



Middle European  
Interdisciplinary Master Programme  
in Cognitive Science

Proceedings of the  
**MEi:CogSci**  
**Conference**  
**2017**

Budapest, Hungary

**Editors:**

Peter Hochenauer, Katharina Rötzer, Cornell Schreiber, Elisabeth Zimmermann  
*University of Vienna, Austria*

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*Comenius University in Bratislava, Slovakia*

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# **Proceedings of the MEi:CogSci Conference 2017**

The conference took place at Eötvös Loránd University in Budapest on 22-24 June, 2017.

## **Editors:**

Peter Hochenauer, Katharina Rötzer, Cornell Schreiber, Elisabeth Zimmermann  
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# Welcome!

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

Welcome to our 11th MEi:CogSci Conference; for the second time hosted by our partner in Budapest, the Eötvös Loránd University.

We want to express our gratitude to Ildikó Király for her efforts in the past years in making MEi:CogSci a fully accredited programme at ELTE and taking over coordination of the programme and this year's conference. We thank the Institute of Psychology (ELTE PPK) and especially Dean Zsolt Demetrovics for hosting our conference this year. We further thank Fanni Tolmár for organising the event locally.

We want to welcome our invited speakers and presenters of workshops, Eubica Beňušková (Comenius University in Bratislava, Slovakia), Penka Hristova (New Bulgarian University, Bulgaria), Attila Krajcsi (Eötvös Loránd University in Budapest) and Isabella Sarto-Jackson (Konrad Lorenz Institute for Evolution and Cognition Research in Klosterneuburg). Thank you for joining us this year.

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

The organising team of Comenius University in Bratislava and the printing of the proceedings were supported by the developmental project 002UK-2/2016, and in part by the KEGA project 076UK-4/2013, both from the Ministry of Education, Science, Research and Sport of the Slovak Republic. Thank you, Igor Farkaš, for organising this, as well as 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 it happen. Your posters, talks, and initiatives will make the MEi:CogSci Conference 2017 an exciting and joyful event!

Thank you all for coming! Enjoy the 11th MEi:CogSci Conference!

Peter Hochenauer

Katharina Rötzer

Cornell Schreiber

Elisabeth Zimmermann

**Eleventh Middle European Interdisciplinary Conference in Cognitive Science**  
**Eötvös Loránd University, Hungary**  
**22-24 June, 2017**



Middle European  
Interdisciplinary Master Programme  
in Cognitive Science

## Thursday, June 22, 2017

12:00 – 14:00	<b>Registration</b>		
14:00 – 16:00	<b>Workshops</b>		
	↘ AULA	↘ Room 115	↘ Room 203
	Phenomenological Rules of Synaptic Plasticity and Metaplasticity <i>Lubica Beňušková</i>	Paradigms for Studying Constructive Memory <i>Penka Hristova</i>	Dualism and Neuroscience <i>Asura Enkhbayar, Damar Hoogland, Robbie Hopper &amp; Dylan Ross</i>
16:00 – 16:30	<b>COFFEE BREAK</b>		
16:30 – 16:45	<b>Welcome &amp; Conference Opening</b> ↘ AULA		
16:45 – 17:45	<b>Plenary Talk: The Bases of Mathematical Understanding</b> <i>Attila Krajcsi</i>  ↘ AULA		
17:45 – 18:00	<b>SHORT BREAK</b>		
18:00 – 19:30	<b>Poster Session 1</b> ↘ AULA		

## Friday, June 23, 2017

10:00 – 11:10	<b>Track A:</b> Emotion & Empathy	<b>Track B:</b> Psychopathology	<b>Track C:</b> Motor Function
	↳ AULA	↳ Room 115	↳ Room 203
	Camera System for Measuring Emotion by Capturing Physiological Parameters <i>Jan Markočíč</i>	Autism Subtypes in Context of Current Theories <i>Nikola Ondříková</i>	Where Do We Stimulate the Motor Cortex <i>Iva Ilioska</i>
	Activation of the Mirror Neuron System by Emotional Facial Expressions <i>Lucia Hrašková</i>	The Use of Embedded Robots in the Therapy for Children on the Autism Spectrum <i>Elena Hirjoaba</i>	Reducing the Variability of Motor Evoked Potentials <i>Benjamin Fischer</i>
	Mirror Neurons and Empathy: What is Neuroscience to Theory? <i>Robbie Hopper</i>	Speech Alterations in Schizophrenia <i>Aisha Tüchler</i>	Motor-evoked and TMS-evoked Potentials: Correlation between the two Measures and their Modulation after 5-Days-Consecutive iTBS Intervention <i>Magdalena Kralik</i>
11:10 – 11:30	<b>COFFEE BREAK</b>		
11:30 – 13:00	<b>Track A:</b> Modelling Approaches	<b>Track B:</b> HCI, BCI & Social Cognition	<b>Track C:</b> Clinical & Ageing
	↳ AULA	↳ Room 115	↳ Room 203
	Connectionist Model of Sentence Comprehension <i>Anton Kouáč</i>	Human-Computer Interaction Overview: Theories & Methods <i>Alex Steiner</i>	Behavioural and Electrophysiological Characteristics of Cognitive Control: A Comparison of Healthy and Clinical Groups <i>Petra Šlahorová</i>

	<p>Embedding Social Behaviour in Emotion in Fuzzy Animats <i>Jan Jug</i></p>	<p>A Universal Game Controller Interface (UGCI) for Neurofeedback ADHD Treatment <i>Aleksandar Miladinović</i></p>	<p>Mobile Parkinson's Disease Monitoring <i>Rok Lenart</i></p>
	<p>Learning to Reach with Cues Using a Simulated Robotic Arm <i>Matúš Štefek</i></p>	<p>The Role of Steroid Hormones in Human Social Behaviors <i>Karina Rerichová</i></p>	<p>Life Satisfaction in Old Age: Comparing the Successful and Harmonious Aging Approaches <i>Cristina Dintica</i></p>
	<p>Collective Dynamics of Multi-Agent Networks: Simulation Studies in Probabilistic Reasoning <i>Max Pellert</i></p>	<p>The Effects of Social Affiliation on Approach/Avoidance Responses Towards Social and Non-social Stimuli <i>Ana Stijović</i></p>	
13:00 – 15:00	<b>LUNCH BREAK</b>		
15:00 – 16:30	<b>Track A:</b> Music	<b>Track B:</b> Language	<b>Track C:</b> Decisions & Innovation in Organisations
	↳ AULA	↳ Room 115	↳ Room 203
	<p>Constrained by Convention: Emotional Effect of Microtonality on Professional Musicians and Non-musicians <i>Marek Osrman</i></p>	<p>Talent for Accent: Is There a Correlation Between Phonetic Native and Foreign Language Aptitude? <i>Marion Coumel</i></p>	<p>Power and Morality <i>Xenia Raufeisen</i></p>
	<p>The Influence of Alcohol on Music Induced Enjoyment – An Inquiry into the Mechanisms <i>Marianne Tiihonen</i></p>	<p>Processing Suffix Combinations in Slovene <i>Špela Medvešek</i></p>	<p>Measuring Cultural Differences via Interactive Medium <i>Stefan Dobrosavljević</i></p>
	<p>Relationship Between Mathematical and Musical Abilities in Middle School Students <i>Matej Sedláček</i></p>	<p>Meaning in Morphological Decomposition <i>Janik Ježovnik</i></p>	<p>A Methodological Proposal on How to Use the Analytic Hierarchy Process Technique to Improve Need-based Solution Knowledge Strategies <i>Caspar Matzhold</i></p>

	<p>Reconstruction of Perceived and Imagined Music from EEG Recordings with Deep Neural Networks</p> <p><i>André Ofner</i></p>	<p>The Effect of Task Description on the p600 ERP in Artificial Language Learning</p> <p><i>Damar Hoogland</i></p>	<p>Communicating Emergent Novelty – Proposing a Theoretical Communicative Framework to Support Novelty Creation in Organizations</p> <p><i>Carina Trapl</i></p>
16:30 – 16:45	<b>COFFEE BREAK</b>		
16:45 – 18:15	<p><b>Poster Session 2</b></p> <p>↳ AULA</p>		
18:15 – 19:00	<p><b>Plenary Talk: Effect of Aging on Functional Brain Networks: A Graph-Theoretical Analysis</b></p> <p><i>Lubica Beňušková</i></p> <p>↳ AULA</p>		



## Saturday, June 24, 2017

10:00 – 10:50	<p><b>Plenary Talk: The Relational Luring Effect: Retrieval of Relational Information as a Function of Strength, Typicality and Accessibility of Relational Representations in Long-Term Memory</b></p> <p><i>Penka Hristova</i></p> <p>↳ AULA</p>		
10:50– 12:00	<p><b>Track A:</b> Thinking</p> <p>↳ AULA</p>	<p><b>Track B:</b> Experience &amp; Qualitative Methods</p> <p>↳ Room 115</p>	<p><b>Track C:</b> Biochemical Factors</p> <p>↳ Room 203</p>
	<p>“Who Will Save Innocent Kitties with Counterfactual Priming?”</p> <p><i>Miroslava Galasová</i></p>	<p>Examining the Relationship Between Hearing and the Sense of Touch</p> <p><i>Fabijan Purg</i></p>	<p>Gabaa Receptor Subunit Distribution &amp; Variants</p> <p><i>Jure Fabjan</i></p>
	<p>The Role of Mental Representations in Problem Solving Process</p> <p><i>Nejc Grenc</i></p>	<p>The Experience of Addiction</p> <p><i>Julija Podbevšek</i></p>	<p>Fetal Development of Hypothalamic Dopaminergic Neurons and their Role in Circadian Rhythms</p> <p><i>Maja Zupančič</i></p>
	<p>Understanding and Assessing Bullshit Receptivity</p> <p><i>Eugen-Calin Secara</i></p>	<p>Optimising Interobserver Reliability in Qualitative Studies</p> <p><i>Evelyn Gasiorek</i></p>	<p>Assessment of Sleep – Wake Patterns in Lesch’s Type 1 and Type 2 Tobacco Dependents</p> <p><i>Noureddine Souirti</i></p>
12:00 – 14:00	<p><b>LUNCH BREAK</b></p>		
14:00 – 15:10	<p><b>Track A:</b> Impact of Social Media</p> <p>↳ AULA</p>	<p><b>Track B:</b> Learning &amp; Memory</p> <p>↳ Room 115</p>	<p><b>Track C:</b> Empirical Aesthetics &amp; Brain Networks</p> <p>↳ Room 203</p>
	<p>Like If Reductionist, Comment If Non-reductionist: A Comparison of the Almetric Performance in Neuroscientific Literature</p> <p><i>Asura Enkhbayar</i></p>	<p>Midsession Reversal Learning in Dogs (<i>Canis Familiaris</i>)</p> <p><i>Katja Letonja</i></p>	<p>Influence of Manipulation of Complexity and Processing Fluency on Liking in Aesthetic Experience</p> <p><i>Marko Kvar</i></p>

	<p>The Dark Side of Technology: Qualitative Insights Into Our Use of Information and Communication Technologies</p> <p><i>Kathrin Bednar</i></p>	<p>Computational Model of Memory Consolidation</p> <p><i>Lukáš Rückschloss</i></p>	<p>How Does Interoception Shape Our Experience of Art?</p> <p><i>Giulia Cabbai</i></p>
	<p>The Costs of Being Behind a Screen – Could Social Media Use be Addictive?</p> <p><i>Dolores Trol</i></p>	<p>Memory Retrieval in a Rapid Sequence Visual Presentation Paradigm</p> <p><i>Miha Medved</i></p>	<p>Overlapping Communities in Functional Brain Networks</p> <p><i>Jan Klusáček</i></p>
15:10 – 15:30	<b>COFFEE BREAK</b>		
15:30 – 16:15	<p><b>Alumni Talk 1: The Audacity to be a Scientist</b></p> <p><i>Vadim Kulikov &amp; Dominic Reichl (MEi:CogSci Year 2013)</i></p> <p><b>Alumni Talk 2: Come Together, Right Now – Temporal Coordination in Musicians Despite Unstable Phase Relation</b></p> <p><i>Thomas Wolf (MEi:CogSci Year 2012)</i></p> <p>‡ AULA</p>		
16:15 – 17:00	<p><b>Plenary Talk: Where Neuroscience Meets Anthropology: Neuroplasticity in Cultural Contexts</b></p> <p><i>Isabella Sarto-Jackson</i></p> <p>‡ AULA</p>		
17:00 – 17:30	<p><b>Best Poster &amp; Best Talk Award</b></p> <p><b>Conference Closing</b></p> <p>‡ AULA</p>		

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**MEi:CogSci Conference 2017,  
Budapest, Hungary**

**Workshops**

**&**

**Plenary Talks**

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**Workshop 1**  
**Phenomenological Rules of Synaptic Plasticity and Metaplasticity**

**Ľubica Beňušková**

Centre for Cognitive Science, Department of Applied Informatics,  
Comenius University in Bratislava,  
Bratislava, Slovakia

Synaptic plasticity is a brain-wide and life-long capacity of interneuronal connections, i.e. synapses to change their strength. Long-term changes in synaptic weights underlie learning and long-term memory formation in the brain. In addition, numerous studies show that the outcome of a particular stimulation protocol which induces long-term synaptic changes, depends also on the state and or previous history of activity of neural circuitry. In this workshop we will describe, compare and discuss several phenomenological rules of synaptic plasticity and metaplasticity that were introduced within the last decade to account for the above phenomena. Phenomenological means that these rules account for the phenomenon per se and not for the molecular mechanisms that are involved.

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**Workshop 2**  
**Paradigms for Studying Constructive Memory**

**Penka Hristova**

Experimental Psychology Laboratory, Department of Cognitive Science and Psychology,  
New Bulgarian University,  
Sofia, Bulgaria

The storehouse vs. the paleontologist metaphor of human memory would be contrasted in searching the unique sequences of constructivist approach to human memory. The main paradigms for studying constructive memory processes will be presented and discussed based on specific examples. The different constructive memory mechanisms that those research paradigms suggest, such as schematization, blending and memory reconsolidation will be critically discussed.

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**Workshop 3**  
(Organised by MEi:CogSci Students)  
**Dualism and Neuroscience**

**Dylan Ross**

Institute for Perception, Action and Behaviour, School of Informatics,  
University of Edinburgh,  
Edinburgh, United Kingdom

**&**

**Robbie Hopper, Damar Hoogland, Asura Enkhbayar**

Department of Philosophy  
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Philosophical assumptions affect the framing of research and the questions asked in neuroscience. In this workshop, we invite everyone to come along and discuss some of these assumptions. In particular, we will focus on the traces of dualism that can be found in neuroscience. In the first place, we will discuss brain-body dualism. As a case study, visiting graduate student Dylan Ross will present their work on maggot movement, which takes a monist rather than dualist approach to studying the brain-body system. We would like the workshop to be a discussion rather than a lecture and so we welcome contributions from everyone who has an interest in the subject area.

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**Plenary Talk**  
**Effect of Aging on Functional Brain Networks: A  
Graph-Theoretical Analysis**

**Ľubica Beňušková**

Centre for Cognitive Science, Department of Applied Informatics,  
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Bratislava, Slovakia

Decline of cognitive especially memory-related capabilities is a well known manifestation of brain aging. This is even more exacerbated with the onset of Alzheimer disease and its progress. It is also well known that with age, there is a decline in the number of neurons in the brain. In our study, we have focused on creation and analysis of the so-called functional brain networks from the fMRI data and their analysis by means of the graph theory. Thus, the talk will deal with a short introduction into the theory of graphs and will describe our results about the changing characteristics of functional brain networks due to aging and the onset of Alzheimer disease.

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**Plenary Talk**  
**The Relational Luring Effect: Retrieval of  
Relational Information as a Function of Strength,  
Typicality and Accessibility of Relational  
Representations in Long-Term Memory**

**Penka Hristova**

Experimental Psychology Laboratory, Department of Cognitive Science and Psychology,  
New Bulgarian University,  
Sofia, Bulgaria

The Relational luring effect (RLE) stands for the false recognition of an exemplar (FLOOR CARPET), which is relationally similar to a previously studied word pair (TABLE CLOTH). Popov, Hristova & Anders (2017) recently demonstrated that false alarms and response times (RTs) to relational lures as well as hits for previously seen exemplars in a continuous associative recognition task increased linearly with the number of different instances of the same relation that were studied beforehand. Moreover, the RLE increases with the typicality of the lure pairs, and with the strength and accessibility of the relational representation in Long-Term Memory. These results were considered as evidence that semantic relations have abstract representations in LTM that are separate from the representations of their specific instances. These abstract representations give rise to relational priming, structural priming and relational luring effects. Sometimes this happens unintentionally, without awareness and without involving executive working memory resources.

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**Plenary Talk**  
**The Bases of Mathematical Understanding**

**Attila Krajcsi**

Department of Cognitive Psychology,  
Eötvös Loránd University,  
Budapest, Hungary

Analogous Number System (ANS) is believed to be the base of number understanding. It is an evolutionary ancient system, without which people wouldn't understand numbers. Its precision is related to school math performance, and improving this base system improves math task performance. The ANS is believed to be one of the most important components of mathematical abilities. Instead of this widespread model, we propose an alternative model to explain symbolic number processing related phenomena. According to our Discrete Semantic System (DSS) model, numbers are partly stored in a conceptual network. In this talk I present several studies contrasting the two accounts, in which we have repeatedly found phenomena the ANS model cannot explain. I'll also discuss why former pieces of evidence were seemingly supporting the ANS account, even when that interpretation was wrong.

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**Plenary Talk**  
**Where Neuroscience Meets Anthropology:  
Neuroplasticity in Cultural Contexts**

**Isabella Sarto-Jackson**

Konrad Lorenz Institute for Evolution and Cognition Research,  
Klosterneuburg, Austria

Modern anthropology is built on an intellectual foundation that attempts to understand behavior from the perspective of both, cultural and human biological systems. Over the last decades, neuroscience has become increasingly influential on how we explain behavior. Methodological advancements in neuroscience tempt us into seeing behavior as a linear extension of brain processes. Yet behavioral substrates unfold at several explanatory levels in a dynamic way. In addition, brain processes and structures are subject to neuroplasticity, i.e. the nervous system can change and reorganize itself throughout life in response to environmental influences like cultural context, social relationships, and historic events. Thus, neuroplasticity provides contextual (cultural) as well as historically dependent (previous experience) mechanisms to shape the neural system and thereby modulating behavior. It is towards this end that I will argue for the integration of anthropological and neuroscience research. By way of example, I will discuss new theoretical developments, hypothesis-testing strategies, and cross-disciplinary methods of observation and data collection. To my mind, the exigency of integrating anthropology and the neurosciences is imminent and anthropology's role in an emerging interdisciplinary science of human behavior will be of paramount importance.



**MEi:CogSci Conference 2017,  
Budapest, Hungary**

**Talks**

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# ***The Dark Side of Technology: Qualitative Insights Into Our Use of Information and Communication Technologies***

**Kathrin Bednar**

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Vienna, Austria

New information and communication technologies (ICTs) have become part of our private, social and work life. In the European Union, almost all (96%) young people and individuals with a higher level of education use the Internet regularly [1]. But how does the use of ICT affect us? And are we in control of our usage behaviour and its effects?

Previous research has tried to determine whether the use of the Internet, social media and cell phones has positive or negative effects on our psychological and physiological well-being, but contradictory results have been reported [2]. Moreover, to my awareness no study has taken a holistic approach to explain ICT use by taking into consideration what drives ICT use, how it affects the users as well as the users' awareness and perceived control of these factors.

The present study makes a first step to close this gap in research. In this interdisciplinary project I take a qualitative approach from the social sciences in order to explore the psychological aspects of ICT use. Students represent young and highly educated regular ICT users. Therefore, 14 semi-structured interviews with students aged 20-28 (50% female) were conducted. They were asked to think about the advantages and disadvantages of ICTs and changes they would like to make with regard to their own and other people's ICT use as well as the ICTs themselves. The resulting interview transcripts are analysed with Mayring's

qualitative content analysis [3], whereby categories are developed in an inductive way from the qualitative data. The resulting set of categories serves as the basis for interpretation with regard to the research question.

Preliminary results reveal that students see advantages of ICTs (e.g., for their student life) but also negative effects (e.g., sleep deprivation). Some of their suggestions for improving ICT use focus on technological restrictions or legal regulations (e.g., no Internet after 9 p.m.), hinting that their perceived control of ICT use is limited.

Final results will be presented once the content analysis is completed. I will interpret the results and discuss the role of ICTs within a broader framework, drawing on theories offered by the philosophy of technology.

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# ***How Does Interoception Shape Our Experience of Art?***

**Giulia Cabbai**

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Germany

## **Introduction**

Emotions are considered essential components of aesthetic experience [1]. Despite that, there are only a few studies that investigated how individual differences in emotional processing influence aesthetic evaluations.

It has been shown that interoception, the sense of the physiological condition of the body [2], is associated with the intensity of the emotional experience as well as the central processing of emotional stimuli. Specifically, people with higher interoceptive accuracy, an objective measure of detecting and tracking internal bodily sensations, tend to experience more intense emotional reactions than people with lower interoceptive accuracy [3].

## **Aim**

The aim of the current study is to explore whether these differences in emotion processing also mediate aesthetic experience. We hypothesize that interoception and emotion are important for the engagement with the artwork and the assessment of its aesthetic value.

## **Methods**

The studies that demonstrated the relationship between interoceptive accuracy and emotional experience mainly used videos or images taken from the IAPS as stimuli (Dunn et al., 2010). Such correlations have not been examined in the study of visual art yet. First, we assess interoceptive accuracy through the heartbeat detection task, in order to obtain an objective measure of the process of detecting internal bodily signals. We then present subjects with artworks (with either low or high emotional intensity) while measuring

neural and physiological activity: EEG, ECG, and EDA.

## **Conclusion**

We will report how these measures correlate with the subjective ratings of the aesthetic experience and the evaluation of the artworks and we will evaluate whether there is a difference between people with high and low interoceptive accuracy.

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# ***Talent for Accent: Is There a Correlation Between Phonetic Native and Foreign Language Aptitude?***

**Marion Coumel**

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Acquiring pronunciation is one of the hardest challenges one has to face while learning a second language (L2). Yet, while some individuals immersed early in their L2 culture never reach native-like competence [1], others manage to acquire native-like pronunciation almost effortlessly despite having started to learn their L2 after the end of the critical period for phonology acquisition. Individuals of the second category seem to display a talent for accent.

Studies on the relationship between L2 pronunciation skills and imitative skills have found correlations between scores of native German speakers, English late learners, on English and on Hindi imitation tasks [2]. First, this shows that talent for accent relies on an articulation capacity that is not language specific. Second, looking at Hindi imitation ability allows controlling for the influence of confounding variables such as proficiency. Since the imitators have not been exposed to this language beforehand, Hindi allows to focus on inherent talent for accent [3].

If some aspects of talent for accent are indeed inherent to the speaker, we would expect them to be detectable in tasks involving various imitation abilities and languages. Plus, a potential explanation for the universality of talent for accent is that it relies on non-linguistic capacities such as working memory and singing ability.

The project's aim is to test whether talent for accent is universal. Thus, we try to see whether varying degrees of imitation skills are detectable in tasks involving different imitation abilities and languages. In one

task, German native imitators (N=31) are rated by 25 German native listeners and an expert rater on their ability to directly imitate their native language. Since all native speakers of German have had the same amount of experience with this language, we assume that this task mirrors inherent talent. In another task, German native imitators (N=43) are graded by 25 French native listeners on their capacity to fake a French accent. We also try to see whether performance on these tasks correlates with scores on English & Hindi imitation tasks, working memory tests and singing ability self reports.

We expect individual differences in imitation ability to be perceived by native listeners in the two tasks and that performance on these tasks will correlate with results on the working memory task and self-report of singing ability.

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# ***Life Satisfaction in Old Age: Comparing the Successful and Harmonious Aging Approaches***

**Cristina Dintica**

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Life satisfaction in old age has generated several theories in philosophy and psychology. The most prominent is the successful aging theory, proclaiming that aging successfully entails maintaining a busy, physically active and independent life, in addition to avoiding chronic diseases.[1] Harmonious aging is a newly formulated theory derived from East Asian philosophy, stressing the importance of balancing negative and positive life circumstances, and to be socially connected in old age.[2] The aim of this thesis was to compare the two theories in how older people evaluate life satisfaction.

Data was acquired from an established database in the Swedish National study on Aging and Care (SNAC)- Kungsholmen in Stockholm (n=1975, age= 60-104), through interviews, self-reported questionnaires and medical examinations. Life satisfaction was measured with the Life Satisfaction Index-A (LSI-A). The hypothesis was that harmonious aging factors (social network and activity, subjective health and feeling harmonious), rather than successful aging factors (number of chronic diseases, physical activity, exercise and independence) are associated with higher LSI-A score. The hypothesis was investigated using logistic regression analysis.

The results are in support of the hypothesis in that high scores in harmonious aging factors were significantly ( $p < 0.001$ ) associated with higher odds of having an LSI-A score of medium ( $\geq 7 < 14$ ) and high ( $\geq 14$ ) LSI-A score compared to a low score ( $< 7$ ). Successful aging factors were not

significantly associated with LSI-A score.

The conclusion is that compared to the successful aging theory, harmonious aging is a more valid theory of life satisfaction evaluation in old age.

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# ***Measuring Cultural Differences via Interactive Medium***

**Stefan Dobrosavljević**

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## **Introduction**

Culture is a complex whole which includes knowledge, belief, art, morals, law, custom and any other capabilities and habits acquired by man as a member of society. It is a complex term – a multi-layered concept composed of: symbols, heroes, rituals, and values. Values contain the essence of national culture; the others constitute a layer of cultural practices.

This work takes Hofstede's [1] cultural dimensions theory. Originally developed to analyze organizational cultural practices in the working environment, it proved applicable in the field of cross-cultural psychology, including different organization, business and cross-cultural communication environments. The model defines six (sufficiently) independent dominant characteristics-individuality, power distance, masculinity, uncertainty avoidance, long-term orientation, indulgence.

The original test asks for preferences in a 24-question survey. Our motivation was to find a more natural way of administering the test, through an interactive medium.

## **Project**

In contrast to a questionnaire directly targeting the inner core of cultural values, requiring people to rationally judge their preferences for certain concepts, we designed and programmed a video-game solution utilizing one's connection with symbols and heroes. Basis for the claim was Boal's [2] theory of connection between social order and expected values, which highlight the interconnectedness of myths and drama with the expected values and norms in a given society. We selected a fairytale as medium connected with cultural

characteristics.

We based our project mainly in the digital sphere due to the development of a concept of computer mediated communication (CMC) that enables the researcher to adapt the game flow to suit the subject in a similar fashion to an engaged narrator making the test engaging to a wider audience, while preserving the notion of one's "personal" adventure. In the course of history, we sacrificed effectiveness to efficiency (the adaptability to one, vs. the ability to reach out to many), the medium allows us to return focus on the individual.

In the construction of the story we focused on A.J. Greimas' structuralist approach [3] to narrative creation.

We achieved a solid framework and a running prototype. The interactive narrative probe can be administered via PC or a mobile device, and takes us through a 24-question game based on Russian mythology. Test will be administered to 3 culture groups and compared to the original Hofstede values. After the administering of the test and the analysis of results, we will draw further conclusions.

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# ***Like If Reductionist, Comment If Non- reductionist: A Comparison of the Almetric Performance in Neuroscientific Literature***

**Asura Enkhbayar**

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Critical neuroscience (CN) [1] as an initiative was born in Berlin around a group of young researchers with various backgrounds (e.g., neuroscience, philosophy, sociology). Their common worry was the “neurohype” in science, especially the humanities, driven by the advancement of neuroimaging technology during the last two decades. With the emergence of new neuro-inspired disciplines in the social sciences (e.g., neuroethics) they emphasise the need for scrutiny in the face of increasingly reductionist approaches.

Scholarly communication (SC), the study of the creation, evaluation, and dissemination of research, has experienced a renaissance with the recent publication crisis and rise of social networks [2]. Social media have become an integral part of society, including the scientific community. Not only are popular services, such as Facebook and Twitter, used and embraced by academics, but platforms tailored to the needs of researchers, like ResearchGate and Academia, are highly successful. While the traditional academic incentive system is driven by grants, publications in high impact factor journals, and citations, the recent success of social media have given rise to alternative metrics of science impact (altmetrics).

Confronted with increasing interest in neuro\* methods across all sciences [1] and an ever accelerating and interconnected system of SC [2], this work intends to investigate whether reductionist

interpretations of neuroscientific findings perform better in their altmetric scores. Altmetrics introduced an alternative to the traditional academic incentive system (“publish or perish”) and, thus, the interpretation of neuroscientific findings (reductionist vs non-reductionist) might represent a publication bias for academics working in the cognitive sciences.

I want to investigate the difference between reductionist and non-reductionist interpretations of neuroscientific findings. While the original piece might be wary of any philosophical conclusions, the interpretations (in e.g., scientific articles, news articles or blogposts) might interpret the results in a different way. I assume that reductionist interpretations will achieve better altmetric scores on social media.

Due to the early stage of this project two main questions still need to be discussed: (1) the selection of the initial set of articles will strongly influence the validity of the results and (2) the distinction between reductionist and non-reductionist poses a critical question, that requires a careful review of the existing literature. While being aware of the constraints, I still hope that the results will show that SC and empirical research can contribute to a CN.

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# ***Gabaa Receptor Subunit Distribution & Variants***

**Jure Fabjan**

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## **Introduction**

GABAA receptors are pentameric ion channels, which exert inhibitory effect in the central nervous system. There are 19 subunits with differing regional, cellular and subcellular distribution. GABAA receptor subunit alpha 6 (Gabra6) is mostly expressed in cerebellum and cochlea [1]. Reduced expression of Gabra6 in temporomandibular joint is associated with increased orofacial hypersensitivity [2]. As there are subtle differences in the amino acid sequence of Gabra6 between rat and human variants, it is important to see if and how these influence the pharmacological properties of the receptor [2], [3]. The aims of our research were to (i) compare  $\alpha 6\beta 3\gamma 2$  receptors present in rat and human and (ii) compare expression profiles of GABAA receptor subunits throughout the whole brain.

## **Methods**

To test the pharmacological properties of different receptor variants we expressed them in *Xenopus laevis* oocytes. We performed two-electrode voltage clamp electrophysiology while simultaneously administering one of the five positive steric modulators with the solution of GABA that elicits 3 – 5 % of the maximal response of the cells. To compare expression profiles of different subunits we created a program, which uses in-situ hybridization data, available on Allen brain atlas to calculate the expression in each anatomical region, specified in the reference atlas.

## **Results**

The receptors did not show statistically significant difference in GABA response curves (p-value 0.9535) or in response to different positive steric modulators (p-value 0.0721). In the comparison of expression profiles we produced the table containing

expression of all GABAA receptor subunits in all the anatomical regions in the reference atlas. This data will provide a basis for further research on co-localization of different GABAA receptor subunits.

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# ***Reducing the Variability of Motor Evoked Potentials***

**Benjamin Fischer**

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Transcranial magnetic stimulation (TMS) is a non-invasive method for the manipulation of neural activity. It has found clinical use in the treatment of a variety of disorders, most notably depression. These treatments are based on the ability to induce long-term changes to the operation of the brain using TMS. Protocols, that is, guidelines for interventions, that induce such changes are called plasticity protocols.

While there has been clinical success with these plasticity protocols, the neurological basis of the observable effects is not yet well understood. A number of scientific studies on the efficacy of plasticity protocols use a series of Motor-Evoked Potentials (MEP), that is, muscle responses due to TMS, to determine cortical excitability before and after application of a plasticity protocol. However, MEPs have recently been found to be problematic as a measure of cortical excitability, since responses are subject to random variation, that make it impossible to determine the effect of plasticity changes.

This thesis is concerned with reducing this variability, and with improving the validity of MEPs as a measure of cortical excitability, which in turn will contribute to improve the validity of scientific research with TMS in general. The approach that is taken here is motivated by previous literature, which is to use concurrent EEG to determine brain states to allow us to determine whether the brain is, at the moment of stimulation, receptive to magnetic stimulation.

The task of this thesis is to investigate how exactly EEG can be utilized to reduce MEPs variability. To achieve this, I will, building on existing solutions, develop a highly-specific software package to perform the relevant real-time EEG analysis, mostly in

the domain of time frequency analysis, implement a multitude of alternative algorithms, and run a number of experiments to test the performance of these algorithms. Finally, I will publish the resulting code on an open platform so that it can be applied in different lab situations.

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# ***Who Will Save Innocent Kitties with Counterfactual Priming?***

**Miroslava Galasová**

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Slovakia

Every time we make a wrong decision an innocent kitty dies. This idiom highlights the power of human reasoning that is full of systematic deviations - cognitive biases. Three well-documented biases are attribution effect, confirmation bias, and sunk cost fallacy [1, 2]. Attribution effect is a tendency to overemphasize internal characteristics while failing to consider situational aspects when judging behavior of other people. Confirmation bias is a tendency to favor, seek, interpret, remember, and recall information that corresponds to prior beliefs or expectations of a reasoner. Finally, sunk cost fallacy is an inclination to irrationally continue in an inefficient activity due to regretting previously invested resources. These cognitive deviations have notable consequences in decision making, and therefore, finding effective debiasing strategies is crucial.

Counterfactual priming is a debiasing method that should induce a mental simulation mind-set. It is based on generating "if only" alternative scenarios. Several studies [1, 2] have proven its effectiveness in reducing confirmation bias, attribution effect, and loss aversion. However, recent neuroscientific evidence [3] indicates that engagement of brain areas during self and other-related counterfactual simulations differs. Previous studies use the same unfamiliar person as the main character in priming. Though, we have decided to examine whether a type of the character (self vs. other-related) moderates the effect of counterfactual priming. Next, we aim to verify the effectiveness of counterfactual priming in reducing selected cognitive biases via more ecological valid measures compared to original studies.

We use a mixed 3x2x2 experiment with at least 230 participants (two-sided tests, medium effect size, 95% power,  $\alpha = .05$ ). We are going to use a well-established "rock-concert" scenario in priming and prepare two - self and other-related versions. Participants will be randomly assigned to one of the three tasks (attribution effect, confirmation bias, sunk cost fallacy) before priming. After priming, they will solve a task on a different bias. We expect that priming will reduce all of the three biases. We also assume different effects of the self vs. other-related priming. Our findings may contribute to designing interventions for optimizing real-world high-consequence decisions.

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# ***Optimising Interobserver Reliability in Qualitative Studies***

**Evelyn Gasiorek**

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The present work aims to develop a standard for maximizing the interobserver reliability in qualitative studies. Qualitative studies examine in detail the object of study, such as a behavior or an interaction. An example of a qualitative study is an analysis of an interaction between two agents, such as between two human agents or a human and a robotic agent. This interaction can be used, for example, as a background research for a design for socially assistive robots.

Qualitative studies are difficult to analyze as there is an open number of categories of an agent's behavior and thus this behavior eludes a classification into a small number of categories. Because of this, the annotation and analysis done by two independent observers are likely going to differ considerably. However, the reason for this difference can be irrelevant for the analysis and a superfluous amount of categories can be created in this way (for example "passes the salt" and "hands over an object" as referring to the same activity). This effect can be restricted by imposing the categories before the analysis, but this introduces bias and can lead to a loss of valuable data.

The present work is concerned with finding a set of interdisciplinary guidelines that could help find an optimal solution which takes into account the considerations above. This guideline will consider the limitations on the usage of resources and extra work, such as financial limitations, but also will provide a minimum requirement for a study that can be said to be satisfactorily free from a subjective bias.

The first step in creating such a guideline is the study of guidelines used in subdisciplines of cognitive science and a close reading of review papers examining

the current state of employment of bias minimizing methods in the relevant fields, such as psychology, animal cognition and human-computer interaction. It is expected to be found that disciplines with a longer history of controlling for observer bias, such as child psychology, have a higher percentage of studies that used at least one method of minimizing observer bias than other disciplines [1]. The second step is the acquisition of statistical tools that could be applied used in qualitative studies, for example to measure the interobserver agreement. After this, an interdisciplinary guideline for qualitative studies will be proposed. The final step is a small empirical study, in which an annotation of a behavior collected as a part of the OFAI Corpus [2] will be conducted by two annotators and these annotations will be compared. The guideline and the statistical tools acquired in the first part will be tested on this study.

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# ***The Role of Mental Representations in Problem Solving Process***

**Nejc Grenc**

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Problem solving research field has been widely researched through many disciplines, such as psychology, medicine and engineering, and a lot of research has been focused on how one tackles a given problem (problem-solving process) through strategy use and optimization [1]. But there exists a very important aspect that is considered intuitive and often neglected: Shape and mental representation of the problem and problem-solving process.

Given a complete problem description, the problem-solving process is far from uniquely determined. The subject's internal mental representation of the problem then fully shapes the problem (and solution) spaces and consequently the problem-solving process as well. This mental shape of the problem determines how problem-solving will occur and which strategies can be applied. Herbert A. Simon and his associates [2] argue that the effectiveness of problem-solving process lies in the mental representation of the problem, which is strongly determined by problem description information and prior knowledge. It was shown that, although initial mental representation may not always be the best and can even block production of a successful solution, subjects are often unable to change it and avoid the knowledge transfer (effect of solving a task on solving subsequent tasks).

The general aim of our study is to examine to what extent people tend to transfer previous mental representation into subsequent isomorphic problem solving tasks. More specifically, we will examine the effect of prior learned knowledge (experiment 1) and also the effect of problem description manipulation (experiment 2) on creation and transfer of mental

representation. Using a matchsticks problem solving tasks in the first experiment we will investigate whether creating a mental representation and learning effective strategies leads to a negative (unwanted) transfer in an isomorphic task, so that other representations and strategies are overlooked. The second experiment will examine the effect of transfer in a more specific field of programming. Here, we will investigate whether manipulating the structure of information about the problem task induces creation of a certain mental representation and choosing of a particular strategy. We will also investigate whether the transfer of strategy used also occurs in neutrally introduced isomorphic task that does not induce creation of a particular mental representation. Hopefully, our research will provide new findings about how prior knowledge and information structure affect the occurrence of transfer, which could create some base-ground for further interdisciplinary research in psychology and computer science.

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# ***The Use of Embedded Robots in the Therapy for Children on the Autism Spectrum***

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It has been demonstrated that social robots used as mediators support the interaction between the children on the autism spectrum and their adult partner[1]. The enactive intersubjectivity concept [2] combines the coordinated interaction of embodied agents and the agents' experience of this process. Our hypothesis is that enactive intersubjectivity should constitute a theoretical basis for designing social robots for therapeutical purposes for children on the autism spectrum.

The primary aim of the master thesis is to study the constitutional features of social interaction of children on the autism spectrum from the perspectives of enactive intersubjectivity and engineering: human-robot interaction (HRI), and to analyze whether the enactive intersubjectivity perspective can be considered a theoretical foundation for the successful interaction of an autistic child with a robot. Taking the enactive intersubjectivity perspective, the ambition is to identify and detail characteristics of the interaction between a child on the autism spectrum and their caregiver and to describe how children on the autism spectrum are interacting when their repertoire of skills is limited. In the HRI approach, the focus is on describing and understanding the characteristics of autistic child-robot interaction, arguing for the robot being perceived as a social agent, and identifying design considerations of the social robot.

We will carry out a meta-analysis of the literature regarding the mentioned fields of study and formulate a conceptual framework, addressing the role of enactive intersubjectivity concept in the design of

social robots for children on the autism spectrum. Frequent meetings with practitioners in the mentioned research areas and in the therapeutical field will be carried out to gather a professional insight and understanding into the phenomenon. Empirical research will be conducted, which aims at describing the manifestation of social skills of children on the autism spectrum.

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# ***The Effect of Task Description on the p600 ERP in Artificial Language Learning***

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The P600 event related potential is an EEG component commonly associated with processing syntactic anomalies. This project aims to investigate whether it is a necessary correlate of ecological sentence processing, or whether its occurrence is a side-effect of the constrained setting of EEG sentence processing experiments.

Syntactic anomalies, or ungrammatical sentences, play a central role in modern linguistic research: In the case of neurolinguistics, the p600 ERP's association with syntactic anomalies is used as a source of evidence about language processing. However, linguistics can be accused of overstating the importance of ungrammatical sentences, since recognizing and analysing ungrammatical or anomalous syntax is not a central aspect of everyday language use.

To approach this problem, this project will address the question whether the p600 reflects a processing effort that is necessary for linguistic behaviour by testing whether it is influenced by the particulars of experimental tasks descriptions. Few studies have investigated this possibility. An exception is a study by Schacht et al. [1], who found that the p600 is robust when participants are asked to judge grammaticality, but absent when participants' attention was distracted from the grammaticality of the sentence toward the font of the stimuli. However, it is possible that their attention was distracted too far away from the task, and these results do not reflect sentence processing at all. Another study by Silva et al. asked participants to study an artificial grammar by exposure and then measured the P600

when participants were asked to judge the grammaticality of new stimuli compared to when they were asked to judge new stimuli for how much they liked them [2]. They found a P600 in both conditions and took this to indicate that both task descriptions are valid. However, they do note slight differences in the p600 in both cases.

This project will use the artificial language learning paradigm from Silva et al. [2] to further study the effect of task description on the p600. Participants will similarly study a grammar, but the test group will be asked not to rate new stimuli for grammaticality or preference, but indicate whether they have seen them before (while none were present in the training phase). We expect that the test group will show the same linguistic behaviour, i.e. they discriminate grammatical from ungrammatical sentences, but they do not show a p600 potential. Such results would indicate that the p600 is an effect of the task description rather than of linguistic behaviour.

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# ***Mirror Neurons and Empathy: What is Neuroscience to Theory?***

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Three theories predominate in contemporary discussions about empathy: theory of mind theory (or theory theory, TT), simulation theory (ST) and the theory of direct access/perception (DP). In the last two decades, interest in ST has surged due to the discovery of mirror neurons. The interpretation of mirror neuron activity as support for simulation theory, however, has raised objections from some philosophers who believe that the neurological picture is better explained with reference to DP. In my thesis, I will explore these approaches, detailing their explanatory powers and weaknesses.

Mirror neurons were discovered in the 1990s by the Parma group in the premotor cortex (area F5) of macaque monkeys. By use of single cell experiments, the group found that the cells fire not only when the monkey subject performs an object-directed action itself, but also when observing another perform the same kind of action. These findings were interpreted as support for ST, which posits that we grasp the mental states of others by using a process of inference; we see the actions of another person and refer to an internal simulation in order to understand the mental states behind them. The Parma group believed that they had found the neural substrate responsible for this simulation process [1, Ch.1,3].

Defenders of DP dispute the simulationist interpretation because, for them, the neurological evidence points toward a different picture of how empathy, and the mind in general, works. DP is grounded in an embodied conception of mind, which means that mental states are believed to be expressed in a person's bodily actions and are therefore directly accessible to the

similarly embodied observer. Mirror neuron activity is, therefore, interpreted as being integral in the process of social perception rather than being one module in a system of inferential reasoning [2].

We then have two interpretations of mirror neuron activity which rest on very different philosophical assumptions. Both are defended in part with reference to neurological evidence. This then raises the question as to what is the place of neuroscientific evidence in empathy research? Can it provide clear, irrefutable evidence of the functional contribution of mirror neurons, or is it always coloured and constrained by the philosophical presuppositions of the researchers?

## **Acknowledgements**

Many thanks to Assist. Prof. Sebastjan Vörös for supervising this project.

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# ***Activation of the Mirror Neuron System by Emotional Facial Expressions***

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Following a thorough review of existing research and related literature, an analysis of fMRI data using FSL software will lead to identification of brain areas specific to processing of emotional facial expressions.

The investigation was conducted on 30 accounting and finance managers (50% women) in business firms in Slovenia. Participants' average age ranged from 24 to 52 years (37 years on average), and their work experience ranged from 1 to 26 years (12.8 years on average). They had an average of 17 years of education, and most of them held a master degree in business, economics, accounting or finance.

The subjects participated in an approximately two-hours long fMRI recording at the Centre of Clinical Physiology, Medical Faculty, University of Ljubljana, Slovenia. The recording included various tasks including the one we are interested in: the participants were asked to observe videos of actors expressing different emotional states (anger, disgust, happiness, surprise, neutral) or a moving geometric shape as control.

I will compare and contrast various conditions among themselves, and with previous research, in order to identify areas specific to emotions [1]-[3]. Those, presumably, part of the mirror neuron system [4]. My goal is to localize the latter and elucidate its involvement in processing emotional expressions.

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# ***Where Do We Stimulate the Motor Cortex***

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The motor threshold (MT) represents the minimum TMS intensity strong enough to produce a predefined motor evoked potential in the contralateral first dorsal interosseus muscle (FDI), in at least 50% of the trials [1]. The MT is used in TMS studies as a reference point for calibrating the stimulation intensities, which makes the FDI area of the motor cortex a crucial site for stimulation. Currently the MT is determined by stimulating the primary motor cortex (M1) fMRI hot spot from a standard finger tapping task that maps the voluntary activation of the FDI on the M1.

Tracer studies in monkeys revealed that supplementary motor area (SMA) and premotor cortex neurons show dense axonal projections to the M1 area, more importantly, between the hand representations of the two areas [2]. These findings and the possibility of improving the TMS MT determination method, inspired us to investigate the existence of a better cortical spot for stimulating the FDI muscle than the M1 hot spot from its voluntary activation.

We hypothesized that the electrophysiological hot spot is anterior from the M1 activation map hot spot. To investigate our hypothesis we conducted an experiment consisting of two sessions. In the first session, a simple finger tapping paradigm, consisting of nine blocks of 10 seconds, with 10 seconds of rest in between was used in order to acquire the hot spot of the M1 for activating the right hand FDI muscle. The results acquired from this session were used as neuronavigation-based target in the following TMS session.

During the TMS session we measured the motor evoked potential, using electromyography (EMG), from the same

intensity stimulation, 100% from the stimulator output, on 13 targets positioned in a circular grid of two rings, with a center in the acquired M1 target from the finger tapping task.

The preliminary results showed highly significant difference between some of the targets with the highest and lowest average EMG responses. The anterior medial area relative to the M1 hot spot showed highest average EMG response compared to the rest of the targets. This finding offers a possibility for improving the TMS method and further investigating the effective connectivity coupling of the premotor cortex and primary motor cortex with a TMS/fMRI combined approach.

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# ***Meaning in Morphological Decomposition***

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## **Introduction**

When we recognize a word, we process it by first dividing it into morphemes [1]. This means that, upon encountering a word like »unlikely«, we subconsciously decompose it into parts like »un«, »like« or »ly«. Research has been done on how this happens for various kinds of words and theoretical models of word processing have been put forth. It is also known that the meaning of a word plays a role in word recognition. However, information on the relation of meaning and morphology in word processing is scarce.

## **Problem**

By stripping the prefix of a word, we sometimes get a non-word (submit → mit), sometimes a word that seems to be related to it in meaning (reconstruction → construction), other times a word that seems to be very unrelated (extent → tent). It is not entirely clear how the word-root relationship influences word processing.

## **Goal**

The goal of the research is to find out what the role of meaning is in the processing of morphologically (more or less) complex words, according to morpheme count.

When this question is reformulated as a hypothesis, it is expected that mean measured reaction times in a lexical decision task would increase in the following fashion:

1. non-words regardless of prefixation
2. non-prefixed words
3. prefixed words with semantic counterpart
4. prefixed words with unrelated counterpart

## **Method**

40 native slovene-speaking students, aged 19–29 will take part in a lexical decision task. There are about 400 stimuli in total.

Reaction times will be gathered by measuring the button-press latency on a computer after the stimulus appears on the screen.

The measurements for each stimulus will first be averaged across participants, then data for stimuli with a relevant number of incorrect answers will be excluded. The data will be analyzed for relevant differences across the different conditions. The details of the analysis are still to be elaborated.

## **Expected Results**

Confirmation of the hypothesis would suggest that semantic relations influence word recognition as a standalone process. However, rejection of the hypothesis offers more interesting scenarios:

- A longer reaction time for prefixed than non-prefixed pseudowords: morphologically complex words are recognized slower simply due to sharing (part of a) form with other words (that share the morpheme) without it necessarily being an actual (meaningful) morpheme.

- A similar latency for all prefixed words: semantic properties of word recognition in this case play no role in word recognition.

- A higher reaction time for unrelated groups (prefix and non-prefix): recognition is throttled only by semantic and not morphological interference.

- A higher reaction time for related groups: word recognition takes longer due to unexpected interference of the word that is homonymous with the root morpheme.

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# ***Embedding Social Behaviour in Emotion in Fuzzy Animats***

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According to evolution all life on Earth is related and as a consequence of this, structures and functions are shared between species. In this view, the study of biological and cognitive phenomena in animals sheds light on processes and functions of the human body and mind. This is also true of emotions, affective states that can be seen as “programs” that orchestrate correct behaviour, from bodily preparations to action readiness and execution, for given historically recurring situations [1]. Thus, emotions are hard-wired responses of which perhaps the best example is fear which prepares the body for the fight or flight response and shifts attention to potentially dangerous stimuli, among other things. These responses also act as cues indicating affective states to other animals and consequently serve as the basis for emotional contagion – transfer of emotions between individuals [2]. Similar behaviour in similar situations is a potential mechanism for group coordination, while positive affect among members may bring about group cohesion, and thus emotions and affect may play a crucial role in group formation [2].

Artificial life, a computational paradigm of modelling principles of living systems, offers a setting in which these speculations may be tested through simulation. I postulate that emotions and their expression are the substrate of social behaviour in animals and test this hypothesis through computational simulation of evolution in a virtual environment, populated by animal automatons – animats. Animats’ behaviour is modelled with fuzzy cognitive maps, structured to represent sensations, drives, internal states, emotions and motor actions which include emotional displays. Fuzzy cognitive maps (FCM) are a type of

knowledge representation that models causality between concepts and inference patterns in dynamic systems [3] and are thus an apt model to study dynamics and causality in artificial agents. My hypothesis postulates that emotion expression and contagion will motivate animats to form groups and express group-like behaviour, without explicit modelling of social behaviour. Social behaviour is thus seen as an emergent phenomenon and emotions as the cement holding the society together. It is too early to talk about results, but since an FCM represents a system’s causality, positive results will prompt analysis of its causal links and perhaps bring new insights on importance of emotion in social behaviour.

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# ***Overlapping Communities in Functional Brain Networks***

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The study of human connectome is a promising way to gain new insights into the overall architecture of the brain. The advances in functional Magnetic Resonance Imaging (fMRI) enabled the study of the architecture of cerebral cortex not only anatomically, but also functionally. Connectivity metrics like correlation or coherence of the BOLD signal are used to compute the strength of functional connections between different areas. By analyzing the connections and clusters within this network, it is possible to identify areas with similar function [1].

The majority of current methods assume that each location only participates in single function and parcellates the network into discrete non-overlapping subnetworks (clusters). This work proposes the symmetric non-negative matrix factorization (symNMF) algorithm [2] that can be extended to enable the formation of overlapping subnetworks (communities).

We first compare the output of symNMF to results from existing literature to measure its utility. We then examine the effects of overlaps by evaluating the test-retest reliability on eighty single subjects from the Human Connectome Project (HCP) dataset. Finally, we examine the properties of overlaps in an exploratory fashion and speculate on their possible role in the cortical architecture.

We successfully replicated results from literature [1,3], thereby proving its utility in connectivity research. Results from test-retest reliability experiments show that introduction of overlaps increase the

reliability when deployed on single subjects in contrast to traditionally used non-overlapping approaches. However, the overlaps also moved the individual parcellations closer to the average solution, which is not a desirable effect in personalized medicine. We then attempt to visualize the complex spatial and temporal relationship between communities and overlaps, experiment with different number of communities and speculate on possible roles of the overlapping regions. In the end, however, it remains unclear whether the existence of overlaps in functional cortical networks is an actual property of the brain architecture or whether it is only an artifact of chosen preprocessing steps, clustering algorithm and evaluation metrics.

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# ***Connectionist Model of Sentence Comprehension***

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The research of the language comprehension has shown that a human creates his own representation of the written or spoken sentences. It is assumed that the best explanation of these representations is in situational level. In this work we assume that the situations described in the text have a specific form, in particular agent, action, and patient. The meaning of the situations is encoded in the pre-trained self-organising map which particular units hold probabilistic relations between text sentences and their meaning [1].

For sentence comprehension task we built two models, the first uses Simple Recurrent Network [2] and the second includes Merge Self-Organising Map [3]. Both models aim to reconstruct the meaning of the sentences represented in the activation of units of self-organising map.

The goal of the thesis was to compare a baseline Simple Recurrent Network model of sentence representation to a Merge Self-Organising Map based on sentence processing, wherein the representation of meaning is obtained by top-down backward propagation in a model trained for sentence production task. The input to the SRN are the text sentences presented by one word at a time and the targets are the activations of the SOM neurons which represent the meaning of the sentence. Since MSOM is unsupervised, these activations are added to the input vectors to MSOM while everything other remains the same.

In our experiments we created 240 sentences with various lengths (from 2 to 7 words). Firstly, we evaluated the error between prediction of the meaning of the sentences and actual SOM-like meaning of

the situations. Secondly, we examined the precision of the meaning prediction after presenting the sentence, one word at the time.

The first model (with Simple Recurrent Network) shows better results compared to the second model (with Merge Self-Organising Map). The first model shows clear decrease of the error after more words have been presented. On the other hand, the second model was unstable in the meaning prediction of the sentences with 6 and 7 words. Further, the first model shows good reconstruction of the meaning, even after the first few words from the sentence have been presented. In the future work we can build on our findings more complex model of sentence comprehension. Regarding the worse performance of the model with Merge Self-Organising Map we assume the main reason is in the high dimensionality of the input vectors.

## **Acknowledgement**

My special thanks belong to Martin Takac for valuable guidance and discussion.

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# ***Motor-evoked and TMS-evoked Potentials: Correlation between the two Measures and their Modulation after 5-Days-Consecutive iTBS Intervention***

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Transcranial magnetic stimulation (TMS) has developed into a powerful tool for studying human brain physiology and brain connectivity. It has been widely used to probe excitability and plasticity of the human cortex. Traditionally used for the quantification of excitability are motor-evoked potentials (MEPs), the motor responses observable in peripheral muscles as an effect of stimulating the motor cortex. This method bears two obvious limitations: First, it is limited assessing excitability in the motor cortex only. Second, MEP amplitude is intrinsically variable from trial to trial which makes its validity questionable. Concurrent TMS-EEG recording provides a more direct access to the effects of stimulation of all cortical areas by analyzing the deflections occurring in the EEG after the TMS pulse, so called TMS-evoked potentials (TEPs). Several TEPs are already described in literature, though their meaning is largely unknown.

For this study, 20 healthy subjects were recruited and received a 5-days-consecutive-iTBS (intermediate Theta Burst Stimulation) intervention, a form of repetitive TMS (rTMS), which is thought to increase cortex excitability. Repeating stimulation sessions should cause more enduring and reliable changes of cortex activity than a single intervention. On the first and last day concurrent EEG/TMS- recordings were conducted. As a first step we attempt to shed light on possible differences in the amplitude, latencies and number of TEPs observable when using different

preprocessing parameters in the off-line EEG-analysis of the data. After the establishment of a preprocessing pipeline the correlation between MEP amplitude and TEP amplitude on a single trials as well as on a group basis (high vs low MEP amplitude) will be investigated. This has only been done once by Mäki and Ilmoniemi for the N15-P30 TEP component [1]. Our approach will try to confirm their results as well as extend the analysis to other TEPs in other brain regions. In addition the information on power in certain frequency bands and phase obtained by frequency analysis will serve as a further source for explaining MEP variability.

Similarly to a study about modulation of early TEPs after rTMS application [2], we will examine differences in MEP and/or TEP appearing after the 5-days-consecutive iTBS application. We expect the modulatory effects to be more evident than in previous studies, as this is to our knowledge the first TMS-EEG study where subjects have received iTBS for five days.

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# ***Influence of Manipulation of Complexity and Processing Fluency on Liking in Aesthetic Experience***

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The mechanisms and even the purpose of aesthetic experience has baffled artists, philosophers, and psychologists since ancient times. In this work, the focus is on complexity and fluency of aesthetic experience. Research problem deals with Berlyne's arousal theory in connection to visual perception of abstract patterns, complexity, and fluency. Degrees of complexity and fluency are manipulated by adjusting the number of triangle elements in the stimuli, and exposure time, respectively. The hypothesis postulates that liking ratings awarded by participants descend as fluency increases with complexity kept at very low levels.

The processing fluency theory states that the ease with which an object is processed, is accompanied by a subjective feeling of fluency, which serves as a basis for several kinds of judgements and evaluations [1]. In previous, typical, experiments on processing fluency, the presentation of stimuli was manipulated in order to lessen or increase the ease of processing, i.e. processing fluency. Variations in presentation duration [1] are commonly used.

The stimuli used were taken from a previous experiment [2] and modified in order to manipulate complexity and fluency by controlling the number of triangle elements comprising the stimuli and presentation duration, respectively. The experiment required 30 participants. Prior to the experiment, the participants were tested in colour vision and visual acuity using standardised tests. The measures of liking

ratings were taken using a five point Likert scale, ranging from least liked to most liked. These ratings, as the manipulation of exposure time, were pre-programmed using software E-Prime version 3.0.

Repeated measures design was used. To avoid stimulus repetition, which could result in mere exposure effects, every pattern was presented only once to each participant. Presentation durations were 100 ms, 300 ms, and 500 ms. This variation was based on previous studies showing reliable fluency effects in this time range [2]. Each trial started with a fixation cross (approx. 2000 ms), followed by a stimulus and a white noise mask (approx. 400 – 600 ms). After the mask, the participants provided their responses. Across participants, presentation durations for each complexity group were systematically permuted.

The analysis of the data is still underway.

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# ***Mobile Parkinson's Disease Monitoring***

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## **Introduction**

Parkinson's disease (PD) is, among other symptoms, accompanied by tremor and a change of gait pattern. The course of PD can be assessed and evaluated using classical clinical methods. This entails a visit to a physician and going through diagnostic tests. Due to population ageing and an increase in neurological disorders, there is a need for improvement in more efficient disease monitoring. Progressive data processing methods make a constant analysis of parameters linked directly to PD possible. The goal of our research is to assess the possibility of implementing an already developed platform, which enables ubiquitous, cheap and simple attainment of data on its user's gait and tremor using a smartphone, in clinical practice. When compared to classical methods, the advantage of the platform is a more precise monitoring of the progress of PB in a domestic environment throughout a longer time period.

## **Methods**

Research approach is based on an already developed platform that enables the analysis of accelerometer signals gained from inertial sensors (IS) found in smartphones [1]. A study will be carried out on 20 PD patients, evaluated using standard clinical testing procedures, and 20 healthy individuals serving as a control group (CG). Gait will be assessed on the basis of symmetry, regularity and stride length and duration parameters, that will be measured using IS data. Tremor will be assessed on the basis of data from frequency amplitude of IS signals. The gait assessment tasks are walking on a 4 x 10 m level surface, a stop and go test, and rising from a chair. The tremor assessment tasks are holding a mobile phone sitting down with arms stretched out in front and holding it sitting down with arms resting on

the chair's armrests. Data processing will be implemented using methods based on signal processing, machine learning, statistical analysis, and blind source separation. The gathered results will be directly compared to clinical test results. IS signals will be compared between PD and CG. We can further compare our results with results from similar studies.

## **Results**

Modularity of the platform makes possible the implementation of different statistical methods suggested by neurologists. It is impossible to predict the exact metrics at this time, since they are to be settled on in collaboration with the Department of Neurology of the University Medical Centre Ljubljana. We expect significant differences between the PD and CG groups and a higher precision in comparison to other similar methods in correlation with clinical tests.

## **Discussion**

With our research, we wish to improve entire neuroscientific practice with the help of modern methods of artificial intelligence. Our vision of the platform includes different levels of healthcare. A paradigm that could be used to additionally improve on the neuroscientific experience is the Internet of Things, which allows for more frequent long-term disease monitoring and dislocated monitoring of patient condition. Assisted by the platform, research personnel could follow the progression of the disease in real time and more efficiently.

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# ***Midsession Reversal Learning in Dogs (*Canis Familiaris*)***

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In their natural environment, animals are required to adapt to constant changes, the ability which reflects their fitness. This calls for a certain amount of behavioural flexibility, which has traditionally been used to identify differences in the general level of intelligence of animals. A commonly used task for studying behavioural flexibility is the reversal learning task, dealing with the ability to respond to changes in contingency and the un-learning of a previously learned stimulus [1]. Reversal learning studies suggest a correlation between the differences in learning abilities of different animal species and their ordering along an evolutionary scale, with phylogenetically related species performing similarly well [2].

The type of reversal learning task used here is referred to as the mid-session reversal task [3]. In this procedure each session involves a simple simultaneous discrimination, beginning with one stimulus (S1) as the correct one and a different stimulus (S2) as the incorrect one (i.e., S1+, S2-). Halfway through the session the discrimination reverses (S2+, S1-). The optimal strategy for solving this task is to rely on local feedback, basing one's choice on the outcome of the last trial and shifting to the alternative option when the reversal happens, thus employing the so called win-stay/lose-shift response strategy.

Tests on rats show, that they follow the optimal strategy, whereas pigeons consistently make anticipation errors before and perseverative errors after the reversal, suggesting that the number of trials serves as a cue for reversal [3]. However, it has also been noted that pigeons outperform dogs on the mid-session reversal task [2]. These results are inconsistent with the suggestion

that dogs perform similarly to a species with a closer phylogenetic relationship (the rats).

The present study's aim is to verify previous results [2] and to learn more about the dogs' strategy to maximize reinforcement on a midsession reversal task. This will be done by testing 20 dogs, using a visual or visual-spatial discrimination task, on a touch-screen computer. Each session will consist of 40 trials of discriminating between two different geometrical shapes, until 60 sessions are reached. The results will be used for further comparative studies to study the influence of phylogenetic relatedness on reversal learning abilities.

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# ***Camera System for Measuring Emotion by Capturing Physiological Parameters***

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Most humans seem to share the ability to understand the emotional state of others. In recent years, there has been huge progress in the development of automatic systems that can measure human emotion for different purposes. There are different ways to get information about the emotional states. Many algorithms make use of Ekman's Facial Action Coding System to retrieve information about basic emotions. Another way would be to analyze the autonomic nervous system, which is seen by many as one that responds to changes in emotion[1]. We are developing a system for measuring the six basic emotions according to Ekman by using a camera. Images of faces are analyzed by our algorithm which is still under development. In this work we focus on the methods for extracting physiological information [2]. We plan to test our system by executing a pilot study, where seven to ten subjects would watch a series of video clips with strong emotional content. The baseline for their emotional responses would be formed by combining a questionnaire and measurements of physiological responses using a Biopac system. The subject's faces would be recorded on video. Our system would analyze this video data, and its results would be compared to our baseline. These results would also be compared to those produced by Noldus FaceReader, which is a prominent application used by researchers interested in measuring emotion. In case our system achieves good results, it could be used in different areas, providing researchers a more accessible alternative for researching emotion.

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# ***A Methodological Proposal on How to Use the Analytic Hierarchy Process Technique to Improve Need-based Solution Knowledge Strategies***

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Developing knowledge about hidden needs of an organization appears to be crucial for organizational learning processes, such as innovation and strategy development. As illustrated by Kragulj [1] a need-based solution knowledge strategy encompasses three ontological dimensions: the capacity to identify needs (Ci), to judge a satisfier's potentiality (Cj) and to design alternative (innovative) satisfier (Cd). To identify (hidden) needs of a social system like an organization Kaiser and Kragulj [2] introduced "Bewextra", a method to assess implicit need knowledge of organizational members. However, being aware of our needs does not tell us how to meet them. A need can be satisfied by different concrete solutions (satisfiers). The relationship between needs and satisfiers is reflected by the principle of Equifinality [1]. The same final state (satisfaction of a need) can be reached from different initial conditions and by different means (satisfier). As illustrated by Thomas L. Saaty [3], the Analytic Hierarchy Process technique (AHP) provides means for analyzing and organizing such complex multi- criteria decisions.

Our main goal is to use the analytic hierarchy process technique to improve the practical application of need-based solution knowledge strategies. The first required step is to identify all relevant components of the network: the goal, the criteria and the alternative elements. We use Bewextra to identify the goal (needs) of organizational members (Ci). The resulting catalogue of

needs will be evaluated to define the prioritized, focal needs of a social system. After identifying the focal needs, we assess in two separate steps the criteria (indicators) of a given need (Cj) and the potential elements (satisfiers) corresponding to the criteria (Cd), by questioning the systems members. Finally, the members systematically evaluate the elements by comparing them to each other two at a time, with respect to the defined criteria. By converting these judgements into numerical values, AHP measures the weighted priority of each element of the network. As a result of this process, we expect prioritized need-satisfier relations to emerge, which will improve the development of need-based solution knowledge strategies.

As a second goal, we plan the application of creativity techniques to improve the mental process of creating new potential satisfiers. We assume that the process of designing potential alternatives to known satisfiers requires a creative atmosphere (Cd). Creativity techniques have not yet been examined.

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# ***Memory Retrieval in a Rapid Sequence Visual Presentation Paradigm***

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## **Introduction**

Memory is the ability of an organism to select, store and retrieve information from continuous streams of data. Several plasticity mechanisms for memory formation have been proposed, but the mechanism underlying information selection is not well understood. Here we study how selection from a rapid sequence of images (RSVP paradigm) is dependent on intrinsic brain rhythms, specifically theta, alpha and gamma oscillations, and how that relationship determines recall. When subjects are asked to memorise a sequence of visual stimuli, they show serial position biases such as the primacy and recency bias [1]. And when stimuli sets are composed of different categories, like human faces, animals or objects, each can have different effects on the selection mechanism. In our experiment, we used images of birds, cars and faces. To test whether these categories have different biasing effects on visual recognition, which could undermine the homogeneous sampling requirement for memory recall, we analysed recognition probability within an RSVP paradigm. In order to interpret the causal role of gamma oscillations, as a part of the larger project, we analysed the behavioural data of selective recall to gain an insight whether or not a serial position effects besides intrinsic brain activity might have directly influenced memory.

## **Method**

42 healthy subjects (18 female, 24 male) were instructed to fixate and attend a rapid succession of 8 images of human faces, birds and cars (in separate blocks) flashed for 32 ms duration each, in an RSVP paradigm while 128-channel EEG was recorded. Each RSVP trial was followed by a visual recognition task where the participants were

asked to identify the initial 8 images from a gallery of 16 images, half of which were new. The selected images were sorted into two groups: correctly recognised stimuli and incorrectly recognised. Failure of recognition could have been due to an encoding failure, a memory retrieval failure, or both.

## **Results**

The analyzed EEG data suggests that it is not the stimulus that resets the gamma phase but rather the actual gamma phase enables downstream processing of visual information. However, this result relies on the assumption that the low-level processing of visual input is serially homogeneous, lacking of primacy and recency effect. We analyzed  $n=10$  subjects data. We found neither significant primacy nor significant recency effects in our subjects ( $n=10$ ,  $p<0.05$ , ANOVA was carried out on probability of recognising the first and last presented image more frequently than other images in the sequence). Our next step will be analyzing the EEG data to see whether information selection is determined by intrinsic brain oscillations.

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# ***Processing Suffix Combinations in Slovene***

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In morphological theory, it is assumed that all derivations start from a lexical base (be it a root or a stem) to which then affixes are attached step by step, i.e. for suffixation: BASE → BASE+SUFF1 → BASE+SUFF1+SUFF2, etc. All theories, irrespective of the type of morphemes they recognize, agree that affixes without bases do not play any role in morphology. However, recent psycholinguistic studies provide evidence that affixes have a life of their own and can be accessed and processed without reference to lexical bases or any other semantic cues [1][2]. The results of the present study speak for this view.

The psycholinguistic experiment the results of which we report was an adapted-to-Slovene replication of Manova and Brzoza's [3] study on processing of Polish suffix combinations. The Slovene experiment consisted of the identification of 60 suffix combinations (30 existing and 30 non-existing), all without bases. We controlled for two variables: 1) existing versus non-existing combinations; and within the existing combinations, for 2) productive versus unproductive combinations. Productivity was determined based on type-frequency. The frequencies were counted in Slovar slovenskega knjižnega jezika (<http://bos.zrc-sazu.si/sskj.html>). 32 native speakers of Slovene (age M = 37.06, SD = 14.72) participated in the experiment.

The accuracy of recognition of the existing and non-existing combinations was very high (89.17% for the existing and 85.67% for the non-existing combinations) but the difference between the two types of combinations was not statistically significant,  $t(29) = -.99$ ;  $p = .33$ . We interpret this result as convincing evidence that native speakers know which suffix

combinations exist and which do not, i.e. suffix combinations should be listed in the mental lexicon as such. With respect to productivity, the participants were better at recognizing productive combinations and there was a statistically significant difference in the accuracy of recognition of the productive and unproductive combinations,  $t(29) = 8.16$ ;  $p < .01$ , which we see as evidence that productive and unproductive suffix combinations should be processed (and learned) differently.

We will present the selection of the data as well as the experiment and its results in detail and discuss the relevance of the results to linguistic theory and methodologies for foreign language learning.

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# ***A Universal Game Controller Interface (UGCI) for Neurofeedback ADHD Treatment***

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According to DSM-5 Attention-deficit / hyperactivity disorder (ADHD) is the most common of psychiatric disorders in children with an assessed prevalence of about 5% in school-aged children. Despite the fact that medical therapy is very efficacious, due to its adverse effects, the focus has been pointed to the development of an alternative treatment for the disorder. One of the most common non-pharmacological treatment of ADHD is behavioral training using neurofeedback in conjunction with video games where measured EEG characteristics modulate the game dynamics. [1]. In that way patterns of optimal brain function are fostered over sessions, leading to the alleviation of the symptoms [1].

However, one of the drawbacks of the therapy is that the selection of the games for ADHD Neurotherapy is very limited. The developed purpose specific video games cannot follow today's high standards. Due to poorer game selection, after a couple of sessions subject's (children's) interests shifts and conceivably making the therapy less effective. Development of new advance games are very resource demanding and require broad market to be profitable.

To overcome the obstacle, I propose an innovative design of a Universal Game Control Interface (UGCI), a physical device that will serve as a modulator of the game commands based on EEG detection of the subject's attention states. In other words, UGCI will be used as a “proxy” between a game controller (e.g. gamepad) and play console or computer. In that means UGCI can provide a haptic feedback (using the

controller's vibration systems). The assumption is that gamepad vibration system will cause subject attention subject recovery and provide supplementary feedback in the neurofeedback loop. A prototype of the UGCI will be realized as standalone device on Arduino board that will be communicating with the Neurosky Mindwave dry EEG cap [3] and modulate game controller commands based on the its input. The EEG cap itself provide on-chip algorithm for real-time attention state estimation [3] that will be used in the realisation of UGCI.

## **Expected results**

The study will cover a preliminary research which will serve as a proof-of-concept study and go towards of validation of hypothesis that UGCI, therefore also haptic feedback, can be used fo ADHD Neurotherapy and achieve comparable results as specially designed games for that purpose.

## **Acknowledgments**

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# ***Reconstruction of Perceived and Imagined Music from EEG Recordings with Deep Neural Networks***

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The neurological basis underlying music cognition has been extensively researched in recent years and several studies within the cognitive neuroscience of music indicate the existence of shared neural representations within music perception and imagination [1]. The reconstruction of musical stimuli from brain activity represents an important step towards researching higher-level processes, such as subjective or aesthetic music experience. Methods like multi-source semantic embedding and multi-variate regression, mostly based on functional Magnetic Resonance Imaging (fMRI) and Electroencephalography (EEG), have been proposed to reconstruct perceived auditory stimuli [2]. Most of these approaches focus on the amplitude envelope or on the onsets of musical events. However, there is still a lack of approaches able to reconstruct perceived as well as imagined stimuli while managing to cope with cross-subject differences.

Inspired by recent successes in stimulus classification using deep artificial neural networks [3], an assortment of neural network architectures is presented and evaluated for the ability to perform continuous reconstruction of the amplitude envelope within single subjects and multiple subjects from EEG recordings. The planned approaches include a convolutional network organized as stacked denoising autoencoders (SDA) and a recurrent neural network (RNN) to incorporate global temporal features. Special focus is paid to spatial aspects of brain activity based on the signal overlap between 64 EEG channels. A network with exchangeable input layers for

each subject is proposed to cope with the complex subject-specific differences. Next to envelope reconstruction, the feasibility of a simultaneous reconstruction of other spectrogram characteristics, such as stimulus frequency, is tested.

The networks are trained on EEG recordings from subjects listening to and subsequently imagining looped sequences of tones and speech in different rhythms that are superimposed on a constant metronome click. To evaluate the performance on complex natural music, the best performing architecture is furthermore evaluated on the OpenMIIR dataset of perceived and imagined excerpts of well-known natural music pieces, both with and without the presence of lyrics.

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# ***Autism Subtypes in Context of Current Theories***

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Autism is a neurodevelopmental disorder usually defined with a triad of manifestations – i) impaired social interaction and ii) communication, and iii) repetitive behavior [1]. Autistic individuals struggle with sharing and understanding of emotions, may have odd interests and clumsy movements. The question what causes the symptomatology remains unanswered. The thesis aims to describe autism in a context of traditional theories of autism. Bayesian Brain Hypothesis is prevailing theory of autism in cognitive science and offers a roof for most of the other theories. Bayesian Brain Hypothesis [2] understands the brain as a probabilistic machine which uses its general model to generate predictions. Current sensory input is tested against predictions or priors, and general internal model updates its beliefs about causes of the input. Pellicano and Burr [2] proposed the general model to be attenuated (hypo-priors) in autism.

Bayesian perspective is encouraging account for autism subtyping due to a possibility of modeling subtypes using various parameters. That could help to understand the nature of the differences within autism and explain inconsistencies in biological research. From previous findings [3], it seems like there are two main subtypes - "less severe" and "more severe". In this study, we derived clusters from behavioral data employing cluster validation and hierarchical cluster analysis with model-based clustering. Our dataset consisted of children's behavior description from their parent's standardized Interview (ADI-R) and clinician's observation (ADOS). Sample involved 217 autistic children, 13,36% girls 7,2 years old in average (SD =4,44) and 86.64% boys 7,5 (SD = 4,64) years old in

average.

Our results are in line with earlier findings and suggest the existence of two main clusters based on onset of developmental anomalies and gesture communication. From the Bayesian perspective, weights of general model predictions could be the right parameter to simulate subtypes. We present a possibility of an association between severity of autism and ability to form representations. Besides, we discuss to what extent this can affect therapies.

## **Acknowledgement**

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# ***Constrained by Convention: Emotional Effect of Microtonality on Professional Musicians and Non- musicians***

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Majority of western music is based on equal temperament, where each scale is divided into twelve equally spaced intervals - "semitones". This is only a convention based on the popularity of this system in the last 500 years. There are many other systems, which were either created in different time periods, come from different cultures or are product of music experiments.

Our (western) ear is trained to interpret certain chord and tonal constructs in a certain emotional way (e.g. major chord = uplifting, minor chord = melancholic), but other constructs seem alien and dissonant. Are there any other musical constructs that might evoke emotions other than disgust? Is it possible to find pleasing sounds outside of equal temperament?

Professional musicians use equal temperament on daily basis and are sensitive to detuned instruments or unexpected pitch [1]. The goal of this study is to show that this ability also makes them less open to new sounds and chords that are outside of the standart tuning. Their strength becomes their weakness in a sense.

The experiment will be completed by two groups - professional musicians and non-musicians. The first group is defined by atleast 10 years of active professional musical career and musicians that have no experience with microtonality will be preferred. E.g. jazz musicians tend to experiment a lot, so they have to be unfortunately skipped. Non-musician is, on

the other hand, a person that does not play any instrument and consumes current pop music. Again, people with experience in microtonal music (some experimental bands) will be left out.

Both groups will listen to semi-randomized sample of musical cues (chords) and respond via PsychoPy interface. The scales used to evaluate emotional effect are based on the research [2] and are: wonder, transcendence, tenderness, nostalgia, peacefulness, power, joy, tension, sadness. In the beginning, the participants encounter basic chord structures (major, minor, diminished) from equal temperament, to set the baseline for both groups and individual participants. Afterwards, the system will choose from more and more exotic pool of musical constructs, sometimes returning to equal temperament. Because evaluating music is relative (interpretation of a certain chord can differ based on the previous one), the resulting data will include also the sequential information about the cues. It is expected that professional musicians will have higher values in negative (tension, sadness) categories than non-musicians.

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# ***Collective Dynamics of Multi-Agent Networks: Simulation Studies in Probabilistic Reasoning***

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Agent-based modelling is seen as an alternative to traditional, "equation-based" modelling. It has seen applications in diverse areas. At the same time, the modern formulation of network theory became part of science, influencing discipline after discipline. Historically, however, networks have almost exclusively been dealt with implicitly by agent-based modellers. Their "network awareness" is a very recent phenomenon [1].

Belief updating refers to the process that enables an agent to alter his belief in a given hypothesis conditional on evidence that it receives. This concept is part of the field of "formal epistemology" that explores knowledge and reasoning using tools from math and logic. Bayesian approaches to probabilistic reasoning are dominant here. Proponents uphold that Bayesianism is the only rational way of belief formation, given that no other strategy protects an agent in principle from "Dutch books" (bets that guarantee a loss to one side). Nonetheless, alternatives that are probabilistic but not (Standard-)Bayesian have been introduced under the heading of "Inference to the Best Explanation". The use of alternatives is justified by questioning the practical relevance of Dutch book arguments and by resorting to pragmatism: It has been shown that there are strategies that have speed and accuracy advantages in belief updating [2].

This thesis will explore different scenarios with multiple agents updating their beliefs and influencing each other through specific network structures. The dynamics on networks as well as the dynamics of networks will therefore be in the focus of analysis [3]. Agent behavior and network

dynamics develop interdependently, i.e. they coevolve.

Apart from being a methodological advance, it is expected that this approach can yield novel theoretical insights on the dynamical formation of network structures by interacting agents. Additionally, it will be possible to demonstrate that there are alternatives to Bayesian updating that also yield advantages in multi-agent settings.

On a meta-theoretical level it will be argued that simulation results can be treated as quasi-empirical. Several necessary conditions will be identified that need to be fulfilled for this aim.

We borrow methods from computer science to investigate questions from philosophy (of science). Additionally, work done in the social sciences on agents and networks will provide input.

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# *The Experience of Addiction*

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The research field of addiction is characterised by terminological chaos and a lack of conceptual agreement as to what addiction really is [1]. The predominant view on addiction as a brain disease cannot explain all aspects of the phenomenon [2]. In the meantime, abuse of psychoactive substances remains one of the main causes of mortality and premature death globally [3]. Additionally, the emerging scientific field of behavioural addictions shows that addiction is not limited to drug abuse and may in fact be a more common phenomenon than has been considered thus far [1].

Our endeavour is to shine further light on the chaos prevailing in addiction research. To do that we will focus on phenomenological features of addiction since this seems to be the least represented approach. To answer our research question – what it is like to experience addiction – we will use second-person in-depth phenomenological inquiry. This technique consists of a series of elicitation interviews, within which participants are taken on as co-researchers. Participants will be chosen among individuals who consider themselves as being addicted to something and who are simultaneously not exhibiting criminal or severe medical issues. The research plan predicts two phases. Firstly, the researcher will inquire about the participants' experience of addiction and familiarise them with the research question. In the second phase the participant will be encouraged to observe the phenomenon in everyday life and keep a diary. Interesting journal entries will be then co-researched in interviews. From specific participant's data we will select prevailing themes and compare them between subjects. However, due to the nature of selected method we are unable to predict how detailed reports about the experience we will get.

Since the method presupposes in-depth study of experience of a small number of participants, we will not be able to generalise our results to the whole population of addicts. We rather aim – by employing a method that has so far received little attention – to shed light on potentially unseen aspects of addiction. Hopefully, our results will therefore provide useful insights and open up new lines of addiction research within neuroscience and psychology.

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# ***Examining the Relationship Between Hearing and the Sense of Touch***

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In this theoretical work I challenge the view that hearing and touch should be considered as separate senses. My goal is to propose two ways in which this separation, proceeding from the traditional Aristotelian notion of five senses, can be challenged. The first involves leaving out one of the five senses, namely hearing, and bundling it up together with the sense of touch. I challenge the widely accepted notion of touch as a contact sense. Touch may perceive a wide range of sources and involves different kinds of receptors on and in different parts of the body. The sense of touch is therefore a very distinctive perceptual system, involved in a wide range of perceptual abilities. Cochlear hearing can be simply understood as one of them. The second way calls for the additional sense of vibration detection (cf. [1], [2]) that involves hearing and certain, but not all, types of tactual achievements. My attempt is to identify the sense of vibration as a somehow graspable sensory modality that cannot be fully explained by the sense of touch or sense of hearing alone, but rather as a means of sensory integration that encompasses both. If touch and hearing work together so closely that they cannot be distinguished, they may be understood as a singular form of perception. Perhaps some of these achievements of perception through vibration are unified, for example, the low-frequencies are perceived using the skin and the ear combined. I concur with Katz's [3] proposal that the vibration sense represents a bridge between the pressure sense and hearing. I conclude that the two explanations of the relationship between hearing and touch that I propose in this work are not exclusive. Claims that one sense is an integral aspect of the other, or that both are composites of an additional

unitary sensory modality, will obviously not be resolved. Hearing and touch represent two fairly distinct senses, but at the same time it is very hard to determine where one ends and the other begins. Such claims suggest that in studying perception, the individuation of the senses may not be the best starting point, and that other approaches, such as the integration of the senses, might be preferable.

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# ***Power and Morality***

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Power is a key component which structures our society. It can be found in almost all social relationships and is therefore important in many fields, such as politics, economics, psychology or sociology. Much of our actions are influenced by the dependence, independence or interdependence on others. Often power, which can be understood as “having the discretion and the means to asymmetrically enforce one’s will over others”, is associative with negative behavior [1]. It could be shown that power has a positive effect on corruption and engagement in unethical behavior [2]. Which factors can moderate this relationship is still an open question. In the ethical decision making literature moral intensity is a recently discovered construct, which affects the whole decision making process. Moral intensity is the “extent of issue-related moral imperative in a situation and consists of several dimensions [3]. This line of research focuses on the ethical issue itself and its consequences on the decision-making process. It is reasonable to assume, that the decision making process is different for reporting your colleague to your supervisor, if you saw him stealing a pen or if you observed sexual harassment. How moral intensity influences the powerful is still unclear. My thesis wants to answer this question and my research question is: Which factors can moderate the relationship between power and ethical decision making and how does moral intensity influence the decision making process? To answer this question an experiment will be conducted and it is expected that the intensity has a greater influence on the powerless than on the powerful. Powerful people are less likely to obey social rules. Therefore, they can more easily ignore the social pressure which results of moral intensity and are able to resist. In contrast powerless people are more dependent on others and therefore are more likely to follow social rules. The consequence is that no matter what the moral issue itself

is, powerful people are more likely to engage in corruptive behavior than powerless people.

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# ***The Role of Steroid Hormones in Human Social Behaviors***

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The self-other distinction is an ability to distinguish self from other related mental representation, to take another's perspective and compute their likely emotional state [1] which is an important socio-cognitive ability necessary for successful human interactions. These social interactions can improve our reputation and social status, which leads to better access to limited resources. Internal physiological states of the human body, including the concentration of hormones, can influence status-seeking behavior and empathy [2]. For example, according to the dual-hormone hypothesis, testosterone increases behaviors related to status-seeking, such as overbidding in auctions or decrease of self-reported empathy mainly among individuals with the low levels of cortisol. However, testosterone effects on empathy and its interactions with cortisol levels have not been systematically examined [2]. We addressed these open questions in a double-blind, randomized, between-subject design study, in which 40 healthy male participants received a single dose of 150 mg topical testosterone or placebo. Thereafter, they were subjected to a nonstressful condition (Warm-water test) to control for low cortisol baseline levels. Subsequently, they completed the self-other distinction tasks (Reading the Mind in the Eye Test, Emotion Recognition Task, Perspective-taking Task and Imitation-inhibition Task) that assess the self-other distinction ability. Saliva samples for testosterone, cortisol, as well as continuous blood pressure measures, were taken repeatedly throughout the procedure of the experiment. The results showed participants with the high baseline level of cortisol had higher levels of baseline testosterone. Moreover, participants who received testosterone, were more accurate in

recognition of subtle emotional expressions.

## **Acknowledgments**

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# ***Computational Model of Memory Consolidation***

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Memory is one of the most important and obvious parts of both human and animal cognition. The way it functions has been shrouded in mystery for hundreds of years. Finally, humankind was capable of observing and studying the memory much more rigorously with advances in psychology and medicine. The study of amnesia by Squire and Shimamura [1] in 1989 revealed a strong correlation between severe cases of temporally-graded retrograde amnesia and bilateral lesions involving all cell fields of the hippocampus and dentate gyrus. Zola-Morgan and Squire [2] later discovered that patients with damaged neocortical structures such as anterior and lateral temporal lobe suffered from ungraded forms of retrograde amnesia. These observations of retrograde amnesia suggest, that the long-term memories, lost in the ungraded retrograde amnesia must be stored in neocortical structures, whereas hippocampus must be involved in some process that turns short-term memories into long-term ones [2]. This process was named memory consolidation.

Developments in computer science allowed us to create computational models, such as neural networks. This enabled the researchers to use these models as virtual laboratories where everything was possible to research and analyze. With advances in connectionist models, scientists started to use the neural networks to model various functions and areas of brain and cognition [3].

Considering this, we aimed to designed and implemented model capable of consolidating memories and later recalling them from long-term memory. To do this, we used two self-organizing maps, one being the hippocampus, the other neocortex, and wast

knowledge gained from research done in neuroscience.

We created model capable of transforming episodic data into short-term memories stored in the hippocampus that are later consolidated into long-term memories stored in the neocortex, taking the emotionality and recency of the episodic memories into account when consolidating them.

Our model was also capable of recollection of the older data from the neocortex showing that even older data was not lost in the neocortex during training.

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I would like to thank Martin Takáč for his support during this project.

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# ***Understanding and Assessing Bullshit Receptivity***

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Frankfurt defines the essence of bullshit (BS) as having a “lack of connection to a concern with truth”, stating that it is not false but phony [1]. BS is described as a ubiquitous phenomenon in society, having a major negative impact on our interactions. Pennycook et al. [2] switched the focus from defining the characteristics of BS to those of the bullshitees and the interindividual differences that are associated with the ability to detect BS. This transition generated several problems, most relevant being that the developed instrument (BRS – Bullshit Receptivity Scale) has disconnected BS from the contextual elements that naturally accompany it. Moreover, due to focusing solely on pseudo-profound sounding BS, the types of BS to which receptivity is assessed are severely limited and detection is biased towards people with religious or spiritual interests.

Our main goal is the development of a broader, more ecologically valid measure of bullshit receptivity. It requires participants to rate the reliability of 9 news articles. Each article exists in three forms: the standard form, which contains only reliable information; the added BS form, which adds a couple of biased paragraphs to the standard form; and the alternative BS form, which presents only biased, unreliable information. Each participant randomly receives 3 articles in each form. Scores will be determined by subtracting added BS and alternative BS ratings from the averaged standard form and, respectively alternative BS form ratings. This approach is based on the way fake news sources operate: having actual news articles with added paragraphs containing slightly related, biased information that link to their previous articles, which lack concern for the truth. The BS forms refer to popular topics, which

require little to no expertise, such as the dangers of microwaving food, the use of overripe bananas in cancer therapy and the human body’s ability to detoxify without external aid.

The psychometric characteristics of the new scale will be investigated as well as the convergent validity with the BRS and differential validity regarding variables such as verbal intelligence and ontological confusion.

As a secondary objective, we plan to interview participants about how they made sense of the items in our scale and those of the BRS. Subjective interpretation of BS has not been investigated and therefore little is known about the cues that determine its classification [3]. Results are expected to highlight the importance of contextual factors.

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# ***Relationship Between Mathematical and Musical Abilities in Middle School Students***

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This thesis explores the relationship between STEM (Science Technology, Engineering and Mathematics) and music from different aspects, including education, psychology, cognition and neuroscience. This relationship is based on transfer of learning, which represents a way of learning, when knowledge is obtained in one field and is available to utilize in some other field [1]. This phenomenon may be approached on neural and behavioural levels and is divided into different categories, based on its context [2]. The aim of theoretical part of this thesis is finding a common intersection of different scientific fields to reinforce interdisciplinarity. This study is carried out in collaboration with Slovak Academy of Sciences and OECD – CERI department, which is currently in the state of conducting international testing of knowledge and creativity in order to explore the international differences between elementary school students. The experiment was in form of pre-/post-tests with intervention. Both series of tests consisted of 3 different types of tasks, derived from OECD PISA and TIMSS testing, exploring knowledge in STEM, VAM (Visual Arts and Music) from which music knowledge was determined, and mathematical creativity. The data obtained from this testing on Slovak students narrowed the selection of subjects to two groups – eight grade students ( $n = 81$ ) and third grade students ( $n = 162$ ). The outcome serves to emphasize the possibility of achieving better motivation and understanding of natural sciences integrating music into educational process and bringing this opportunity to public educational system, which currently does not utilize the potential of this phenomenon

[3]. The results have shown only weak significant correlation and regression analysis shown a significant trend between music and STEM scores ( $r = 0.227$ ;  $R^2 = 0.051$ ), music scores and divergent mathematical creativity ( $r = 0.184$ ;  $R^2 = 0.034$ ) on third-graders data and even negative non-linear significant correlations and trends in regression between STEM scores and the amount of two types of music lesson activity - active music engagement ( $\tau = -0.187$ ;  $r_s = -0.251$ ;  $R^2 = 0.073$ ) and standard activity ( $\tau = -0.265$ ;  $r_s = -0.355$ ;  $R^2 = 0.136$ ). This finding demonstrates relationship between the two fields at least to some extent, yet the nature of it is quite disputable.

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# ***Behavioural and Electrophysiological Characteristics of Cognitive Control: A Comparison of Healthy and Clinical Groups***

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Cognitive control is essential for higher cognitive functioning. It is the ability to flexibly adapt behaviour to the requirements of a particular task, preferring the task-relevant goal-oriented information over other competing ones [1]. The theory of dual mechanism (DCM) [2] proposes the existence of two distinctly operating modes – proactive control as a form of ‘early selection’ and reactive control as a ‘late correction’. The DCM framework was built on a simple delayed-response paradigm known as the AX-Continuous Performance Task (AX-CPT), where participant is instructed to respond every time a cue A is followed by a probe X. It was shown that diverse situational factors can lead to a shift in cognitive control strategy [3] and a strategy usage also varies amongst different age groups, and between healthy and clinical groups; which results in distinct brain activation profiles and behavioural performance characteristics [2].

Therefore, the aim of this work is to study behavioural and electrophysiological characteristics of two healthy (young and old adults) and three clinical groups (Parkinson diseased patients in early stage and in later stage with cognitive impairments, and Alzheimer’s dementia patients/patients with mild cognitive impairment without other specification), since those clinical groups are highly untested. We compare them in accordance with the age and clinical condition. The participants’ EEG activity was measured during AX-CPT in four different conditions: AX-70 (70% of AX

trials, 10% of BX, AY and BY trial type separately), BX-70 (70% of BX trials and 10% of others), short delay between the cue and the probe (1.5s), and long delay (4s).

Apart from the fact that the results may bring a deeper theoretical knowledge of the nature of cognitive control, they may be beneficial in terms of better understanding of the chosen neurodegenerative diseases on the cognitive and behavioural level. In addition, abnormalities found in ERP components may be linked to an alteration of cognitive processing and may be of clinical relevance in early diagnostics of those neurodegenerative diseases.

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# ***Assessment of Sleep – Wake Patterns in Lesch’s Type 1 and Type 2 Tobacco Dependents***

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A significant correlation between smoking and sleep interruptions which are related to chronic diseases have been documented in many research papers [1,2]. Any interruption in the neurotransmitters of the suprachiasmatic nucleus (SCN)[3], the hypothalamic– pituitary adrenal axis (HPA), or the hypothalamus, interferes negatively in producing sleep disorders. Earlier animal studies showed that nicotine influences the circadian system via stimulating the nicotinic acetylcholine receptors (nAChRs) in SCN of the hypothalamus. The stimulation of nicotine to the HPA axis leads to the secretion of corticotropin-releasing hormone (CRH) in the paraventricular nucleus of the hypothalamus. This secretion urges the production of adrenocorticotrophic hormone (ACTH) in the pituitary gland and hence leads to the increased secretion of cortisol by the adrenal gland. The sleep neurotransmitter like GABA and melatonin can be suppressed either through the inhibition of nicotine to neurons in SCN or through the stimulation of nicotine to the HPA functions by increasing the secretion of monoaminergic transmitters like serotonin, dopamine, noradrenalin. These neurophysiological pathways of suppressing the sleep system due to nicotine abuse is confirmed by a study of cortisol test from morning and evening saliva of patients suffering from primary insomnia. The high cortisol level which was found in the early morning's saliva was strongly correlated to the low sleep quality of the patients at night. The purpose of this study is to investigate the relationship between tobacco and sleep disorders in Lesch type 1 and type 2 smokers through the assessment of their biomarkers and their sleep patterns. Building on our

previous data from the four types of Lesch tobacco dependents, we assume to see sleep disorders like insomnia disorder in type 1 smokers who may have less total sleep time (TST), longer sleep latency, high REM sleep density, in comparison with type 2 and the control group. In this investigation, the Lesch European Smoker Classification instrument and test of biomarkers will be used to assess the nicotine dependence. To assess the sleep structure in different severities of tobacco abuse in this study, we aim to use actigraphy in combination with sleep log and polysomnography (PSG).

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# ***Learning to Reach with Cues using a Simulated Robotic Arm***

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We will implement a reinforcement learning (RL) algorithm in the context of a simulated robotic arm trying to reach the given target that should, based on given reward, learn to interpret linguistic cues given to it. We will try various parameters of the model to find the best ones for the task. The main goal of the work is to explore capabilities of the used algorithm and its relation to human cognition in (to some extent) realistic scenario simulating the whole agent with the “brain” and the “body” in a physical environment.

RL is a type of machine learning that is inspired by operational conditioning (OC). OC works by giving a reward to an agent with the goal of reinforcing or decreasing given behavior. RL can be applied to problems that can be formalized as Markov decision processes (MDP), which is the case in our task. There is also neurological evidence that in the brain there are mechanisms similar to how reinforcement learning algorithms (also with the Actor-Critic architecture) works [1].

We will need a RL algorithm that is capable of dealing with continuous state and action spaces because in our scenario the simulated robotic arm that can get into “infinitely” many states and do “infinitely” many actions. The agent will in each step of simulation do an action (move in some way) and receive a reward proportional to how close the tip of the robotic arm is to the predefined target.

We will use the algorithm called Continuous Actor-Critic Learning Automaton (CACLA) [2], in which the Critic learns to evaluate how good a state is and Actor, based also on feedback from Critic, learn to choose actions

that will maximize the received reward. The Actor and the Critic have to work, generally speaking, as function approximators. We will use artificial neural networks (specifically multilayer perceptron) to do the job. The Actor and the Critic will receive an input representing current state of the robotic arm and the linguistic (imprecise) cue (e.g. “left”, “right”..., in one-hot encoding) that is giving the agent information about where to move.

The performance of the agent will be measured as a number of steps it will take to reach the target. This work is interesting also from the perspective of Human-robot interaction [3] as natural language is the natural way for humans to communicate.

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# ***Human-Computer Interaction Overview: Theories & Methods***

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For my projects and thesis, I have been immersing myself in Human-Computer Interaction literature. HCI is an interesting and very active field with a lot of potential for Cognitive Science. A big part of that potential is its focus on practical applications, which provide exciting possibilities to apply methods and results from Cognitive Science to real-world settings. In this talk, I want to share the results of my investigation. I will give a quick overview over the theories and methods of HCI and try to draw a rough map for other students to find their way into the field.

## **Theories & Terms**

This part will present different views on who (or what) does (or should) change when new technology is introduced to humans. Should the machines change to fit the people as best as possible? Or is it always a two-way adaption? Do we look at individuals or whole organizations? Do we care about task performance, people's internal experience, or even their position in society? Each of these questions has been debated at length.

Often, the different positions and their evolution over time has been described as happening in three waves [1, 2]. The first wave was based on Cognitive Psychology. It relies on a positivist epistemology and controlled experiments. In the second wave, focus shifted towards human agency and an understanding of context and user's perspectives. Interpretivist approaches increasingly replaced positivist ones. It is still connected with Cognitive Science through Situated Action and Distributed Cognition. The third (and most recent) wave focuses on non-work scenarios, interaction between multiple devices and user's internal experience.

## **Methods**

Here, the methods available to researchers interested in the interaction between people and computers will be discussed. They are very varied, and highly dependent on the questions asked. Additionally, quite a few methods from other fields are applicable here. While some of these will be mentioned, the focus is on methods that have originated in or are characteristic for HCI. However, these are not specific to HCI and could find applications elsewhere, potentially enriching other fields. The methods discussed will be divided into qualitative and quantitative methods. Additionally, prototyping as a scientific method will be mentioned.

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# ***The Effects of Social Affiliation on Approach/Avoidance Responses Towards Social and Non-social Stimuli***

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Although it is usually proposed that oxytocin affects social behavior, Harari-Dahan and Bernstein postulate that it may directly affect a general approach/avoidance system [1]. According to this hypothesis, oxytocin facilitates the approach towards positive social stimuli and attenuates avoidance of negative social stimuli. However, the authors claim that the same applies to non-social stimuli, as long as they are emotionally evocative and motivationally relevant for the person. Also, the presence of a socially affiliated person in a stressful situation has been repeatedly shown to have an anxiolytic effect and to decrease avoidance behaviors, while this effect may also be partly mediated by oxytocin [2]. If this assumption is correct, the induction of social affiliation might affect general approach/avoidance via the oxytonergic system.

The aim of this study is to test the effects of social affiliation on approach/avoidance towards social and non-social stimuli. Social affiliation will be induced by manipulating participants' beliefs of how similar the mental states of another participant are to their own mental states. In the experimental group, similar responses to statements about mental states will prevail, while in the control group dissimilar responses will prevail. To measure approach/avoidance behavior, we will present participants with six categories of stimuli which vary on: valence (positive, negative or neutral) and content (social or non-social). Social and non-social stimuli will be taken from the IAPS database and matched for arousal and

valence. Participants' task will be to control how long each stimulus stays on the screen. Prolonging the stimulus presentation time is interpreted as an approach response, and shortening the stimulus presentation time as an avoidance response. Participants will complete this task both before and after the experimental/control manipulation, so that any individual differences in approach and avoidance behavior levels could be controlled for. In the end, participants will fill an anxiety sensitivity scale and an explicit measure of social affiliation.

We expect that the induction of social affiliation, compared to the control manipulation, will increase approach to positive social stimuli and decrease avoidance of negative social stimuli. The same is expected for the non-social, emotionally evocative stimuli. Following recent findings [1], we expect to induce a stronger decrease in avoidance of negative stimuli in participants who are more anxiety sensitive.

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# ***The Influence of Alcohol on Music Induced Enjoyment – An Inquiry into the Mechanisms***

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Music induced chills, also known as shivers down the spine or goose pimples, are considered a sign of intense enjoyment. Chills have been researched in the context of musical pleasure, because, despite being a subjective feeling of emotional arousal, they can be observed objectively by measuring changes in psycho- and neurophysiological parameters, such as heart rate, muscle tone, skin conductivity, and hemodynamic activity. Thus far chills are known to correlate with dynamic changes in music, with the onset of the singing voice, with sudden changes in volume, and also with autobiographical factors such as memories [1]. The perception of the above enlisted musical parameters can be attributed to different mechanisms, which have been suggested to underlie music induced emotions such as rhythmic and melodic anticipation, emotional contagion, and memory. Indeed, musical enjoyment, similar to pleasure in general, has been suggested to consist of different processes of wanting & expectation, learning and liking, which can be cognitively, functionally and even neuroanatomically separated [2]. In sum, chills are an indication of musical enjoyment which is manifested as changes in the low-level (e.g. neurotransmitter systems), and high level (e.g. long term memory) processes underlying life sustaining functions, affect and cognition.

In a previous study, it was shown that the intake of alcohol leads to a reduction of the number of chills indicated behaviourally. Alcohol is a widely consumed psychotropic substance known to impair several cognitive functions by disturbing the encoding and retrieving of information. Also, depending on the given task, on the level of

intoxication, and personality, among other factors, alcohol can have behaviourally euphoric and anxiolytic effects. Yet the neurobiological foundations of the influence of alcohol are complex consisting of direct and indirect modulation of neurotransmitter systems [3].

This thesis is a theoretical inquiry discussing the different mechanisms in which alcohol intake interferes music induced enjoyment. By summarizing literature from neuropharmacology and music psychology, it is discussed how alcohol influences the human brain by interfering bottom-up and top-down processes related to cognition and physiology, and how these changes may contribute to the reduced number of chills while inebriated. The main contribution of the thesis is the unification of literature from fields that traditionally have had little dialog. This way the thesis is hoped to contribute to the scientific understanding of how alcohol is used to modulate emotions. A further understanding on the consequences of alcohol intake and its metabolism is considered important when developing treatment of maladaptive alcohol use.

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# ***Communicating Emergent Novelty – Proposing a Theoretical Communicative Framework to Support Novelty Creation in Organizations***

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In order to be successful in this complex, dynamic market, organizations have to focus on innovation approaches that are oriented towards shaping a rapidly changing environment by creating novelty [1]. For this, they must be able to (1) identify and (2) cultivate - as [3] put it - “emerging opportunities before they become manifest in the marketplace” and to successfully (3) diffuse them.

There is consensus that communication plays an important role in innovation processes [2]. However, the focus currently seems to be on the distribution of innovations after their creation [2], leaving out the key role communication plays before and during the innovation process. Its facilitating role is underestimated, probably resulting from a failure to understand that novelty creation is a dynamic, social, emergent process that cannot be managed, but only enabled [1]. Hence, communication strategies that focus on enabling novelty creation are currently missing [2].

The aim of this work is to provide a theoretical communication framework for the enabling approach to innovation. It is inspired by two important theories in the field of innovation: C.O. Scharmer’s Theory U provides a pointer on how to deal with change and uncertainty in organizations [3]. M.F. Peschl’s Emergent Innovation process [1] is destined at creating game-changing innovations that at the same time fit into the existing environment.

The aim of this work is to highlight the enabling role of communication in processes of novelty creation in organizations and to develop a framework for communication strategies that can be employed by organizations. It is assumed this will successfully contribute to organizations’ innovation activities in three ways: first, by preparing and guiding innovators through the innovation process; second, by identifying and facilitating organizational changes; third, by strategically engaging (future) users and thereby shaping the future market - as it emerges.

Results will be implemented in actual innovation communication strategies within organizations from different industries, providing a “reality check” for its applicability. However, this is not part of the master’s thesis.

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# ***The Costs of Being Behind a Screen – Could Social Media Use be Addictive?***

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Roughly, 1.5 billion people around the world use social media (e.g.: Facebook, LinkedIn, Youtube, Instagram, Twitter, Snapchat, etc.) for different purposes, mainly however, for social motives [1]. This ubiquitous use of social media generates a massive amount of data. Lately, modern human can attempt to satisfy basic social needs not just by face-to-face meetings, but also through online interactions. There are three domains in cognitive functioning which are especially important in online social media communication: social cognition (mentalizing), self-referential cognition and social reward processes. Due to such influence on our cognition, social media use could also be addictive. However, excessive social media use may have detrimental effect on personal, social and professional lives of the users [1][2].

My master thesis topic will revolve around the question of the relationship between social media use and the potential addiction to it through cognitive functioning. The aim of my project is to explore and assess the characteristics and prevalence of problematic/excessive use of social media. In my talk, I will present different theoretical models that provide explanations for the development of problematic social media use. I will explore the nature of clinical perspective of behavioral addiction in relation to social media. What is already known in previous studies of popular social media about influences on a behavior of users? How (and if) social media use could influence our cognition and behavior? My research questions are: i) could the use of social media reproduce addictive behavior? And ii) could social media use also present new research environment about human

social cognition and function within which we can study social behaviors (social crisis, social conflicts, prosocial or antisocial behaviors)? I will acquire the data from different fields within cognitive science. The result will be a theoretical framework with systematic review of neuroscientific and psychological theories of behavior which will support social-cognitive processes connected to addictive behavior of social media use.

It would be informative to see if there are any perturbations in individual elements (e.g.: novel technological use) which might perturb the functioning of the larger system - like brains. Further research of problematic usage of social media could prevent children, adolescent and adults from addictive behaviors.

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# ***Speech Alterations in Schizophrenia***

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The dopamine hypothesis of schizophrenia and psychosis is a model linking specific traits and behaviour in schizophrenia as hallucinations and other positive symptoms to alterations in signal transduction of the mesencephalic dopaminergic pathways [1]. This assumption is strengthened by the observation that amphetamine, a potent dopamine-releasing compound, being able to induce a reversible psychosis in healthy controls resembling aspects of schizophrenia such as auditory hallucinations and thought broadcasting [2].

Alterations of speech such as incoherence in discourse are commonly observed in schizophrenia and confer significant burden of disease. This is considered to reflect thought disorder in schizophrenia [3], hence finding an objective measure for these alterations might prove useful in schizophrenia diagnosis and in future research of thought disorder.

In our study healthy volunteers are sensitized to d-amphetamine using a previously established paradigm. Sensitization can be conceptualized as an increased neurochemical and behavioral response to repeated administration of a stable dose of a substance. In this framework schizophrenia is associated with a state of 'natural sensitization' [2]. As sensitized individuals show increased responsiveness of dopaminergic pathways which is also reflected in behaviour, we expect to observe amphetamine effects as well as sensitization phenomena also in terms of speech production.

Combining measures of discourse coherence with a PET-competition paradigm to evaluate the amount of dopamine released into the extracellular space after amphetamine administration. Furthermore

[18F]-FDOPA PET scans will be acquired prior and after amphetamine sensitization. This then might reveal possible interactions between speech output and dopaminergic neurotransmission.

Speech samples of study participants will be collected prior and after amphetamine intake and before and after sensitization and will be analyzed employing suitable methods of computational linguistics, such as latent semantic analysis or graph analysis.

Alterations in speech production could be a discriminative characteristic [3] in subjects under influence of drugs of abuse and patients with schizophrenia and might possibly lead to the development of valid diagnostic or monitoring tools in the long run.

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# ***Fetal Development of Hypothalamic Dopaminergic Neurons and their Role in Circadian Rhythms***

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The hypothalamus is a region in the brain just below the thalamus and its main function is to maintain the homeostasis of the body. Hypothalamic neurons play important roles in controlling the body's essential functions, including sleep and eating behaviours which are influenced by the circadian rhythmicity. Under the circadian rhythms we define any biological processes with endogenous oscillations of approximately 24 hours. The internal biological clock that drives these circadian rhythms is located in the suprachiasmatic nucleus in the anterior hypothalamus. The functional integrity of the biological clock is associated with many benefits, such as better cognitive performance, alertness, health and well-being. Patients that are suffering from neurodegenerative diseases, such as Alzheimer's Disease, Parkinson's Disease and Huntington's Disease, display disturbances in circadian rhythmicity which show as irregular sleep-wake cycle [1], [2].

Single cell transcriptomics of the adult hypothalamic area in mice revealed a particular group of novel dopaminergic neurons, located in the periventricular area in the hypothalamus, which show involvement in circadian activity [3]. Detailed analysis of this cell population revealed characteristic expression profiles which are specifically expressed by these dopaminergic cells. However, the birth, migration and differentiation of this particular cell group during fetal development, as well as their adult function, remains unknown [3]. The main goal is to investigate the physiological function of this cell population by tracing their development and synaptic integration into hypothalamic

circuitry. Our hypotheses are that these cells are born at the ventricular zone of the hypothalamus, then migrate outwards and travel back to periventricular space. Once integrated at their final position they incorporate into circadian associated neuronal circuits. To test our hypotheses we will use different methods, including immunohistochemistry and in utero electroporation with a fluorescent construct, to show their origin. In addition, we will analyse cell-type specific knockout mice and wild type littermates for brain circuit analysis and behavioural testing to understand their function in circadian behaviours.

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**MEi:CogSci Conference 2017,  
Budapest, Hungary**

# **Posters**

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# *Explaining Robot Actions*

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Human-robot interaction is a multidisciplinary field with contributions from human-computer interaction, AI, robotics, natural language understanding, design, and social sciences. Our research focuses on human-robot interaction via natural language. The possibilities that accompany the fast development of AI technology put us at a certain unease. In order for human users to “trust” the robots, we must first understand how they function. One way of illuminating the reasoning of robots is by programming them to explain why they execute certain actions. We believe that explanations via natural language are one of the most appropriate ways of describing the robot's intentions.

Our main task was to improve the explanations given by the robot in Cvetkov's master thesis [1]. The robot uses natural language to explain its actions (moving coloured blocks), which are guided to complete certain goals. The robot has to explain every course of action it takes in order for us to understand its reasoning. After thorough analysis, we have concluded that the explanations given by the robot are unsatisfactory, mainly because they are too complicated and at times irrelevant. We believe our adjustments make explanations more comprehensible and intelligible because they only reveal vital information. We present one such adjustment. It is important to emphasize that at this stage, adjustments are manually added and not implemented in the robot itself through a general algorithm. Robot: »Moving orange block from violet block to blue block, so that violet block is clear. This brings the robot closer to completing the main goals: violet block on top of center 1 and orange block on top of violet block«, [1] pp. 55. Adjustment:

»Clearing violet block. This helps achieve goals number 1 and number 2«. This is the only information essential for the user to understand the course of this action. The explanation is given in a concise manner and we therefore believe we have realised our task.

It is important for future robots to be able to explain their behaviour as efficiently as possible. Future improvements of our work could include visualization (each step of the robot's planning presented with visual cues) and multiple levels of explanation that would suit different users' preferences and needs. Furthermore, explanations presented in our example and in [2] and [3], could effectively be gathered, evaluated, and produced by crowdsourcing. We believe that the principles of robot's explanations we have presented could be applied in other fields of working with robots, such as GPS systems or autonomous mobile robots, [2], [3].

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# ***Towards an Understanding of the Emotional Modulation Effects of Focused Attention Meditation***

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Meditation is becoming increasingly popular as a topic for scientific research. Specific components of meditation have been shown to have differential, dissociable effects extending across a wide range of cognitive control processes. Using functional magnetic resonance imaging (fMRI), our study explores the neural substrates and behavioral effects of the focused attention aspect of meditation. During focused attention meditation, practitioners direct their attention towards a chosen object, such as the internal sensation of the breath entering and leaving the nostrils, and maintain their focus on that object from one moment to the next.

In a previous study differentiating focus on breathing and focus on external stimuli during meditation [1], one of the key differences found between the groups was a greater deactivation of the posterior cingulate cortex (PCC) during the breathing-focused task. PCC deactivation has been linked to attenuation of emotional intensity during evaluation of emotional imagery [2], and our study aims to examine whether the impact of focused attention on emotional reactivity will differ with varying foci of meditation. While both attention conditions should lead to overall lower activity in the default mode network (DMN), only the internal attention focus should lead to a specific, strong deactivation of the PCC. If these deactivations correspond to lower intensity ratings of negative emotional imagery, this would suggest that the PCC serves as the underlying mechanism governing the emotional regulation effects of

focused attention meditation. Such results would be consistent with existing evidence implicating the PCC in the interactions of emotional and memory-related processes.

While undergoing fMRI, participants of our study will evaluate negative emotional stimuli after a focused attention task where attention is directed either towards an external visual stimulus or towards the internal bodily process of breathing. We expect that the intensity ratings of the emotional stimuli will be lower following the breathing-focused attention task, and that these lower ratings will be correlated with greater deactivations of the DMN, particularly in the PCC. Such results would support a differential effect of internally and externally focused attention on emotional regulation, as well as the neural mechanism through which it may occur.

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# *Illusion of Control and Persistence*

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The illusion of control is the false belief of having an influence on the outcome of events that depend purely on chance [1] and has been reported in various everyday situations (e.g. professional trading and risk perception in driving). While perceived control over one's own outcomes, even if illusory, can be beneficial in some cases, it may also be costly and disadvantageous in other contexts. For example, believing one is in control may bias decisions to persist in competitions despite growing and impending losses. While previous studies provide some correlational evidence to support this link [2, 3], no studies have yet experimentally manipulated illusion of control to determine its causal effects on costly persistence in disadvantageous competitions.

To induce an illusion of control, we use a rigged computer game in which participants have to illuminate a lightbulb by choosing between two different key presses across multiple trials. Every 20 trials, participants judge their control over successfully illuminating the lightbulb. Unbeknownst to the participants, the frequency of successful illumination is manipulated to be high for participants in the high illusion group and low for participants in the low illusion group irrespective of individual key choices. The induction phase is followed by a competitive phase in which participants play the same game but with an additional opponent, actually a computer programme. Each trial costs a small fee. Moreover, participants have the possibility of betting on the outcome of each trial. Any expenses are subtracted from an endowment received at the beginning of the competition. To simulate a growing and impending loss, we rigged the competition such that the probability of winning equals that of losing

in the first trial, but decreases slowly across each subsequent trial. Importantly, participants can quit the competition at any time, keeping any remaining money from their initial endowment.

Based on the hypothesis that the illusion of control may bias decisions to persist in competitions despite increasing losses, we predict that participants who are manipulated to feel more in control of the lightbulb will persist longer on the task and will bet more money than participants who are manipulated to feel less in control. The predicted differences between subjects will be investigated by comparing self-reported (e.g. believed level of control over the lightbulb) and behavioural measures (e.g. persistence and betting behaviour) obtained throughout the induction and competitive phase. These are complemented by demographic information and psychometric data on perseverance-related personality traits and a post-task feedback questionnaire checking for suspicion towards the task design. A confirmation of our prediction would corroborate the idea that the illusion of control potentially functions as a motivator, even in disadvantageous competitive situations that are costly to the individual.

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# ***Insights into the Skillscape of Yoga: Explicating Coordinative Synergies and Meta-regulation Skills***

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This project explores embodied Yoga skills in micro-genetic detail. Mindfulness and alignment are key to Yoga philosophy, understood as continuous attention towards the body and its organization that particular poses (asanas) presuppose. Not only the more adventurous asanas, but very basic, seemingly simple ones – like the basic standing pose *tadasana* – constitute sensorimotor tasks of high complexity, when done right. As such – as dynamic systems approaches to motor skill highlight (e.g. [1]) – they depend on the situated interplay of multiple elements, i.e. coordinative structures or synergies.

From a seasoned practitioner's viewpoint, it is fairly clear what an asana's form should look like, yet it poses a challenge to reflexivize (and in pedagogic settings to explicate) the minute details of, especially inner execution, a typically tacit dimension of embodied skill.

Our aim is to describe and inventorize synergies underlying the coordination of Yoga postures by addressing the following questions: (1) What is the task's overall structure? This delineates the (possibly diversely achievable) outcome-defining macro-performance parameters: like, in *tadasana*, a centred, balanced upright stand. (2) Which elements are involved and how do they cohere? This question reveals the task's numerous (central, and peripheral or even optional) micro-parameters and their functional roles: like, in *tadasana*, a lifted sternum, the tailbone drawing down, relaxed knees, and more. (3) How do elements

create a functional ensemble together – what larger structures do they establish? What trade-offs kick in when local changes occur – how does the rest of the system compensate, e.g. buffer glitches, or help tone down overactivations, overcome rigidity or a general bad training state? (4) How are synergistic patterns built up over micro-time – do some central aspects come first, is there sequentiality?

To elicit selected Yoga coordination patterns we draw on think-alouds with experienced Yoga practitioners, and developments of Explication-Interviewing techniques (e.g. [2]). We may also encourage variation or consciously perturb patterns (quasi-experimentation). These methods help us enable experts to tap into their experience during performance and become aware of the manifold details of the ongoing processes.

The rationale of this qualitative, micro-phenomenological approach to embodied skill understood as synergy-building can enrich motor control theory by addressing frequently eclipsed complex action patterns and experts' rich knowledge of them. In addition, a better understanding of competencies and strategies underlying Yoga practice can be of pedagogic use for trainers in the domain.

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# ***Uncertainty in Knowledge Creation Processes***

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The research of knowledge and innovation creation constitutes itself though an interdisciplinary field of study. Investigations done in the associated Enabling Space Lab are examining under which circumstances knowledge and innovation can emerge. Therefore numerous aspects are investigated, as for example the social and spacial environment of a person that is willing to create something radically new.

Besides theoretical and applied research done in the Enabling Space lab, data was collected in seminars on innovation, knowledge creation, and philosophy of science which were held jointly by the University of Vienna and Vienna University of Technology in the summer term (March - June) 2015. Within this seminar, students (N=17) were working together in Knowledge Creation Teams (KCTs). Each KCT was consisting of 4-7 people. Based on the process of "Theory U"[1], every team was working on a collaborative innovation which was chosen freely due to common interests. The final purpose entailed creating a prototype of the innovation. During the seminar different data sets were collected. At seven points in time, students had to fill in diary entries concerning their learning and group processes.

The collected data sets of the students are now evaluated within our research process. Regarding those datasets the following research question was emerging: "How do members of a group experience uncertainty during the knowledge creation process?"

The research question could be seen as relevant for several reasons. Considering different fields of research in Cognitive Science, it becomes clear that the state of uncertainty was investigated rarely. Furthermore, there is a common trend in science to avoid all kind of uncertain states

and feelings. Regarding this tendency we argue that specific investigations on uncertainty would contribute in understanding the importance of this ambiguous phenomenon better.[2]

The qualitative data analysis is guided by the principles of "Grounded Theory"[3] and executed through the data analysis software Atlas.ti. Using "Grounded Theory" as a analysis method we are able to construct a theory that is grounded on data and therefore not dependent on already established scientific theories. Apart from that, "Grounded Theory" is a good tool for investigating issues and phenomena that haven't been investigated thoroughly yet. Therefore "Grounded Theory" could be seen as perfectly suitable for the our research project.

Studying the question of uncertainty in knowledge creation processes could lead to various implications in different fields of Cognitive Science. Investigations could contribute to research of qualitative, empirical approaches that seem to be underrepresented in the field of Cognitive Science. Furthermore, possible results about uncertainty could have various impacts on knowledge and innovation creation processes and on learning in university contexts in general.

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# ***Hedonic Treadmill Theory Applied To Virtual Reality Technologies***

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Rapid developments in information technologies can make us wonder what the future has in store for us. Ray Kurzweil predicts we will develop brain-computer interfaces that will allow us to experience full-immersion virtual environments, indistinguishable from real reality, by the late 2020s. [1] Because such a profound technology could have a huge impact on our society, such as global apathy and emotional absence to achieve new things, the goal of the project was to review literature of Hedonic Treadmill theory, while assuming that the technology actually won't make a huge impact.

In 1971, Brickman and Campbell coined the term Hedonic Treadmill, which explains sensory adaptation that seems to happen to people experiencing emotional reactions to significant life events. [2] People adapt to any positive or negative life event and return to the previous neutral emotional state, which suggest, that we have to continually set new goals and strive for new things to keep ourselves happy. What would happen if virtual reality would allow us to experience any desirable sensory experience at the snap of our fingers? Would this mean that we would have the feeling that we have achieved all of our goals and that this would lead us into a state of apathy? Would we continue to value any experience or material thing, if they would be instantly accessible in virtual worlds?

But there is also another side to the story. Even though the Hedonic Treadmill theory states that life circumstances don't have an effect on well-being of a person, newer research finds they do have at least a mild effect. People are mostly in a happy, not

neutral state of being, they have different default levels of general happiness which depend on life circumstances, but also on their personality traits. It also varies throughout life, meaning the general level of happiness can be improved with the right interventions. [3] This adds importance to the ethical discussion about the regulation of virtual reality technologies and the best practices of dealing with such technologies to maximize our well-being and prevent possible negative effect.

While the classic Hedonic Treadmill stated that full-immersion virtual reality won't cause a wide societal impact to well-being, more recent findings and analyses suggest a different mechanism. Therefore, the effect of virtual reality on society should be studied carefully and regulated accordingly.

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# ***Designing Web Usability: Cognitive Psychological Experiment as a Part of UX Research***

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UX, short for User Experience, entails user behaviours, emotions and attitudes of individuals when interacting with products or services. UX research utilizes various quantitative as well as qualitative methods with the aim of an overall improvement in usability, findability and accessibility of the aforementioned digital products. Directly observable utility attributes are usually the main focus of a quality assessment within classic usability research. The ISO standard 9241/11 describes these attributes primarily through effectiveness and efficiency [1]. This suggests that UX research is centred around the examination of subjective qualities for users in relation to human computer interaction (HCI).

As UX examines the behaviour of humans, it is believed to be appropriate to carry out psychological experimentation that would enhance the findings of classic UX research. In our research, Stroop priming experiment was used to explore whether individuals correctly implicitly connect categorical icons with correct category labels. A more general interpretation of the Stroop experiment is that stronger a stimulus captures human attention, the more delayed the response. Steve Krug [2], a respected author in the UX field, describes intuitiveness of each web page elements as the most basic building block of usability. Data in the experiment was pulled from five e-commerce stores offering electronic devices and participants were asked to connect product category icons to corresponding labels. These icon-label pairs were in turn ordered by reaction times and number of correct responses, whereby pairs with the shortest reaction

time and greatest accuracy of response were deemed to have the highest usability score.

A usability test was carried out consequently, where the tested user tasks were related to the search for items falling into priorly examined product categories. This user testing was conducted on six participants. The assessment of user testing was done by the participants through Likert scales as well as by observations of the test conductor. This research was based on the premise that the findings of Stroop experiments should be in correlation with the findings of our usability testing. Hence, the product icon-label pairs that received the highest score from Stroop experiments will also be the ones that will receive highest rating from users in the usability testing. These findings have the potential to give way to an effective product categorization and improved usability of webpages.

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# ***Cognitive Control in Patients with Depression***

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Cognitive control is a term describing processes that jointly enable goal-directed behaviour and thoughts. It is responsible for action planning on several stages, maintenance, and execution. Cognitive control has a limited capacity, meaning that we can only process a certain number of stimuli simultaneously. In complex environments, cognitive control system plays a critical role with its ability of flexible switching between various stimuli and processes. Components that form cognitive control communicate in several stages in subcortical and cortical structures in the brain. Basal ganglia are thought to control cognitive switching by regulating top-down projections from prefrontal cortex to posterior sensory areas. They inhibit cognitive processes that are not task-relevant, enabling the prefrontal cortex to act in accordance with the appropriate behaviour [2]. In many psychiatric and neurodegenerative disorders cognitive control system is impaired. The impairment can be divided into primary and secondary. Primary control disorders are characterised by a neural dysfunction of the control system itself, such as in schizophrenia or bipolar disorder. On the other hand, the secondary cognitive control impairments are exacerbated by the low control system capacity, however their underlying neural dysfunction does not directly affect the cognitive control system. An example of such disorder would be depression [1]. Our research is focused on testing cognitive control in depression and comparing clinical population's profile with healthy subjects. According to our goals we hypothesise that patients with depression will have several issues with inhibition and integration of the stimuli, their cognitive processes will be less flexible, which will worsen their ability of

switching between various task trials. Therefore, there will be a significant difference in cognitive control abilities between the sample of patients with depression and their healthy controls. In our research, a flexible switching task will be developed and used that demands coordinated activity of various cognitive processes and effective cognitive control. Subjects will participate in a detailed psychological testing, and information about their current stage of depression will be obtained. Results are not yet available but we expect that they are going to significantly contribute to our knowledge about cognitive control in depression, which could help develop better treatment and understanding of the depression disorder in general.

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# ***Living With Social Robots: Some Aspects Of Future Human-Robot Relationships***

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Main goal of this project is to point out the need for quality research on this topic, so we will be better prepared for the relationship with human like robots. My method was critical analyses of already written articles.

Technological progress is a part of our sociocultural evolution. [2] This progress is quite fast, so it is possible that social robots will soon be a part of human society. Social robots are human-like robots. They will try to mimic humans; the way we talk, the way we walk, how we think, how we manifest our emotions, etc. They will be a part of our everyday life as our friends, partners and co-workers. They will help us with taking care of the elders and kids. [1] In short, they will become a part of our society. The fact that we are able to create something like that is very appealing. Because of this attractiveness, many have forgotten about potential problems. Investors are usually in a hurry to get money, so researches are often neglected. These researches are important because they would help us to be prepared for unwanted, unplanned and unpredictable situations. Because of the way the robots are designed, they are in need of special maintenance – we need to specify their role and place in our society. The real questions are: »How will social robots affect our lives?«, »How should they be programmed?« and »How should we act in the event of a morally questionable situation?«. [3]

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# ***Connection of Executive Functions with the Use of Reading Strategies in Primary School Students***

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Executive functions (EFs) are a set of general-purpose control processes that regulate one's thoughts and behaviour [1]. We are investigating the scale/development of three of the arguably most commonly discussed EFs in literature: automatic responses (inhibition), constant monitoring and rapid addition or deletion of no-longer relevant information of working memory contents (updating), and shifting between tasks or mental sets (shifting) [2]. One of the hypothesis is EFs such as working memory, verbal fluency, inhibition, word recognition etc. are significantly connected with all components of a good summary. The purpose of the following study is to focus on the connection of EFs in fourth grade primary school students with their ability to use reading strategies - summarizing and taking notes. The study includes a new designed course for teaching students with workbook texts and trained teachers for running it. Efficiency in students' independent ability of text processing has been assessed before, between and after an intervention course with the help of a test battery. The three-part course lasted from 5 to 6 weeks. In the first part, the students were learning to find/highlight essentials and write a summary for short chosen texts. Second, students had to apply this knowledge to summarize longer and more difficult workbook texts. The third part was designed to use skills from the first and second part when taking notes with the help of Pauk's strategy, known as The Cornell notes. Since the study is currently in the third stage, results are still pending. In the context of the test batteries' results and the new intervention course that has been developed, this study could provide a better understanding of EFs in connection with the

use of reading strategies in primary school students. It could also improve reading skills in terms of speed and understanding, grasping the essential, writing summaries and perhaps even strengthen or improve reading motivation in students.

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# ***Typology of Phenomenological and Physiological Responses to the Increase of Difficulty in Solving Mathematical Problems: A Continuation***

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Skin conductance refers to how well the skin conducts electricity, and was already used in some event-related skin conductance responses studies to analyse participants reactions to sudden stimuli, such as a loud noise or emotional pictures [2] and also their reaction in relation to mathematical anxiety [3]. For our research we assumed the existence of individual differences in experiencing mathematical problem solving. By observing at the same time the physiological response, i.e. electrodermal activity and pulse, of participants, our research aims to analyse the correlation between phenomenological and physiological responses. The aim of the research is to produce typology of responses while solving mathematical problems.

The preliminary research was conducted in 2015 and presented at the 2015 MEi:CogSci conference [4]. For the recording of skin conductance and the heart rate we used the Biopac MP150 System; the acquiring was constant throughout the testing. Participants were asked to solve 20 mathematical problems, divided into four sets of five problems each. Because it was found in pilot testing that a countdown on screen had an impact on the experience of the problem solving, the research was divided in a first non-clock phase (first 2 sets) and a clock phase (last 2 sets) in order to investigate whether a time-limit is contributing as a stress factor in solving mathematical problems. At the beginning and after every phase, an interview was conducted to assess the overall physical and

psychological well-being of participants (i.e. their physical sensations and the focus of their thoughts), and the experience of problem solving (i.e. the specific strategies and techniques).

In the preliminary research analysis, one of the parameters for interviews was the fun participants experienced while solving mathematical problems (on a scale 1 to 5, where 1 means “not fun”). The experiment showed a correlation between how much the participants had fun while solving and their correspondent skin conductance reaction. The data showed also that the visual presence of the clock had an impact on the experience of problem solving, with an increase of experienced anxiety and an experienced loss of concentration. The further research will investigate the correlation between physiological responses and the corresponding experience in order to gain a better understanding, thus moving closer to the intended neurophenomenological typology.

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# ***Relationship between Social Rejection and Neurocognitive Functioning***

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Social rejection is a very common phenomenon which affects all spheres of human's life: behavioural, affective and cognitive. In the poster will be presented the most visible changes in brain functioning as well as the relation between changes in cognitive functioning and behaviour. Classic neuroimaging studies have provided evidence that rostral cingulate cortex is a key area of emotion and motivation, and recent research has led to the extension that the function of this area includes also pain sensation and cognitive control. People who experience social rejection show a characteristic pattern of behaviour, they often take risky behaviours, their behaviour is aggressive and their prosocial behaviour is significantly reduced. This pattern may be related to cognitive functioning impairment, particularly cognitive control, which has not yet been fully investigated. The main research paradigm to manipulate a sense of rejection is the CyberBall paradigm. It is used to study relationships between rejection and behavioural changes as well as cognitive and emotional functioning. People are very sensitive to every signal of rejection. It is shown that the worsening of mental wellbeing has the same power, regardless of whether the participants believe they are playing with another person or know that they are playing with a computer program.

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## ***Striatal ROI Delineation in PET D-Amphetamine Sensitization Studies***

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Sensitization to d-amphetamine (AMPH) manifests as a progressive increase of physiological and psychological drug effects upon constant dose administration. On a neurochemical level, AMPH sensitization has been shown to elicit increased AMPH stimulated dopamine (DA) release. Due to increased drug effects and exacerbated positive symptoms following ingestion of small doses of AMPH, schizophrenia is sometimes conceptualized as a state of endogenous sensitization [1]. Sensitization studies can, therefore, provide better insight into the mechanisms of schizophrenia, as well as early stages of addiction which are in many cases accompanied by sensitization phenomena.

AMPH induced DA release can be measured by dopaminergic radioligand displacement with positron emission tomography (PET). Region of interest (ROI) approach in analyzing PET imaging data, based on averaging time activity curves (TACs) within each of the relevant predefined regions, is generally considered a very robust method for PET image analysis. However, the results obtained by ROI analysis as well as their interpretation are highly dependent on the way ROIs are defined.

This project will compare two automated ROI delineation methods for quantifying D2/3 receptor specific agonist radioligand [11C]-(+)-PHNO binding in the striatum (in the course of AMPH sensitisation). It will be realized using the data from an ongoing study evaluating the binding of [11C]-(+)-PHNO and AMPH stimulated DA release in a healthy cohort prospectively sensitized to AMPH as well as a cohort of medication naïve patients with schizophrenia. Two sets

of ROIs will be used for data analysis; one based on the anatomy of the striatum comprising ROIs for the caudate, the putamen and the ventral striatum and the other based on functional subdivisions of the striatum comprising ROIs for the associative-, the limbic- and the sensorimotor subdivision of the striatum [2]. The results will then be evaluated with the goal of determining which ROI set is better able to identify AMPH and sensitization effects on radioligand binding.

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# ***Integration of Science and Art in the Case of Evolutionary Art***

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Art has always encompassed more than mere creation of objects. It also shows the growth of ideas throughout history and manifests as a reaction to the wider cultural climate. Galanter [1] presents a new approach, dubbed “complexism”, which applies the scientific understanding of complex systems onto the content of the arts and humanities. It offers the cooperation of science and humanities through a synthesis of the modern and the postmodern. Evolutionary art uses complexism both as a method and as its subject matter. More specifically, evolutionary art uses methods from evolutionary computation which employ supervised or unsupervised fitness assignments for art creation. The field of computational aesthetics, on the other hand, investigates how computational methods can be used to assign aesthetic judgments to objects. The aim of this theoretical research is to determine how exactly these fields relate to each other and how they can benefit from the findings of cognitive psychology and neuroscience, ultimately forming a model of the human creativity process and perception, and find ways to automate it.

Through an overview of these fields, we see that computational aesthetics takes its basis from the first quantitative theory of aesthetics and its later iterations which represent aesthetics through formulae and rules. A common starting point is Birkhoff’s formula which states that the aesthetic measure is the ratio between order and complexity, commonly referred to as “unity and variety”. Many elaborations have emerged from this basis, one specifying complexity as the complexity of a signal the way the human perceptual system receives it, and another defining order as a degree of predictability [2]. Different approaches have been used for determining and correcting

this ratio, often used in the implementation of the fitness function of an evolutionary art algorithm. A distinction is also made between perception of form and content, the perception of the latter being more challenging to put into computerized terms [3].

Throughout both theoretical and empirical research, we notice a widespread effort to find a balanced cooperation between a human and a computer, giving both of them the roles of artist and critic. The interdisciplinary approach needed for this task gives us great insight into how human cognition works in the context of art creation and perception, as well widens our knowledge of the mechanics of human cognition in general.

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# ***Neural Correlates of Visuospatial Working Memory: An fMRI Study***

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Using functional magnetic resonance imaging (fMRI), we attempted to locate neural correlates of visuospatial working memory. Working memory is a cognitive process that enables people to maintain a certain amount of information. We are interested in finding out where visual and spatial information is stored and if a different system is involved when maintaining a combination of the two.

We relied on a number of assumptions. The first is based on an article by Vogel and Machizawa [1]. They used electroencephalography (EEG) to test the capacity of visuospatial working memory, which is said to be between 3 and 4 objects. They found that what correlates with this capacity in the brain is the so called CDA – contralateral delay activity, which is crucial to further research on the topic of working memory. Another assumption is based on the idea of functional localization. Sala and Courtney [2] used fMRI to detect different areas of the prefrontal cortex, responsible for processing different aspects of visual working memory. Our prefrontal cortex tends to be domain-general when we are required to memorize a unified stimulus, for example an object in a location, and domain-specific if the task demands either the identity of an object or its location.

This study was the last in a series of three, testing where and how working memory is stored. 34 participants (mean age = 20.3, 82.4% female) were asked to perform a task while in the fMRI machine, where they had to maintain a series of visuospatial stimuli in their working memory. The stimulus was a colored square on a 5 by 5 grid. They either had to remember their location (anywhere

on the grid), their identity (one of 25 different shades of color), or a combination thereof. These tasks came in two levels of difficulty; either the subjects had to memorize two unique stimuli, each repeated twice, or four, where each stimulus only occurred once.

We expect to find similar results to the previous studies. Specifically, this means finding that working memory capacity for visual information is found in a cognitive system independent from where spatial information is found, but when maintaining integrated information, both systems are active, though to a lesser extent. The brain areas that we expect to represent working memory are the frontal and parietal regions.

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# ***Character Mining and Generation from Film Dialogs***

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Robots that live and work with humans need both flexibility and consistency in their interaction. This necessitates that conversation “in character” is generated from a coherent character model. Systematic accounts of the conversational devices that contribute to the modeling of characters in the existing literature are scarce [1].

The premise behind our research is that it is possible to generate an interacting character based on utterances. Hence, one of the aims was to establish how fictional characters are structured through dialog. For this purpose, a corpus of utterances from film scripts was analyzed. Our focus was on the characters of mentor and mentee as these two types are widely represented in popular culture, and have potential applications in robots that perform various tutoring tasks.

At the exploratory stage, we applied manual analysis in parallel with automated distance based analysis [2] to the textual descriptions of 51 mentor tropes extracted from tvtropes.org [3]. This allowed us to 1) gain a deeper understanding of the relations between individual mentor tropes, and to arrange them into 10 types based on several dimensions, e.g. moral compass (evil/benevolent), communicative style (direct/cryptic), source of expertise (expert knowledge/supernatural power), and others 2) to compare advantages and limitations of the automated analysis in comparison to the manual analysis performed by human experts.

Further on, the manual analysis of a sample of film scripts allowed us to identify two narrative strategies that define the interaction and the development of the relationship between the mentor and the

mentee. The first strategy implies that the mentor is the one to seek out the mentee, when in case of the second strategy, it is the mentee who initiates the interaction by reaching out to the mentor for help or advice. The work in progress is focused on the manual modelling of the interaction between the mentor and the mentee based on these two strategies, and on the compiling and categorizing a database of utterances used at the key moments, e.g. first encounter, of the interaction between the mentor and the mentee.

The results obtained during the exploratory stage of the project will be used to build and train a computational model that will allow to generate dialogues between a virtual mentor and a human/virtual mentee. We expect to be able to modify the dialogues by influencing the weights of different factors, e.g. affective style.

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# ***On the Very Idea of a Constructivist Master Program***

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The goal of the present collaborative project is to reflect on our educational experience as students of cognitive science. In a field as diverse as cognitive science, common philosophical concepts between researchers and a sense of shared history seems essential to the community. We reflect on our experience by referring to concepts from Zimmermann et al. [1], which describes the philosophical background and the practical experiences the authors encountered in setting up the MEi:CogSci master program. The core philosophical concepts from the paper that we discuss are the following: (i) the idea that many fundamental challenges in cognitive science have common roots in paradigms as formulated by Kuhn [2], and (ii) constructivism as a theory of knowledge and the vision of teacher-student relations that it implies (according to the authors).

In our discussions, we identified discrepancies between these philosophical concepts as they are described in [1] and how they are implemented in the master program. First, we aim to argue that, although the authors claim to analyse cognitive science in terms of Kuhn's paradigms, their usage of this concept appears to be essentially different from Kuhn's. It is difficult to extend Kuhn's paradigms to real-world problems of linguistic or disciplinary divides, which are in most cases not problems of incommensurability [2]. Second, we aim to show that using constructivism as an epistemological foundation for a curriculum risks introducing preconceived notions. The authors claim that their intention is to allow students to form their own perspectives and

that constructivism provides a basis for this activity. However, constructivism itself relies on specific notions of what knowledge is, while, at the same time, the question 'what is knowledge' is an explanandum of cognitive science. Additionally, asserting constructivism's basic tenets, as the authors do with: "[students] are supposed to understand knowledge to be not an (static) object, a product, or a result, but a process and activity" [1:153] is at odds with the aim to stimulate students to form their own opinion by not forcing on them a conception of what is truth.

The MEi:CogSci program presents an original design with many benefits. However, there might be a gap between the philosophical ideals of the program and its actual implementation. This gap becomes apparent in some rigid aspects of the resulting framework.

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# ***“Wanting” And “Liking” Of Primary and Social Rewards in Humans***

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Motivation of human behavior through rewards represents a highly important yet complex topic for which different concepts and models of explanation have been proposed in the scientific community. One model prominently features the differentiation of two components of reward processing: a motivational component called “wanting” which is driven by incentive salience and an affective component called “liking” which relates to the hedonic pleasure while obtaining rewards [1].

While this has been investigated at large within animal research, more evidence is needed to support a similar dissociation of these components in humans.

Furthermore, it remains to be seen whether identical or separate neural networks underlie processing of different types of rewards, for example, primary rewards (e.g. food) versus social rewards (e.g. physical contact) [2]. Hence, paradigms considering both “wanting” and “liking” as well as primary and social rewards are of interest.

In this pilot study, a new behavioral paradigm is introduced which shall be applicable to psychopharmacological and neuroimaging techniques (fMRI) in the future.

Using a within-subjects design, healthy male and female participants were tested in a standardized real effort task, which enabled not only measurement of subjective responses (ratings of “wanting” and “liking”)

but also objective responses to both primary and social rewards.

Objective assessment of “wanting” a reward was realized through subjects’ squeezing of a hand dynamometer while electromyographic activity of the zygomaticus major muscle (involved in raising the corners of the lips) and the corrugator supercillii muscle (involved in frowning) was used as an objective measure of “liking” a reward.

As a primary reward, small amounts of milk mixed with different concentrations of cacao-drinks (e.g. 25% or 100%) were delivered using computer-controlled pumps. As a social reward, participants received forearm caresses at different speeds by a same-sex experimenter mirroring social grooming in animals.

Preliminary subjective and objective behavioral data suggest comparable responses of “wanting” and “liking” to all stimuli regardless of the type of reward. This paradigm or respective adaptations will be employed in future research regarding “wanting” and “liking” in the social neuroscience domain. The anticipated insights through this new experimental approach shall aid understanding of instances of dysfunctional reward processing such as addiction (primary rewards) and autism spectrum disorders (social rewards).

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# ***Extending Concept-level Knowledge Bases in favor of Information Extraction***

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The aim of the present project is to seek and match the regularities in source databases, for extending the knowledge within the word map (in Continuous Vector Space)[1].

The two major systems of representing conceptual meaning (the information to be extracted) are: word vectors (Continuous Vector Space or CVS Semantics), forming a high dimensional space - word map) [3] and knowledge graphs (known as Algebraic Conceptual Representation or ACR semantics).

Source databases are both, Microsoft Concept Graph (ACR) [2] and the Stanford glove.840B (CVS) [3]. Where we are to find non-redundant links between the entities of Concept Graph, supported by the glove.840B database of pre-trained word vectors.

Within the Concept Graph, subjects of information – entities – are still extracted, therefore there is no need to process unstructured text. The database itself consists of entity-pairs with a specific “is\_a” directed tie between them. E.g. pepper -is\_a-> vegetable.

The database to extend is the word-map, because word vectors offer from many perspectives near-optimal “numerical” representation of words. The technique offered by the GloVe supports opposite word vectors and even specific related categories. Appropriate representation of categories means generalization of meaning type based on the (Euclidian, cosine ...) distance of two related words in high dimensional (300 D) space. E.g. pepper - vegetable = tiger –

mammal

Moreover, extent of semantic similarities is relative to difference between two word vectors and it's orientation , representing two Concepts.

In first stage, we are to find general nodes in Concept Graph, where replacing one node with one of the nearest word in feature space do not mean depreciation of the tie between the substituted and the remained node. In that case, the knowledge-base can rise without expensive web crawling for more instances to analogous relation. Next, we make attempts to express these relations via suitable linear transformations in the high dimensional space (CVS), to be recallable without modifying the source database.

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# ***The Paradox of Freedom: What Believing in Free Will Can Do For Us?***

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A fierce debate has been unfolding between philosophers, psychologists, and neuroscientists around the topic of free will. Our experience shows us that we are free to choose which way to take, which choice to make, which ideas to believe in. Nonetheless, recent research has shown that even our simplest choices are being triggered by some previous event, making difficult to sustain the case for free will both in brain research and behavioral research. So the question here is not to pick a side and try to decide which one is right, but this: Since we came to develop such a belief in free will, what does it do for us? If and how the belief in free will transform our behavior?

Kathleen D. Vohs [1] examined this question and found that a lack of belief in free will - that is in a deterministic chain of events - increases cheating. Several other papers suggested similar outcomes.[2][3] This time, we wanted to examine this phenomenon in the working environment. We wanted to explore if and how the belief in free will, compared to a deterministic belief and a neutral belief, could in fact influence the results of employees in terms of altruistic behavior, moral behavior and in creative problem-solving.

We've developed a questionnaire containing 3 types of problems to be solved by the subjects. From a sample of 120 individuals, we divided the sample into 3 groups, each containing one belief induction - one for free will, one for determinism, one neutral. The questionnaires were sent to several different companies (12 different companies in several business industries) to be responded at random and anonymously.

Our hypothesis is that, if this experiment shows similar results from the ones found in the literature, we can expect significant differences in the behavior of those subjects presented with the deterministic belief: we shall expect increasing in cheating, decreasing in altruism and creativity. Verifying this hypothesis should mean that we get to the heart of the free will paradox, that is, if the belief induction actually changes the observed behavior, this means that the freedom of the will in this particular event did not occur, even if the belief induced is the belief in the freedom of the will. Nevertheless, the outputs of this research, if confirming the original hypothesis, would translate into a necessity of reinforcing free will belief in the corporate discourse as well as to lead further investigation around what else may trigger positive behaviors.

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# ***Psychological, Neurological and Social Mechanisms of Imagining the Future***

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Humans have a future oriented psychology – we spend up to a quarter of our waking lives engaged in mental activity that is decoupled from the present and devoted to constructing future scenarios [1]. This offers humans unique evolutionary advantages: first, prediction, which allows us to prepare for possible outcomes and thus adapt us to future as well as present settings. Second, creation, which goes beyond adaptation by recombining experience so that humans not merely adapt to their environment as it is, but also actively change their environment to suit their needs. Schacter and Addis thus propose a reconceptualisation of the brain as a fundamentally prospective organ [2]. However, there is still no comprehensive model of how individuals and societies envision the future that would integrate the neurological, psychological, social, and cultural processes involved in the complex and multifaceted, yet extremely common activity of imagining the future.

We will present a model of future thought that will begin at its psychological core, examining the well-researched notion that episodic memory is the key underlying mechanism. Constructive episodic simulation [3] will serve as the cognitive foundation that will be supplemented in each following section as we move along the axis from psychological to social processes. The clear distinction between the two will be blurred in the second section, which will consider mental time travel as a temporal form of perspective taking. Third section will investigate how one's sociocultural milieu contributes to the process, both enabling and constraining the imagining of the future. The final section will detach from the perspective of an individual time traveller to

probe how the future is imagined collectively. The model will thus present a multi-level integration of neurocognitive and sociocultural mechanisms involved in prospective cognition.

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# ***Automatic Estimation of Problem Difficulty for Humans in the Case of Raven's Progressive Matrices-like Puzzles***

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Estimation of problem difficulty for humans is often desirable, for example in Intelligent Tutoring Systems. These computer systems are designed to interact with students and perform a variety of instructional functions while adapting to their individual needs and providing feedback that improves their learning experience. In our research we addressed human problem solving skills in the case of the Raven's progressive matrices-like puzzles of varying difficulty. The Raven's progressive matrices tests are an example of visual matrix problems that are commonly used in general human intelligence testing [1]. They are based solely on visual representations and thus serve as a nonverbal test of analogical reasoning by challenging one's ability to recognize patterns consisting mainly of visual similarity and analogy [2].

Our main goals were to determine the features of matrix problems that are most informative with respect to problem difficulty, and to assess the problem difficulty automatically. Since we did not have access to the Raven's progressive matrices tests that are used in the official IQ tests, we developed a set of 45 visual matrix problems using 3-by-3 matrices and different sets of intrinsic rules of formation as well as combinations of symbols with low, medium and high complexity that we believe correspond to increasing levels of difficulty. In our research we presented the puzzles to participants in the form of an online questionnaire. The difficulty of problems was determined according to their success rates. The analysis of the results enabled us

to determine most informative puzzle features. For data visualization and analysis we used software Orange. The obtained decision tree, optimized by pruning, suggests that the complexity of symbols plays the most important role in puzzle solvability.

We achieved both of our goals to some extent. Determination of important features was strongly influenced by the given matrices, the reasonableness of their underlying rules of formation, and the set of possible answers. Our decision tree model split data into training and testing sets in the ratio 80:20 and reached the classification accuracy of 76% which suggests that the assigned features were relevant to determining puzzle difficulty. The research will continue in the direction of optimizing puzzle features, improving predictive power of our model and testing data with other classification methods such as support vector machines and neural networks.

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# ***Team Dynamics During Innovation, Knowledge Creation and Learning Processes***

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Innovation, knowledge creation and learning process (learning process) is a process that takes place when new knowledge is created in accordance to the Theory U [1]. It allows us to learn from the future instead of learning from the past. Learning processes have mostly been studied through the cognitive and epistemological point of view, but there has been less interest in how the social factors can affect it. This is why the focus of this study have been on the team dynamics aspect of it, where the team dynamics are defined as behaviour relationships between members of the team. The research question I started with is 'What roles members take on during the knowledge creation process, and how does this affect it?'

Data for this research has been collected during the university seminar on the innovation, knowledge creation and philosophy of science in the summer term of 2015, jointly held by University of Vienna and Vienna University of Technology. The students worked in the knowledge creation teams (KCTs) on a self-selected topic. They were using the process based on Theory U [1], with the aim of creating a prototype. The data had 17 students, grouped in 3 teams from 4 to 7 students. The individuals wrote 7 diary entries regarding the KCTs learning and group processes during different points of the seminar.

This data is being analysed with the grounded theory methodology according to Charmaz [2]. Grounded theory is a qualitative method, used to construct new theories, which allows for a detailed view into the data and the underlying processes. Because of that, it is used to study

phenomena, where all the variables that could have an effect were not yet identified, like in this case.

During the initial coding, I have noticed differences in how people in the same team perceived the team dynamics of their own group. These differences included noticing problems by some and claiming that the work is going without problems by others. Or the same situation can be perceived both as problematic, and as a relief.

In the following steps of research, there is going to be a deeper investigation into these differences. This could help us understand how the perception of the group dynamics can affect the learning process. This could have implications for understanding learning processes, especially in the university settings.

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# ***Human Brain Neuronal Activation While Playing Tetris***

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This project is being realized as part of a larger clinical investigation that will assess neuronal plasticity induced by regular playing of the game Tetris. Tetris was chosen as the cognitive paradigm because it is a challenging task, which demands planning, mental rotation, problem solving as well as rapid visuo-spatial and motor coordination from the participant. Previously, it has been shown that Tetris evokes changes in neural activation [1] and can enhance the performance of related tasks involving mental rotation [2]. Still, the question remains how the brain adapts to cognitive training and how imaging of such neuroplastic adaptations can improve the clinical diagnosis of patients with e.g., traumatic brain injuries or mental disorders, which is currently based on the assessment of cognitive abilities. The aim of this project was to implement and test a version of Tetris®, which can be used for neuroimaging applications.

The game of Tetris® consists of 2D bricks falling from the top of the screen. The aim is to rotate and move the bricks to form rows without gaps, which then disappear and yield points. The cognitive paradigm was implemented as functional MRI block design. Each task block consists of one of three versions of Tetris®: easy, hard or control, which are picked randomly in groups of three. The easy version of the game initially has just two filled rows on the screen with a few empty blocks so the player can easily fill a row. The hard version initially has 1/3 of the screen filled and random empty blocks, and the speed of the falling bricks is 7 times faster than in the

easy version. The control condition has two gray columns with a space between them and the subject simply has to navigate the bricks through that space, without the need to fill the rows.

To test the paradigm 9 subjects (right-handed, 2 women) were examined on a PET/MR scanner. Data processing was carried out in SPM12 and included slice timing and motion correction, spatial normalization and modeling of the neuronal activation.

For this pilot study, the expected results are differences in the neuronal activation between the different conditions. Hence, there should be more activation for the hard version than for the easy one and the control condition. The results of study will finally be combined with further imaging parameters such as structural MRI and PET as well as cognitive performance metrics to assess neuronal plasticity on a multimodal level.

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# ***Nothing New under the Sun: Problem of Induction Still Not Solved***

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The sun has been going up every morning for the last 6,5 Million years, therefore it will go up tomorrow, too. This famous Humean example is only true if we accept a little hidden assumption called “induction”, which states that, at least in some cases, our observations about a sample generalize over a population. Even though induction is used widely in science and daily life, a justification is notoriously hard to come by. A statistics-informed attempt by David Stove [1] has been championed by some philosophers [2]. His approach states that, according to the law of big numbers, the proportions of some feature in a sufficiently big sample are very similar to the proportions of the population. On these grounds, he argues that, because the sun has risen hundreds of million times in the past, it is reasonable to believe that it will rise tomorrow.

While different aspects of this reasoning can be attacked, I am focusing on what I call the Restricted Population objection (RPO, inspired by [3]): it admits that Stove’s proof of induction may hold true for many types of inductive inference, but not for Hume’s famous case of the rising sun. For an inductive inference to be justified, the sample must be representative of the population. For this purpose, the sample has to be drawn randomly from the whole of the population: If you want to make claims about all ravens in the world, you need to make sure to draw your sample from the whole population of ravens, and not just from ravens in e. g. Australia. Otherwise, your claim is limited to the restricted population of ravens in Australia. In the case of the rising sun (just like any other inductive claim about the future), the

sample can only ever be drawn from the present and the past, but never from the future. Therefore, we can only generalize over present and past, but not over the future. Induction is thus generally justified, but the range of admissible generalizations has to be monitored closely.

One counter-argument has been put forward against the RPO: most of the samples that are seemingly representative only of a restricted population, turn out to be representative of the broader population. However, this approach fails to provide an in-depth justification of what connects the restricted population (ravens in Australia, sunrises in the past) with the broader population (ravens worldwide, sunrises in the past and future). How can we be sure that they belong to the same category? Until these bridges are built, induction from restricted to broader populations remains unjustified and we can’t reasonably believe that the sun will rise tomorrow.

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# ***Placebo Strategies in TMS Research***

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Repetitive TMS offers a non-invasive method of stimulating neuronal pathways inside the brain of a conscious subject [2]. The effects of rTMS are many times very negligible, highly variable among subjects and rarely last longer than 30 minutes [2]. In our study, we were interested in the possible effects rTMS has on cortical excitability of the motor cortex.

To ensure that any measured changes of cortical excitability were indeed caused by rTMS, a placebo group was also necessary. This is commonly referred to as sham TMS. Sham TMS approaches are widely used in basic and clinical research to ensure that observed effects are due to the intended neural manipulation instead of being caused by various possible side effects [1]. Generally speaking, there are two types of sham TMS approaches. One common method is using a regular but tilted TMS coil, which produces a clicking sound that is very similar to an active TMS pulse while also producing other sensory and nerve effects that are usually accompanied by TMS stimulation [1]. The other method includes purpose built sham TMS coils that resemble regular TMS coils, but that are equipped with a magnetic shield that attenuates the magnetic field and inhibits any possible effects of TMS pulses [1]. Particular creative methods use somewhat of a middle way. For instance, a proposed approach involved mimicking the sham TMS coil using a matched, air-cooled sham TMS coil. To simulate the effects of real TMS, the scalp stimulation associated with TMS was replicated using large rubber electrodes placed over selected muscles [3].

To test for placebo effects, our study used the first method, that is, the same TMS coil as the one in the main condition, placed on

its side, so as to ensure that there was no direct neural stimulation. The measurements (TMS and rTMS) were carried out for five days for a single subject (either control/placebo or not). The first and last days included EEG measurements alongside the TMS / rTMS protocols. During the intermediate days, EEG measurements were not carried out. The first and last days also consisted of various tests of cognitive ability.

The aim of our study was thus manifold. First, to test previous studies interested in motor cortex excitability after rTMS and second, to test whether the sham TMS method used is sufficient enough as a control strategy.

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# ***The Influence of Emotional Stimuli on P3 in an »Oddball« Paradigm***

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In this study the electrophysiological correlates of processing stimuli with different content (human, non-human) and affective valence (negative, neutral) will be investigated with oddball paradigm. In this paradigm participants are exposed to three kinds of stimuli: infrequent targets and distractors and frequent standard stimuli. The task of participant is to respond to the targets but not to distractors or standard. An event-related potential (ERP) associated with this response is called P3, which has a positive parietoccipital peak with average latency of about 300 ms and is mainly associated with attention.

Previous research has shown that the affective valence of the targets alters P3 [1]. It was also shown that the ERPs elicited by emotional stimuli differ when participants have to make an appraisal of the stimuli over an affective or nonaffective dimension [2].

The aim of our study is to investigate how P3 is affected by the type of event (target, distractor), affective valence of the stimulus (negative, neutral) and content (human, non-human). We will also explore the correlation between amplitude of P3 and aspects of personality and mindfulness.

30 participants will take part in the study in which EEG signal will be recorded with 64 channel actiCAP system. During the task they will have to press one button when target occurs and another button for any other stimuli. Targets and distractors will be pictures from affective picture databases, which differ in two dimensions: content (human, non-human) and emotional valence

(negative, neutral). Their scrambled versions will be used for standard stimuli. In each of the four conditions the target stimuli will be different: negative, neutral, human or non-human, while the distractor will be from the opposite pole of the dimension. Participants will also fill out three questionnaires: the Zuckerman-Kuhlman Personality Questionnaire (ZKPQ), the Reinforcement sensitivity theory of personality questionnaire (RST-PQ), which both measure affective and motivational aspects of personality, and the Kentucky Inventory of Mindfulness skills (KIMS) which measures different dimensions of mindfulness.

Based on previous research [1] we expect differences in P3 due to the type of stimuli and its affective valence. We also expect differences in the P3 due to the requested appraisal from the participants (affective or nonaffective) [2].

A suggestion for the future research is to include patients with mood disorders, e.g. depression, to investigate the mechanisms of altered emotional processing in clinical populations.

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# ***Mechanisms of Integration of Neural Activity for Efficient Cognitive Control***

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Cognitive control is an umbrella term that covers a number of top-down processes that guide thought and behavior in accordance with current goals, especially when bottom-up stimuli and automatic, habitual responses either do not specify a direction or must be overridden because they conflict with those goals [1]. The ability of dynamically responding to changing circumstances and demands of the environment is one of the fundamental faculties allowing us successful and efficient goal-oriented behavior.

The key element of cognitive control are so-called task sets. They are shaped and retained as mental representation of a number of processes needed for task completion that may be reused when faced with a similar context. When we find ourselves in new situations, however, these task sets are not adequate, and we are forced to alter our automated behavioral patterns, or at least overcome them and establish a new configuration. Quick shifts between the usage and adaptation of previously learned task sets, and the creation of new ones allow us efficient and flexible behavior in dynamic every-day environments.

On the level of neural functioning in goal-oriented behavior, a concert action of separate brain regions and systems, each performing specific functions, is required. From the point of view of neural circuits, the key role in enabling cognitive control is performed by the prefrontal cortex, the parietal sections of the brain, and subcortical structures (especially the basal ganglia) [2].

Over the course of the current research, we seek to determine which are the mechanisms that enable us to flexibly shift between different activities, which brain systems are involved in efficient integration of neural functioning, and how they relate to individual's general cognitive capabilities.

Subjects participate in the research over the course of two sessions. At the first session subjects are asked to perform a series of behavioral tests of cognition. During the second session the subjects perform a computer-guided test of cognitive control. They are asked to react to various simultaneous stimuli presented via headphones and screen and required to judge as quickly as possible whether the presented stimuli correspond to various combinations of rules. During the performance of the task we monitor their brain activity using functional magnetic resonance imaging (fMRI). Research work is currently in the phase of gathering data, therefore results are not yet known.

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# ***Age-dependent Memory Decline: A Pathological or Sociological Trait?***

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It is well established that around 50 years onwards episodic and working memory usually diminish their performance while semantic memory operates without significant impairments [1]. It has been argued that memory-aging patterns and in particular, memory deficits could represent an evolutionary adaptation. Despite adult memory models (e.g., Alan Baddeley and Elvin Tulving) being well known, there is little research, from an evolutionary perspective, on their application to old age memory loss. This paper argues that elderly people may be selectively predisposed to preserve old memories to the detriment of a neurobiological weakening of new memories. A literature research in academic databases was carried out until May 2017 to identify reports that examine human memory during old age from an evolutionary perspective. Twenty-two reports were identified and included for analysis. Main findings indicate that in order to increase human life span it was necessary for individuals to conserve an adequate cognitive performance [2]. During the evolution of the modern *Homo sapiens*, those elders with a preserved semantic memory would have contributed significantly to their group's survival [1], [2]. Acquired cultural knowledge in addition to personal experiences could have been successfully passed on to their younger kin, thereby establishing an ongoing process of accumulation and transmission of knowledge over many generations. However, episodic and working memory suffer from age-related impairments during the encoding and retrieving of new information. Neuropathology often starts in the entorhinal cortex and the hippocampal formation, spreading from there to

association cortical areas. During advanced age, appropriate functioning of these other memory types would not have been essential for survival, as older people would have received assistance from younger members of the tribe. From an evolutionary perspective, memory deficits should not be regarded exclusively as a negative biological trait but could also be seen as key factors in the evolution of stable long-term social structures. It is proposed that taking into consideration evolutionary and social aspects could contribute to a better understanding of differential degrees of aging-related deterioration of human memory faculties.

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# *The Meaning of Dying*

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In trying to understand why people act in the way they do, the cultural anthropologist Ernest Becker investigated the relationship between death anxiety and the way people conceive of reality. The social psychologists Solomon, Greenberg and Pyszczynski, while studying Becker's work, developed the Terror Management Theory (TMT).

TMT can be introduced with two observations. First, humans, like other animals, are striving to survive. Second, the capacity for abstraction gives human beings the awareness of their own mortality. Limited existence combined with the will to survive creates a potential for anxiety. In order to deal with this terror of death, humans developed cultural worldviews that give life a sense of order and permanence [1].

Culture gives humans the possibility to cope with death by pursuing, for example, literal immortality - some religions for instance offer the belief that life is just a transition to eternity - and symbolic immortality, by which people want to be part of something bigger than themselves. In the latter case, the ideas of nation and ideology have a strong appeal in reducing death anxiety. They can be understood as cultural worldviews that will be defended when threatened.

Culture could be seen as a set of beliefs about reality that are able to give the sense that humans are valuable individuals in a meaningful world. However, to what extent does death play a role in giving meaning to life itself? Viktor Frankl argues that human responsibility, the foundation of a meaningful life, rests on the transitory nature of the existence. Human finitude imposes the need to take the responsibility of utilizing the lifetime to the utmost [2].

The methodologies developed in empirical

studies with TMT are used then to access what is the role of a meaningful finite existence in the cultural worldview defense. In this study, the participants, after being primed either with reminders of death- also referred to as mortality salience (MS) - or with a pain related control condition, will access two different arguments: one endorsing the belief in mortality, but supporting the meaningfulness of human existence; the second affirming the belief in immortality, but refuting the meaningfulness of life. The hypothesis in this study is that the subjects who were primed with MS, after reading the essay supporting the belief in a meaningful mortality will present a reduced defense mechanism in comparison with the participants who read the essay advocating a meaningless immortal existence.

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# ***Psychophysiology of Groove: The Effects of Rhythm and Bass on Cardiac and Respiratory Activity***

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Humans can hardly help but tap, sway, and bob our heads in response to rhythmic sound. In no other species is this auditory-motor connection so widely expressed and flexibly realized.

When investigating the effects of rhythm and bass on humans we built upon the premises that:

1. Rhythm perception in humans involves a coupling of sensory and motor processes [1]
2. Certain musical characteristics have known emotional and psychophysiological effects on the listener. [2]

To investigate how the human body reacts to rhythm we conducted two experiments in which participants listened to musical stimuli presented on a high-fidelity sound system while we recorded electrocardiographic and respiratory activity. In experiment 1, the stimuli consisted of simple drum loops designed to test the effects of syncopation and bass frequencies. In experiment 2, the stimuli consisted of real music samples (from the Janata groove library[1]) selected to test the effects of groove) and bass frequencies. Analyses focus on heart rate, heart rate variability, respiration rate, and respiratory variability, but also examine whether any temporal coordination exists between physiological cycles and musical beats. The results describe cardiac and respiratory responses to key temporal and spectral dynamics of rhythmic music, providing insight into how music engages us.

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# ***The Phenomenology of Habit Formation and its Connection to Body – Mind Centering***

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In this project, I investigate the concept of habit and its development in embodied cognitive science. I look at various notions of habit in the so-called “organicist trend” [1]. According to the understanding of this trend, habit is intimately involved in the constitution of meaningfulness through inherent corporeal intentionality. This holistic, ecological, notion of habit offers a framework where the organism is seen as an inseparable unity of body and mind, a view that the classical cognitivist paradigm fails to acknowledge.

I provide examples of habit formations and discuss them from a phenomenological perspective. The examples are taken from the practice of Body-Mind Centering (BMC). BMC is a multidisciplinary experiential somatic movement school, mostly based on anatomy, physiology, psychology, and movement developmental studies [2]. During the practice of BMC one gains awareness of a wide range of bodily sensations from all the anatomical structures and tissues of the body. BMC claims that the patterns formed by the mind are manifested in the patterns of the body and therefore our bodily movements are reflections of the movements of the mind. I critically assess this claim and offer a comparative analysis of the differences in the understanding of habit in cognitive science and in BMC.

The examples of habit formation support my hypothesis: the movement developmental aspects of BMC resemble the vision of constructive phenomenology [3]. BMC aims to go back to the first experiences of movement and then travel through all the developmental stages of the organisation of

movement with increasing complexity and re-experiencing these stages as adults. With this increased movement awareness, BMC re-educates developmental patterns, as a therapeutic means, in other words, it reforms fundamental habitual movements. Similarly, constructive phenomenology aims to gain a foundational understanding of the origin of habit by a regressive inquiry into ontogenetic life. Therefore, I argue that BMC might be a promising candidate for an application in a constructive phenomenological investigation, adding a new perspective to this field, along with the results of infant developmental psychology research. I also assess whether the attitude of the practice of BMC can indeed be considered as a phenomenological attitude.

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Special thanks to Elisabeth Zimmermann for supervising this project.

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# ***Supervised Learning of Basis Function Coefficients for Computer-generated Speech***

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Speech synthesis is the problem of automatically generating an acoustic speech signal for arbitrary textual input. Several approaches to this problem have been developed, such as statistical parametric methods, where representative features are extracted from human speech (e.g. spectral parameters, fundamental frequency, duration parameters) and used for training a statistical machine learning model.

Hidden Markov Models (HMMs) are commonly used for speech synthesis [1]. HMMs are used for generating parameters for the re-synthesis of speech. This produces a speech signal that is rather intelligible, but in terms of “naturalness” it is still distinguishable from human speech. Naturalness is the main challenge in current HMM based speech synthesiser [2]. The presented work shows a different approach to generate these parameters for the re-synthesis of speech by using weighted sums of basis functions.

The literature describes HMM-based approaches or non-parametric approaches like concatenative speech synthesis. Basis function representations have not been investigated for parametric speech synthesis before. A single phone can be elegantly represented as a function of the parameters over time. This representation can be extended to the level of whole sentences. In this work speech synthesis will be done by training a machine-learning model on extracted parameters of speech which are represented as weighted sums of basis functions. The model is then used for generating new speech parameter

representations, which are used to produce the final speech signal.

The goal of this work is to implement a speech synthesiser using basis functions and evaluate its performance in terms of intelligibility and naturalness. The evaluation will be done both visually by studying the resulting plots of the Mel Generalized Cepstral (MGC) coefficients, and acoustically by listening to the resulting generated speech to study the effect of the parameters.

If promising, this work could lay the foundation for a new approach to computer-generated speech.

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# ***Slovene Compounds: Towards a Psycholinguistic Approach***

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Compound words (e.g. blue + berry > blueberry) have been studied extensively, both linguistically and psycholinguistically, for their insight into the combinatorial mechanisms of word formation, as well as their storage and representation in the human processor [2]. From a psycholinguistic perspective, they are especially informative with regard to the listing, interconnectedness, and access of their representations in the mental lexicon [2, p. 292].

Compounds have been the subject of various psycholinguistic analyses in several languages (e.g. Greek [2], English [1], etc.), contributing to our understanding of linguistic representations in the human processor. Although Slovene compounds (Slovene: *zloženke*) have been extensively analyzed and discussed in theoretical linguistics [3], a psycholinguistic approach hasn't yet been attempted.

As Slovene is a highly inflected and morphologically rich language, a psycholinguistic examination of its compounds (which also feature elaborate word-formation processes [3]) might highlight the syntactic, morphological, and semantic factors involved in their lexical access and representation. In light of this, a preliminary corpus-based extraction of frequent Slovene compounds (informed by psycholinguistics and theoretical linguistics) was decided upon. Thus, lemmas were collected from the Kres corpus (a balanced corpus of Slovene) and sorted by frequency, followed by a manual extraction of compounds. 20,000 most frequent lemmas were examined, ultimately yielding roughly 200 compounds.

Preliminary examination has revealed a diversity of combinations based on the compounds' categorization. In terms of semantic transparency (i.e., whether a compound's meaning can be derived from its constituents [1]), the extracted sample contained few opaque compounds (e.g., *hudournik*), the transparent instances (e.g., *avtocesta*) being most frequent. Nouns, followed by adjectives, constituted the most frequent word class, whereby the compounds themselves exhibited a variety of word formation processes, as described by Muha [3].

This preliminary analysis has found several patterns that might be interesting for psycholinguistic analysis (e.g. transparent vs. opaque compounds; compounds with simple vs. derived constituents; compounds featuring stems that cannot appear on their own; etc.). Further analysis is necessary to identify productive homogenous subcategories fit for psycholinguistic experimental evaluation.

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# ***When Language Goes out of Hand: Measuring the Effect of Hand Movement on N400 Component***

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Rizzolatti and Arbib [1] imply that human language evolved from the capacity to recognize actions, in which mirror neuron system plays a significant role. The idea that the mirror system in monkeys is the homologue of Broca's area in humans, which is assumed to be responsible for speech processing, has been suggested by other authors as well [2]. There have been many assumptions about the links between language, hand, and gestures at the neural level, however there is still a lot to learn.

The aim of our research is to explore the relation between the hand movement and language using event-related potentials (ERPs), which provide a sensitive measure of changes in language processing. We focus on N400 component, which is typically observed when semantically incongruous words are presented.

We used within-subjects experimental design. In total, 6 participants will go under two experimental and one control condition, across three different days.

In the first condition, participants will watch a video that shows how to use Chinese chopsticks. They will be instructed to repeat the hand movements using the technique described in the video and practice on several tasks with various types of food and level of difficulty. The aim of this task is to use fine hand movement which requires certain amount of attention and awareness. Moreover, it's been shown that imitation elicits stronger responses in Broca's region compared to action observation or execution alone [2].

The second condition is focused on hand movement exercises adapted from Feldenkrais therapy method that increases the awareness and physical sensitivity in the hands. This condition will explore the effect of hand movement alone. The third, control condition, consists of breathing exercises.

ERPs are measured using go/no-go task before and after each manipulation. Stimuli for this task are pictures of common objects, followed by a matching or mismatching word. The N400 is widely noted to be decreased in amplitude in patients with aphasia, and previous research demonstrated the modulation of N400 after rTMS treatment [3].

We expect to find difference in mean amplitude of N400 after hand movement lessons and compared to the control condition, and by doing so, we hope to shed some light on the relation between hand movement and language processing.

## **Acknowledgments**

Special thanks to Barbora Cimrova, Peter Gergel and Julia Unger for their guidance and support.

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# ***Fetal Testosterone and Autism***

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There is a significant prevalence of autistic traits in population towards men and it has lot to do with sexual hormones (testosterone in particular). For this reason in year 2002 Simon Baron-Cohen[1] came out with a theory which elevated correlation of these two as an effect on the development differences that cause autism. Derived from Systemizing-empathizing theory, but with the testosterone effect in the mix, Baron-Cohen created Extreme male brain theory.

Where it began with the Extreme male brain theory, this project continues to explore ways how to prove it. In addition we try to explore and find new connections between the autism and its biological and cognitive correlates to figure better ways to diagnose people within autistic spectrum. The theory mentioned above puts the effect of higher fetal testosterone levels exposure in relationship to autistic traits occurrence. Therefore one of the markers that can be studied and indicates who was exposed to the testosterone during their prenatal phase is the ratio of the index and the ring finger, known as 2D:4D.

The data were collected of the 2D:4D ratios(scanning palms and calculating ration in a computer program) and screening tests for autism and aggressivity(as a tendency to aggressive behaviour; which is almost always present in autistic people; towards themselves or the others) of students of Faculty of Mathematics, Physics and Informatics. In this faculty there we assume a higher concentration of people with more autistic traits due to the school's programmes dedication to the computational, analytical and mathematical direction. Participants to the project were students of studying programmes: Mathematics, Applied Informatics, Physics

and Cognitive Science. We divided these into two groups; first one being more technical/analytical (Informatics,Physics) and the second as social technical(Management Mathematics, Cognitive Science; as having social subjects in school beside the technical ones).We believe to find the difference in correlations between the biological and the cognitive markers in the two groups.

This project serves also as a part of a major study conducted by the Institute of Physiology and the Faculty of Medicine of Comenius University in cooperation with other institutions whose dedication is to study, diagnose and treat autism. The data collection for this study are currently happening on other faculties of Comenius University. Together to have unique perspective about distribution of autism and the correlates that relate one to another, and in compare to neurotypical population.

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# ***Combining Electroencephalography With Transcranial Magnetic Stimulation As a New Step in Understanding Mechanisms of Non- invasive Brain Stimulation Techniques***

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In the 1980s, a new non-invasive neuromodulatory technique called transcranial magnetic stimulation (TMS) was developed and is now being increasingly used in clinical and research practices around the world. During this period, we have seen numerous comprehensive and consistent reports about the beneficial effects of high-frequency TMS to the left dorsolateral prefrontal cortex (l-DLPFC) in patients with major depressive disorder who have not benefited from at least two courses of antidepressant medication. Despite these advances, the main question remains open: how exactly does this technique work?

In general, we distinguish four types of TMS, depending on the frequency and shape of the induced electric field; single-pulse TMS, repetitive TMS (rTMS), paired pulse TMS and theta burst stimulation (TBS). Latter is a patterned rTMS protocol, which uses short bursts at 50-100 Hz stimulation frequency that are then repeated at 5 Hz. This has been shown to induce long-term potentiation (LTP) in a faster and more secure way than traditional rTMS protocols. The most widely used methods for measuring the effects of non-invasive brain stimulation (NBS) in cortical excitability, is by looking into the motor evoked potentials (MEPs). It was shown that a single TBS session produces a mixture of facilitatory and inhibitory effects

on synaptic transmission, with facilitation building up faster than inhibition. This led to the proposition that intermittent TBS would favour rapid build-up of facilitation. After a few years, more investigations of cortical excitability were starting to show a big issue with the TBS protocols, namely that the MEP responses observed are highly variable both within and between individuals. This has to do with factors of gender, aerobic exercise, age, attention, pharmacology and genetics. [1]

Since MEPs are highly variable, and limited to the motor cortex, new techniques are starting to be searched for. One of them is the combination of TMS with electroencephalography (EEG). Researches are reporting EEG correlates of cortical excitability, inhibition and interhemispheric connectivity. Using this methodology, we can observe TMS-evoked potentials (TEPs), that already have specific and described components, such as P30, N45, N55, N100 and P180. [2] The next logical step, which we are currently undertaking, is to find the most suitable interpretation of these components and with this also their possible correlation with MEPs. We believe this is how we can achieve a better understanding of the mechanisms and effects of NBS techniques when treating conditions such as, treatment-resistant depression.

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# ***Software Onboarding Process Evaluated Using Biometrics Data***

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Every user of any software once faces the software for first time. The user has to understand how software works and what options a User Interface (UI) offers and also how do they work. Most software solutions neglected this aspect of software lifecycle and "threw" user into UI without any help.

Phase or process of getting to know software is called onboarding. Software should provide some help, aids or cues to make this onboarding easier and to allow user understand how to work with UI as fast as possible. There are various approaches in providing this help. Yet it is not known which approach is most effective or how to choose approach based on context of a software. Effectiveness of onboarding can be determined by estimating whether user is able to use a software by various parameters which can be whether he/she is able to finish task in the software or remembers how to use UI after some time. Or whether a user is willing to use the software at all.

Physiological data can be used to measure and study this parameters. Eye tracking is used most for such needs. Eye tracking can be supported by other biometrics for example electroencephalography (EEG). Data from EEG can help determine emotions and cognitive load of user while going through onboarding process. It also can help get some insight at how users perceive the UI [1].

Study will consist of current usage and statistics of onboarding solutions used by established software applications. Next part will be dedicated to describing various approaches to onboarding. Study will also describe some concrete implementations of approaches into chosen web application and

evaluate them using biometrics. Outcome of study should be some general principles for implementing onboarding into applications.

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# ***Augmenting Aesthetic Experience of Art with Brain Stimulation***

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Within recent decades, the empirical study of beauty and the aesthetic experience has increased as an area of interest in psychology, cognitive science, and neuroscience. The aesthetic experience can be attributed to numerous areas of activation within the brain. Particularly, the left dorsolateral prefrontal cortex (IDL PFC) has been found to play an essential role in aesthetic appreciation [2]. Previous studies on aesthetic appreciation of artworks have found anodal stimulation of the IDL PFC to increase liking responses to various representational and abstract artworks[1]. This increase in liking is believed to result from the down regulation of negative emotions, mediated by the IDL PFC. Yet, the underlying processes explicating why the IDL PFC stimulation leads to a higher liking response remains unclear.

In this experiment, the IDL PFC was stimulated using transcranial direct current stimulation (tDCS) to test the hypothesis regarding the IDL PFC and its functional role in the aesthetic experience of art [3]. This study focuses on positive valence and negative valence representational artworks, rather than neutral valence artworks as used in the previous studies [1]. During this experiment, 20 participants rated artworks in two 90 minute sessions, one in which they received stimulation and one in which they did not (sham). The participants were randomly shown representational artworks of both negative and positive valence before and after tDCS stimulation. The participants rated the artworks according to colourfulness (control) and how much he or she liked the art, using a 1 (least colourful/strongly dislike) to 9 (most colourful/strongly like) point scale.

evaluate the potential increase in liking of negative valence artworks by comparing liking ratings before and after stimulation. These findings could further support the claim that the IDL PFC plays a crucial role in the aesthetic experience of art, and furthermore, contributes to the notion that one has the capability to appreciate usually negatively categorised art.

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The specific purpose of this experiment is to

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# ***Philosophy of Dance. Body, Knowledge and Subjectivity***

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Traditionally, in the field of philosophy dance as art form has been neglected and is considered as under-represented in aesthetics. Possible reasons are the marginalized position of dance in the system of fine arts and in cultural institutions. However, in the second half of the twentieth century, a few philosophers have formed groundwork, which has fueled the increased scientific interest in dance over the last decades. Additionally, phenomenologically- and poststructuralist-informed dance studies demonstrate the significance of dance for understanding philosophical issues, such as embodiment, meaning, and subjectivity, to name but a few [1].

In cognitive science, dance has entered the scene in interestingly diverse ways. Firstly, fMRI studies are being done with dancers, contributing to the field of neuroaesthetics. Secondly, it is used by various philosophers as a metaphor for thinking, supporting embodied and enactive approaches of cognition. Thirdly, the growing number of researchers with a dual background (dance and science) as well as recent collaborations between scientists and dance artists show that the interest is mutual, and the encounters are enriching [1] [2] [3].

These developments can be understood as a profound challenge to our understanding of knowledge. Dance subverts a binary mode of thinking that poses body versus mind, emotionality versus rationality, and theory versus practice. By doing so, dance ultimately questions our notion of science [3].

By examining philosophies of dance in this project, I expect a refined understanding on how body, knowledge and subjectivity configure human being. I will draw on three

French thinkers of poststructuralist stance in particular, Paul Valéry, Jean-Luc Nancy and Laurence Louppe. Their approaches represent a counterweight to phenomenological dance studies, and offer additional insights to the aforementioned question as well as to the philosophical study of dance.

On the long run, this project serves as preliminary investigation to a thesis on 'dance as a culture of knowledge' and its implications for conceptualizing cognition and (scientific) knowledge [3].

## **Acknowledgements**

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# ***Investigating the Structuring Role of Multimodality in Adult Verbal Discourse***

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Embodiment and situational context are critical factors in verbal discourse. Indeed, this is best understood as a multi-modal process. Meanwhile, models of artificial language learning machines are being developed to operate on the basis of the same multi-modal grounding.

Among the necessary research is the development of artificial learning machines that take into account the roles of the embodied and situational features of the multisensory experience of verbal discourse. The scaffolding and structuring role of overt behaviour throughout evolving discourse is of particular interest.

Thus far, the focus in the literature has been on the level of individual utterances - with notable exceptions (see [2]). Concurrently, the temporally extended nature of verbal discourse has been associated with better learning during language acquisition. Indeed, discourse episodes likely constitute a more meaningful level of analysis given the dynamics of human speech.

The present work addresses these omissions by investigating multi-modality in exactly such discourse episodes. These may consist of multiple utterances and reflect the high inter-connectivity between the individual utterances that constitute the episode. In this sense, our approach emulates [2]. We extend their work by refocussing on adult human interactions, thereby moving beyond the developmental context of language acquisition. This illuminates the persistent role of multi-modality once linguistic skills have matured.

Based on data from an existing multimodal

corpus [1], we investigated the role of two primary features of verbal discourse: gaze and object holding, with the latter representative for physical interaction with objects. Among other things, both factors contribute to directing attention during verbal discourse. In the paradigm, one participant takes on the role "instructor" for the purpose of explaining a simple assembly task to a second, the "learner". The analysis considers the instructor only. Annotations are visualised in timeseries plots in order to reveal the temporal dynamics of verbal discourse across the various modalities.

The present qualitative analysis improves understanding how language is shaped by other modalities, with a view towards implementing the insights in language learning machines. We expect our results to converge with [2] in stressing the significance of multi-modal features of verbal discourse. Our approach offers a contrast to the classical, utterance-based literature and extends discourse-level analysis to adults.

## **Acknowledgements**

The author would like to thank Dr. Brigitte Krenn and Dr. Stephanie Gross for their help and guidance.

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# ***Explaining the Divergent Effects of Socioeconomic Status on Prosocial and Antisocial Behaviour in Economic Decision Making***

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Socioeconomic status (SES) has been described as a relative measure of person's economic and social standing in society, based on their income, occupation and level of education. Previous studies have revealed links between SES and bargaining behaviour. Specifically, Piff and colleagues [1] found that higher SES predicts "unethical decision-making tendencies" as it induces selfish preferences and stronger feelings of entitlement, furthering antisocial behaviour. It has been postulated that different attitudes toward greed are responsible for such divergence, as higher SES individuals tend to see greed in a positive light. In order to delineate the specific mechanisms at play, the study is the first to investigate the link between different facets of SES (subjective, objective) and economic judgment when retaliation is possible, i.e. in an ultimatum game (UG).

## **Methods**

A baseline questionnaire was administered to ascertain objective and subjective SES levels, as well as personality traits such as dominance, prestige, grit and self-efficacy. Participants' monthly income was the measure of objective SES, while subjective SES was assessed by subjects' comparison to other individuals. Two subsets of subjective SES were distinguished: comparison to society at large, and to other students within the local environment. Next, participants played the UG and dictator game (DG), while being presented with two alternating sets of faces (high vs. low-threat). The stimulus set was the same across the two tasks within subjects, but randomized across

our sample of 80 male subjects. In investigating the relationship between different facets of SES and bargaining behaviour within subjects, the ANOVA test was applied to measure the change in offers from the UG and DG. The difference was computed by subtracting DG from the UG score. Finally, a correlation analysis was applied across two sets of faces, to measure the effects of high vs. low-threat circumstances on bargaining behaviour.

## **Results**

Analyses revealed a significant positive relationship between high subjective SES for society and higher offers in the UG game, showing that subjects who perceived themselves higher in status, offered more when retaliation was possible. Inconsistent with previous findings [1], objective SES in the high group was found to predict prosocial behaviour in the DG game, as offers were higher despite the low-threat circumstances. Overall, these findings could help elucidate the nature of the link between specific facets of SES and UG vs. DG tasks, thus resolving the existing disparate evidence in the literature.

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# ***Agent-based Modeling: A Novel Practitioner's Generative View on Social Systems***

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A common argument in the social sciences is that social systems are too complex to be captured formally: mathematical models necessarily oversimplify them [1]. As a result, the methodological focus has been on capturing the entirety of a social system qualitatively and quantitatively, rather than researching normative aspects, as computational modeling allows. In cognitive science, computational models play a crucial role for the analysis of complex systems: a “good model” is “a simpler and more abstract version of the system” [2, pp. 135] that can be executed and leads to insights that can be reapplied to the original system. Agent-based modeling (ABM) employs interacting agents following some predefined (e.g., adaptive) behavior. It has been successful in the study of emergent phenomena in natural and social worlds.

Key questions we address are: What kinds of knowledge can be gained through ABM (in principle)? To what extent is it justified and sound to apply insights gained from ABM to real social worlds? And, in particular: How do behaviors of individual agents relate to that of a social system overall?

To complement our theoretical study of the ABM method (drawing also on our anthropological background) with the development of a grounded understanding of its practical potential for research in the social sciences, we first carried out replication studies of established social models (using the popular NetLogo system). At the time of writing, we are about to extend the gained knowledge and skills by implementing an exploratory model of the impact of affective agents on social systems (cf. e.g. [3]).

This project was aimed at explicating the status of the relation between the traditional descriptive methods in social sciences and the possibilities of generative ABM. Countering the initially stated widespread skepticism, we show from a novel practitioner's point of view how ABM can enable a deeper understanding of phenomena occurring in social systems.

## **Acknowledgements**

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# ***Face Recognition***

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[4] M. Ho, and K. Pezdek, "Postencoding cognitive processes in the cross-race effect: Categorization and individuation during face recognition," *Psychon Bull Rev*, vol. 23, no. 3, pp. 771–780, 2016. doi:10.3758/s13423-015-0945-x

Face recognition is a subset of cognitive processes associated with template recognition. In my research, I come from templates theory based on bottom-up processing theory. The most important cognitive functions are: long-term memory and work with it and search in templates.

My goal is to execute an experiment in order to determine the effectiveness of face recognition attributes like age, gender and race. [1] The experiment plan to be executed on a group of 30-50 participants which will be divided into 2 age groups. There will be online questionnaire where will be presented images from FG-NET aging database [2].

The cross-race effect (CRE) is a phenomenon in which individuals have better memory for faces of their own race than for faces of another race [3] This phenomenon was further investigated by an experiment published last year [4].

Results of the experiment will be analyzed and presented that it could be later on compared with machine recognition results.

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# ***The Impact of Sleep Depression on the Attention of Students Playing MOBA Games***

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Sleep is one of the basic human needs. The lack of sleep has a negative impact on the human nervous system and its cognitive processes. The appearance of insomnia, regardless of its causes, duration and severity, is most commonly reported at around 35% in the entire population.

The definition of sleep deprivation is based on a subjective sleep assessment, which is difficult to achieve, interrupted by repetitive restarting with a difficult re-sleep, short to early morning wake, no sense of refreshing. Sleep deprivation also includes daily effects, and the most common feeling of fatigue, lack of energy, difficulty concentrating, increased irritability. The basic criterion for the severity of sleep deprivation is the degree of deterioration in social and working abilities during the day.

Nowadays, researchers have noted that the number of MOBA (Multiplayer Online Battle Arena) player has increased. Thanks to games such as League of Legends (LoL) or Defense of the Ancients (DOTA), many studies have been made based on these games. (1, 2)

The purpose of our experiment is to find out what impact the lack of sleep has on my attention during the play of MOBA games. We chose pretest and posttest design. Experiment will be attended by 20 participants. The experiment will take place in the evening and at night. After 10 hours of wakefulness, participants will undergo, Psychomotor Vigilance Test, that we have coded. In following 14 hours they will play next 14 hours, League of Legends. After 14 hours of night-time wakefulness that

participants used to play MOBA games, we are administering the Psychomotor Vigilance Test again. We assume that the test scores before and after the experiment will vary, so the amount of attention after sleep deprivation will drop.

## **Acknowledgments**

Honorable thanks to all participants

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# ***The Co-Creation of Meaning: A Qualitative Investigation***

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When humans “understand” something, they think of this understanding as the something’s “meaning”. Yet, “meaning” is used variedly in linguistics, philosophy and psychology. It remains open what part “meaning” plays in cultural systems, what social role it serves and what epistemic (and hence cognitive) function it fulfills.

When investigating the interdependence of social dynamics and cognitive processes, the question of meaning often is not of primary interest. Sperber/Wilson [1], however, present the “principle of relevance” to explain communicative understanding (i.e. meaning in linguistic interaction) by a general cognitive principle of maximizing relevant information. Further investigation seems pertinent, whether this conversational account scales up to collective sense-making, i.e. “co-creation of meaning”.

Groups negotiate meaning by communicating about their member’s experiences. Settings of knowledge creation could serve as case studies of highly acculturated environments, in which groups engage in meaning-creation. An empirical investigation addresses the following research question: What notions of meaning do individuals in a knowledge creation setting adopt and what role does subjective relevance play? The qualitative, exploratory approach employed allows open, in-depth examination of this salient phenomena, reducing the risk of imposing external theories onto the observations.

Data was gathered during a seminar on knowledge creation and innovation by the University of Vienna and Vienna University of Technology from March to June 2015. The didactic design followed the “Theory U”

process by C. Otto Scharmer [2]. In teams of 4-7, students worked on a self-chosen project towards realizing a prototype. Data was taken from student’s (N=17) personal journal entries, reporting on their learning and group process at seven points during the term.

The material is currently analyzed with Grounded Theory Methodology (GTM). According to Charmaz [3], GTM aims to build a theory by “constant comparative methods”, i.e. comparing data with data, towards theoretical saturation. GTM is suitable for analyzing latent patterns in elicited texts, such as diary entries [3].

Based on this abductively generated theory, conceptual and empirical scrutiny should be applied in future projects. Findings of this project could shed new light on collective sense-making and yield ways to strengthen educational or professional settings through social learning.

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# ***The Role of the Moving/Dancing Body in Treating Mental Illnesses***

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In the context of a circular or ecological psychiatry as described by Thomas Fuchs, there is a need to extend the concept of mental illness to one that encompasses not only the brain but also the body and the environment [1]. This goes hand in hand with the concept of mental illness in phenomenological psychopathology as primarily being a disturbance of the lived body. The aim of the project is to analyze how two different therapy methods, namely Somatic Experiencing (SE) and dance/movement therapy (DMT), both endorsing an embodied and enactive approach to mental illness, make use of bodily movements to resolve symptoms related to Posttraumatic Stress Disorder (PTSD) and Depression.

Although insights into the therapeutic benefits of the moving/dancing body are growing and promising, much of the literature is not sufficiently concrete about how bodily movements are involved in the healing of mental illnesses, neither from a neurobiological nor a phenomenological perspective. Moreover, as there is a huge diversity in embodied therapies, differing in their theoretical and practical frameworks, important insights into the role of bodily movements are left unconnected.

In SE, which is grounded in an evolutionary biological perspective, Peter Levine argues that PTSD develops when the body is restrained from completing its movements in a traumatic situation and thus to release trauma, one must allow these blocked movements to come to completion [2]. Levine's work is rarely mentioned either in phenomenological psychopathology or in the context of embodied therapies, let alone

connected to outcomes provided by DMT-studies on PTSD and Depression. In order to strengthen and deepen the importance of the body and its movements in restoring mental health, this research project aims at connecting and bridging the different insights gained in SE and DMT. This will mainly be done through a theoretical analysis of the commonalities and differences in SE and DMT, such as in their theoretical and practical frameworks and the patient-therapist relationship. Given the success of SE and the increasing insights on the effectiveness of DMT in patients diagnosed with PTSD or Depression, it is argued that the moving/dancing body should become an essential part of therapy, though it will also be questioned to what extent it can replace traditional talk-therapy and pharmaceutical interventions.

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# ***Response Inhibition in Bilinguals***

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Large body of research on bilingualism has indicated that using two or more languages has a beneficial effect on the efficiency of attention and cognitive control. This relation is believed to be the result of tremendous training of executive functions, caused by constant activation of both languages in the bilingual brain. Two simultaneously active language systems compete with each other and therefore enforce frequent use of selection mechanisms and the inhibition of interference. [1]

One of the tasks which can be used to measure the inhibition of interference is a stop-signal task (SST). This variation on go/no-go paradigm is especially suitable for measuring the ability to alter one's behavioural response while performing the activity in order to optimise its results. SST provides a possibility to measure an inhibition of a response that have already been initiated. [2][3] Up to this day, the potential advantages of bilinguals regarding this particular skill has not been thoroughly examined.

I will present a detailed description of the stop-signal task, its mechanism and the principles behind it, as well as examples of the previous usage of this task in the field of psycholinguistic research. Moreover, I will present summary and the preliminary results of my own study conducted on 32 Polish monolinguals and 32 Polish-English bilinguals.

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# ***Auditory Verbal Hallucinations and the Content-Specificity Problem: A Study in Phenomenology and Cognitive Science***

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Due to their indisputable complexity, auditory verbal hallucinations have always been a challenge for scientists from various disciplines. Usually defined as percept-like phenomena occurring in the absence of a corresponding stimulus, they are characterised by extraordinary diversity. One of the ways that this dissimilarity manifests itself is in the specific contents of the hallucinations [1]. Described phenomena may differ from one another in accent, gender, familiarity and the occurrence of abusive content. On the other hand, there is a certain consistency in the way that auditory and verbal hallucinations are described. There is, however, no coherent explanation why this specific diversity takes place. In spite of the wide range of literature on the subject, there has thus far been no attempt to synthesise their findings and explain why auditory and verbal hallucinations can be so dissimilar in some features while at the same time maintaining a certain thematic similarity. As a result, an explanatory gap is emerging.

In my thesis, I will contrast two competing approaches to auditory verbal hallucinations. I will start by introducing the phenomenological approach [2] and then proceed with the presentation of ideas advocated by the cognitive sciences [3]. Although these two methodologies are commonly viewed as contradictory, they both attempt to explain the same phenomenon and seem to lack the sensitivity necessary to resolve the discussed issue. Furthermore, I will also argue that the

two paradigms are complementary rather than contradictory, and that there is a need to reexamine aspects of the existing literature through the lens offered by a more evolved approach to the existing paradigms. In my final remarks I will address whether these approaches are capable of accommodating both the diversity and the similarities within hallucinatory experience.

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