Leocadi, E. Canu, A. Paldino, F. Agosta, and M. Filippi, "Awareness impairment in alzheimer's disease and frontotemporal dementia: A systematic MRI Review," *Journal of Neurology*, vol. 270, no. 4, pp. 1880–1907, 2022. doi:10.1007/s00415-022-11518-9
- [2] M. Amanzio et al., "Unawareness of deficits in alzheimer's disease: Role of the Cingulate Cortex," *Brain*, vol. 134, no. 4, pp. 1061–1076, 2011. doi:10.1093/brain/awr020
- [3] S. Shinagawa et al., "Neural basis of motivational approach and withdrawal behaviors in neurodegenerative disease," *Brain and Behavior*, vol. 5, no. 9, 2015. doi:10.1002/brb3.350

# Operationalizing Attitudes: Comparing Models' Internal States in Perception

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We all have varying expectations and states of mind that shape our subjective experience of the world. Theoretical accounts, such as predictive processing, highlight the top-down influence of internal states on perception [1]. However, there is currently a lack of empirical operationalization (i.e., practical implementation and measurement) and verification of these hypotheses in the field of cognitive science. This may be due to a disconnection between researchers using different terms and understanding to refer to similar phenomena. For instance, Herz et al. introduced a 5-dimensional model called “overarching states of mind” [2], providing a comprehensive framework for understanding cognitive states contributing to subjective experience. Additionally, Peter Lush developed a context-specific scale to measure expectations, which are believed to play a role in shaping perception [3]. These examples illustrate different operationalizations of inner states and their influences on perception and experience. Our aim is to bridge the gap in empirical operationalization by establishing a standardized classification structure for internal states and their influences on perception that transcends domain-specific boundaries.

## Methods

We will conduct a comparative meta-analysis to examine attitudes' operationalization in the research field of perception and experience in cognitive science. In this study, attitudes refer to the properties of internal states and their impact on perception. We will consider models

that presuppose the significance of attitudes in shaping perception and propose specific methodologies for operationalization. While acknowledging potential limitations arising from terminological and explanatory differences, our primary focus will be examining the influences of attitudes on perception and experience, excluding reasoning, social compliance, ideologies, opinions, biases, etc.

## Expected Results and Implications

Our analysis will identify key elements of theories, methods, and models and provide a comparative analysis of attitudes' operationalizations. These insights can facilitate understanding and communication among researchers, contributing to a comprehensive mind and brain research approach. The framework can also shed light on the intricate relationship between cognitive processes and perception, aligning with the latest paradigms in cognitive science.

## References

- [1] A. Clark, “Whatever next? Predictive Brains, situated agents, and the future of Cognitive Science,” *Behavioral and Brain Sciences*, vol. 36, no. 3, pp. 181–204, 2013. doi:10.1017/s0140525x12000477
- [2] N. Herz, S. Baror, and M. Bar, “Overarching states of mind,” *Trends in Cognitive Sciences*, vol. 24, no. 3, pp. 184–199, 2020. doi:10.1016/j.tics.2019.12.015
- [3] P. Lush, “Demand characteristics confound the rubber hand illusion,” *Collabra: Psychology*, vol. 6, no. 1, 2020. doi:10.1525/collabra.325

# **A Bird's Eye View of Weight: Do Kea Rely on Visual Cues to Infer Weight?**

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Humans utilize an assortment of clues to determine the weight of an object, including but not limited to size, material, apparent density, and quantity. Previously believed to be a purely human capability, studies with species such as capuchins have shown that animals may also be capable of inferring weight from the visual qualities of an object [1]. To date, however, this phenomenon remains relatively unexamined and few studies have explored the extent to which other species attend to the visual signals regarding the weight of an object. In this study, we aim to test whether kea (*Nestor notabilis*), known for their curiosity and physical problem-solving skills, can use the visual cues of size, material, apparent density, and quantity (i.e., how full a container is) to determine the weight of an object prior to directly interacting with it.

The kea were previously trained to drop either a light (16g) or heavy (116g) object into a box. In this study, the kea are presented with pairs of objects – one light and one heavy – from the four different categories and will be rewarded for dropping the object of their target weight into the box. We measure i) which object the birds first contact, ii) whether they switch after handling (and feeling the weight of) incorrect objects, and iii) which object the birds drop into the box.

The results from this study will provide insight into whether kea can use visual cues to infer weight and, if so, which visual cues they rely on. The findings of this study will help shed light on the physical cognition of this species and contribute to the conversation surrounding the capacity of non-human animals to have a theory of weight.

## **References**

- [1] B. L. De Moraes, A. Da Silva Souto, and N. Schiel, "Adaptability in stone tool use by Wild Capuchin Monkeys (*sapajus libidinosus*)," *American Journal of Primatology*, vol. 76, no. 10, pp. 967–977, 2014.



# Global Versus Local Symmetries

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## Introduction

Symmetry has been a cornerstone of human thought and aesthetics since ancient times in various civilizations. While the ancient interpretation of symmetry encompassed the idea of equal arrangement and proportion, the modern understanding is limited to the set of transformations that leave the object invariant. [1]

## Thesis

We investigate the concept of partial (local) symmetry, which may be viewed as a sort of return to the original meaning of the term symmetry, stressing the importance of proportionality but capturing the current meaning of symmetry as well. Moreover, we investigate its significance in various disciplines, such as neuroaesthetics and mathematics. Furthermore, we argue that the concept of local (partial) symmetry, as opposed to global (total) symmetry, is more natural, more general, and better describes natural phenomena and symmetries in abstract structures.

## Argument

We argue that the concept of symmetry is insufficient to capture the complexity of the world because 1.) it is very restrictive to just slight asymmetries, and 2.) symmetries hold too much redundant information and are therefore extremely simple to generate complexity, while the concept of partial symmetry provides a more accurate representation. [2] 3) The concept of partial symmetry better addresses proportion, emphasizing both the whole and its parts, akin to the master tilers' approach when tiling objects.

## Methods

Building on the work of [2] and [3], we develop the relevant part of the theory of inverse semigroups axiomatically and logically. Then, we synthesize perspectives from various disciplines to analyze how partial symmetry is treated in different fields and identify unifying principles in these approaches. Examples and images are employed to establish a comprehensive and consistent understanding of the (partial) symmetry concept.

## Results and Conclusion

With the synthesis, we find that:

1. The concepts of partial symmetry and symmetry should not be viewed in opposition but as very close concepts.
2. The concept of symmetry is insufficient to capture the complexity of nature and cognition (it fails to give any information when there is just a slight asymmetry).
3. The concept of partial symmetry is a suitable candidate to capture the complexity of nature and cognition.

We think that by embracing the concept of local (partial) symmetry, researchers across disciplines can gain a more nuanced representation of the structure of objects in both natural and abstract contexts.

## References

- [1] G. Hon and B. R. Goldstein, *From Summetria to Symmetry: The Making of a Revolutionary Scientific Concept*, Springer, 2008.
- [2] R. Jajcay, T. Jajcayová, N. Szakács, and M. B. Szendrei, "Inverse monoids of partial graph automorphisms", *Journal of Algebraic Combinatorics*, vol. 53, no. 3, pp. 829–849, 2021.
- [3] M. V. Lawson, *Inverse semigroups, the theory of partial symmetries*, World Scientific, 1998.



# Automated EEG Channel and Epoch Quality Control

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## Introduction

Electroencephalography (EEG) is a neuroimaging method widely used in neuroscience, clinical applications, and research in general. Part of every pre-processing routine of EEG signals involves the annotation of bad channels and bad epochs. In EEG, a bad channel refers to an electrode or channel producing poor-quality or unreliable data due to factors such as a malfunctioning electrode or poor contact between the electrode and the scalp. A bad epoch refers to a specific segment of time in the EEG recording that is compromised and cannot be used for further analysis. This can occur due to a variety of factors like movement, blinks, horizontal and vertical eye movement, or other physiological and non-physiological artifacts that can distort or obscure the EEG signal. Bad epochs and channels are typically removed from EEG signals using manual methods that are labor-intensive and often impossible to reproduce or automated methods that usually rely on basic statistical approaches [1] that usually do not give optimal results.

We aim to develop and explore the reliability and accuracy of modern machine learning methods for their detection in EEG recordings. Our objective is to create a solution that is both reproducible and gives good-quality annotations of manual methods.

## Method

We plan to develop several machine learning models for the automatic detection of bad epochs and bad channels that are compatible with 32-, 64- and 128-channel EEG caps from

diverse groups of EEG experiments. The datasets that are currently available consist of 16 experiments averaging two dozen participants. During the initial modeling phase, we will apply traditional machine learning methods such as K-nearest neighbors (KNN) or Support Vector Machines (SVM). In the subsequent phase, we plan to develop more sophisticated models utilizing deep-learning approaches such as Recurrent Neural Networks (RNN).

To validate the results of the models, we will compare the performance of our models with most of the popular EEG pipelines (e.g. [2]) that are equipped with automatic rejection of bad epochs/ channels.

## Limitations

A major limitation of this study is the diversity, quality, and quantity of the available data for machine learning. As machine learning models are only as effective as the data they are trained on, the performance and generalizability of the models may be affected by the limitations of the dataset.

## References

- [1] H. Nolan, R. Whelan, and R. B. Reilly, "Faster: Fully automated statistical Thresholding for EEG artifact rejection," *Journal of Neuroscience Methods*, vol. 192, no. 1, pp. 152–162, 2010. doi:10.1016/j.jneumeth.2010.07.015
- [2] N. Bigdely-Shamlo, T. Mullen, C. Kothe, K.-M. Su, and K. A. Robbins, "The Prep Pipeline: Standardized preprocessing for large-scale EEG analysis," *Frontiers in Neuroinformatics*, vol. 9, 2015. doi:10.3389/fninf.2015.00016

# The Role of Reciprocity in Developing Trust in Human-Agent Interaction

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## Introduction

This work examines the importance of reciprocity in the human-agent interactions framework (HAI). Within the social sciences, the term reciprocity refers to the practice of collaborating with others for mutual benefit. In this context, it refers to an agent's ability to reciprocate human actions and responses, which can enhance the perception of collaboration in HAI. According to previous studies, reciprocity is meaningful in building trust and promoting engagement [1]. In this study, we want to investigate the role of reciprocity in developing trustworthiness toward the agent in a collaborative drawing task. Collaborative drawing requires interacting with the lines and patterns of others and guessing their intentions to complete a picture together [2]. Therefore, we will conduct an experimental study to analyze the perception of trust toward an agent, testing two opposed attitudes: collaborative and individualistic. We assume that, during the collaborative task, participants rate the collaborative agent, namely the one showing reciprocity, as more trustworthy than the agent with individualistic behavior. The ultimate goal is to investigate the perception of trustworthiness in humans during interaction with agents, contributing to designing a trustable agent.

## Methods

We will conduct two experiments. The first is a pilot within-subject study to classify and select object drawing categories pre-selected from the Google Sketch dataset (e.g. truck, face, flower, etc.) based on the users' reported difficulty and time latency. In the main between-subjects experiment, participants will be assigned to different collaborative drawing tasks, where we will manipulate collaborative vs. individualistic agent behaviors to test the effect on perceived trustworthiness. After collaborative drawing, participants will rate the perceived, likability, enjoyment of the interaction, and legibility of the agent's intention expression on a 7-point Likert scale. We will also use the Inclusion of Others in the Self (IOS) Scale to measure the perception of trust toward the agent and the Robotic Social Attributes Scale (RoSAS). In conclusion, we expect that participants will be more likely to perceive the collaborative agent as more trustworthy than the individualistic one, highlighting the importance of assessing collaborative systems in promoting trust and effective interactions.

## References

- [1] J. Zonca, A. Folsø, and A. Sciutti, "The role of reciprocity in human-robot social influence," *iScience*, vol. 24, no. 12, p. 103424, Jun. 2021. doi:10.1016/j.isci.2021.103424
- [2] T. Backer van Ommeren, H. M. Koot, A. M. Scheeren, and S. Begeer, "Reliability and validity of the interactive drawing test: A measure of reciprocity for children and adolescents with autism spectrum disorder," *Journal of Autism and Developmental Disorders*, vol. 45, no. 7, pp. 1967–1977, 2015. doi:10.1007/s10803-014-2353-x

# Exploring the Role of ChatGPT in Czech Culture

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Large language models have recently garnered widespread popularity and significant media attention due to their impressive performance on various tasks. ChatGPT, a chatbot developed by OpenAI, is one such implementation of a large, pre-trained language model that became a viral sensation due to its: (a) natural language-like capabilities and qualities (it can write poems, formulate university essays and homework, and exhibit a sufficient level of coding) and (b) its user-friendliness, reachability, and availability [1]. Consequently, the application reached one million subscribers in only five days. However, little hard evidence is available regarding its impacts on society. Understanding such societal consequences is essential because it can provide insights into the potential success or failure of ChatGPT and mitigate the risks regarding its safe deployment [2]. However, it is necessary to analyze the model and the social environment in which it operates since AI systems alter human behavior and vice versa [3].

## Methodology

Therefore, we conduct an interdisciplinary mixed-method study exploring the role of ChatGPT in specific cultural settings of the Czech Republic. We first theoretically and systematically review the model architecture and its evolution, benefits, risks, and artificial general intelligence (AGI) potential. Then, we perform in-depth qualitative analyses of four experts' interviews (thematic analysis) and 201 Czech news articles collected over three

months (content analysis). Through the analyses, we define the main topics about ChatGPT among Czech populations.

## Results

While ChatGPT's AGI narrative is often discussed, its ecological burden, business case, monetization practice, and working conditions of digital workers are omitted. Our results show that people in the Czech Republic have a low adoption rate of ChatGPT due to a missing regulatory body and fear of novelty. The fear is artificially created by media dominance of topics, such as technological competition, job dismissal, and an apocalypse caused by ChatGPT. One topic exception is education, where overwhelmingly positive sentiment is expressed. Regulatory actions are needed to establish fair practice and mitigate potential societal risks.

## References

- [1] T. B. Brown et al., "Language models are few-shot learners," arXiv:2005.14165v4, 2020. doi:10.48550/arXiv.2005.14165
- [2] L. Weidinger et al., "Ethical and social risks of harm from Language Models," arXiv:2112.04359v1, 2021. doi:10.48550/arXiv.2112.04359
- [3] I. Rahwan et al., "Machine behaviour," *Nature*, vol. 568, no. 7753, pp. 477–486, 2019. doi:10.1038/s41586-019-1138-y

# Phenomenology of Sexual Desire

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## Introduction

Sexual desire is a natural, complex phenomenon where a combination of physical and emotional reactions and cognitive processes occurs [1]. When we mention sexual desire, we refer to the experience of wanting or sexual drive, often in reaction to various stimuli such as physical touch, visual stimuli, or psychological influences. It can be influenced by various factors, including biological and hormonal factors, psychological factors (well-being, mood, stress), social and cultural factors such as childhood, education, and social norms [1]. It is a highly subjective experience where individuals experience and interpret sexual desires in their own unique and personal way.

Sexual desire is a natural phenomenon of human sexuality and has been investigated by various disciplines, e.g. psychology, sociology, and biology. Researchers have investigated the mechanisms and processes triggering sexual desire, as well as the factors that can influence its expression and manifestation [1].

What we will be interested in the research is how sexual desire varies from individual to individual and how different factors affect it. In general, sexual desire is a multifaceted aspect of human desire that can play an important role in our physical, mental health and quality of life. Understanding the factors that shape sexual desire and researching individual experiences can provide an important and very valuable understanding of human sexuality and enlighten the development of interventions that promote sexual health and well-being.

## Method

We will approach the research from a first-person perspective. Up to 20 participants (10 female and 10 males, in a variety of ages, sexual orientations, and relationship statuses...) will take part in the research and will sample their experience. The moment they feel sexual desire, they will answer a couple of questions via the app about that experience, and in the following, we will expand these samples through a phenomenological interview. In the first phase, we will conduct a preliminary study to introduce the participants to the first-person research and to see if any similarities emerge between the participants.

We expect that, despite the differences in the experience of sexual desire, some general characteristics will emerge that will not be specific to men or women, sexual orientation, age, education... And maybe we will be able to conduct a universal insight into how sexual desire manifests itself.

## Limitations and Conclusions

The first limitation is that there is no similar research from a first-person perspective, and we can not precisely predict what differences (if any) between subjects will occur. The second limitation is the method itself. For successful research, subjects need to be trained in how to become aware of their experience in the first person.

## References

- [1] K. R. Mitchell, K. A. Wellings, and C. Graham. "How Do Men and Women Define Sexual Desire and Sexual Arousal?" *Journal of Sex & Marital Therapy*, vol. 40, no.1, pp. 17–32, 2013.

# The Experiential Landscape of Mind Wandering

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## Introduction

Although it has long fascinated philosophers and scientists, due to its private nature, mind wandering, defined as thoughts unrelated to the task at hand (MW), has long been disregarded as inaccessible to empirical enquiry.

With the development of cognitive psychology, MW has returned to experimental labs, but although we spend almost half of our time awake mind wandering, researchers mostly viewed it as a form of distraction and used it to research attention and executive functions. Few studies have tried to delve into the phenomenology of MW, and they came to interesting findings about the prospective bias and goal-oriented purpose of mind wandering. Other phenomenological features have also been explored like form, emotional valence, realism, agency, etc. [1]

In 2010 a group of scientists showed that the “wandering mind is an unhappy mind” in a giant first-person study that used smartphones for data collection. However, the study collected only “thin” phenomenological data (multiple-choice questions) rather than describing their experience in-depth. [2]

## Methods and Results

In this research, we will use the Descriptive Experience Sampling (DES) method to obtain ecologically valid data from the participants about their mind wandering. [3]

There will be 15 participants in the study: 10 first-year students of Cognitive science at the University of Ljubljana, and 5 second-year and

former students of the program. Each will provide min. 27 samples.

The participants will sample their experience at several random moments throughout the day over the course of three weeks. They have no prior education about MW and will receive only the minimum information needed to be able to collect the data. In addition to this spontaneous “capturing” of the mind wandering, the participants will be encouraged to share a number of purposeful (important moments) samples.

Data collection will be followed by interviews and qualitative analysis of the data.

The main research questions that will be guiding this study are: how does MW start? What are its experiential domains? What is the role of the agency? What are the main topics of MW?

The study also faces a number of limitations. Participants who become familiar with the DES method usually start to check out the experiential qualities of their thoughts as described by Hurlburt. Other potential issues are participant engagement and data quality.

## References

- [1] D. Stawarzyk, “Phenomenological properties of mind-wandering and daydreaming: a historical overview and functional correlates,” in *The Oxford Handbook of Spontaneous Thought: Mind-wandering, Creativity, and Dreaming*, New York: Oxford University Press, 2018, pp. 193–214.
- [2] M. A. Killingsworth and D. T. Gilbert, “A wandering mind is an unhappy mind,” *Science*, vol. 330, no. 6006, pp. 932–932, 2010.
- [3] R. T. Hurlburt and S. A. Akhter, “The descriptive experience sampling method,” *Phenomenology and the Cognitive Sciences*, vol. 5, pp. 271–301, 2006.



# **Towards Empirical Enactivism: An Eye-tracking Study of Looking at Art While Feeling Aloud**

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Various researchers have presented evidence that verbalizing thoughts while looking at something affects viewing behaviour [1]. This implies that eye-tracking and concurrent think-aloud (CTA) do not supply independent data points, because viewing and verbalization create a feedback-loop that affects both activities. While this exemplifies the tenets of enacted cognition, it is precisely to avoid this reactivity that cognitive psychologists and aesthetic researchers have often opted against using CTA so as not to distort their data [2]. Both despite and because of this, hardly any research has been conducted on the exact nature of these interactions.

To fill this gap, an explorative experiment is proposed in which abstract art is presented to several subjects under different viewing conditions: a) silent viewing, b) viewing with unrelated verbalization task, c) viewing with CTA. The traditional CTA is adapted to a “feel-aloud” protocol with a focus on affective appraisal (in order to boost the contrast of stimulus-driven and introspection-driven verbalizations, and eye-movements). Abstract art was chosen as a stimulus set for ease of isolating basic visual features (i.e. colours, shape), maximizing explorative gaze, and reducing the effect of culturally engrained gaze patterns. Expected results for the CTA condition include more but shorter fixations on fewer regions of interest and more transitions between fixation clusters,

indicating visual revisitations of details that are most salient in verbal references [1]. Explorative analysis of latencies and links between fixations and verbal references in individual cases is also planned, drawing on aesthetic processing models, research on the role of language in perception, and affective appraisal in viewing art [3].

Far from being a mere methodological hurdle to be sidestepped in controlled experimental setups, reactivity between an attention metric (like eye-tracking data) and a meta-cognitive measure (like CTA) could give valuable insights into the dynamic interplay of lower-level stimulus-driven attention and higher-level cognition; and may well be a crucial step in the development of a method for the empirical investigation of enactivism.

## **References**

- [1] C. Klein et al., “Describing art – an interdisciplinary approach to the effects of speaking on gaze movements during the beholding of paintings,” *PLoS ONE*, vol. 9, no. 12, 2014. doi:10.1371/journal.pone.0102439
- [2] K. A. Ericsson, “Valid and Non-Reactive Verbalization of Thoughts During Performance of Tasks. Towards a Solution to the Central Problems of Introspection as a Source of Scientific Data,” *Journal of Consciousness Studies*, vol. 10, no. 9–10, pp. 1–18, 2003.
- [3] P. J. Silvia, “Emotional responses to art: From collation and arousal to cognition and emotion,” *Review of General Psychology*, vol. 9, no. 4, pp. 342–357, 2005. doi:10.1037/1089-2680.9.4.342

# The Role of Sensorimotor Grounding of Concepts in Semantic Memory Retrieval

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Semantic memory accumulates, stores, and organizes knowledge. Proper retrieval from semantic memory is necessary for human adaptive behavior – perception, attention, thinking, and verbal communication. Neuroimaging studies have revealed that controlled semantic processing utilizes the left prefrontal cortex (PFC). However, the functional role of the PFC remains poorly understood. The non-invasive transcranial direct-current stimulation (tDCS) technique has become an increasingly popular way to understand cognitive processing. Marko and Riečanský [1] found that stimulation of the left PFC supports inhibitory processing during semantic memory retrieval. The purpose of this master thesis is to study the role of left PFC during automatic and controlled semantic memory retrieval in more depth. We will focus on the problem from the perspective of the theory of grounded cognition which proposes that cognitive processes are shaped by our bodily experiences and that concepts are grounded in sensory and motor experiences [2]. Therefore, we will explore the effect of the sensorimotor grounding of words on semantic memory processing and retrieval using the tDCS. In the first data collection phase, we will collect sensorimotor ratings of Slovak words. Participants will be given a list of words and after reading the instructions, they will be asked to rate on the 7-point rating scale the degree of grounding in distinct modalities (sound, shape, color, taste, smell, manipulation, and motion). In the second phase of data

collection, we will use a double-blind, randomized, placebo-controlled experiment. Participants from three distinct groups will receive anodal (tDCS) over the left lateral PFC, a control tDCS over the right lateral PFC, or sham stimulation. Cognitive tests will be administered in three blocks: baseline, online, and offline with respect to stimulation (tDCS). During the automatic retrieval task, the participants will be presented with a word on a computer screen and they will be asked to type on the keyboard a word associated with the stimulus word. Conversely, during the controlled retrieval task, they will be asked to type in a word not associated with the stimulus. We will measure the retrieval speed, number of errors, and number of intrusions during the execution of the tasks (incorrect words that “pop up” in mind, before the participant comes up with a correct answer). After collecting the data, we will try to answer whether the sensorimotor grounding predicts the participants’ performance on the semantic memory tasks. Furthermore, we will try to explain the role of the left PFC in semantic memory retrieval and processing depending on the degree of sensorimotor grounding of the stimulus words.

## References

- [1] M. Marko and I. Riečanský, ‘The left prefrontal cortex supports inhibitory processing during semantic memory retrieval’, *Cortex*, vol. 134, pp. 296–306, 2021.
- [2] D. Kemmerer, *Cognitive Neuroscience of Language*, 1st ed. Psychology Press, 2014.



# Foundations for “Cognitive Political Systems’ Science”

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Consider a Cognitive System (CS) whose goal is to determine if it ought to exit a given room or not.

A way to tackle this task would be to use the information processing cognitive architecture ACT-R, to structure the turning of data into information, deriving a rational decision to inform its actions. First, a hierarchy of goals would need to be front-loaded with different weightings: if the CS is sensible to a gradient of thresholds in humidity and temperature, these variables are layered in urgency and importance, to generate rational trade-off behaviour: if there is damaging humidity inside the room, it nevertheless should conclude that it makes sense to remain, in case the alternative room is on fire. To be informed about its environment, it would require an exploratory module — with search strategies — enriched with perceptual sensors to gather and categorise stimuli. To store these values and make sense of the world, a declarative memory system ought to organise its input in clusters, turning it into symbolic information. Buffers of current states would be matched against alternative potential states, yielded from different search strategies with emphasis on alternative variables, to compare benefits and fine-tune the articulation of different hierarchic goals. A dynamic loop — testing search strategies, weighting different sensors per importance of goal type, updating of declarative and procedural memory, and so on — would run in an explicit and traceable manner, in an architecture designed to transform data into information,

accounting for the variables relevant to the task.

Now consider that the CS is responsible for a nation, that the room is the European Union, and that its goal is deciding to leave it or not: is this task less important than the described above? Then why were Brexit’s methods of turning data into information so as to derive a rational decision so radically less structured and explicit, and so dependent on intuition?

Embracing Externalism and Distributed Cognition, Parliaments and such Institutions are cognitive systems [1]: protocols aimed at problems solving; endowed with specialised modules that run on individual human nodes; processing and transmitting information within an architecture from which decision-making emerges.

Inspired by Varela’s “Neurophenomenology”, in which the author devised an actionable walk-through synthesis between Neuroscience and Phenomenology, so as to lay out the steps into a new research field – the aim of this thesis is to provide a foundational synthesis to function as a bridge between Cognitive Sciences and Political Science, elaborating a framework with which to further pursue studies on collective decision-making protocols at the societal level. It is a foundational theoretical work, based on first-principles analysis.

## References

- [1] E. Petracca and S. Gallagher, “Economic Cognitive Institutions,” *Journal of Institutional Economics*, vol. 16, no. 6, pp. 747–765, 2020.

# Heritability of Heschl's Gyrus

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Heschl's gyrus (HG), also known as the first transverse temporal gyrus, is located on the inferior surface of the lateral fissure. It includes the primary auditory cortex, which is the first cortical relay station of auditory information in the brain. Its anatomy is highly variable between individuals and hemispheres [1]. Studies have shown a relationship between HG's structure and individual differences in language skill, learning and expertise, and dyslexia. Structural differences could be due to experience-dependent structural plasticity and/or to differences in pre-existing, innate factors [2]. The aim of this research is to estimate the heritability of different HG structural measures: volume, thickness, surface area and shape. Knowledge about the heritability of HG anatomy could help to inform the origins of its relationship with musicianship or language aptitude.

Data from the Human Connectome Project was used for this study. The sample contained 426 MRI scans from 272 monozygotic and 154 dizygotic twins aged from 22 to 36 years. Two toolboxes (TASH and MCAI) [1,2] were applied to the data to extract HG structural measures. The classical twin design was used to estimate narrow-sense heritability ( $h^2$ ) [3]. Variability in the HG structural measures was partitioned into 3 components: additive-genetic (A), common environmental (C) and residual variance (E) [3]. Structural equation modelling was used to estimate A, C and E components.

Heritability estimates for bilateral HG surface area and volume and for right thickness were all low to moderate (ranging from  $h^2=.02$  to  $h^2=.21$ ) yet non-significant (all  $p>.16$ ). Heritability estimated from left thickness,  $h^2=0.51$ , was found to be significant ( $\chi^2(\Delta df=1)=4.46$ ,  $p=.03$ ). Heritability of shape is yet to be estimated.

Interpretation of the results is a work in progress. However, power analysis showed that our study is underpowered to detect small heritability effects in surface area and volume, and marginally powered to detect them in thickness, which could help understand the origin of low heritability estimates.

## References

- [1] D. Marie et al., "Descriptive anatomy of Heschl's gyri in 430 healthy volunteers, including 198 left-handers", *Brain Struct Funct*, vol. 220, no. 2, pp. 729–743, Mar. 2015. doi:10.1007/s00429-013-0680-x
- [2] J. L. Dalboni da Rocha, O. Kepinska, P. Schneider, J. Benner, G. Degano, L. Schneider, and N. Golestani, "Multivariate concavity amplitude index (MCAI) for characterizing Heschl's gyrus shape," *NeuroImage*, vol. 272, p. 120052, 2023.
- [3] K. J. H. Verweij, M. A. Mosing, B. P. Zietsch and S. E. Medland, "Estimating Heritability from Twin Studies," in *Statistical Human Genetics: Methods and Protocols*, Totowa, NJ: Humana Press, 2012, pp. 151–170

# Individual Differences in Sensorimotor Synchronization to Speech and Music

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## Introduction

The aim of this study was to investigate how rhythmic synchronization is congruent in different domains of speech and music perception. In the speech domain, findings show the preferred rhythmic range (syllable rate) of speech is between 2 and 8 Hz, and this temporal structure is remarkably stable across languages [1]. Researchers found that some listeners can spontaneously synchronize their syllable production in a Speech-to-Speech Synchronization (SSS) test with the perceived rate, defining them as high synchronizers, while others cannot, defining them as low synchronizers [1]. In the domain of music, the Precise Auditory Timing Hypothesis suggests that the link between rhythm and phonology is established through precise neural timing in both phonological skills and beat synchronization ability [2]. Beat synchronization can be studied by the tapping task [3]. There are only a few studies on the relationship between sensorimotor synchronization and working memory, but results show that the two do not seem to be correlated, which supports the notion of the neural oscillator model [3]. Based on previous studies, we propose the following hypotheses: (1) Participants will show a bimodal distribution in the SSS test. (2) There will be a positive correlation between the results of the SSS test and the tapping task. (3) Musical background (participants with more

musical experience) will correlate positively with high synchrony on the SSS test and/or good results on the tapping task. (4) Results on the working memory task will not significantly correlate with synchrony on the SSS test and/or result on the tapping task.

## Methods

We measured behavioural data based using the SSS test [1], and a tapping task based on Kertész & Honbolygó [3]. In both tasks, the degree of synchrony to external stimuli is measured. We also measured working memory capacity (counting span task), and the musical background of participants using a questionnaire.

## Results

We collected data from 34 participants (5 males; 20.68 years old  $\pm$  2.87). We confirmed the first hypothesis: Participants showed a bimodal distribution (low and high synchronizers) in the SSS test. Second hypothesis we rejected: ... [ed.: abstract cut due to exceeding the length requirement]

## References

- [1] D. Poeppel and M. F. Assaneo, "Speech rhythms and their neural foundations," *Nat Rev Neurosci*, vol. 21, no. 6, pp. 322–334, Jun. 2020. doi:10.1038/s41583-020-0304-4
- [2] A. Tierney and N. Kraus, "Auditory-motor entrainment and phonological skills: precise auditory timing hypothesis (PATH)," *Front Hum Neurosci*, vol. 8, Nov. 2014. doi:10.3389/fnhum.2014.00949
- [3] C. Kertész and F. Honbolygó, "Tapping to Music Predicts Literacy Skills of First-Grade Children," *Front Psychol*, vol. 12, Oct. 2021. doi:10.3389/fpsyg.2021.741540

# Psychedelic Substances as a Potential Treatment for ADHD with the Focus on Female Subjects

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According to [1], the diagnosis of attention deficit hyperactivity disorder (ADHD) is increasing, making it one of the most prevalent mental disorders within child and adolescent psychiatry, affecting approximately 5% of the population. ADHD is associated with significant societal and personal burdens, impacting academic and occupational functioning. Furthermore, while it was previously believed that males were more susceptible to this condition, closer examination of previous research suggests that the observed gender disparity in diagnoses may be attributed to biased samples or a lack of symptom recognition in females. Therefore, it is crucial to gain a better understanding of ADHD, particularly in women [2].

Considering the potential bias in diagnostic criteria, similar concerns arise regarding the current medications used to treat ADHD symptoms. Apart from potentially being more suitable for male physiology, these medications can also lead to numerous side effects. As a result, researchers are exploring the possibility of using microdosing with psychoactive substances, such as psychedelics, as an alternative treatment approach for ADHD. Although this field of research is still in its early stages, promising results have been obtained from preliminary studies and self-reports [3]. However, controlled studies are needed to establish the efficacy and safety of psychedelics for ADHD treatment.

While many details of this study are yet to be determined, an ideal approach would involve an empirical investigation utilizing both behavioral and neurophysiological methodologies. This would include collecting data through brain scanners (EEG/fMRI), questionnaires, and interviews. Additionally, assessing participants over an extended period (e.g., one, three, and six months) would provide insights into the potential long-term effects of microdosing psychedelics and help determine the most beneficial dosage and timing ratio.

Considering that ADHD significantly affects human cognition, conducting research in this area will not only advance our understanding of its causes and treatments but also contribute to a broader comprehension of cognition.

## References

- [1] R. Drechsler, S. Brem, D. Brandeis, E. Grünblatt, G. Berger, and S. Walitza, "ADHD: Current Concepts and Treatments in Children and Adolescents," *Neuropediatrics*, vol. 51, no. 5, pp. 315–335, Oct. 2020, doi:10.1055/s-0040-1701658
- [2] S. Young et al., "Females with ADHD: An expert consensus statement taking a lifespan approach providing guidance for the identification and treatment of attention-deficit/ hyperactivity disorder in girls and women," *BMC Psychiatry*, vol. 20, no. 1, pp. 1–27, Aug. 2020, doi:10.1186/s12888-020-02707-9
- [3] N. R. P. W. Hutten, N. L. Mason, P. C. Dolder, and K. P. C. Kuypers, "Self-Rated Effectiveness of Microdosing With Psychedelics for Mental and Physical Health Problems Among Microdosers," *Frontiers in Psychiatry*, vol. 10, Sep. 2019, doi:10.3389/fpsyt.2019.00672

# User Experience of Classic and AI-assisted Search Engines

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## Introduction

It is hard to imagine a world without search engines such as Google. They have become a staple in online activity as they allow an unparalleled ease of access to information. The classic search engines such as Google use a word similarity-based algorithm to obtain entries from its database that are most closely related to the user query. With the rise in popularity of Generative Language Model (GLM) companies such as Microsoft have started to adopt such artificial intelligence (AI) models in combination with the classic similarity-based search engines [1], which allow both a classical method of searching for information and the conversational method seen in chatbots. This combined approach of search engines poses a question about the influence of AI on user experience (UX). Studies in the field of UX have proposed that when chatbots are introduced, humans tend to perceive them as more humanlike [2], changing the UX.

We will be looking at the UX of people interacting with classic and AI-assisted search engines. With that in mind, we will be exploring the question: “How does the UX in regard to interaction and interface design differ between the classic and AI-assisted browser search engines?”.

## Method

We will develop multiple web applications simulating a browser. The web applications will be of two types, the classic search engine and the AI-assisted search engine. The classic search

engine will follow the current UX practices, while the AI-assisted search engine will make use of both the classic search engine and chatbot UX practices.

The participants of the study will be given tasks regarding obtaining with the use of the two different tools. They will report their experience while using the tools as well as score the tools based on their UX such as usability, user-friendliness, information clarity, etc.

## Results and Implications

The study is still in its infant stages, therefore data has yet to be collected. The data analysis will with identifying UX patterns and categorizing them.

The results of this study will offer an additional evidence-based approach to studying UX of people using search engines, interacting with AI and the combination of the two. Additionally, the study has the potential to bring insight to the adaptation of classic search engine optimization practices for AI-assisted search engines.

## References

- [1] “Reinventing search with a new AI-powered Microsoft Bing and EDGE, your copilot for the web,” The Official Microsoft Blog, 2023. (Accessed: 8 May 2023).
- [2] I. K. Haugeland, A. Følstad, C. Taylor, and C. A. Bjørkli, “Understanding the user experience of Customer Service Chatbots: An experimental study of chatbot interaction design,” *International Journal of Human-Computer Studies*, vol. 161, p. 102788, 2022.



# A Knowing Look - The Influence of Interpretative Labels on the Perception of Art

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Engaging with an artwork means answering its challenge: “See me if you can!” [1]. When confronted with a painting, our spontaneous interpretations are subjected to changes triggered by its title or accompanying text (when it is provided). By learning to see things to which we were blind before, we are granted an opportunity to witness the role of understanding in granting us access to the world, bringing it into perceptual consciousness [1]. This study focuses on the differences in visitors’ responses and gaze patterns with or without contextual information as present in interpretative museum labels. Eye tracking technology has proven useful in the interdisciplinary research of perception of art, as it offers a clearer insight into an observer’s gaze behavior. Visitors’ interpretations have thus been shown to deepen and differ when they have access to contextual information [2]. I believe that bringing this relation into focus can inform the way we interact with art objects, as well as our more general conception of visual perception.

Data was collected from a temporary exhibition at the Belvedere Museum, which featured works associated with Realism. This paper’s focus is on the exhibition’s second room, where label text was altered or added between experimental conditions. We included 244 participants, which were randomly recruited on-site, among normal museum-goers. We asked each

to complete a survey, with which we gathered sample characteristics. After instructing the participants to view the exhibition at their own pace, we outfitted them with mobile eye-tracking glasses to capture their gaze behavior. When they concluded their visit, we subjected them to an open-ended interview.

I expect the data to show an indication of ‘deeper’ interaction with exhibited paintings in the condition with added painting labels. This can be inferred from a longer visit duration to the exhibited paintings and their labels, a higher average fixation duration on areas of interest, as well as various expressions of engagement with the work present in the qualitative data. Further exploratory analysis into saccadic movement will be conducted, to reveal possible patterns of changes between conditions.

There is not one way of understanding an artwork, but by opening ourselves to the dialogue it offers, we are able to change the way we perceive it – and critically, expose the habitual ways in which we overlook the role our knowledge has in opening our eyes to the world.

## References

- [1] A. Noë and A. Noë, *Varieties of Presence*. Cambridge, MA: Harvard University Press, 2012.
- [2] L. Reitstätter, K. Galter, and F. Bakondi, “Looking to read: How visitors use exhibit labels in the Art Museum,” *Visitor Studies*, vol. 25, no. 2, pp. 127–150, 2022. doi:10.1080/10645578.2021.2018251

# Dwarves on the Shoulders of Giants. The Dark Side of Cognitive Science

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Cognitive Science is the multidisciplinary study of the mind... but which minds are we speaking of? Those of humans or those of other animals. While cognitive science frameworks often focus on models of the human mind, recent advances in neuroscience and cognitive psychology have only been possible thanks to animal models [1]. These are often based on in vivo experiments on animal subjects. In the European Union alone, in 2020 over 640'000 animals have undergone studies on the nervous system [2]. Of these, 101 were primates, 406 pigs, 44 dogs and 35 cats. On 99.1 out of 100 cases, the animals were not reused after the study, meaning that they were euthanised [2].

Generalising animal models to human cognition - or to cognition in general - leads to two issues. The first can be called the problem of inter-species extrapolation: is it always methodologically valid to extrapolate conclusions from animal studies to human cognition? The second is a moral problem: to what extent are we morally justified to cause physical and psychological suffering to non-human subjects in a scientific setting? These two questions are gaining prominence in the neuroscience and psychology literatures, but not so much in the cognitive science literature. The thesis will focus on the moral question, with occasional references to the extrapolation problem.

The thesis will be a purely theoretical work. It will begin with a review of the literature on

methods of animal experimentations for studies on cognition. This will help to put together a glossary of relevant terms, as well as a list of techniques used in animal models. These will allow for the design of a checklist with which to evaluate papers. The cognitive science literature will be systematically analysed to answer the following questions: how reliant is cognitive science on animal models? Which current paradigms are more so? And to what extent might this reliance be ethically problematic? In addressing these questions, the aim is to raise awareness of the issue within the cognitive science community.

## References

- [1] J. L. Bermúdez, *Cognitive Science an Introduction to the Science of the Mind*. Cambridge, United Kingdom: Cambridge University Press, 2023.
- [2] EUROSTAT, "Section 2 – Details of all uses of animals for research, testing, routine production and education and training purposes in the EU," ALURES - Animal Use Reporting System - European Commission, [https://webgate.ec.europa.eu/envdataportal/content/alures/section2\\_number-of-uses.html](https://webgate.ec.europa.eu/envdataportal/content/alures/section2_number-of-uses.html) (accessed May 29, 2023).



# Age-related Differences in Default-mode Network Connectivity

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In recent decades, one of the focuses of interest in Neuroscience has been studying the patterns of neuronal activity and identifying networks within the brain. A well-known example of such a network is the Default Mode Network (DMN). Its subnetworks are involved in higher-order cognition which allows for theorizing about the role of the DMN in cognitive processes [1]. The activity of the DMN has been linked to a wide range of functions, such as memory, decision-making, social cognition, daydreaming, and creativity [2]. Research on age-related differences in the functional connectivity (FC) of the DMN has shown a significant decrease in connectivity between anterior and posterior regions [3]. However, the correlation can be both linear and non-linear. Studying these changes in FC as people age could provide insight into brain disorders and disruptions in cognitive functions. This research intends to investigate how FC within the DMN changes with age using the graph topology analysis to measure how the regions of the DMN assemble in space. It is hypothesized that these measures will differ between the young and elderly adults.

This study uses resting state fMRI (rs-fMRI) data acquired on 3 Tesla scanner equipped with a 32-channel head coil. Two hundred and twenty-seven healthy participants formed two groups: young adults (N=153, 25.1±3.1 years, range 20–35 years, 45 female) and elderly adults (N=74, 67.6±4.7 years, range 59–77 years, 37 female). The total time of rs-fMRI was

15 min 30 s. The participants were instructed to remain awake during that time. This dataset is publicly available as a part of the MPI-Leipzig Mind-Brain-Body database.

The goal of this study is to better understand changes in functional connectivity within the DMN as a function of age, and to investigate potential implications for cognitive functions and disorders. The topological data analysis will be implemented as the main method. The study will involve defining network nodes and links between them, generating a graph, and analyzing the graph's topology for two different age groups. Each node will represent a voxel, and the links between nodes will be defined. The analysis will evaluate various characteristics, including node degree, number of nodes, clustering coefficient, path length, global efficiency, and small-world index.

## References

- [1] J. M. Kernbach et al., “Subspecialization within default mode nodes characterized in 10,000 UK Biobank participants,” *Proceedings of the National Academy of Sciences*, vol. 115, no. 48, pp. 12295–12300, 2018. doi:10.1073/pnas.1804876115
- [2] J. Smallwood et al., “The default mode network in Cognition: A Topographical Perspective,” *Nature Reviews Neuroscience*, vol. 22, no. 8, pp. 503–513, 2021. doi:10.1038/s41583-021-00474-4
- [3] M. De Marco, S. Ourselin, and A. Venneri, “Age and hippocampal volume predict distinct parts of default mode network activity,” *Scientific Reports*, vol. 9, no. 1, 2019. doi:10.1038/s41598-019-52488-9

# **The Effects of Motivated Remembering on the Recall Accuracy**

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Relevance theory [1] presents a comprehensive framework for understanding communication, positing that it encompasses more than a simple coding-encoding process. According to this theory, communication involves a complex exchange of information, where speakers encode their messages and hearers employ their cognitive abilities to decode and derive meaning from these messages. In this process, the ability to recall information becomes crucial for hearers to accurately infer the intended meaning of the speaker.

Interestingly, research has indicated that individuals' belief in a just world, defined as the tendency to perceive the world as operating fairly and individuals receiving what they deserve, can significantly influence their memory and recall accuracy [2]. When events or situations contradict this belief, it can lead to cognitive dissonance and emotional distress [3]. Based on this observation, we propose that individuals are more likely to implicitly recall situations that challenge their belief in a just world. This inclination can be attributed to their desire to restore and justify their belief system.

To examine and test this hypothesis, our study will involve recruiting participants through Mechanical Turk and presenting them with structured stories. Each story will consist of an introduction, a dialogue containing promises, and an outcome indicating whether the promises were kept or broken. Following the story

presentation, participants will be asked to recall the dialogue lines that include the commitments made in the story. They will also complete the Just World Scale [3], a 20-question Likert scale measuring an individual's endorsement of the belief in a just world, with 10 questions assessing perceptions of justice and 10 questions assessing perceptions of injustice. Subsequently, participants' recalls will be scored using an algorithm we have developed to measure the extent to which they employ implications while recalling. Through this approach, we aim to investigate whether participants are more inclined to implicitly recall commitments when those commitments are broken, potentially due to the violation of their belief in a just world associated with broken promises. Furthermore, we predict that a correlation will be found between participants' scores on the just world scale and their implication scores in stories that include broken promises.

## **References**

- [1] D. Wilson, "Relevance and lexical pragmatics," UCL Working Papers in Linguistics, vol. 16, pp. 343–360, 2004.
- [2] S. Sharma, "Remembering a Just World: Motivated Recall of Victim Culpability," *The Yale Review of Undergraduate Research in Psychology*, vol. 63, 2015.
- [3] Z. Rubin and L. A. Peplau, "Who believes in a just world?" *Journal of social issues*, vol. 31, no. 3, pp. 65–89, 1976.

# Hopelessly Biased? An Attempt at Averting Motivated Numeracy in the Interpretation of Science

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There are two competing accounts for why certain topics with overwhelming scientific evidence - such as climate change, evolution, GMOs, etc. - fail to generate a consensus in the public. Science Comprehension Thesis (SCT) attributes this to the lack of scientific literacy and posits that people with greater cognitive ability should converge in their interpretation of polarizing scientific information. Cultural Cognition Thesis (CCT) claims that people with greater cognitive ability use it to defend and justify their existing beliefs - referred to as motivated reasoning - and should diverge in their interpretation of such information. Depicting polarizing information in a tabular, difficult-to-solve covariance-detection problem has resulted in evidence for CCT [1] while utilizing easier tasks has produced evidence in favor of SCT [2], which indicates that using easier tasks can help avert motivated reasoning. It is also known that visual/iconic depictions of apolitical covariance-detection problems are easier to solve [3]. This leads to the question: can motivated reasoning be reduced by using an iconic version of the polarizing covariance-detection problem instead of a tabular version?

To answer this question 400 adult Slovaks were randomly allocated to a tabular or iconic version of the covariance-detection problem about the impact of Muslim immigration on crime rates, a polarizing topic. The first hypothesis (H1) was that the iconic version was easier

than the tabular version. The CCT-consistent H2 was that polarization will increase with increasing numeracy - a measure of cognitive ability - for the tabular version. The SCT-consistent H3 was that polarization will decrease with increasing numeracy for the iconic version.

The responses revealed a general bias against Muslim immigrants. Surprisingly, there was no evidence to support any of the hypotheses. The failure to substantiate H1 implies that either (a) the experimental manipulation was ineffective, or (b) it was insufficient to overcome bias. The inability to validate H2 raises questions about the (a) polarizing effect of Muslim immigration in the sample, and (b) replicability of previous findings [1]. The lack of evidence for H3 leaves the door open for further research into experimental manipulations that can help avert motivated reasoning in the interpretation of polarizing scientific information.

## References

- [1] D. M. Kahan, E. Peters, E. C. Dawson, and P. Slovic, "Motivated numeracy and enlightened self-government," *Behavioural Public Policy*, vol. 1, no. 1, pp. 54–86, 2017.
- [2] G. Pennycook and D. G. Rand, "Lazy, not biased: Susceptibility to partisan fake news is better explained by lack of reasoning than by motivated reasoning," *Cognition*, vol. 188, pp. 39–50, 2019.
- [3] M. Sirota, L. Kostovičová, and M. Juanchich, "The effect of Iconicity of visual displays on statistical reasoning: Evidence in favor of the null hypothesis," *Psychonomic Bulletin & Review*, vol. 21, no. 4, pp. 961–968, 2014.

# Meaningless Phenomenality: Physicalist Reduction of Intentionality and Subjectivity

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Kim concludes that “physicalism is not the whole truth, but it is the truth near enough” [1], with qualia being the only mental residue that resists physical reduction. The terms “qualia” and “phenomenality” have ontological commitment to the existence of something-it-is-likeness as real non-physical properties. First, starting from Kim’s halfway physicalism, I argue that the ontological status of language (formal system and semantics) is physical, while the physical domain is the limit of meaningful speech. That is, the semantical relationship is naturalistic. Hence, as non-physical properties, qualia are beyond the reach of meaningful discourse. Even philosophical theories, as physical-formal systems, are not able to talk about qualia meaningfully. Second, I deploy Wittgenstein’s private language argument [2] to argue that Mary, in Jackson’s knowledge argument [3], does not gain any knowledge after leaving the black-and-white room. In conclusion, phenomenality is not a legitimate object of reference and knowledge, and physicalism is the perfect metaphysical theory within the boundary of meaning.

## References

- [1] J. Kim, *Physicalism, or Something near Enough*. Princeton University Press, 2008.
- [2] L. Wittgenstein, *Philosophical Investigations*, trans. G.E.M. Anscombe, Oxford, UK: Basil Blackwell, 1968.

- [3] F. Jackson, “Epiphenomenal qualia,” *The Philosophical Quarterly*, vol. 32, no. 127, p. 127, Apr. 1982. doi:10.2307/2960077

# Synaesthetic Experience as Cognitive Architecture

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## Introduction

Synaesthesia, nowadays, is understood as a cognitive phenomenon characterized by the involuntary blending of senses. It translates perceived information into diverse sensations and a mixture of sensory modalities [1, 3]. This interconnectedness occurs when sensory organs transmit and interpret processed information to the frontal lobe. A neuroscientific perspective explains that synaesthesia involves atypical processing in the limbic systems, indicating a stronger link to emotional and logical connections with an individual's external reality rather than a global reduction in cortical activation.

## Research

The following study is focused on researching synaesthesia in connection to colours and symbols, such as letters, numbers, and words. Theoretical predispositions are based on neurological connections in synaesthetic experience, while a practical examination is researched deeper through a phenomenological perspective. The research aims to look at the inner experience of synesthetes and non-synesthetes with phenomenological research methods like descriptive experience sampling (DES) and phenomenological interviews.

The research will include 3 participants, a synesthete trained in DES, a non-synesthete trained in DES, and a non-synesthete not trained in DES. The phenomenological finding will be analysed through theoretical frameworks of phenomenological samplings' encoding and cognitive neuroscience.

The hypotheses are: 1) synaesthetic experiences are neuro-based encoded metaphors, which can provide detailed ways of language use for introspective descriptions, and 2) when processing information, distinct patterns of cognitive architecture activation are observed between individuals with synaesthesia and those without.

Possible expected results could explain everyday life use of metaphors, and optimal ways of expressing through the use of language as tools for first-person research, more precisely, the optimal and intuitive language for detailed and precise expression [2], aiming for highly detailed observation and description of the inner experience.

This research on an individual's experience may bring new aspects of cognitive architecture and specifics of sensory experiences, meaning some tiny missing gaps or bridges in a cognitive research field and the field of consciousness research since the experience can be researched and described in detail.

## References

- [1] G. Böhme, "Synesthesia in a phenomenology of perception," *Cloud-Cuckoo-Land, International Journal of Architectural Theory*, vol. 18, no. 31, pp. 21–33, 2013.
- [2] S. Kühn, C. Fernyhough, B. Alderson-Day, and R. T. Hurlburt, "Inner experience in the scanner: Can high fidelity apprehensions of inner experience be integrated with fmri?," *Frontiers in Psychology*, vol. 5, 2014.
- [3] L. E. Marks, "Synesthesia. A Union of the Senses: by Richard E. Cytowic, Springer-Verlag, 1989.," *Trends in Neurosciences*, vol. 13, no. 10, pp. 434–435, 1990.

# Posters



# Exploring the Relationship Between Democracy and GDP per Capita: A Neural Network Approach

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This interdisciplinary project aims to investigate the correlation between democracy and GDP per capita by employing a neural network approach. By harnessing the capabilities of machine learning and integrating knowledge from diverse fields such as politics, economics, philosophy of free will, and cognition, the project seeks to illuminate the potential connections between democratic values and a nation's economic prosperity. Additionally, in the current era of rising totalitarian regimes, this work becomes particularly relevant as it offers potential solutions to address this global challenge [1].

The project starts by gathering comprehensive data from a diverse range of countries worldwide, covering multiple decades of development. The data preprocessing phase involves loading the dataset into pandas dataframes and extracting the relevant features and target columns: the degree of democratic values as the input and GDP per capita as the predicted value. To ensure consistency and comparability, we employ the MinMaxScaler from Scikit-learn to normalize both the features and target values. This normalization step allows us to effectively train and evaluate our neural network model [2].

For our neural network architecture, we choose a fully connected neural network, also known as a feedforward neural network or a

multi-layer perceptron (MLP). This architecture, consisting of an input layer, hidden layers, and an output layer. The rationale for this choice lies in the MLP's ability to handle complex non-linear relationships and make accurate predictions.

The model training phase involves optimizing the model using the normalized training data. We employ the mean squared error (MSE) loss function and the Adam optimizer to minimize the difference between predicted and actual GDP per capita values. We monitor the loss value for each epoch to assess the model's performance, taking into account the MSE criterion [3].

Our findings indicate that democratic values can predict a country's GDP per capita, but we acknowledge limitations and suggest exploring additional variables to enhance accuracy. We emphasize the role of free will in shaping economic progress, individual agency, and societal well-being, recognizing GDP per capita as an indicator of prosperity.

## References

- [1] S. Levitsky and D. Ziblatt, *How Democracies Die*. New York: Penguin Random House, 2018.
- [2] P. Virtanen et al., "SciPy 1.0: Fundamental Algorithms for Scientific Computing in Python," *Nature Methods*, vol. 17, no. 3, 261–272, 2020, doi: 10.1038/s41592-019-0686-2

# What Power Should Be Used for Power Analysis?

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Power analysis is a statistical method that describes the probability that the results of an experiment will be statistically significant (the probability of avoiding a false negative). Choosing a power level, however is most of the time based on convention, often following Cohen's recommended 80% [1]. Determining what power should be used could impact scientific practice and funding promoting more rigorous research methods, as, for example, within subject design experiments tend to require fewer participants to detect effect of comparable size [2]. In this literature review, I try to find a basis for choosing power and describe what parameters one should take into consideration when using the method.

Four parameters of statistical inference can be described, they are closely related, so knowing 3 of them will determine the fourth. These parameters are power, significance criterion ( $\alpha$ ), sample size ( $N$ ), and (target) effect size ( $\square$ ), and so there are four types of power analysis [1]. The difficulties in determining the power we wish to use lie in the fact that when determining these parameters ahead of time, most of the time, the effect size will be set arbitrarily. This is an issue, as usually the researcher does not wish to detect an effect size expressed in an exact numeric value, in addition, this is the parameter that most heavily affects power, and through it, sample size. This means that larger effects are going to produce higher power at smaller sample sizes as compared to smaller effects producing larger power only in large sample sizes [3]. Perhaps a more data driven

way to determine effect sizes could involve metaanalyses reviewing previously found effect sizes. I conclude that it is difficult to determine a uniform way to choose the effect size ahead of time, and so choosing a power level is going to be to some degree arbitrary, based on the previous experience of the scientist and their expectations of the results. It should be fine to keep Cohen's 80% suggestion as a minimum value, but the scientist should decide what the relative cost of a false positive and false negative is and determine the power based on that.

## References

- [1] J. Cohen, Statistical Power Analysis for the Behavioral Sciences. L. Erlbaum Associates, 1988.
- [2] V. A. Thompson and J. I. D. Campbell, "A power struggle: Between- vs. within-subjects designs in deductive reasoning research," Psychol. Int. J. Psychol. Orient, vol. 47, pp. 277–296, 2004. doi:10.2117/psysoc.2004.277.
- [3] G. Cumming, Understanding The New Statistics: Effect Sizes, Confidence Intervals, and Meta-Analysis. Routledge, 2013.

# **Quantifying Infants' Movements to Maternal Singing - a Comparative Methodological Approach**

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Rhythmic movements in infants are motivated by music; but also, they are found to offer practical training for performing coordinated and precisely timed movements, which are also necessary for speech [1]. New research reveals that increased rhythmic movements and high neural tracking of live maternal infant-directed (ID) play songs relate to infants' linguistic development [2]. Nguyen et al. [2] measured neural and behavioral responses in 7-month-old infants to their mothers' singing of play songs and lullabies as well as the vocabulary size at 20 months. To study infants' behavior, commonly their movements are manually labeled as infants often dislike wearing markers, and motion tracking which can be applied successfully on adults is tricky to be transferred to babies due to their different proportions. Likewise, manual labeling is time-consuming and prone to subjectivity. New advances in animal research to quantify the behavior of small organisms bear great potential to allow studying the movements of infants. DeepLabCut (DLC), a tool for markerless pose estimation building upon a deep learning algorithm, aims to overcome limitations imposed on experiments, that use markers that ought to be expensive and distracting [3]. This research project aims at replicating and refining Nguyen et al. [2] study results which relied on two independent human coders for their behavioral data analysis. Less than a handful of studies have been

published that apply DLC to study infants' behavior and no study to date presents the results of two independent behavioral analyses, comparing the methods of manual human coding and DLC on the same dataset. Such comparative approaches and repeated analyses are effortful and often inaccessible to researchers who work under the diverse constraints of their resources. This research project bears the potential to inform future decisions of researchers in the field when it comes to designing their experiments and opting to find the most suitable method of analysis. Analyzing the dataset again, using a novel method, gives rise to potentially concluding new best scientific practices in the analysis of behavioral data of infants.

## **References**

- [1] J. M. Iverson, "Developing language in a developing body: The relationship between motor development and language development," *Journal of Child Language*, vol. 37, no. 2, pp. 229–261, 2010.
- [2] T. Nguyen, S. Reisner, A. Lueger, S. V. Wass, S. Hoehl, and G. Markova, "Sing to me, baby: Infants show neural tracking and rhythmic movements to live and dynamic maternal singing," Pre-Print, *bioRxiv* 2023.02.28.530310, Feb. 28, 2023.
- [3] A. Mathis, P. Mamidanna, K. M. Cury, T. Abe, V. N. Murthy, M. W. Mathis, and M. Bethge, "Deeplabcut: Markerless pose estimation of user-defined body parts with deep learning," *Nature Neuroscience*, vol. 21, no. 9, pp. 1281–1289, 2018.

# DANCR: An Improvisational Tool for Contemporary Dance

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The implementation of robots into the artistic space of dance has been a topic of increasing research in the past decade. Previous research has focused on the ability of a humanoid robot to embody different dance positions and create aesthetic performances. However, few have researched the ability of a humanoid to improvise with a human dance partner. Improvisation in the dance world is an act of communication, connection, and expression that leads to novelty in movement [1]. It is elusive and subjective to the creative's experience which allows for different avenues to explore within the research field. One past study has been done to explore improvisation with a non-anthropomorphic robot coded with preset motions [2]. While other work has focused on a virtual avatar rather than a physical robot [3]. Much of this research relies on technical metrics or audience-based methods to evaluate the performance measure, with few focusing on evaluating the interaction between a human dancer and the robot from the dancer's perspective. The goal of DANCR is to create a system that serves as an improvisational tool that contemporary dancers can use to explore new ideas and movements through interacting with the system in real time. The system is set up in the following way: A dancer is positioned in front of three motion sensors which capture their joint positions, this information is fed into a machine learning model that has been trained on data sets from four expert dancers, the model processes the information and re-

turns a set of joint angles that can be embodied by the robot, in our case the pepper robot manufactured by SoftBank robotics. The result is a movement that corresponds to the input from the human dancer and has the potential to influence novel movements. Our specific task of the project is to evaluate the performance of the system as it pertains to creating moments of improvisation. In order to approach this issue, we have created a qualitative framework that can judge the quality of the system from the experience of the dancer.

## References

- [1] L. A. Blom and L. T. Chaplin, *The Moment of Movement: Dance Improvisation*. Pittsburgh, PA: University of Pittsburgh Press, 1988, pp. 6–7.
- [2] E. Jochum and J. Derks, "Tonight we improvise!," *Proceedings of the 6th International Conference on Movement and Computing*, 2019. doi:10.1145/3347122.3347129
- [3] A. Berman and V. James, "Kinetic Imaginations: Exploring the Possibilities of Combining AI and Dance," *Proceedings of the Twenty-Fourth International Joint Conference on Artificial Intelligence*, 2015.

# Real-time Facial Emotion Recognition for Human-Robot Interaction

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## Introduction

Emotions guide our decisions, affect our behaviour and represent a crucial role in human-human interaction. Given that machines, especially robots, collaborate with and assist humans in diverse domains, it is important that they also possess the ability to affectively engage with people. Researchers have been studying the importance of human-robot interaction (HRI) and working on the development of “affective computing” solutions for more than three decades [1], with the aim of endowing machines with the skills to handle affective data, interpret emotions, and react properly. Such systems should be able to interact with people in a more natural, spontaneous, and efficient manner.

Although emotional states are conveyed through different modalities, the majority of emotional recognition solutions have focused on facial emotion recognition [2]. With the recent advances in the field of artificial intelligence, especially in deep learning [3] and hardware technologies, the number and accuracy of these applications have been accelerated.

The focus of our project is on the development and implementation of a facial emotion recognition system, as well as the appropriate facial responses of the robot. It will serve as the basis for the future development of more advanced designs that will also consider context and other modalities of emotion recognition. The goal is to enrich HRI and enable further studies of the social and psychological aspects of this interplay.

## Methods

With the objective of enhancing HRI, we will develop a system for real-time facial emotion recognition and appropriate robot facial responses. To achieve improved accuracy for the emotion classification task, we will fine-tune the pre-trained VGG-16 model using the Affect-Net dataset. The classifier will be able to identify six emotions (sadness, happiness, anger, fear, disgust, and surprise) and the seventh class - neutral. Additionally, we will construct a lightweight deep learning network for detecting facial feature points to map head pose and facial expressions. In the final stage of the project, a robot mirroring response will be generated in real-time using 68 detected facial feature points. This will enable the robot to mimic human facial expressions effectively.

## References

- [1] R. W. Picard, *Affective Computing*, Cambridge: The MIT Press, 2000.
- [2] N. Rawal and R. M. Stock-Homburg, “Facial emotion expressions in human-robot interaction: A survey,” *International Journal of Social Robotics*, vol. 14, no. 7, pp. 1583–1604, 2022. doi:10.1007/s12369-022-00867-0
- [3] S. Li and W. Deng, “Deep Facial Expression Recognition: A Survey,” in *IEEE Transactions on Affective Computing*, vol. 13, no. 3, pp. 1195–1215, Sept. 2022. doi:10.1109/TAFFC.2020.2981446.

# Measuring Physiological Responses in a VR Environment Using Empatica's E4 and Faros 360

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## Introduction

In various cognitive science studies, researchers are interested in physiological data under different conditions. Empatica's E4 and Faros 360 are two commercially available and popular devices to obtain such data. E4 wristband measures blood volume pulse, inter-beat interval, electrodermal activity and temperature. Faros 360, positioned centrally on the chest, is a device recording heart rate measurements. Previous research [1] has shown that the data obtained with Faros is reliable, but the problem arises with the E4's measurements due to the movements of the participants. We designed an experiment, where we measured physiological responses with Faros and E4 in a motion-controlled VR environment. We will use Faros measurements as a reference point and compare its data to E4 to determine its reliability. Our research question was: What is the data quality of E4 when measuring physiological signals in a motion-controlled VR environment?

## Method

We conducted a within-subject design to check for intra-individual reliability. Participants were exposed to two VR scenes while wearing both devices. The second scene was expected to elicit a high degree of arousal, whereas the first supposedly should lead to a milder response. After each scene, participants completed questionnaires reporting on their VR experience.

## Expected Results

We anticipate differences in physiological parameters between the first and second scene. We expect the heart rate to be higher during the second and lower during the first scene compared to the baseline. We anticipate positive correlations between participants' experiences, as reported in questionnaires, and their physiological responses. Given that participants did not move their hands, we expect the results from E4 and Faros 360 to be similar. However, we expect the results obtained from Faros 360 to be more accurate.

## Limitations

The E4 on the participant's non-dominant hand required them not to move that hand. Despite this warning it turned out to be quite challenging for many of them to follow this instruction resulting in a potential motion artifact.

## Discussion

Even though we expect the E4 results to be as reliable as those from the Faros 360 in a controlled VR environment, we have concerns about its broader usability due to the requirement for not moving. Regarding further research, it would be interesting to conduct a similar experiment using different VR scenarios or longer movie clips to observe E4's measurements.

## References

- [1] T. Gruden, K. Stojmenova, J. Sodnik, and G. Jakus, "Assessing drivers' physiological responses using consumer grade devices," *Applied Sciences*, vol. 9, no. 24, p. 5353, 2019. doi:10.3390/ap.9245353



# Virtual Lesion Approach to Explain Linguistic Impairment in Multiple Sclerosis

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## Introduction

Multiple sclerosis (MS) is an autoimmune maladaptive disease affecting the axons of the white matter; it causes the deterioration of the myelin sheet that insulates the axons in the nervous system [1]. Although physical or sensorimotor symptoms are the most common in MS, linguistic impairments are also observed. The language deficits may be of different kinds, affecting various abilities, for instance, verbal fluency, lexical access, or language comprehension [1].

Transient “virtual lesions” can be created with transcranial magnetic stimulation (TMS) through causing disruption of function and associated behaviour in a targeted cortical area [2]. This way, the causal role of areas can be tested, and virtual lesions can be used to simulate the effects of neurodegenerative diseases in the brain, such as the language alternations in MS.

## Methods

The variety of linguistic symptoms suggests the complexity of the underlying cognitive processes. Thus, analysing language impairments in MS not only allows for insights into more general linguistic processes, but could improve treatment options by optimizing brain stimulation treatment designs. TMS-evoked virtual lesions allow for the non-invasive study of implications of neurodegenerative diseases in healthy subjects, without the involvement of actual patients. This aspect is important if the

stage of neurodegeneration does not allow subjects to take part in the study, as people living with MS often experience fatigue, sensory deficits, or weakness [1].

The present study investigates the effect of TMS-induced virtual lesions on language processing in healthy subjects, in areas of the brain that are affected in MS. A picture naming task is used to focus on the most common linguistic symptom in MS: impairment of word retrieval [1]. The proposed project is relevant from a cognitive science perspective, as it analyses a complex cognitive phenomenon (language processing) and suggests possible applications and insights for medical treatment and diagnosis.

## Expected Results

We aim to modify brain activity by using TMS for creating virtual lesions to alter language characteristics, allowing for translational insight into the linguistic processes in MS patients. Through localising – by probing different TMS coil positions – and analysing the speech-related altered behaviour, a more general brain-behavioural relationship may be derived and targeted therapeutic or rehabilitation methods for people living with MS may be found.

## References

- [1] S. Renauld, L. Mohamed-Saïd, and J. Macoir, “Language disorders in multiple sclerosis: A systematic review,” *Multiple Sclerosis and Related Disorders*, vol. 10, pp. 103–111, 2016.
- [2] I. Weissman-Fogel and Y. Granovsky, “The ‘virtual lesion’ approach to transcranial magnetic stimulation: Studying the brain-behavioral relationships in experimental pain,” *PAIN Reports*, vol. 4, no. 4, 2019.

# Competing Approaches to Artificial General Intelligence

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This research project explores the concept of artificial general intelligence (AGI) as it is currently used in cognitive science and AI engineering.

The key research question is whether any consensus exists about what AGI consists of, either in the scientific literature or in industry. This question has not been adequately addressed in the scientific literature primarily because AGI as a concept has only recently gained widespread currency, though its historical roots are deep.

Taking inspiration from Pei Wang [1], I argue that while there is no overall consensus about what constitutes AGI, approaches to developing AGI fall into two broad categories: Single principle systems and multiple principle systems. Single principle systems aim to solve a wide range of problems using a single rational principle or learning approach, while multiple principle systems integrate various distinct problem-solving techniques into a single agent.

I argue that multiple principle systems constitute a more promising approach to AGI than single principle systems. I illustrate this point with a paradigm case – the Soar cognitive architecture. Soar was originally conceived as a single principle system by Allen Newell [2] but eventually morphed into a multiple principle system under John Laird [3]. I argue that this evolution reflects the unavoidable practical

limitations of single principle systems and points to the greater promise of multiple principle systems.

My primary methodology is scientific literature review, mostly focused on contemporary work but with some attention to historical work. In addition, I review some public statements and media interviews by industry leaders.

This research is timely, given the present boom in AI investment, development and deployment. Several industry leaders, including Sam Altman, CEO of OpenAI, have recently proclaimed their intention to pursue AGI, and the considerable resources they wield mean we should take these ambitious seriously. As the pursuit of AGI heats up, research like this has considerable implications for how scientists, policymakers, and the public should understand and evaluate claims about AGI.

## References

- [1] P. Wang, “On defining artificial intelligence,” *Journal of Artificial General Intelligence*, vol. 10, no. 2, pp. 1–37, 2019. doi:10.2478/jagi-2019-0002
- [2] A. Newell, *Unified Theories of Cognition*. Cambridge, Mass: Harvard Univ. Press, 2008.
- [3] J. E. Laird, “Extending the soar cognitive architecture,” *Frontiers in Artificial Intelligence and Applications*, vol. 171, pp. 224–235, Jan. 2008. doi:10.21236/ada473738

# Behavioral Markers of Movement Quality in Immersive Environments

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Decades of work are behind us in the fields of therapy and rehabilitation development for conditions brought on by neurodegenerative diseases. However, most of the developments have been unsatisfactory because of the lack of impact on life quality, post-disability. An important step in such research was the implementation of brain-computer interface (BCI) devices for therapeutic purposes. In such settings, individuals would engage in therapy that was commonly based on methods to enhance motor imagery that has underlying neural mechanisms involved with actual movement and therefore can be used in its restoration. Going a step further, a physical rehabilitation practice that is becoming prevalent in medical neuroinformatics research is the combined use of BCI and virtual reality (VR) in creating dynamic environments that allow for accelerated progress in motor rehabilitation, or recovery. The BCI-VR system allows users to control external devices such as their ‘virtual hands’, while also adding the immersion factor, which allows for a more natural-like, intuitive, and real-time feedback. Because of its immersion factor, the implementation of VR in BCI is making the motor rehabilitation process more engaging for the patient and has been shown to improve the efficiency of the system [1].

In this research, we will be exploring the construct of movement quality (MQ) through an EEG-based BCI-VR. Healthy participants will be performing a series of tasks in a virtual envi-

ronment, targeted at their upper limbs, simulating physical therapy tasks. In this setting, MQ can be operationalized through neuronal markers such as oscillation strengths, onset times, and localizations, as well as by assessing behavioral markers. This research focuses on assessing behavioral markers, namely task time and accuracy, as separate entities as well as their correlation with each other and with neuronal markers. The specific research questions being posed are, firstly, the correlation of behavioral and neuronal markers. We hypothesize that neuronal markers of MQ will be present along with behavioral markers of MQ, or rather that they will positively correlate. Secondly, we will examine training-induced differences in movement quality, or movement quality optimization (MQO). We hypothesize MQO could be observed in lower task time and higher accuracy, with participants having more tasks completed.

Finally, the significance of many previous and current research lies in the potential implications of the results and their usability in a real-life, medicinal setting.

## References

- [1] W. Dong, Y. Fan, S.H. Hsu, J. Xu, Y. Zhou, J. Tao, X. Lan, and F. Li, “Combining Brain-Computer Interface and Virtual Reality for Rehabilitation in Neurological Diseases: A Narrative Review.” *Annals of Physical and Rehabilitation Medicine*, vol. 64, pp. 101404, 2021. doi:10.1016/j.rehab.2020.03.015

# Transcutaneous Auricular Vagal Electrostimulation and Its Effect in Parkinson's Disease Patients

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## Introduction

Parkinson's disease (PD) is a progressive disease caused by the deterioration of dopaminergic neurons. It is associated by motor symptoms that are usually adequately treated with drugs in early PD. Patients also suffer from non-motor symptoms. Their cause is not fully understood, but one hypothesis is that they arise from degeneration of other diffuse neuromodulatory systems (DNMS) involved in motor and cognitive function, mood and metabolism. Although certain drugs are able to modulate the DNMS, they are often associated with side effects. A new treatment option is vagal nerve stimulation. Recent studies show its ability to alter DNMS through different nuclei in the brainstem. Transcutaneous auricular vagus stimulation (taVNS) is a non-invasive technique applied at the auricular branch of the vagus nerve. An electrode is placed on the outer part of the ear. The frequency of stimulation appears to be the determining factor in its efficacy [1]. Not much is known about regions actually stimulated with taVNS. Our study is the first to examine the effect of taVNS in early and late PD patients using fMRI to compare the difference between two commonly studied frequencies on strictly defined regions of interest (ROI) to avoid multiple comparison problem. Knowledge about effects of stimulation of DNMS could lead to broader understanding of various cognitive disorders. We have two main

hypotheses: [1] taVNS will stimulate predetermined nuclei of DNMS in the brainstem (ROI); [2] the response to stimulation will vary depending on the stage of disease.

## Methods

25 Hz (the most commonly studied), 100 Hz (most efficient) and a sham frequency of taVNS are used on each participant. Stimulation is delivered in randomized order during the same session of fMRI recording with pauses in between. fMRI is used to measure the response of ROI. We aim to enroll 20 participants in early stage of disease and 20 patients in progressive stage.

## Expected Results

Given the early stage of the research, we can only speculate on the results. We believe that taVNS will activate the DNMS, but the extent of the response may vary depending on the stage of the disease and the frequency used.

## Limitations

Major limitations lie in the small number of participants, the heterogeneity of the group and lack of healthy controls - early stage PD patients are used as one. Having only neuroimaging data, we can see the correlation between stimulation and activation of certain structures, but clinical interpretation is limited.

## References

- [1] R. Sclocco, R. G. Garcia, N. W. Kettner, H. P. Fisher, K. Isenburg, M. Makarovsky, J. A. Stowell, J. Goldstein, R. Barbieri, and V. Napadow, "Stimulus frequency modulates brainstem response to respiratory-gated transcutaneous auricular vagus nerve stimulation," *Brain Stimulation*, vol. 13, no. 4, pp. 970–978, 2020.

# Age Differences in Human EEG Theta Oscillations During Spatial Navigation in Virtual Reality

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Spatial orientation is a multifaceted behavior that necessitates a range of perceptual and cognitive abilities. Individuals employ diverse strategies and cognitive resources to navigate and orient themselves in their surroundings. Oscillatory patterns of activity in the electroencephalogram (EEG) have been associated with various cognitive functions in both animals and humans. In rodents, theta oscillations (4–12 Hz) have been connected to spatial navigation and specifically to the encoding and retrieval of spatial information in the hippocampus. These findings suggest a role for theta oscillations in spatial cognition. More recently, research has also investigated task-related characteristics of theta oscillations (4–8 Hz) in humans, aiming to understand their involvement in cognitive processes [1].

There are sex and age differences for ability of spatial navigation in human. Previous researches have shown that there is no sex differences were found in spatial performance during the spatial navigation task. However, female participants showed a stronger increase in theta oscillations when processing landmarks as navigational aids compared to men [2]. In age aspect from another research, virtual environment (VE) technology was employed to evaluate age-related differences in spatial navigation. Older participants exhibited longer completion times, covered greater distances, and made more spatial memory errors compared to younger participants. Performance on the VE navigation task was positively correlated with mental rotation, verbal memory, and visual memory measures [3].

Based on the conclusions above, younger participants have better performance on navigation task [3]. My research would mainly focus on the activation of theta oscillation while participants from different age groups doing spatial navigation task. The assumption is that while doing the task, the participant in younger group will detected stronger increasing and more frequency activation in theta oscillations while doing task.

Expected age range of participants will be 20–70, and the number of participants will be about 50 and their age spread as evenly as possible across age groups (about 45 years old in average).

The navigation task will be presented by a VR maze task which consists of a number of T-junctions. Participants will be asked to find the exit of maze. In the duration of the task doing, EEG measurement will be applied from the beginning of maze task. Based on previous research, the most active theta oscillation will most occur in the crossing part of maze [1], so the data of EEG will be mainly focused in these spot during the task.

## References

- [1] W. F. Bischof and P. Boulanger, “Spatial Navigation in Virtual Reality Environments: An EEG Analysis,” *CyberPsychology & Behavior*, vol. 6, no. 5, pp. 487–495, Oct. 2003. doi:10.1089/109493103769710514
- [2] S. E. Kober and C. Neuper, “Sex differences in human EEG theta oscillations during spatial navigation in virtual reality,” *International Journal of Psychophysiology*, vol. 79, no. 3, pp. 347–355, Mar. 2011. doi:10.1016/j.ijpsycho.2010.12.002
- [3] S. D. Moffat, A. B. Zonderman, and S. M. Resnick, “Age differences in spatial memory in a virtual environment navigation task,” *Neurobiology of Aging*, vol. 22, no. 5, pp. 787–796, Sep. 2001. doi:10.1016/s0197-4580(01)00251-2



# **The Role of Culture in Entrainment to Music from the Perspective of Embodied Cognition**

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Entrainment is the process by which an independent agent synchronizes or coordinates its frequency or motion to that of another. Entrainment is an abstraction that describes processes that occur in different phenomena [1]. What my study is concerned with is the human ability to “lock-on” or synchronize with an external rhythm, or a beat, in music. In particular, I aim to investigate what light the perspective of embodiment has shed on musical entrainment.

Music is a universal human trait. A great number of music cultures exist around the world and studies show that beat detection is innate in human beings [2]. At the same time, there is a great deal of rhythmic variety and knowledge of musical structures that we learn in the culture we are embedded in [3]. This could be the reason why someone with no musical experience or exposure to the music culture of the Balkan, or Turkey, for example, would experience difficulty synchronizing their movement, in the form of dancing or even tapping, to the Aksak rhythm (an irregular rhythm that alternates between two and three eighth notes, giving it a sense of unevenness or a “limping” effect). In other words, these unfamiliar rhythms would not be fit to elicit an entrainment response for that person.

Our interaction with music involves the body, mind, and environment – whether that is the environment in which we are engaging with

music or the environment we are immersed in while growing up. The emphasis that embodied cognition places on the role of the body and the environment in perception makes it a promising perspective for exploring entrainment. The intention of this study is to understand: what contributions could the field of embodied cognition make to explain the cultural component of entrainment?

I approach this research question by doing a concise review of the literature and identifying the current state of knowledge on the matter of musical entrainment. Next, I analyze the literature and explore to which extent it incorporates or has space for cultural components.

The aim of the study is to shed light on the matter of entrainment to music in cross-cultural contexts specifically from the embodied perspective. By connecting research concerns of cognitive science and embodiment with research on music in different disciplines, including ethnomusicology, musicology, and psychology, I hope to expand my knowledge of the perspectives offered by embodied cognition on the phenomenon of entrainment.

## **References**

- [1] M. Clayton, “What is Entrainment? Definition and applications in musical research,” *Empirical Musicology Review*, vol. 7, no. 1–2, pp. 49–56, 2012, doi: 10.18061/1811/52979.
- [2] I. Winkler, G. P. Háden, O. Ladinig, I. Sziller, and H. Honing, “Newborn infants detect the beat in music,” *Proc. Natl. Acad. Sci. U.S.A.*, vol. 106, no. 7, pp. 2468–2471, Feb. 2009, doi: 10.1073/pnas.0809035106.
- [3] E. E. Hannon and L. J. Trainor, “Music acquisition: effects of enculturation and formal training on development,” *Trends in Cognitive Sciences*, vol. 11, no. 11, pp. 466–472, Nov. 2007, doi: 10.1016/j.tics.2007.08.008.



# Neuroscience in Law: Rethinking Free Will

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## **Context**

When sentencing a perpetrator in court, there is an important question that needs to be answered. To what extent did the perpetrator act of his own free will? The question needs to be examined through various aspects that take into consideration economic, psychological, and sociological factors. With modern technology for brain imaging, we are able to better understand how neural systems correlate with our cognitive abilities and how those are limited when pathology occurs. Cognitive neuroscience offers a new perspective on free will and it is believed that its knowledge needs to be used in court when dealing with perpetrators with brain pathology. [1]

## **Introduction of the Project**

My (still ongoing) project is divided into two parts - theoretical and empirical. The latter is yet to be completed. In the theoretical part, the field of neuroscience and law (neurolaw [2]) was introduced. The goal was to capture the complexity of the field as much as possible. The limitations of neurolaw were also described as it does elicit many philosophical and ethical questions that are important to take into consideration when stepping into the field of neurolaw. Three research questions were used during the literature review process: What is the meaning of free will in law? How does brain pathology affect free will? What are the limitations of neurolaw?

In the field of neurolaw, there are mainly quantitative research studies done that do not consider the complexity of the problem and therefore have many limitations.

That is why for the empirical part of the project, there were found three examples of prisoners who are sentenced for a violent act that are going to be subjects for a case study. Prisoners were selected based on the information that is publicly available. There needed to be enough information on the case and pathology of the perpetrator in order to be chosen for the case study. Concerning the literature gathered in the first part of the project, the case study should make the complexity more apparent and will try to show why it is important to add a neuroscientific perspective when dealing with perpetrators with brain pathology. Qualitative research should show that we must consider the convict's case holistically and take into account all aspects of the circumstances that led to their actions. Among these, the neuroscientific perspective is important when considering the free will of the perpetrator – however, it should not be considered separately, but only as part of the mosaic.

## **Further Research**

The results of the three case studies still need to be gathered to support the hypothesis of the importance of a holistic approach that was formed based on the gathered literature.

## **References**

- [1] M. S. Gazzaniga and M. S. Steven, "Free Will in the Twenty-first Century," in *Neuroscience and the law: Brain, mind, and the scales of Justice*, B. Garland, Ed. New York, NY: Dana Press, 2009, pp. 51–71.
- [2] T. M. Spranger, *International Neurolaw a comparative analysis*. Berlin, Germany: Springer Berlin, 2014.

# Heat Interaction for Humans & Hug Robots - Design Testing of Hug Pillows for Children

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In recent years the interaction between children and robots has received increased attention. To further understanding of human robot interaction in particular the dynamic between developmental cognition and responsive objects can help build more secure and ethical applications. Responsive objects designed to provide comfort, companionship, and emotional support, hold promise for various applications, including therapy, education, and entertainment. A critical component for child robot interaction with huggable objects, such as hug pillows is the mediation for the sense of touch and social presence through synchronization [1, 2]. The purpose of this paper is to compare the specific dynamics and implications of child-hug robot interactions, focusing on the role of touch in facilitating emotional connections.

By examining existing literature and conducting an empirical field observations, we aim to gain insights into how children perceive and respond to huggables, as well as the potential benefits and challenges that might be associated with these interactions. One aspect of interest is categorizing and exploring the physical properties, such as softness, perceived implemented responsiveness and warmth. Research suggests that these factors can significantly influence the child's perception of the robot's social presence and their willingness to engage with it. [2]

Furthermore, this paper will explore the emotional and psychological effects of a particular hug robot interaction with an already existing prototype, in the form of a pillow. Understanding the underlying mechanisms behind the effects the hugbit (hug-pillow) can help shape the design and implementation of robots that effectively support children's emotional development. By investigating the design elements that contribute to a more comforting tactile experience, we can inform the development of future huggable robots that better meet the needs of children.

Design categories were derived from existing literature (n=30) and by conducting preliminary field tests, which compared interactional dynamics and implications of child-hug robot interactions. A particular finding were 3 out of 6 design tenets derived from literature for hug-robot interactions; hug robots should: be sized similar to an adult human, be soft, and be warm. [3] ... [ed.: abstract cut due to exceeding the length requirement]

## References

- [1] E. Nunez, M. Hirokawa, A. Hautasaari, and K. Suzuki, "Remote communication via huggable interfaces - behavior synchronization and social presence," CHI Conference on Human Factors in Computing Systems Extended Abstracts, 2022. doi:10.1145/3491101.3519699
- [2] A. E. Block, S. Christen, R. Gassert, O. Hilliges, and K. J. Kuchenbecker, "The Six Hug Commandments: Design and Evaluation of a Human-Sized Hugging Robot with Visual and Haptic Perception," in Proceedings of the 2021 ACM/IEEE International Conference on Human-Robot Interaction. New York: Association for Computing Machinery, pp. 380–388, 2021. doi:10.1145/3434073.3444656

# Legibility and Predictability of NICO Robot Movement

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## Introduction

In the context of the rapid development of AI and robotics, the question of effective human-machine interaction becomes increasingly important. Various factors contribute to the success of communication between humans and machines, and one such crucial factor is movement design, which significantly affects legibility and predictability. Legibility refers to humans' capacity to understand and anticipate a robot's intentions and actions based on its movements [1]. A study conducted using the NICO platform reveals that fluency and trajectory are essential factors that enhance humans' ability to predict a robot's intentions [3]. Additionally, research suggests that human perception of robot intentions is influenced by the robot's movements [2]. Building upon these findings, our experimental design aims to investigate and validate these results.

## Experimental Design

This study aims to investigate the impact of movement design on the ability of humans to understand and predict the intentions of a robot. The NICO robot platform is utilized to perform a task involving pointing to specific fields on a 3x8 grid. An HRI experiment pilot is conducted, where respondents are asked to predict the final state of the robot's arm after the movement is stopped at one point. Half of the respondents witness the robot's movements with its head involved, while the other half only observe the arm movements with the head locked in one position. The experiment is followed by a Godspeed questionnaire to gather

feedback and optimize the experimental design. The hypothesis posits that movements involving the head will enhance legibility and make the final states easier to predict. The results of this study will contribute to understanding the role of movement information in human perception of robot intentions, aiding the development of effective human-robot communication systems.

## References

- [1] A. D. Dragan, K. C. T. Lee, and S. S. Srinivasa, "Legibility and predictability of Robot Motion," 8th ACM/IEEE International Conference on Human-Robot Interaction (HRI), 2013. doi:10.1109/hri.2013.6483603
- [2] M. Kerzel et al., "What's on your mind, Nico?," *KI - Künstliche Intelligenz*, vol. 36, no. 3-4, pp. 237-254, 2022. doi:10.1007/s13218-022-00772-8
- [3] L. Sartori, C. Becchio, and U. Castiello, "Cues to intention: The role of movement information," *Cognition*, vol. 119, no. 2, pp. 242-252, 2011. doi:10.1016/j.cognition.2011.01.014

# Mechanisms of Bottom-up and Top-down Information Flow in the Mouse Visual Cortex

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Understanding population activity of sensory neurons is one of the key areas of modern systems neuroscience. Especially understanding information flow between higher and lower-level cortical areas is still in its infancy. In this work, we aim to use modern machine learning methods on publicly available neural datasets to study mechanisms of bottom-up and top-down processing in different layers of the mouse visual cortex.

Traditionally, neurons in the primary visual cortex have been characterized by artificial stimuli, such as gratings. For these, neuronal sensitivities could be described with simple features, resembling Gabor filters. However, recent studies have shown that sensitivities of visual cortical neurons markedly differ from the classical ‘receptive fields’ when richer stimuli like natural images are presented to the animal [1]. Technological advances allow for simultaneously recording many neurons in many different brain areas, which enables us to take one further step and study how different cortical areas and layers communicate.

The recorded neuronal data will be selected from the public database of the Allen Brain Observatory. To examine connections between populations of neurons we can use natural scenes and artificial stimuli. Changes in the collaboration between the activity of populations

of neurons for natural scenes or artificial stimuli could highlight aspects of how stimuli with different complexities are processed. We can use multiple machine learning based methods to explore the connection between populations of neurons, such as reduced rank regression, canonical correlation analysis [2], or delayed latents across groups [3]. Using these approaches we also want to look at how different layers of the visual primary cortex take part in bottom-up and top-down information flow.

## References

- [1] T. D. Marks and M. J. Goard, “Stimulus-dependent representational drift in primary visual cortex,” *Nat Commun*, vol. 12, no. 1, Art. no. 1, Aug. 2021. doi:10.1038/s41467-021-25436-3
- [2] J. D. Semedo et al., “Feedforward and feedback interactions between visual cortical areas use different population activity patterns,” *Nat Commun*, vol. 13, no. 1, Art. no. 1, Mar. 2022. doi:10.1038/s41467-022-28552-w
- [3] E. Gokcen et al., “Disentangling the flow of signals between populations of neurons,” *Nat Comput Sci*, vol. 2, no. 8, Art. no. 8, Aug. 2022. doi:10.1038/s43588-022-00282-5

# The Neuroscience Behind the Words. How We Program Our Minds Everyday

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My project, as the literature review, wants to investigate a relation and connection between spoken/thought language to the body and mind. I will focus mainly on the linguistic units – words – their emotional charge how they shape and determine our lives, bodies, world around us and our perception of reality.

During processing of negative, positive, and neutral words there were found differences in brain imagery, which refers to the process of how words we use everyday shape our brain from a long-term perspective with priming and neuroplasticity. For example, words we associate a fear and danger with awaken subconsciously our defence brain mechanism in the frontal lobe and if this connection is strengthened over time we learn negative association related to that stimuli which changes our experiences. [1]. This process can be compared to programming – rewiring our minds and the way we experience our lives. Words can basically influence our wellbeing, our self perception and our relations with the outer world. From how encouraging words influence our sport performance, how they impact our musculoskeletal rehabilitation and what is the impact of words to pain processing [2]. Words we use also determine our perception: “When we allow negative words and concepts into our thoughts, we are increasing the activity in our brain’s fear center (the amygdala), and causing

stress-producing hormones to flood our system.” [3]. On the other hand, positive charged words can activate areas which are responsible for motivation and dedication, serotonin and dopamine release. “Over time the structure of your thalamus will also change in response to your conscious words, thoughts, and feelings, and we believe that the thalamic changes affect the way in which you perceive reality.” [3].

The purpose of this project is to offer a literature overview, highlight the potential in mind-body connection research and raise questions and curiosity about psychophysiology. The interdisciplinary approach of linguistics, psychology, neurology and philosophy can open the doors for better understanding how we “program” ourselves every day. I also see great potential for healing mental illnesses, understanding personal identity, cognitive patterns and predicting human behavior with computation, just by understanding the process of pattern creation, autosuggestion and identification with meanings behind the words.

## References

- [1] T. Straube, A. Sauer, and W. H. R. Miltner, “Brain activation during direct and indirect processing of positive and negative words,” *Behavioural Brain Research*, vol. 222, no. 1, pp. 66–72, 2011. doi:10.1016/j.bbr.2011.03.037
- [2] A. Ritter, M. Franz, W. H. Miltner, and T. Weiss, “How words impact on pain,” *Brain and Behavior*, vol. 9, no. 9, 2019. doi:10.1002/brb3.1377
- [3] A. Newberg and M.A. Waldman, *Words Can Change Your Brain. 12 Conversation Strategies to Build Trust, Resolve Conflict, and Increase Intimacy*, Penguin, 2013.



# Meditation Techniques Effects

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## Introduction

Meditation is proven to have strong positive effects on emotional well-being, health, performance, and intelligence [1]. Hundreds of different meditation techniques exist, which differ in procedures and effects. Researchers are only beginning to understand how various techniques affect the human organism, how to categorize them, and how to use them [2]. It is the goal of this work to contribute to the filling of this very knowledge gap.

## Issue

The common classification categorizes meditation techniques based on occurring brain wave frequencies (measured by EEG) and methodical procedures into: a) “Focused Attention”, b) “Open Monitoring” and c) “Automatic Self-Transcending” [2]. This categorization however seems to have significant weaknesses. Firstly, the “Focused Attention” category seems overly broad, with some techniques aligning more closely with other categories than their own. Furthermore, phenomenological criteria are not considered, which seems restricted considering that meditation is precisely about the experienced effect.

I hypothesize that a different categorization is more useful. Using EEG technology and phenomenology I conduct a self-experiment on the following techniques that all, except the last, conventionally fall into the category of “Focused Attention” to test the validity of the model: 1. Samatha Meditation is the focused attention on the breath. It has previously been

associated with delta brain waves and deep relaxation. 2. Shambhavi Mudra Meditation is the focused attention on the space between the eyebrows. High increases in delta and theta activity were associated. 3. Insight Meditation as Vipassana or Zen focusses on the impermanence of whatever experiences arises and were associated with increases in gamma activity. 4. Manifestation Meditation focusses on cultivating desired states (e.g., health or wealth) by focussing and imagining them. It has been associated with alpha and theta brain waves. 5. Loving-Kindness Meditation is practicing and focusing on a well-meaning attitude towards all beings. It has been associated with an increase in slower frequencies, such as theta. 6. Transcendental Meditation focusses on quieting the mind and arriving at a state of “just being”. It is associated with alpha brain activity and conventionally categorized as “Automatic Self-Transcending”.

## Methodology and Aim

The gathered data will be analysed for patterns in frequency, methodology and phenomenology to approve the conventional model or provide an alternative. Although the conclusions drawn from this personal experiment may not be universally applicable, the aim is to serve as a door opener for further debate and research.

## References

- [1] J. Eberth, and P. Sedlmeier, “The effects of mindfulness meditation: a meta-analysis”, *Mindfulness*, vol. 3, no. 3, pp. 174–189, 2012.
- [2] F. Travis, “On the neurobiology of meditation: comparison of three organizing strategies to investigate brain patterns during meditation practice”, *Medicina*, vol. 56, no. 12, p. 712, 2020.



# Ethno-phenomenological Study of Experiencing Lectures

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Our pilot study is a multiple case study focused on the qualitative experience of 7 different students during lectures. Alongside that, we gathered some behavioural and contextual data, thus making our study ethno-phenomenological. Our research questions are “What impacts learning (defined as memorization and comprehension) of students during lectures?” and “Is the classroom where lectures take place is one of the factors?”.

Two concepts closely related to explorative study are experience and behaviour. Experience is anything that is going on in your awareness at any moment, behaviour is the range of observable students’ action.

Firstly, we aim to gather information on student experience and behaviour by identifying the main factors that influence students’ learning process during lectures to improve study processes and provide relevant information to better cater to students’ learning needs.

Secondly, we aim to identify some basic categories of the student experience and indicate the main methodological considerations that could inform future research.

## **Methods**

Methods used in this study combined the approach of Descriptive Experience Sampling (DES) method [1] and ethnographic questionnaires. Our research consisted of 5 data collecting phases: 1. pre-lecture questionnaire (assessing mood, prior activities), 2. DES during

the lecture, reporting behaviour, attention, atmosphere, sense of environment (sampling 3 random moments that were indicated by a beep and 2 individually selected moments), 3. post-lecture mini test (assessing memorization and comprehension), 4. post-lecture questionnaire (inquiring about overall impression of the lecture), 5. a detailed diary of the participants’ experience and behaviour during a lecture. Participants used video recordings to help them with diary entries.

## **Results**

Expected results are 7 thorough reports of experience and behaviour during 6 lectures. We are interested in any patterns that might emerge and could potentially inform future research on student learning experience during lectures.

## **Conclusions**

Although the study is still ongoing, we are confident that the broad collection of qualitative data will provide at least some useful information on what hinders or enhances memory and comprehension of students during lectures.

We believe that we have managed to maintain a high level of ecological validity, however, we are aware that the study has impacted the experiences and behaviour of the participants. Our discoveries in this field hold significant value in establishing guidelines for improved study environments and reducing the influence of demand characteristics in future research.

## **References**

- [1] R. T. Hurlburt and S. A. Akhter, “The descriptive experience sampling method,” *Phenomenology and the Cognitive Sciences*, vol. 5, no. 3–4, pp. 271–301, 2006. doi:10.1007/s11097-006-9024-0

# Do Subjective Mood Ratings Covary with Spectral Power EEG Characteristics? Exploratory Analysis

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## Introduction

Mood is a persistent affective state of low or moderate arousal that is not induced or triggered by a specific stimulus or event. Because of its stimulus independence, the neural correlates of mood are studied using the resting-state paradigm. In the following research we have focused on resting state (RS) EEG. There are two main ways of investigating this topic: linking subjective reports to brain activity [1], or investigating brain activity by inferring subjective experience from the tasks chosen for the experiment [2]. Some researchers [1] concluded that spectral power is an important indicator of arousal independent of mood valence, but others [2] described methods to classify the valence of felt emotions based on gamma activity.

To improve on previous findings, we used a mood questionnaire to assess the valence of the current mood. We were therefore interested in how spectral power EEG characteristics covaried with participants' subjectively reported valence of mood.

## Method

Seventy-two psychology students (11 males, 61 females) aged 18–25 years (mean age = 19) were recruited for this study. To track differences in mood during the experiment, RS EEG was measured at three time points: before the task (RS1), after the task (RS2), and after guided relaxation (RS3). Between RS1 and RS2,

participants completed tasks designed to investigate the influence of cognitive control on emotional regulation. This task was not related to the present research and will not be discussed further. To assess mood, participants completed a 12-item Scale of Positive and Negative Experiences (SPANE) after each RS measurement.

## Results and Further Research

First, we analysed the brain and subjective data separately. Initial results showed lower spectral power at all frequencies in the frontal lobe and greater power in alpha activity at RS1 than at subsequent time points. Subjects reported more positive than negative subjective mood states at RS1 and after guided relaxation (RS3). After the task (RS2), however, subjects reported more negative than positive mood states. The next step in the analysis will be to correlate the two sets of data.

As the SPANE questionnaire only assesses the valence of mood numerically, we should include more detailed first-person data on the subjective experience of mood in the future research. This could be done with phenomenological interviews after training subjects in phenomenological introspection.

## References

- [1] M. Wyczesany, J. Kaiser and A. M. Coenen, "Subjective mood estimation co-varies with spectral power EEG characteristics", *Acta Neurobiologiae Experimentalis*, vol. 68, no. 2, pp. 180–92, 2008.
- [2] T. M. Li, H. C. Chao, and J. Zhang, "Emotion classification based on Brain Wave: A survey," *Human-centric Computing and Information Sciences*, vol. 9, no. 1, 2019.

# Modeling Wearable Data for Predicting Individual Circadian Rhythms

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The study of circadian rhythms and the epidemiology of circadian disruption is an emerging area of interest for the fields of chronobiology and chrono-medicine; however, validated measurements of circadian markers have mostly been confined to laboratory settings. The main aim of this project is to explore and systematically map the methods of monitoring circadian markers through wearable devices and review the biologically inspired mathematical models used for the prediction of circadian rhythms, so that they can be applied in general population [1]. The ultimate goal is to find more time and cost-effective methods of tracking compared to the in-lab circadian gold standard markers (core body temperature and plasma levels of cortisol and melatonin).

The project consists of an overview of the human circadian rhythms, followed by the presentation of physiological parameters that have been used for estimation (both inside and outside of the laboratory). The project further outlines the basic principles of mathematical modeling of circadian rhythms [2] and estimates which parameters and models are the best fit for wearable consumer-grade devices, such as the Apple Watch. Our main preliminary finding is that movement as a sole parameter could be used as a proxy for light in such cases [1]. Another promising approach is statistical modeling that extracts underlying circadian rhythmicity from human heart rate [3].

In conclusion, the project estimates the outcomes and performance of such models and presents some possible future applications. These include overcoming disruptions due to phenomena such as sleep-wake disorders, (social) jet lag, shift work, etc., which have already been implemented in some mobile phone apps. Regarding gaps in research, since this is a fairly new area of study, the main aim is to improve the predictability of models for more complex situations (e.g. rotating shift work). Furthermore, the project also highlights the importance of these approaches for future translational studies and the field of personalized medicine, enabling a more precise timing of administration of various therapies.

## References

- [1] Y. Huang et al., “Predicting circadian phase across populations: a comparison of mathematical models and wearable devices,” *Sleep*, vol. 44, no. 10, May 2021. doi:10.1093/sleep/zsab126
- [2] A. Asgari-Targhi and E. B. Klerman, “Mathematical modeling of circadian rhythms,” *WIREs Systems Biology and Medicine*, vol. 11, no. 2, Oct. 2018. doi:10.1002/wsbm.1439
- [3] C. Bowman et al., “A method for characterizing daily physiology from widely used wearables,” *Cell Reports Methods*, vol. 1, no. 4, p. 100058, Aug. 2021. doi:10.1016/j.crmeth.2021.100058

# Situating Large Language Models Within the Landscape of Digital Storytelling

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## Introduction

Large language Models (LLMs), such as ChatGPT, have been used to generate complex human-like text, including stories, with remarkable success. However, limitations of reliability and explainability are inherent to such systems. These limitations have also surfaced in the domain of interactive storytelling [1]. Overall, storytelling is a promising avenue for investigating these issues, as shown by ongoing research efforts in the field, that aim to merge LLMs with other, less opaque, approaches to AI [2].

## Research Goal and Methods

The research project is exploratory in nature. Our primary research goal is to gain a better understanding of the field of digital storytelling and LLM's place in it. This is accomplished through a survey of important literature, as well as hands-on familiarization with different storytelling systems.

## Theoretical Framework

A crucial distinction we apply is the one between stories and storytelling. This distinction can be explicated in terms of the difference between Marr's Type 1 and Type 2 systems [3]. A Type 1 system can be divided into distinct sub-parts relatively cleanly. Hence, Type 1 systems are algorithmic in nature; we can understand them by identifying and understanding their individual sub-parts. The production of a closed, completed story can be seen as a Type 1 system, because the story is composed of

clearly identifiable sub-parts, like the structure of the story-arc, the characters that all serve some purpose, etc.

Contrarily, a Type 2 system is complex, rather than algorithmic, with components of the system interacting and affecting each other, such that disentanglement becomes impossible. Thus, in order to understand a Type 2 system, we cannot solely rely on analysis, but need to consider the entire system holistically. We propose that the ongoing activity of telling a story, for example in live improvisation or role-play games, be best viewed as a Type 2 system, because its constitutive parts, like the developing psychological situation between participants, cannot be meaningfully disentangled.

This theoretical framework should enable us to interpret LLM's success in story-generation and their simultaneous challenges in the field in an informative manner.

## References

- [1] J. Kelly, M. Mateas and N. Wardrip-Fruin, "Towards Computational Support with Language Models for TTRPG Game Masters," in FDG '23: Proceedings of the 18th International Conference on the Foundations of Digital Games, no. 78, April 2023. doi:10.1145/3582437.3587202
- [2] J. Sung Park, J. C. O'Brien, C. J. Cai, M. R. Morris, P. S. Liang and M. S. Bernstein, "Generative Agents: Interactive Simulacra of Human Behavior," arXiv:2304.03442, April 2023. doi:10.48550/arXiv.2304.03442
- [3] D. Marr, Vision, A Computational Investigation into the Human Representation and Processing of Visual Information, San Francisco: W.H. Freeman and Company, 1982.

# The Doxastic Assumption in Coherentist Justification of Empirical Beliefs

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## Introduction

In epistemology, knowledge is traditionally defined as justified true belief [1]. A large portion of epistemology is concerned with establishing conditions for adequate justification.

Coherentism is a theory of epistemic justification that opposes foundationalism, which posits that a belief is justified by a chain of reasons that end with certain basic, a priori justified beliefs. Coherentism denies such asymmetry [2] [1]: justification rests on how well a particular belief coheres with the rest of a system of beliefs (SB). Coherentism rejects the notion of basic beliefs and posits coherence as a necessary condition for epistemic justification [3]. Coherentism is usually regarded as an internalist account of epistemic justification. While externalist theories posit that the factors determining justification are external to the subject, internalism assumes that they are internal. The doxastic assumption (DA) is held by internalists who argue that a belief can only be justified by other beliefs (e.g. [3]). My research question concerns empirical beliefs – whether doxastic coherentism can provide a solution for how sensory input can enter the SB to support its justification, so that it is not isolated from empirical reality.

Laurence Bonjour [1] has proposed a unique solution to this problem. He states that coherentist empirical justification necessitates the Observation Requirement: the SB must possess laws which attribute a high reliability to a variety of cognitively spontaneous beliefs

(CSBs) [1] – non-inferential beliefs arising from sensory input [2] that *prima facie* enable contact with the empirical [3].

According to Bonjour, justification also requires the cognizer's (justified) meta-belief about his SB's coherence. The doxastic presumption (DP) states that one's grasp of his SB must be approximately correct for coherentist justification to uphold [1].

Some philosophers have raised concerns about the validity of this argument: if DP is taken as a premise of an argument justifying meta-beliefs, it must be justified by internal reasons, and those must be justified the same way, leading to infinite regress. If DP is taken to describe meta-beliefs as basic, it introduces foundationalist features [2].

## Aims and Methods

By reviewing different solutions, I aim to show that doxastic coherentist accounts of empirical justification fail in that they require some form of foundationalism or the abandonment of the DA. This offers a way to reconsider the justificatory power of the DA and construct new solutions.

## References

- [1] L. Bonjour, *The structure of empirical knowledge*. Cambridge, MA: Harvard University Press, 1986.
- [2] T. Grundmann, "Bonjour's Self-Defeating Argument for Coherentism," *Erkenntnis*, vol. 50, no. 2/3, pp. 463–479, 1999. Available: JSTOR, <http://www.jstor.org/stable/20012929> [Accessed April 25, 2023]
- [3] J. L. Kvanvig, "Coherentist Distractions," *Philosophical Topics*, vol. 23, no. 1, pp. 257–275, 1995. Available: JSTOR, <http://www.jstor.org/stable/43154203> [Accessed April 25, 2023]



# The Effect of Categorical Distinctiveness on Memory Recognition in Adults and Children 7–9 Years Old

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Previous research has shown that knowledge structures like categories affect recognition memory (De Brigard et al., 2016). However, few paradigms allow the direct manipulation of category representation to study their effect on memory performance in adults and children. In this study, we offer a novel experimental paradigm to examine how categorical distinctiveness is related to memory. In the first stage, participants searched for a target image to remember it among five distractor images belonging to another category. The categorical visual search was organized differently: in the low categorical distinctiveness (LCD) condition, the target image was surrounded by perceptually similar images, from the same superordinate category (e.g., cat/dogs); in the high categorical distinctiveness (HCD) condition, it was surrounded by dissimilar objects, from another superordinate category (e.g., cat/chairs). In the second stage, participants solved a recognition test. We expected that visual search would lead to a distortion in remembering, a shift of the memory trace to the prototype (Lupyan, 2008): more false alarms in the LCD condition than in the HCD condition. Our hypothesis was fully confirmed in adult participants (N=30). In children (N=83) we expected that the effect of category representation on recognition should increase with age: younger

children (7–8 year-olds) should be less susceptible to this distortion from category representation, neither the number of hits nor the number of false alarms should differ in LCD and HCD conditions, than older ones (8–9 year-olds). But we haven't found statistical differences between age groups. At the same time, we found the effect of categorical distinctiveness in each of the children groups: their false alarms and numbers of hits were higher in LCD than HCD condition. The difference in effect between adults and children is particularly strong for false alarms.

In this experiment we have shown how categorical representation affects recognition and how this effect changes with age. We intend to discuss the mechanism of recognition memory development in children, as well as the advantages and limitations of the proposed paradigm for younger children.

## References

- [1] G. Lupyan, "From chair to 'chair': A representational shift account of object labeling effects on memory.," *Journal of Experimental Psychology: General*, vol. 137, no. 2, pp. 348–369, 2008. doi:10.1037/0096-3445.137.2.348
- [2] F. De Brigard, T. Brady, L. Ruzic, and D. Schacter, "Tracking the emergence of memories: A category-learning paradigm to explore schema-driven recognition," *Memory & Cognition*, vol. 45, no. 1, pp. 105–120, 2016. doi:10.3758/s13421-016-0643-6



# Deep Dive into Climate Change Attitudes: Classification of Tweets by NLP

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## Introduction

In recent years, social media platforms have become a rich source of information for exploring public opinions and attitudes on a variety of topics. Climate change is one such topic that has recently gained considerable attention in relation to NLP, as highlighted by Stede and Patz [1]. In this project, we propose the use of neural models to classify tweets related to climate change. Our goal is to develop robust and accurate models capable of analyzing attitudes toward climate change. To achieve this goal, we use the available dataset from Kaggle [2]. The dataset contains 60000 tweets about climate changes collected in a span of 10 years. In this dataset, tweets are labeled as believers or non-believers in climate change, but it also includes a sentiment tag to indicate whether the tweet is positive or negative. Thanks to this possibility, we can research the difference between attitude and sentiment.

## Targets and Research Questions

In this project, the goal is to use neural models to classify tweets related to climate change. Our secondary goal is to compare transfer learning models to identify the most appropriate model for this specific classification task. Our final goal is to compare the sentiment and attitudes of a given tweet. From the paper by Wilson [3], we can infer that there are differences between sentiment and attitudes toward a phenomenon.

Which transfer learning will help to achieve the best evaluation? Which neural networks will help qualify tweets into categories? Is there a relationship between attitude and sentiment?

## Methods

Using natural text processing techniques, we will classify the tweets into three groups, namely those that do and do not believe that climate change is a real problem. We use lemmatization instead of stemming in text processing, a study by Balakrishnan and Lloyd-Yemoh [4] showed that lemmatization is a better way of processing text, although the difference was not completely significant. We use base deep neural networks (CNN and RNN) for classification with a combination of transfer learning to achieve higher classification accuracy. From the review paper by Weiss, Khoshgoftaar, and Wang [5]... [ed.: abstract cut due to exceeding the length requirement]

## References

- [1] M. Stede and R. Patz, "The Climate Change Debate and Natural Language Processing," in *Proceedings of the 1st Workshop on NLP for Positive Impact*, pp. 8–18, 2021. [Online]. Available: <https://doi.org/10.18653/v1/2021.nlp4posim-pact-1.2>. (accessed May 09, 2023)
- [2] "10 Years of Climate Science Denial on RCGroups," 10 Years of Climate Science Denial on RCGroups|Kaggle./datasets/rickt15/10-years-of-climate-science-denial-on-rcgroups (accessed May 09, 2023)
- [3] T. A. Wilson, "Fine-grained Subjectivity and Sentiment Analysis: Recognizing the Intensity, Polarity, and Attitudes of Private States," in *Proceedings of the 1st Workshop on NLP for Positive Impact*, pp. 8–18, 2021. [Online]. Available: <http://d-scholarship.pitt.edu/7563/1/TAWilson-DissertationAp.08.pdf> (accessed May 09, 2023)

# Passive Viewing of Emotion-Evoking Images Using EEG and fNIRS

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Emotions play an important role in daily life, therefore understanding the underlying neural mechanisms of emotional processing is important both in a clinical and everyday setting. The basic emotion model assumes that each emotion has its own patterns of brain activity [1]. Consequently, the number of debates in affective neuroscience on how emotions are organized in the brain is on the rise, together with neuroimaging studies of emotional processing.

Up to recently most research studies focused on describing the valence of stimuli response without regard to how that measure corresponds to basic emotions like fear, anger, and disgust. Thus, no study researching the patterns of brain activity during the discrete states of basic emotions has been done [2].

We will examine the brain's response to viewing pictures that evoke the emotions of disgust, joy, and sadness, which have been selected based on efficiency of measuring the response while viewing the images. We will simultaneously use electroencephalography (EEG) and functional near-infrared spectroscopy (fNIRS). Previous research using this combination showed activity of prefrontal cortex, the part of the brain we will examine. Our main hypothesis is that we will observe a statistically significant difference in the brain activity between the aforementioned emotions.

## Methods

In our measurements, we will use a combination of EEG and fNIRS. With EEG-fNIRS hybrid measurements, we will detect the electrical activity in the brain (EEG) concurrently with hemodynamic responses (fNIRS), which will provide us with more comprehensive data on the brain activity. For emotion elicitation/evocation, we will use 400 stimuli containing images from multiple image databases. The stimuli will be divided into 4 categories of basic emotions: disgust, fear, joy, and neutral state. After the viewing we will use a questionnaire to attribute participants' evoked emotions to the image. The study will include 40 healthy, right-handed participants aged between 18 and 60 years.

## Expected Results

We expect to obtain results that will reflect statistically significant differences in brain activity among selected categories of basic emotions. With that we expect a correlation between areas with higher/lower levels of oxygenated hemoglobin and statistically significant ERPs. Since the expected differences in brain responses across emotional categories will not be attributed to differences in arousal or valence of stimuli, the obtained results will elucidate patterns of brain activity underlying basic emotions.

## References

- [1] R. Adolphs, "How should neuroscience study emotions? by distinguishing emotion states, concepts, and experiences", *Social Cognitive And Affective Neuroscience*, vol. 12, no. 1, pp. 24–31, 2016.
- [2] M. Balconi, E. Grippa and M. E. Vanutelli, "What hemodynamic (fNIRS), electrophysiological (EEG) and autonomic integrated measures can tell us about emotional processing", *Brain and cognition*, vol. 95, pp. 67–76, 2015.

# Predicting Coreferences with Large Language Models

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The purpose of our project is to build a machine learning model that can accurately determine coreferences in Slovenian texts for tasks within the Winograd Schema Challenge (WSC) and WinoWhy. WSC was presented in 2012 by Hector Levesque as an upgrade and alternative to the Turing test from 1950. It consists of a set of tasks where the predictive model must correctly identify coreferences at the same rate as a human. The challenge is made up of pairs of sentences that differ by only one word, which has a different coreference in each sentence. This means that the model cannot infer the reference solely from the sentence structure. A model that successfully solves the WSC could be argued to be capable of processing natural language meanings and common-sense reasoning to some extent. WinoWhy is a set of tasks that, in addition to identifying the correct referent, require the solver to provide a meaningful explanation for their decision, which is intended to provide insight into the model's common-sense thinking abilities [1]. Explaining the decisions made by machine learning models is also important from ethical and legal perspectives; with the development of generative language models and artificial intelligence, the need for their regulation and control is growing. Increasing transparency in the operation of various UI models can increase trust in them and thus accelerate their development. Due to the complexity of deep neural networks, we do not have insight into what is happening with certain information within

them and why the network produces a particular output. With WinoWhy and similar tests, we are also exploring the possibilities of the network explaining its own decisions.

Our project is in the early stages; we are currently preparing a Slovenian training set consisting of WSC and WinoWhy tasks and their solutions, on which our language model will later learn to predict and provide reasons for its decisions. The tasks have been translated into Slovenian from a database [2], and we will add explanations to them.

## References

- [1] H. Zhang, X. Zhao, and Y. Song, "Winowhy: A deep diagnosis of essential commonsense knowledge for answering Winograd Schema Challenge," Proceedings of the 58th Annual Meeting of the Association for Computational Linguistics, 2020. doi:10.18653/v1/2020.acl-main.508
- [2] E. Davis, L. Morgenstern, and C. Ortiz, "The Winograd Schema Challenge," Collection of winograd schemas, <https://cs.nyu.edu/faculty/davise/papers/WinogradSchemas/WSCollection.xml> (accessed May 10, 2023).

# Subjective or Objective? NLP-Based Model to Evaluate Emotional Tone Used in Mass Media

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With the ever-growing influence of news on our lives, it has become more difficult than ever to distinguish between biased and unbiased information. The main responsibility of reporters is to present information as objectively as possible, although in reality it's much more different. Natural Language Processing (NLP) has shown to be a very powerful tool to help with analysing language and its nuances. Therefore, we have tried to implement an NLP-based model for detecting the emotional tone of news articles as subjective or objective, which in turn might help the community to develop a better understanding of media biases and manipulation.

We used a pre-trained Bidirectional Encoder Representations from Transformers (BERT) model and the Subjectivity (SUBJ) dataset from the Natural Language Toolkit (NLTK) to fine-tune our model. We achieved a testing accuracy of 98% on the SUBJ dataset.

However powerful these tools may be, the biggest drawback is its usability on other languages, where available, pre-trained models are few or non-existent. According to Reporters without Borders (RSF), Albania has ranked the 96th in regards to press freedom for the year 2023 [2], which is the lowest ranking from all the Western Balkans countries. The availability of annotated subjectivity datasets in the Albanian

language is limited due to the lack of research in opinion mining. To overcome this challenge, we employed a machine translation approach similar to Přibáň & Steinberger [1]. Concretely, we utilised the “Helsinki-NLP/opus-mt-en-sq model” to translate English to Albanian, enabling us to annotate the SUBJ dataset with subjectivity labels.

In addition, we created a second database to analyse subjectivity in news articles. To construct this dataset, we performed web scraping on one of the most popular news websites in Albania, namely “Top Channel.” The dataset comprises unique identifiers (ID), article titles, and the respective date and time of publication on the website.

Overall, our NLP-based approach provides an effective and efficient method for analysing the emotional tone of news articles. We believe this research can contribute to the development of more accurate and unbiased news media, which is essential for maintaining informed and democratic societies.

## References

- [1] P. Přibáň and J. Steinberger, “Czech Dataset for Cross-lingual Subjectivity Classification,” in Proceedings of the Thirteenth Language Resources and Evaluation Conference, Marseille, France: European Language Resources Association, 2022, pp. 1381–1391.
- [2] Reporters Without Borders, “Albania,” <https://rsf.org/en/country/albania> (accessed May 10, 2023).
- [3] H. Huo and M. Iwaihara, “Utilizing BERT pre-trained models with various fine-tune methods for subjectivity detection,” in Web and Big Data: 4th International Joint Conference, APWeb-WAIM 2020, Tianjin, China, September 18–20, Proceedings, Part II 4, Springer International Publishing, 2020, pp. 270–284.

# Moving Away from a Human Centered Definition of Creativity: An Exploratory Study

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What is creative behavior? Its definition varies from culture to culture, context and level of inquiry. Recently, technological advancements in artificial intelligence have challenged our conception of creativity as a uniquely human trait even further.

To adapt and evolve in synergy with the developments in AI and to get the best out of these advanced technologies it is crucial to contemplate what we mean when we talk about creativity. What are the components that we can outsource and which are the aspects that only humans can fulfill? Are those aspects skills that can be learned and developed?

To understand what creativity essentially represents, I am focusing on the behaviors we can call creative. Taking a strong behavior analytic stance, the goal of my research is to operationalize creative behavior and its building block behaviors. Analogies and definitions of creative behaviors originating in other fields - artificial intelligence [1] and machine learning in the first place, but also animal behavior [2], dynamical systems theory and aesthetics [3] help to get a grip on a potential operationalization of creative behavior. Once the behaviors have been operationalized, I will be able to go on to develop appropriate measurement tools.

In my research I am using a transdisciplinary approach to examine the phenomenon of creativity that includes methods from artistic research. Stretching out my field of inquiry in between behavior analysis, artificial intelligence and ethology I look for definitions of creativity that are not necessarily human centered but hold the possibility to operationalize creative behaviors and its building blocks in detail. Ultimately, I am looking for definitions of creativity that hold for human behavior as well as for either animal behavior or the behavior of artificial cognitive systems.

The character of my research is exploratory and has the goal of understanding the topic generally from different vantage points. Secondary literature research and talks with experts are guiding my research process at this point. The product of this research process should be hypotheses that I can explore and test in future projects.

Practical utility of my research outcomes can give new impulses to help design informed educational and instructional programs in the arts more efficiently. My research vision for further projects would be to define environmental arrangements to enable the occurrence of creative behavior and establishing a basis for the architecture and design of instructional programs on creating creative behavior.

## References

- [1] V. Braitenberg, *Vehicles, Experiments in Synthetic Psychology*. Cambridge, MA: MIT Press, 1984.
- [2] A. B. Kaufman and J. C. Kaufman, *Animal Creativity and Innovation*. London: Academic Press/Elsevier, 2015.
- [3] K. R. Sawyer, *Explaining Creativity*, 2nd ed. Oxford: Oxford University Press, 2012.



# Prototyping a c-VEP-based BCI Implementation on Mobile Phones

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Brain-computer interfaces (BCI) establish a direct communication pathway between the human brain and the outside world by translating human intentions, measured by electrical activity in the brain, into control signals [1]. Patients with severe motor disabilities and highly limited means of verbal expression could benefit immensely from such a novel communication channel. BCIs based on code visually evoked potentials (c-VEPs) have gained significant interest recently, primarily because they require little user training, are easy to use, and possess high information transfer rates resulting in more accurate and faster signal processing. The c-VEP signal is generated by presenting a flickering stimulus on the central retina, resulting in an electroencephalogram (EEG) pattern that matches the flickering rate [2]. Typically, multiple targets with distinct flicker frequencies are presented to the user, each associated to a specific command. The user's intended target can then be determined by matching the c-VEP signal to the command associated with that particular flicker frequency.

Scalp EEG, which is a portable, low-cost brain monitoring technology, already has the potential to be commercialized for the public [2]. If the scalp EEG could potentially be combined with commonly used mobile phones for stimuli presentation, this could become a highly useable communication channel for patients in everyday life. What is however still unclear; are mobile phone screens technologically suitable

for the demonstration of stimuli and consequently the generation of consistent c-VEP signals? To answer this question the current research project is concerned with the development of a prototypical mobile application that generates patterns flickering at (pseudo)random frequencies. The key functionalities of the application involve: 1. A layout of four word boxes flickering at different frequencies, 2. A user feedback system for training purposes, 3. Compatibility with widely used mobile operating systems and different mobile phone hardware and 4. An intuitive and easily understandable interface to minimize the amount of required training. In the end, the performance of the app will be tested in terms of consistency and accuracy of flicker frequencies across various mobile devices and over multiple trials. Lastly, a successful implementation of the application prototype would be succeeded by testing the generation of c-VEPs with EEG recording, however this is outside the scope of the current project.

## References

- [1] G. Bin et al., "A high-speed BCI based on code modulation VEP," *Journal of Neural Engineering*, vol. 8, no. 2, p. 025015, 2011. doi:10.1088/1741-2560/8/2/025015
- [2] R. Abiri, S. Borhani, E. W. Sellers, Y. Jiang, and X. Zhao, "A comprehensive review of EEG-based brain-computer interface paradigms," *Journal of Neural Engineering*, vol. 16, no. 1, p. 011001, 2019. doi:10.1088/1741-2552/aaf12e



# Identity Fragility and Coping Mechanisms of Russian Emigrants

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## Introduction

The war taking place in Ukraine since February 2022 has provoked significant changes worldwide, particularly in the Russian anti-war community. Many people left their homes because they disagreed with the invasion of Ukraine, and many were forced to do so because it was not safe for them to stay in Russia. Previous research conducted on refugees and immigrants showed difficulties that they face in navigating their national identity in a host country, but studies have also explored coping mechanisms that are highly dependent on the cultural and historical background [1]. A major life event such as forced migration that compromises positive feelings of social identification and group membership can lead to identity fragility or even disidentification, i.e. distancing oneself from the threatened identity (ethnic background) and perceiving the corresponding identity negatively [2].

## Aim of the Study

The aim of the study is to examine the experience of Russian emigrants in the context of forced migration with a focus on identity negotiation and coping strategies previously identified, including avoidance, problem-solving, and seeking social support. The study is based on recent findings of research conducted with Ukrainian and Syrian refugees, however, it is new in terms of the Russian sample and timely considering the current geopolitical situation.

## Methods

Semi-structured interviews covering the reasons influencing the decision to move, ethnic and national identification, and resilience strategies were conducted. 7 participants of age 26–66 were interviewed, 4 females and 3 males, residing in 5 different countries. The interviews were audio recorded and transcribed. Data were analyzed using Interpretative phenomenological analysis (IPA) [3]. The IPA is the method of exploring the way how people make sense of their reality, and what is the meaning of particular events and experiences, which allows researchers to explore unique first-person experiences of a situation.

## Implications

The purpose of the study is twofold. First of all, the findings will help us gain a deeper understanding of the phenomenon of identity negotiation when a positive perception of social identity is threatened. Secondly, the results of the exploratory study will be used for forming a theoretical model that will be tested quantitatively on a bigger sample of Russian emigrants. Together, these findings will uncover sociocognitive identity mechanisms under conditions of forced migration and negative perceptions of national identity.

## References

- [1] L. Oviedo et al., “Coping and resilience strategies among Ukraine War Refugees,” *International Journal of Environmental Research and Public Health*, vol. 19, no. 20, p. 13094, 2022.
- [2] J. A. Smith, P. Flowers, and M. Larkin, *Interpretative Phenomenological Analysis: Theory, Method and Research*. Sage, CA: SAGE publications, 2009.
- [3] L. Timotijevic and G. M. Breakwell, “Migration and threat to identity,” *Journal of Community & Applied Social Psychology*, vol. 10, no. 5, pp. 355–372, 2000.

# Where Virtual Dialogue Robots Begin. State-of-the-art of AI Implementation in Video Games

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While building non-playable video game characters, developers focus on creating life-like physical behavior, while they leave the dialog to be handled by writers and voice actors. Large and accessible natural language processors have not been around for long enough to be implemented in major video game titles; however, these technologies could be used to generate characters that inhabit the words of open-world video games. NLP powered non-playable characters combined with real-time transcription tools and voice synthesizers could mean the future of immersive gaming, but how close are we to seeing something like this widely available? What tools need to be developed to make something like this work? What are the possible implications of making these tools widely available? What are the possible limitations and challenges that still need to be overcome? My research is exploratory in the intersecting realms of game design and emerging AI technologies. Based on the project conducted at ÖFAI “Charming – Character mining and generation”[1] that mainly focused on extracting character types from movies, I will examine these questions, see what is already there and where the industry is headed. Charming developed a character mining tool that they used to determine different personality markers from immense movie dialogue data. They studied how companion robots could be trained based on film characters, but this proved to be insufficient due to the lack of

technicality in film dialogue. However, video games have been implementing this character type for decades, built for technical correctness to guide players in the diegetic world and show them proper control usage. The investigation of this phenomenon is currently a highly prominent subject of scholarly inquiry, captivating the attention of both academic scholars and industry professionals, leading to a continuous influx of novel findings and models daily. In my research I am going to find the state-of-the-art implementations, models, and research on character generation, and I am also going to review the limitations the other researchers have found, trying to contact them and cooperatively try to find ways to overcome them. An example for this can be seen on a TikTok posted by AI enthusiast and coder @Tamulur who already made significant contributions [2] to making AI implementation experiments accessible and have found that at the moment delay [3] is one of the largest problems to overcome.

## References

- [1] Charming – Character Mining and Generation, Project leader: Robert Trapp, Project number: P27530-N15
- [2] Tamulur: “ChatGPT -driven NPC experiment 1” April 15, 2023 Available: <https://www.tiktok.com/@tamulur/video/7222341218460585222> [Accessed: 10.05.2023].
- [3] Tamulur: “Well the by far biggest problem right now is the awful delay. [...]”, Personal message on Tiktok (April 18, 2023)

# A Data-Driven Algorithm for Identification of Tonic and Phasic Sleep Phases based on EEG Data

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Rapid Eye Movement (REM) sleep is a crucial phase of sleep, which is responsible for memory consolidation, emotional regulation, and cognitive function [1]. REM sleep consists of phasic and tonic microstates that exhibit distinct neural activity patterns. Our research endeavors to investigate the currently limited knowledge regarding neural activity within subcortical structures during both tonic and phasic REM sleep phases [2]. The primary objective of this study is to devise a data-driven algorithm that can effectively discern between tonic and phasic sleep phases with high accuracy, leveraging EEG data as its foundation. A dataset of 20 participants, professionally coded with tonic and phasic sleep phase labels, have been collected. The analysis will involve several steps, including data preprocessing, feature extraction, feature selection, model training using machine learning algorithms, model evaluation, algorithm validation on an independent dataset, refinement and optimization, and interpretation of results. The proposed algorithm will be designed to capture specific characteristics of tonic and phasic REM sleep phases by extracting relevant features and utilizing machine learning techniques. The algorithm will be validated and optimized to ensure its robustness and generalizability. The ultimate goal is to gain insights into the neurophysiological mechanisms underlying tonic and phasic REM sleep phases.

This research aims to contribute to the understanding of sleep physiology and potentially facilitate the development of novel sleep stage classification methods.

## References

- [1] D. Tempesta, V. Socci, L. De Gennaro, and M. Ferrara, "Sleep and emotional processing," *Sleep Medicine Reviews*, vol. 40, pp. 183–195, 2018.
- [2] P. Simor et al., "REM sleep microstates in the human anterior thalamus," *The Journal of Neuroscience*, vol. 41, no. 26, pp. 5677–5686, 2021. doi:10.1523/jneurosci.1899–20.2021

# Semantic Priming Across Many Languages (SPAML)

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## Introduction

The understanding of how the mental lexicon (i.e. how words are stored in our mind) is organised broadens our knowledge on language, cognition, and memory. Among the many theories proposed, the semantic view (i.e. based on meaning) has a key role [1]. In our study, we will focus on semantic priming, a paradigm generally employed in studies on language to better understand how our minds process language and meaning, where participants are first presented with the prime word (e.g. spoon) and immediately after with the target word (e.g. fork). If the two words are semantically related they respond faster than in unrelated pairs [2].

The focus of our study is to gather a large dataset of response latencies and priming scores for prime and target word pairs across 55 languages. Additionally, the primes and targets will be supplemented with other important variables (e.g. concreteness). Our aim is to collect semantic priming data to lessen the burden of research labs to collect such data for themselves and provide them with a dataset of carefully controlled stimuli. This updatable database would be accessible via internet. Our part is focused on the Slovene language.

## Methods

We will include 40 young adults (18–40) who will be presented with a lexical decision task with semantic priming on an online web portal where they will indicate whether the shown word exists in their native language or not. The prime and the target will be either semantically

related (stol-miza) or unrelated (stol-nebo). The study will also include pronounceable non-words generated by replacing one character of an existing word for another (skol). Before the lexical decision task, the participants will provide their demographic information and after the task, they will answer a questionnaire about subjective measures of different concepts, such as familiarity, concreteness, and imageability.

## Expected Results and Discussion

Based on previous research we expect to see more accurate responses with words than non-words and a shorter response time in semantically related prime and target conditions than unrelated. These results would indicate a facilitation in processing words based on their meaning.

With the study, we aim to advance our knowledge about the organisation of the mental lexicon and explore the role of semantics. Additionally, we wish to enhance the cross-linguistic perspective on the topic. Some of the limitations of the study include the difficulty of selecting words controlled exclusively for semantics among numerous other variables. Another difficulty has to do with the broader study of morphologically less complex monosyllabic words compared to multisyllabic words [2].

## References

- [1] M. Lehmann, “Models of the mental lexicon,” *Argumentum*, vol. 15, pp. 277–289, 2019.
- [2] D. A. Balota et al., “The English Lexicon Project,” *Behavior research methods*, vol. 39, no. 3, pp. 445–459, 2007. doi:10.3758/BF03193014

# Troubadour: A Gamified e-Learning Platform for Ear Training

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## Introduction

Music learning is a complex cognitive process, and the development of a support tool for online ear training in music education can greatly enhance the learning experience. Troubadour offers a collection of games aimed at improving users' listening skills, sense of rhythm, music memory, and relative pitch. The platform is designed to support music students and teachers in formal and informal environments. It has an automatic generation of exercises and includes several gamification elements to increase user engagement. Previous studies have shown that Troubadour can be highly beneficial for formal music education at the conservatory level, yielding positive results demonstrated by improved exam scores [1, 2, 3].

The latest version of the platform incorporates new features such as a rhythmic recognition application for music school students and inversion games for melodic and harmonic exercises where the user can input their answers via singing or humming. The current stage of the project investigates how additional games and vocal input methods impact engagement, user experience, and students' academic results.

## Methods

The backend and administration framework was written in PHP programming language; the frontend for both the web and mobile application was created with Flutter – a software development platform.

Evaluation will focus on the new inversion games. Quantitative data will be gathered through questionnaires and platform usage frequency to assess the user experience, as well as A/B testing of exam grades of students in the control and test groups to evaluate the platform's effectiveness.

## Results

Data collection is currently ongoing, and we expect to see improvements in user engagement and experience of the platform. The sample is limited by the number of conservatory students (approximately 25).

## Conclusions

The newly added features, such as the singing input method, have the potential to significantly improve students' experience and develop their music production skills. Furthermore, we are working on developing more games for the music school level, with the aim of making the platform usable throughout all years of formal music education.

## References

- [1] M. Pesek, Z. Vucko, P. Savli, A. Kavcic, and M. Marolt, "Troubadour: A gamified e-learning platform for ear training," *IEEE Access*, vol. 8, pp. 97090–97102, May 2020. doi:10.1109/access.2020.2994389
- [2] M. Pesek, L. Suhadolnik, P. Šavli, and M. Marolt, "Motivating students for ear-training with a rhythmic dictation application," *Applied Sciences*, vol. 10, no. 19, p. 6781, September 2020. doi:10.3390/ap.10196781
- [3] M. Pesek, F. Klavž, P. Šavli, and M. Marolt, "Online and in-class evaluation of a music theory e-learning platform," *Applied Sciences*, vol. 12, no. 14, p. 7296, July 2022. doi:10.3390/ap.12147296



# Semantic Primitives in Word Embeddings

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## Introduction

Semantic primitives are the core concepts that possibly all humans share. They cannot be defined by any other concepts, for the chain of definitions ends in them. Finding such a set would provide us with a common communication “mother language”. We could use such a set to communicate ethical norms to less developed communities [1]. The list of such primes is already stable, numbering 65 in total including words such as TRUE, GOOD, NOT, YOU, etc.

Modern NLP models can capture the semantic similarity of words based on statistical co-occurrences of words. Such models create global embeddings, vectors for each word that occurs in the training where words that co-occur in similar contexts should occupy a similar place in the vector space [2]. The vector spaces produced by these models are based on co-occurrence statistics, and the models do not explicitly encode the fundamental semantic properties associated with semantic primitives.

Do the vectors corresponding to semantic primitives emerge near mathematically special regions in the vector spaces of NLP models, despite their lack of explicit encoding in those places? In other words, are the primes close to SVD singular vectors, PCA components, or K-Means cluster centers?

## Methods

We have compared vectors corresponding to semantic primitives with three sets of mathematically significant, in a sense “atomic” vectors – PCA, SVD, K-Means all in a variety of settings, e.g., on reduced vocabulary to most commonly used words in English. We used

three different comparison measures (Word mover’s “minimum” distance similarity (WMDS), Cosine similarity (CS), Soft cosine similarity (SCS) in 6 pre-trained 300-dimensional global word embeddings models such as FastText, Conceptnet and GloVe. Lastly, we compared the results to random words for baseline.

## Results

While FastText and ConceptNet performed better with WMDS, GloVe, and FastText excelled with Cosine Similarity, and GloVe was the standout performer with Squared Cosine Similarity. However, using WMDS, no effect was seen once compared to random words, thus, contradicting our hypotheses.

## Conclusion

We think that the WMDS is the most reliable measure for this task since it takes into account each vector separately when comparing two sets of vectors, while other methods compare averages of sets of vectors. Moreover, we think that in some cases FastText, ConceptNet, and GloVe models captured semantic primitives near mathematically special places in the vector spaces, in this corresponding order. However, semantic primitives are not uniquely captured in the models when compared to the set of random words.

## References

- [1] A. Wierzbicka, “‘Semantic Primitives’, fifty years later,” *Russian Journal of Linguistics*, vol. 25, no. 2, pp. 317–342, 2021.
- [2] D. Jurafsky and J. H. Martin, *Speech and Language Processing* (3rd (draft) ed.), pp. 102 - 113, 2019.



# Impact of Nature on the Processing of Acute Stress

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## Introduction

The aim of this study is to evaluate the impact of nature contact on the processing of acute stress. Existing studies suggest that there is a positive link between exposure to nature and decreased levels of stress [1, 2]. Yet, the temporal dynamics of the effects are not fully understood, and a recent model – the nature-based biopsychosocial resilience model (NBRT) has been developed [3]. This model suggests four pathways on how the positive effects of nature contact are maintained: prevention of exposure to stressors (preventive resilience), through decreasing the initial stress response (response resilience), through facilitating the recovery from an experienced stressor (recovery resilience) by resilience mechanisms, and, through spontaneous restoration without relying on resilience mechanisms (spontaneous restoration).

## Methods

To test and compare the suggested resilience pathways, an experimental study involving 160 participants will be conducted, in which participants will be exposed to nature stimuli (video) before or after an acute stressor (Maastricht Acute Stress Test), or to a neutral environment (video) as control group. Additionally, participants will engage in a task requiring physical effort to make decisions for themselves or another person (pro-social effort task). Behavioural, physiological, and hormonal data of the participants will be collected to analyse the effect of nature stimuli on emotional states, physiological conditions, and on pro-social behaviour.

## Expected Results and Discussion

Based on previous research we expect that participants with exposure to nature compared to participants without exposure to nature will be more resilient towards an acute stressor and engage in a more pro-social behaviour, suggesting that nature contact has a positive impact on individual's biological, psychological, and social resilience.

## Impact

As the NBRT model has not been empirically tested yet, this study will provide novel insights into the extent to which the suggested resilience pathways contribute to the stress-reducing effects of being exposed to nature. Findings of this study can be used to design future interventions to build and maintain nature-based resilience, i.e. in the fields of physical and mental health.

## References

- [1] R. S. Ulrich et al., "Stress recovery during exposure to natural and Urban Environments," *Journal of Environmental Psychology*, vol. 11, no. 3, pp. 201–230, 1991. doi:10.1016/s0272-4944(05)80184-7
- [2] S. Kaplan and M. G. Berman, "Directed attention as a common resource for executive functioning and self-regulation," *Perspectives on Psychological Science*, vol. 5, no. 1, pp. 43–57, 2010. doi:10.1177/17456916093567843
- [3] M. White, et al., "Nature-based biopsychosocial resilience: An integrative theoretical frame to advance research on nature and health" [Manuscript in preparation], Cognitive Science HUB, University of Vienna

# Assessing Social Interactions Through the Interpersonal Circumplex Affiliation Axes

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## Introduction

Interpersonal Circumplex is a model of social interactions containing two axes, an autonomy axis describing behaviors ranging from dominant to submissive, and a communal axis ranging from friendly to hostile behaviors [1]. Based on the model, measures have been established to rate general interaction perceptions and situation-specific instances from the first and third perspectives. The research question follows: “Do submissive and dominant conditions affect the participants’ perceptions of the interaction?”.

## Methods

The Interpersonal Grid (IG) is a one-item questionnaire that assesses participants’ beliefs concerning the behavior of their conversational partner [2]. Social Behavior Inventory (SBI) is used to assess own behavior during an interaction [3]. The current project aims to elicit and evaluate the participants’ perceptions of social interactions on the Interpersonal Circumplex communal and autonomous axis using IG and SBI measurements. The pairs of participants are asked to engage in a three-part dyadic interaction including Task 1 – introducing themselves to each other, Task 2 – explaining a concept, and Task 3 - providing feedback on the explanation of the other. Two conditions will be available: one requiring a participant to explain a topic of their choosing, and the second condition – explaining a topic provided by the researchers.

## Results

Collected scores will be used to validate whether the emotional responses have been elicited during the social interaction tasks. The two hypotheses are: the participants in the dominant condition will rate their performance higher on the autonomous axis and will rate the other participant lower on the same axis, while the participants in the submissive condition will rate themselves lower on the autonomous axis and the other participant higher. The second hypothesis suggests, during Task 1 there will be minor differences between the participants’ scores on autonomous and communal axes, while there will be more significant differences in Task 2 and Task 3.

## Discussion

Using the findings of the current project, in future research we will attempt to establish a possible relationship between the behavioral and EEG neural correlates to apply it to the design of Brain-Computer Interface (BCI) technologies.

## References

- [1] M. A. Fournier, D. S. M. David, and D. C. Zuroff, “Origins and Applications of the Interpersonal Circumplex,” in *Handbook of Interpersonal Psychology*, John Wiley & Sons, 2010, pp. 57–73. doi:10.1002/9781118001868.ch4
- [2] D. S. Moskowitz and D. C. Zuroff, “Assessing Interpersonal Perceptions Using the Interpersonal Grid,” *Psychol. Assess.*, vol. 17, pp. 218–230, 2005. doi:10.1037/1040-3590.17.2.218
- [3] D. S. Moskowitz, “Cross-situational generality and the interpersonal circumplex,” *J. Pers. Soc. Psychol.*, vol. 66, pp. 921–933, 1994. doi:10.1037/0022-3514.66.5.921

# Gut Microbiota Influencing Mind

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The gut microbiota has received increasing attention for its potential impact on bodily functions, particularly through the gut-brain axis. This complex interplay allows the gut to impact mood, cognition, and mental health, while also enabling the brain to modulate intestinal activities [1]. The composition of gut microbiota varies widely among individuals. Lower microbiota diversity has been associated with various brain disorders [1]. Therefore, probiotics are considered as a potential supplementary treatment for these conditions [2]. The metabolites produced by gut microbiota, used as precursors to neurotransmitters, or affecting CNS via the vagus nerve, play a crucial role in this effect [3].

This research project is conducted as a literature review with the aim to further describe and summarize the effects of *Lactobacillus* on cognition and to identify gaps. PubMed and Google Scholar were utilized, excluding journals with an impact factor below 3. Keywords such as *Lactobacillus*, cognition, gut-brain axis, human, and rodent were used.

*Lactobacillus* is one of the most common bacterial species in humans that positively affect the body. *Lactobacillus* probiotics were found to have an antidepressant effect on rodents [2]. After being exposed to chronic-restraint stress, rodents treated with *Lactobacillus* had lower levels of corticosterone hormone. They exhibited less depressive and anxious behavior and better performance on the maze task. Similar

reductions in cortisol levels have been observed in human studies, with probiotic-treated patients displaying reduced reactivity to sad mood. However, it is worth noting that the benefits of probiotics may have a ceiling effect, with no further improvement seen in individuals who are already happy [2].

Overall, there is increasing evidence supporting the positive effects of *Lactobacillus* species on rodents, and some showing similar effects on humans. The research field primarily focuses on impairments and diseases, and there is a lack of studies involving healthy individuals. Direct causal effect and mechanism of influence on human cognition is still not clear. Further studies are necessary to address these gaps.

## References

- [1] Y. Chen, J. Xu, and Y. Chen, "Regulation of neurotransmitters by the gut microbiota and effects on cognition in neurological disorders," *Nutrients*, vol. 13, no. 6. MDPI, Jun. 01, 2021. doi:10.3390/nu13062099
- [2] A. Sarkar, S. M. Lehto, S. Harty, T. G. Dinan, J. F. Cryan, and P. W. J. Burnet, "Psychobiotics and the Manipulation of Bacteria-Gut-Brain Signals," *Trends Neurosci*, vol. 39, no. 11, pp. 763–781, Nov. 2016. doi:10.1016/j.tins.2016.09.002
- [3] J. A. Bravo et al., "Ingestion of *Lactobacillus* strain regulates emotional behavior and central GABA receptor expression in a mouse via the vagus nerve," *Proc Natl Acad Sci U S A*, vol. 108, no. 38, pp. 16050–16055, Oct. 2011. doi:10.1073/pnas.1102999108

# Infants' Neural Tracking of Melodic Expectations in Children's Songs

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Musical engagement appears to be universal across human cultures. The ability to process music is already present in early stages of brain development, suggesting a predisposed mechanism that enables neural encoding of rhythm and pitch. Findings show that this early sensitivity to auditory input is facilitated by a cognitive mechanism called statistical learning, where probabilistic relations are extracted from incoming sensory information [1]. This allows for the formation of a continuously updated, feature-specific, internal model, which enables anticipation of subsequent auditory stimuli. Interestingly, already neonates show a clear differentiation in neural activity when the structural regularity of auditory cues is violated, indicating a context-specific model adaptation [2]. Since most studies on infant music cognition use non-naturalistic stimulation paradigms, it remains unclear whether the formation of melodic expectations based on statistical relations of prior sensory input is present during naturalistic music listening in infants. The present study aims to answer the critical question of whether distinct cortical responses in infants encode pitch and note-onset expectations during music listening. Using electroencephalography (EEG), we record cortical signals of healthy infants at the age of three, six, and twelve months (n=30 each) during passive listening to polyphonic MIDI (musical instrument digital interface) versions of two children's songs. Subsequently, we investigate

pitch and note-onset expectations by quantifying melodic surprise of the melody lines using IDyOM (Information Dynamics of Music), which is an empirically validated framework for computationally assessing musical structures based on variable-order Markov models [3]. Using temporal response function (TRF) analysis and ridge regressions, we investigate cortical encoding of melodic expectations. Here, we expect a higher predictive accuracy when predicting infants' neural response from acoustic, timing, and pitch information than from each parameter alone. Additionally, we hypothesize this prediction accuracy to increase with age, reflecting an improvement in tracking structural regularities across development. These results contribute to understanding melodic expectancy during naturalistic music listening and neural tracking in ecologically valid settings in early infancy.

## References

- [1] J. R. Saffran and N. Z. Kirkham, 'Infant Statistical Learning', *Annu. Rev. Psychol.*, vol.69, pp.181–203, Jan.2018. doi: 10.1146/annurev-psych-122216-011805
- [2] J. Todd, G. P. Háden, and I. Winkler, 'Relevance to the higher order structure may govern auditory statistical learning in neonates', *Sci. Rep.*, vol. 12, no. 1, Art. no. 1, Apr. 2022. doi:10.1038/s41598-022-09994-0
- [3] M. T. Pearce, "The Construction and Evaluation of Statistical Models of Melodic Structure in Music Perception and Composition," dissertation, City University London, UK, 2005.

# Effects of ECT on Memory Consolidation Process in Patients with Major Depressive Disorder

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Despite its longstanding successful use, the mechanisms of action of electroconvulsive therapy (ECT) are still not fully understood. Converging evidence shows that ECT is accompanied by widespread regional changes in gray matter volume and altered structural and functional connectivity. How these changes relate to ECT response remains to be further elucidated. It is highly conceivable that an interaction of imaging, genetic and biochemical factors related to neuronal plasticity contributes to the antidepressant effects of ECT. In this perspective, the aim of the present investigation is to detect predictive markers of ECT outcome in depressed patients by combining multimodal MRI with serum- and CSF-based laboratory measurements. Results of the study might be useful to establish an individualized medical indication for ECT.

In combination with the ongoing 3-years long study, we will try to develop a theoretical framework of how ECT affects the process of memory consolidation in patients with major depressive disorder. There is evidence that some patients report noticed memory impairments after obtaining ECT. With our theoretical framework, we want to claim against the latter statement. Because of onward depression before getting ECT; patients show to have reduced hippocampal volumes and recollection

deficits in depression (stress-related inhibition), inhibited midbrain dopamine neurons and stress-related sensitization of the amygdala. All the listed structural and functional dysconnectivity highly affects the process of memory consolidation and causes memories not to be constructed. However, after successful ECT, structural and functional connectivity in the brain improves and memory can again consolidate naturally. Overall, ECT stabilizes the memory consolidation process of depressed patients, and that is in our regards, one of the main contributions to antidepressant effects of ECT for patients with major depressive disorder [1].

With our research we would like to bring more positive evidence in hands of obtaining ECT as a successful treatment for patients with major depressive disorder. Since ECT is still widely negatively accepted and can be taken as a taboo in modern society; it is very important to provide more papers on giving reasons for accepting ECT more positively and with less fear. In that way, ECT will also be able to be researched more and will because of that, improve the treatment itself. Hypothetically speaking, more researched ECT intervention could open windows for development of future treatments, for instance, treatment of neurodegenerative disorders (dementia).

## References

- [1] D. G. Dillon and D. A. Pizzagalli, "Mechanisms of memory disruption in depression," *Trends in Neurosciences*, vol. 41, no. 3, pp. 137–149, Jan. 2018. doi:10.1016/j.tins.2017.12.006



# Composing Music for Babies and Toddlers

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## Introduction

Music plays an important role in the social and emotional development of babies [1]. However, there is a lack of research exploring the process of composing music for babies and toddlers. Previous research was focused either on general process of composing music [2] or it was aimed at a different target group, such as young musicians learning to play an instrument [3]. Literature dedicated to researching the process of composing is focused on its different aspects such as: creative process of composing, composer, and the musical work itself [2], [3].

Therefore, the aim of this research is to develop practical guidelines for future composers creating music for babies and toddlers, by exploring their creative process of composing for this age group, and their understanding of musical characteristics that are in line with music perception, music cognition, and music preferences in babies and toddlers.

## Method

The research employed a qualitative method to gather data, conducting one-on-one interviews with five composers who have created music for babies and toddlers. Given the limited research in this area, grounded theory was selected as the general research methodology. By using a qualitative approach, we aim to explore composers' phenomenological experience of quality music for this age group. The semi-structured interviews consisted of pre-given questions divided into three sections: composers' artistic process, their process of learning about developmental characteristics

of this age group and their understanding of music suitable for babies and toddlers. The interviewing process was documented through recordings, which were transcribed for further analysis. During the interview composers were asked pre-given questions, as well as being asked additional ones to gain a better understanding of their creative process. Some of the composers, whose compositions had already been performed were questioned regarding their experience with the execution of their works.

## Future Research

The received answers from the three sections will be analyzed to identify patterns in their composing and knowledge-acquiring processes, as well as their understanding of musical characteristics that are suitable for babies and toddlers according to their music perception and cognition. Based on these findings, we hope to create guidelines that will be beneficial to future composers of this kind of music.

## References

- [1] S. E. Trehub, "Infant Musicality," in *The Oxford Handbook of Music Psychology*, 2nd ed., S. Hallam, I. Cross and M. H. Thaut, Eds., Oxford: Oxford University Press, 2016, pp. 387–397.
- [2] S. Bennett, "The Process of Musical Creation: Interviews with Eight Composers," *Journal of Research in Music Education*, vol. 24, no. 1, Apr., pp. 3–13, 1976.
- [3] B. Andrews, "Secrets of the Piped Piper: Strategies for Composing Music for Young Musicians," *Research Perspectives in Music Education*, vol. 13, no. 1, May, pp. 6–14, 2009.



# Three-year-olds Hemodynamic Brain Responses in an Object-viewing-listening-naming Paradigm

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Neuroimaging studies in adults provided converging evidence for specialized brain regions that are involved in object recognition and language-related tasks [1, 2]. Since it is challenging to employ neuroimaging methods in young children, previous studies investigated this question in school-aged participants only [3], which left open the question of how these brain areas are developing. The aim of the present study is to examine this question and reveal which brain regions play a fundamental role in visual object recognition, comprehension of object labels, and production of object labels in 3-year-old children. To address this, we use functional near-infrared spectroscopy (fNIRS) to record participants' hemodynamic response during an object-viewing-listening-naming paradigm. Across all three tasks, children are presented with images of real-world entities from two subcategories: animals and household objects. The viewing task comprises silently looking at the images, the listening task looking at the images and listening to the respective object labels, and the naming task requires naming of the images. As control stimuli, we are using the scrambled versions of the images in the viewing and naming task, and scrambled images paired with rotated, incomprehensible speech in the listening task to differentiate between the representation of low-level and high-level information processing. We predict that the lateral occipital cortex will

activate for object perception [1], left-lateralized language regions, including frontal and temporal cortices for the comprehension task, and a larger contribution of prefrontal, frontal, and temporal language regions for production compared to comprehension task [2, 3]. By localizing brain regions involved in low-level and high-level visual processing, auditory perception, and speech production in 3-year-old children, we aim to provide valuable insights about shared and specialized neurocognitive resources for speech-related processes in the developing brain. Understanding the neural background of the development of language production and comprehension has important implications for basic and applied science, thus, our results can be relevant for language research, education, and therapeutic interventions.

## References

- [1] K. Grill-Spector, and R. Sayres, "Object Recognition: Insights From Advances in fMRI Methods," *Current Directions in Psychological Science*, vol. 17, no. 2, pp. 73–79, 2008.
- [2] L. Menenti, S. M. E. Gierhan, K. Segaert, and P. Hagoort, "Shared Language: Overlap and Segregation of the Neuronal Infrastructure for Speaking and Listening Revealed by Functional MRI," *Psychological Science*, vol. 22, no. 9, pp. 1173–1182, 2011.
- [3] F. Stephan, H. Saalbach, and S. Rossi, "Inner versus Overt Speech Production: Does This Make a Difference in the Developing Brain?," *Brain Sciences*, vol. 10, no. 12, p. 939, 2020.

# Exploring the Romantic Potential of Museums: Emotion Exchange in Art Context

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This study aims to explore the impact that museums and their exhibitions have on dating experiences. The term “emodity” has been established by sociologist Eva Illouz [1] and forms the theoretical starting point of this study. Emodity describes emotions as commodities and commodities as emotions. Leading to exploring the economics of emotion in the Museum.

Previous studies have explored the role of museums as dating venues in different cultural contexts [2], and the perception of dating relationships in adolescent women using artwork and photography [3]. However, these studies focused on individual subjective experiences of museum visits rather than exploring emotional exchanges during dates. Therefore, the study aims to conduct a multi-level empirical investigation of museums’ romantic potential, including four sub-studies, preceded by a pilot study.

The Pilot Study conducted on Valentine’s Day aimed to exemplify the romantic potential of museums. Observations of couples and related interviews were held and showed a trend in museum visitors. These findings offered initial insights into the underlying dynamics of romantic interactions within museum settings.

This project’s methodological diversity offers a holistic view on dating behavior. The first sub-

study involves an online survey to collect quantitative data on the emotional potential of museums as a romantic venue. Additionally, the survey explores the economic aspects of dating and their potential influence on the emotions experienced during the dating process. Qualitative data will be collected through interviews in the second and third sub-study. These sub-studies involve investigating the initial stages of romantic connections through speed dating events hosted by museums, as well as exploring museum visits as a component of first dates. Finally, the last sub-study includes eye-tracking observations of museum visits in the context of repeated dates by long-term couples.

Overall, the study could shed light on how museums can position themselves as potential dating venues. The project is a novel attempt to understand how emotions are traded in a museum context, and the findings could have implications beyond the field of dating behavior.

## References

- [1] E. Illouz, *Emotions as Commodities: Capitalism, Consumption and Authenticity*, 1st ed., Routledge, 2017. doi:10.4324/9781315210742
- [2] I. Ross, “The museum as a dating venue: Couples in the Madhya Pradesh Tribal Museum in Bhopal, India,” *Museum and Society*, vol. 16, no. 1, pp. 72–87, 2018. doi:10.29311/mas.v16i1.2459
- [3] G. D. Hays, J. Forman, and A. Sikes, “Using Artwork and Photography to Explore Adolescent Females’ Perceptions of Dating Relationships,” *Journal of Creativity in Mental Health*, vol. 4, no. 4, pp. 295–307, 2009. doi:10.1080/15401380903385960

# The Validation of Cognitive Tasks for Studying Executive Functions in Children

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Executive functions refer to a set of mental processes, including attention, working memory, inhibition, and cognitive flexibility, that enable the monitoring and control of behavior. Due to their central role in cognition, executive functions are often disrupted in various neurological and psychiatric disorders [1]. During childhood, executive functions undergo developmental changes characterized by a shift from reactive to proactive control, which typically occurs around the age of 5. Reactive control is cognitive control applied as a corrective mechanism after a cognitively demanding event, while proactive control entails maintaining goal-relevant information before such an event to facilitate more effective responses [2]. However, investigating executive functions in children poses several challenges, such as the primary development of behavioral tasks for adults, lack of testing on children, and tasks being too demanding for children, resulting in reduced attention and fatigue during data collection. To address these concerns, we have developed engaging and practical behavioral tasks that provide reliable measurements for use with children.

Our study aims to assess and compare the validity of different versions of the AX-CPT task, specifically designed to evaluate reactive and proactive control [3]. The AX-CPT task is structured using a series of visual stimuli, where each trial consists of a sequential presentation

of an initial stimulus (A or B) followed by a subsequent stimulus (X or Y). Participants are instructed to respond differently in the AX condition compared to all other conditions. The study will involve approximately 300 participants spanning a wide age range, from children to elderly. We will attempt to determine the optimal proportions of task conditions (AX, AY, BX, and BY) for children aged 8 to 15 by analyzing response accuracy and reaction time and comparing the results with those obtained from older age groups.

Our preliminary results, based on data collected from 47 young adults, indicate a prevalent use of proactive control, which aligns with our expectations. Upon comparing the analyses of diverse task variations, notable distinctions in their validity were observed, indicating that variants featuring a higher proportion of AX trials may exhibit greater reliability for practical applications. To establish more robust conclusions regarding the most appropriate tasks for children, further investigation involving a larger dataset encompassing different age groups is warranted.

## References

- [1] A. Diamond, "Executive functions," *Annual Review of Psychology*, vol. 64, no. 1, pp. 135–168, 2013. doi:10.1146/annurev-psych-113011-143750
- [2] C. Gonthier, M. Zira, P. Colé, and A. Blaye, "Evidencing the developmental shift from reactive to proactive control in early childhood and its relationship to working memory," *Journal of Experimental Child Psychology*, vol. 177, pp. 1–16, 2019. doi:10.1016/j.jecp.2018.07.001
- [3] C. H. Chatham, M. J. Frank, and Y. Munakata, "Pupillometric and behavioral markers of a developmental shift in the temporal dynamics of cognitive control," *Proceedings of the National Academy of Sciences*, vol. 106, no. 14, pp. 5529–5533, 2009. doi:10.1073/pnas.0810002106

# How Language Influences Executive Functions

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## Introduction

In general, the domain known as executive function consists of multiple cognitive processes that are active in planning, monitoring, and executing plans to achieve a goal. The main processes in this domain are inhibition, working memory, and cognitive flexibility. It is possible that differences in linguistic processes, mainly monolingualism and bilingualism, additionally morphological differences, may interact with executive functioning.

The reason behind studying such a connection lies behind multiple hypotheses. Firstly, language according to multiple theories of development is an aid in the development and emergence of executive functions [1]. Secondly, many studies have yielded that bilingual showed better performance than monolinguals in executive functions which has been associated with the need for more inhibitory control required by bilingual speakers [2]. Morphological differences in spoken language may also be relevant to executive function differences specifically in attention and working memory [3]. Hence, this study investigates whether there is a positive correlation between executive function performance and level of bilingualism and the morphological status of the spoken languages.

## Method

Currently, I am involved in a study led by Professor Alexander Logemann which investigates mechanisms of self-regulation and includes Adapted Stop Signal Task (SST) and Visual Spatial Cueing Task (VSC). SST is a task designed to

assess motor response inhibition while VSC assesses visual attention. The method of collecting data regarding linguistic abilities is not set yet, however, a possible tool of assessment includes Language Experience and Proficiency Questionnaire. This questionnaire measures proficiency, age of acquisition, type of language exposure, and many other dimensions that allow for judgment on the level of bilingualism. Identification of the languages they are proficient in will also reveal whether they are agglutinative or fusional language speakers. Data collected from these tasks and questionnaires could reveal information regarding the correlation between language and executive functions.

## References

- [1] U. Müller, S. Jacques, K. Brocki, and P. D. Zelazo, "The executive functions of language in pre-school children," *Private Speech, Executive Functioning, and the Development of Verbal Self-Regulation*, pp. 53–68, 2009. doi:10.1017/cbo9780511581533.005
- [2] E. Chrysochoou, S. Kanaki, and A. B. Vivas, "Executive functions in French-greek early bilinguals: In search of the suggested bilingual advantage," *Psychology: the Journal of the Hellenic Psychological Society*, vol. 25, no. 2, p. 76, 2020. doi:10.12681/psy\_hps.25588
- [3] J. Don, "What causes languages to be transparent?," *Language Sciences*, vol. 60, pp. 133–143, 2017. doi:10.1016/j.langsci.2017.01.004

# Pain in Preterm Newborns

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## Introduction

Pain is an unpleasant sensory and emotional experience associated with, or resembling the experience of, actual or potential tissue damage. While nociception is objective, pain is subjective. It is a complex, personal experience influenced by biological, psychological, and social factors hence not being equal to nociception. Pain mechanisms start developing early and mature during development. Through life experiences individuals learn the concept of pain. Verbal inability to communicate should not be interpreted as absence of pain. In preterm newborns who are prone to medical interventions due to their immaturity and medical conditions associated with it, recognising, assessing, treating and preventing pain remains a challenge.

Through literature review our aim is to answer the following questions: (1) How do pain mechanisms develop during pregnancy? (2) How do premature birth and procedures in preterm newborns influence pain mechanisms? (3) How do we recognise pain during perinatal period?

## Results

**Development of Nociception and Pain:** At 8 weeks of gestation (WGA) fetus has a sufficiently developed neural system to respond to touch and noxious stimuli, at 12 WGA pain capacity can be enabled via cortical subplate. Some researchers see these reactions prior to 24 WGA as unconscious and reflexive. Preterm babies of 22–27 WGA share physiology with fetuses of same age [1]. Neurons that modulate

and inhibit pain undergo rapid growth beginning at 22 WGA [2].

**Effects of Preterm Birth and Procedures on Pain Mechanisms:** Repeated painful exposures in preterm babies have potential for deleterious consequences [3]. Procedures may permanently modify individual pain processing and present risk factors for persistent altered neurodevelopment.

**Recognising Pain:** Newborns use behavioural (facial expressions, crying, body movement) and physiological (increased heart rate and blood pressure) signals to communicate their experience of pain which can be measured with pain scales, but these signals are not uniquely specific to pain. Prolonged pain can lead to exhaustion, causing newborns to stop expressing it [3].

## Conclusions

Pain mechanisms are developed in preterm infants. Because of immaturity pain is difficult to recognise, interpret, and measure. From ethical point of view as well as from the possible consequences on neurodevelopment, further research is needed.

## References

- [1] R. Pierucci, “Fetal pain: The science behind why it is the medical standard of care,” *The Linacre Quarterly*, vol. 87, no. 3, pp. 311–316, 2020. doi:10.1177/0024363920924877
- [2] A. C. Rodrigues and R. Guinsburg, “Pain evaluation after a non-nociceptive stimulus in preterm infants during the first 28 days of life,” *Early Human Development*, vol. 89, no. 2, pp. 75–79, Feb. 2013. doi:10.1016/j.earlhumdev.2012.08.002
- [3] E. Keels et al., “Prevention and management of procedural pain in the neonate: An update,” *Pediatrics*, vol. 137, no. 2, Feb. 2016. doi:10.1542/peds.2015–4271



# Philosophical and Scientific Review of Mahayana Buddhist Theory of Consciousness and Nirvana

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According to the Buddhist tradition, six different consciousnesses (vijñāna) are distinguished, the first five of which are sense-bases (āyatana) corresponding to visual, auditory, olfactory, gustatory, and tactual perception. The last is called manovijñāna, and its object is not external perception like the former five, but ideas, concepts, or mental objects. Yogācāra school of Mahayana Buddhism following Vasubandhu adds two more consciousnesses into the schema: manasvijñāna and ālayavijñāna. The eighth consciousness, ālayavijñāna, is sometimes translated to “store-house consciousness” and is “the base” or “the seed” of other seven consciousnesses. Between this base-consciousness and the first six consciousnesses is manasvijñāna which mediates them. It is also to be noted that manasvijñāna is traditionally believed to be the source of the attachment (upādāna) to one’s ego (ātman) and hence hindering them from achieving nirvana.

In this paper, we will review these principles of consciousness developed by Indian and East Asian philosophers based on modern psychological and neuroscientific findings. For example, ālayavijñāna will be compared to the role of memory and unconscious bias in cognition.

Then we further analyse the concepts in the frame of analytic philosophy of mind, focusing

on the recent discourse on the nature of consciousness. One point to be made is that this Buddhist theory of consciousness, for it includes certain higher-order perception as a constituent of consciousness, can be classified as what is commonly referred to as higher-order theories of consciousness. Based on this interpretation, we will review how the phenomenon of nirvana can be understood in terms of philosophy of consciousness.

We hope this approach to facilitate understanding the argumentative structure of Buddhist philosophy of mind and epistemology more clearly, ultimately leading us to the reconstruction of the theory using modern terminologies.

## References

- [1] T. Kuan, “Conscious of everything or consciousness without objects? A paradox of Nirvana,” *Journal of Indian Philosophy*, vol. 48, no. 3, pp. 329–351, 2020. doi:10.1007/s10781-020-09422-5
- [2] N. Srinivasan, “Consciousness without content: A look at evidence and prospects,” *Frontiers in Psychology*, vol. 11, 2020. doi:10.3389/fpsyg.2020.01992
- [3] B. C. Hall, “The Meaning of Vijñapti in Vasubandhu’s Concept of Mind,” *The Journal of the International Association of Buddhist Studies*, vol. 9, pp. 7–23, 1986.



# Attention, Reading and Comprehension of Chinese-English Bilinguals. An Eye-tracking Study

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Mother language (first language or birth language, L1) plays a crucial role in education, especially during reading. It has been suggested that mother language education facilitates learning a second language (L2), and that if a child reads in their mother language from an early age, they will have more substantial reading skills in other languages [1]. As mother language has such a dominant influence on the personal reading skills, and on thinking and comprehension, we assume that bilinguals have a “mother language preference” for decoding of L1 as an automatic process while they do not have it for L2.

We designed a few original eye tracking experiments for Chinese-English bilinguals. In experiment 1 (E1), participants will be told to pay attention to the picture 1 which is shown on the screen for a limited time (10 seconds). The stimuli in picture 1 is a long sentence in L2 reading material (at the top) and it is followed by an “L1 translation” (at the bottom). There are small mismatches between the two sentences, which are not very obvious. After the presentation of the stimuli, we will ask participants some questions related to the sentences, in order to see whether they understood the meaning of both sentences and whether they detected the mismatches.

The principles of experiment 2 (E2) are similar to E1. In E2, we show participants another picture (similar but not the same as the picture 1) with L2 version at the top and L1 at the bottom. The most significant difference between the two experiments lies in the questions. In E2, participants need to make inference from the reading material or even do a simple calculation based on both sentences. So we will also make comparison between the results of E1 and E2. Eye tracking metrics such as fixation duration, total fixation time are collected. The hypothesis of the experiments are: 1. No matter how proficient in L2 the participants are, when given reading materials in L1 and L2 at the same time, in a given duration, bilinguals will pay more attention to the L1 sentences. 2. Even being implied paying attention to both versions, when the L1 reading material seems like the translation version of L2 reading material, bilinguals still prefer understanding the L1 sentences first than L2 sentences.

## References

- [1] X. Tong, C. McBride, H. Shu, and C. S. Ho, “Reading comprehension difficulties in Chinese-english bilingual children,” *Dyslexia*, vol. 24, no. 1, pp. 59–83, 2017. doi:10.1002/dys.1566

# How Does Statistical Learning of an Artificial Grammar Happen? A Behavioural Study

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## Introduction

It was shown that human brain keeps track of linguistic units in speech processing on various levels, e.g. at the level of syllables, words, phrases and sentences [1]. Studies using artificial grammars instead of natural language input additionally suggest that this tracking of differently sized units can proceed also in the absence of specific language knowledge and on mere basis of the statistical relations present in the input.

In a previous study using artificial grammar learning approach[2], the authors found evidence for simultaneous neural tracking of both adjacent word-level and non-adjacent phrasal-level structures. That tracking was based on mere distributional information without any top-down language knowledge or additional prosodic cues to guide learning. However, there was no conclusive evidence of pattern learning on a behavioural level evident from the grammaticality judgement task.

The present research project builds upon that work and aims to address the encountered misalignment between neural and behavioral evidence. The main research question is the following: How does the learning of an artificial grammar happen on a behavioural level?

## Methods

Healthy adult volunteers are participating in the study. The project will use an artificial grammar learning approach. The experiment

consists of 2 stages: 1. Learning stage. Participants are actively listening to a long sequence of nonsensical syllables (e. g., fi lo pa fu se ba). There is a hierarchical structure in the sequence: every 2 syllables constitute a „word,“ every 3 „words“ constitute a „sentence.“ 2. Test stage. Participants are presented with new „sentences“ individually. They judge whether new sequences are “grammatical” or “ungrammatical”, based on the rules they learnt from the experiment.

## Expected Results

We expect to find a pattern in participants’ grammaticality judgements indicating the exact nature of representations they form during the learning phase. A between-subjects design with differently structured test items for each group will then allow conclusions about which types of structures were likely learned in the previous study and further allow inferences about which types of structures may facilitate learning. This research serves the purpose of a pilot study for subsequent experimental research involving EEG.

## References

- [1] N. Ding, L. Melloni, H. Zhang, X. Tian, and D. Poeppel, “Cortical tracking of hierarchical linguistic structures in connected speech,” *Nature Neuroscience*, vol. 19, no. 1, pp. 158–164, 2015. doi:10.1038/nn.4186
- [2] I. Weyers, B. Walkenhorst, K. Nettermann, Ö. Bulca, T. Gruber, and J. L. Mueller, ” Neural entrainment reveals simultaneous, implicit learning of adjacent word and non-adjacent phrasal structure,” unpublished paper, 14th Annual Meeting of the Society for the Neurobiology of Language, Philadelphia, USA, 2022.

# **MEi:CogSci Conference 2023**

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