

**BME Department of Cognitive Science
Doctoral Students' Conference**

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BME, Building T, Room 515

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Abstracts

Executive control deficit in schizophrenia

Dombovits Renáta

Previous studies have shown various decrements in many cognitive domains or specific deficits in memory in schizophrenia. Such studies have grouped test results or have used few executive measures, thus, possibly losing information. We therefore, measured a range of executive ability tests, supplemented with highly sensitive eye tracker measurements, to find cognitive deficits characteristic for schizophrenia.

Fifteen schizophrenic patients and 15 normal volunteers, matched for age and Raven IQ, were examined with computerized test of cognitive control, spatial working memory and attentional set shifting compatible with eye-tracker measurements. Additionally, Verbal Fluency Test, Visual Pattern Test, Wisconsin Card Sorting Test, N-back, Stroop and a Go/No-Go test were obtained.

Patients performed worse on all tests but the profile was non-uniform. A componential analysis indicated that the patients were characterized by a poor ability to switch attention between sets and inhibit prepotent responses.

Individual differences in auditory multi-stability

Dávid Farkas, Susan Denham, Alexandra Bendixen, István Winkler

When sensory input is ambiguous, individuals differ in how much they switch between the possible percepts (perceptual bi-/multi-stability; e.g. Aafjes *et al.*, 1966; Kondo *et al.*, 2012). A recent study (Denham *et al.*, 2014) employing an auditory multi-stable streaming paradigm found that individuals retain the same idiosyncratic switching pattern even one year after the first test. Here we searched for correlates of these characteristic individual switching patterns in executive functions and various personality traits. Results showed that two executive functions, namely shifting and inhibition, can be linked to the individual switching patterns. We also found that neither inhibition as a personality trait nor creativity was correlated with the switching patterns. From the personality trait correlates, multiple linear regression revealed that the “Active Engagement with the World” factor of the meta-trait Ego-resiliency (Block, 2002; Farkas & Orosz, in prep) is the personality trait most closely correlated with inter-individual variance in how listeners perceive streaming sound sequences.

Exhaustiveness in Hungarian: entailment or implicature? An eye-tracking experiment

Káldi Tamás

Based on introspection, generative linguistic accounts claim that the Hungarian pre-verbal focus (pre-VF) has exhaustive interpretation determined at the syntax–semantics interface. Alternative pragmatic accounts, however, postulate that the interpretation of pre-VF is determined by contextual and cognitive factors. More specifically, the former claim that exhaustive interpretation is the result of logico–semantic entailment (i.e. there is a deterministic relationship between form and meaning), while the latter claim that it is the

result of pragmatic implicature. Previous research carried out on healthy and mildly agrammatic Broca aphasic patients revealed that although subjects were sensitive to word order variations typical of pre-VF marking (as in the analogous progressive marking structure), and could perform the pre-VF related set operation, the structure at hand does not have an inherently exhaustive interpretation. The offline methods used so far, however, have their limitations since it could only have been concluded that exhaustiveness is *not* syntactically determined, i.e. it does not emerge as a semantic entailment, but nothing has been said about determining, possibly pragmatic factors. In the current phase of the research thus we hypothesise the pragmatic implicature status of exhaustiveness and run an online, eye-tracking experiment to compare interpretational differences of the pre-VF and progressive aspect marking structures. The rationale behind the research is as follows. We have established that the exhaustive interpretation of pre-VF sentences is around chance level, while the analogous progressive structure is more reliably interpreted as predicted by syntax. In order to achieve a satisfactory level of validity when comparing the structures at hand a baseline measure has to be made on elements about which the aforementioned dichotomy has been attested experimentally. Noun expressions coordinated by *and* and *or* are suitable for this measurement, since Babarczy et al. (2013) has shown that while the semantic entailment (i.e. inclusive reading) of *and* coordinated phrases emerge automatically, the exclusive reading of *or* phrases resulting from a pragmatic implicature does not. The comparison of these phrases provides a basis for the comparison of pre-VF and progressive structures. If we get similar results in the pre-VF condition to that of the *or*-condition and the progressive condition yields similar results to that of the *and*-condition, we can conclude that the exhaustive interpretation of pre-VF structure emerges through pragmatic implicatures.

Age-dependent changes of feedback stimulus processing – event-related oscillatory dynamics during a gambling situation

Zsófia Kardos , Brigitta Tóth, Roland Boha, Bálint File, Márk Molnár

Rapid evaluation of outcome events are reflected by specific stimulus-locked electrophysiological activities like the feedback-related negativity (FRN) and the P300 event-related potential (ERP) components, and event-related changes of theta (4-7 Hz) oscillatory power mostly at the fronto-central sites. How these variables are changed as a result of aging is still not clarified. The present study aimed to investigate the age-related characteristics of this feedback evaluation and risk-taking behavior. 64-channel EEG was recorded from 20 young and 17 old participants during a monetary gambling game in which they had to choose between high or low monetary stakes in win-or-lose trials. Event-related potential and time-frequency analyses were performed in the time window of the feedback stimulus. Both young and old participants showed equal probability of risky choices (laying high stake), but old adults preferred these more frequently following losses than the young. The FRN and the P300 ERP components, as well as the event-related oscillatory power in the theta range were sensitive to the monetary outcome only in the young, but not in the old. The altered electrophysiological pattern of feedback processing together with the risk-taking behavior pattern suggest inefficient processing of negative outcome in the elderly which may explain some of the maladaptive behavioral patterns characterizing this age group.

Understanding negative numbers in elementary school

Orsolya Kis

In our research we assume that the understanding of the numbers derives from the system in which they are anchored. Our hypothesis is that children discover the meanings of number words based on their knowledge about the objects, number words being anchored in the understanding of the objects semantic system, and matching sets. Children are able to perform those numerical operations that can be performed on the objects as well.

Furthermore we assume that numbers could be anchored to other semantic systems too.

Using a different kind of anchoring we can expand the set of meaningful operations, because they can be transferred from the newly anchored semantic system to the numbers.

We test this theory on the learning of negative numbers. We expect that in the case of the original object based analogy the negative numbers are not comprehensible. But if we succeed in anchoring the numbers to an extended number line for both positive and negative numbers, a one dimensional space, it is conceivable that the operations on negative numbers become meaningful to the children.

Participants included first and second graders, ranging the age of 8 to 9 years. In order to test the two possible analogies, we gave the children simple arithmetical operations such as addition and subtraction, using different counting tools: either number line or marbles. We expect that children make less error with number line, using the number line analogy, than with using the debt analogy and marbles, where negative numbers are represented as owed quantities.

Effects of word distance on the left anterior negativity (LAN) and P600 event-related potentials to violations of Hungarian syntax

Zsuzsanna Kocsis

In this study, we assessed the effects of word distance on two well-known event-related potential (ERP) components elicited by syntactic violations. The left anterior negativity (LAN) peaks between 300 and 500 ms whereas the P600 between 500 and 800 ms. The results obtained in previous studies are equivocal: with increasing word distance, increased, attenuated, and also unchanged component amplitudes have been obtained. Another aim of the study was to determine whether these syntactic-violation related components can be observed not only for subject-verb agreement violations, as was shown previously, but also for object-verb agreement violations in Hungarian. Hungarian syntax requires agreement between the verb and the suffix of the object. Subjects were presented sentences word-by-word on a computer monitor. Their task was to answer a question about each sentence. We found that object-verb agreement violations also elicited both the LAN and P600 components. Further, we found an attenuating effect of word distance on the LAN and P600 component amplitudes for both subject-verb and object-verb agreement violations.

Active execution of facial expressions disrupts identifying noisy faces.

Petra Kovács

Recognition of faces is mediated by an extended network of cortical areas. Although there exists an extensive literature which describes a detailed model of the face perception

(Haxby, Hoffman, & Gobbini, 2002, Calder, & Young, 2005, Zhen, Fang, & Liu, 2013), the functional specialization of the various areas is still poorly understood and explained. My talk will cover the new project which I have just started. Unfortunately there are no results yet, but I will present the aim of the research and prospective results.

Hermann and colleagues, (in prep) conducted a study using fMRI where participants had to categorize noisy and clear face images. The analysis of intrinsic functional connectivity of the right fusiform face area (FFA) in resting state (during rest) revealed positive correlation between the behavioral noise effect and the strength of the functional connectivity between the FFA and a subset of regions of the extended face network (the supplementary motor area-SMA, precentral gyrus and insula) We know that visual noise changes the phases of an image which carry location information of the image (Oppenheim & Lim, 1981). Location information is crucial for object categorization, specially for facial emotion recognition. We predict that these areas (SMA, precentral gyrus, and insula) are also involved in processing noisy images, disrupting them could decrease the performance on noisy face recognition.

Also it has been suggested that these areas are highly involved in processing facial emotion, based on studies using TMS and fMRI (Rochas et al., 2012, Pohl et al., 2013). Studies with TMS found that disrupting pre-SMA activity impairs facial happiness recognition (Rochas et al., 2012), and that disrupting right somatosensory cortical activity selectively impaired the performance of facial expression, but had no effect on identity task (Pitcher et al, 2008). Another method to interfere emotion recognition is to make subjects imitate or execute various emotional expressions. In one of the studies using fMRI, subjects had to imitate facial expressions or passively view movies of facial expressions (Leslie et al., 2003). The authors found a common cortical imitation circuit for face imitation, including several areas, among others the SMA and the precentral gyrus. To my knowledge, this method has not been used to test the processing noisy face images.

To test our hypothesis, we use a paradigm where subjects perform a three alternative forced choice task categorizing noisy and clear face images while executing various facial emotional expressions (happy, angry or neutral). The experiment consists of two types of block; one of the blocks is emotion discrimination task, while the other is an identity discrimination task. We propose that disrupting SMA with emotion expression execution participants will show a decreased performance in discriminating face identity deteriorated by visual noise, in the same way as in the emotion recognition task.

Pupil diameter and heart-period variability as measures of mental effort: building towards adaptive human-computer interaction

Máté Köles

The level of mental effort needed to perform a task can characterize the interaction between human and computer. There is an abundance of self-report, subjective rating based methods of assessing this level of effort, but their feedback lacks the speed needed to construct a truly adaptive system. Physiology based methods can offer online and unbiased feedback on mental effort. My previous research was either focused on heart-period variability or pupil diameter change alone. They are both proven methods of measuring mental effort: the average diameter of the pupil during a task is bigger, while the average spectral power of the mid-frequency peak (0,07-0,15 Hz) of the ECG is lower under higher levels of effort. In my current study, both were utilized at the same time. However, both

methods have different temporal resolutions and are affected by different external or internal effects. There is no readily available method of integrating both into a single measure of mental effort. Results regarding the resolution of each metric will be presented. Future plans of adding Electroencephalography as a third metric will also be discussed.

Conflict resolution in word retrieval and the role of cognitive control

Enikő Ladányi

When we want to retrieve a word several competing word representations can be activated together with the representation of the target word. According to theories of word retrieval, for successful production of the target word, its activation level has to be significantly higher than the activation levels of the competing words. However, it is not clear yet how this activation difference is reached. One recent view attributes an important role to cognitive control which is a higher order process and is responsible for keeping relevant information active and inhibiting irrelevant information. Motivated by this view, we investigated the role of cognitive control in word retrieval in adults. Our participants were university students between 18 and 30 years and were selected from a Hungarian (n=32) and a German (n=30) population. Word retrieval abilities were assessed with a Rapid Automatized Naming (RAN) task in which we manipulated the level of conflict with presenting pictures both in a semantically homogeneous (high conflict) and mixed (low conflict) context. Cognitive control abilities were measured with an n-back task and a verbal and non-verbal Stroop task. We found significant correlations between conflict effects in the RAN task and in the n-back task but not in case of the Stroop tasks. Correlations with the n-back task suggest that cognitive control abilities might have a role in conflict resolution during word retrieval. However the lack of correlations with the Stroop tasks indicate that beyond cognitive control parallel updating and working memory storage components contribute to this effect as well and their role should be also included in the explanation.

Same side of different coins: the role of the perceptual and memory factors in subtypes of developmental prosopagnosia

Kornél Németh

Individuals with developmental prosopagnosia are unable to identify familiar people via their faces, despite normal low-level vision and intellect and in the absence of any obvious damage of the central nervous system.

Current results suggested the existence of different types of prosopagnosia, however to date the selective role of the perceptual, and memory factors in face recognition processes formally never been tested in this disorder. Additionally, the reliable evaluation of the possible subtypes was impossible in most prior studies due to the small number of participants.

To this end in this study we have recruited individuals presenting with developmental prosopagnosia and individually matched neurotypical participants (n=26-26) to analyse various aspects of the face recognition disorder.

Our results suggest the existence of two different subtypes in developmental prosopagnosia, one related to impaired memory and associative, while the other to impaired perceptual functions. Our findings help us to understand the heterogeneity of previous results and may also provide better tools for developing efficient training techniques in prosopagnosia.

Creativity on the psychosis-spectrum: a neurocognitive approach

Bertalan Polner, Szabolcs Kéri

Schizotypal traits are continuously distributed healthy phenotypes which resemble the positive, negative and disorganized symptoms of schizophrenia. Interestingly, some features of schizotypy seem to be beneficial to certain aspects of creativity such as divergent thinking or loose semantic associations. Here we examined the connection between creativity-related abilities and schizotypy within a psychopharmacological and an individual differences framework.

Emerging creativity has been documented in some Parkinson's disease (PD) patients as a delightful side-effect of dopaminergic therapy. It was hypothesized that schizotypy might mediate changes in divergent thinking during pharmacotherapy. We found that positive and disorganized schizotypy and lifetime creative achievement predicted changes in divergent thinking in PD. In another study we examined the relationship between schizotypy and problem solving among university students. It was predicted that schizotypal traits will be related to insight problem solving. We found that the interactions of schizotypal traits with working memory were related to variance in problem solving performance.

The results implicate dopaminergic influences on creative thinking. These studies draw attention to the interactions between personality, cognitive abilities and neurobiology underpinning human creativity.

Altering second-order configurations reduces the adaptation effects on early face-sensitive event-related potential components

Pál Vakli

The spatial distances among the features of a face are commonly referred to as second-order relations, and the coding of these properties is often regarded as a cornerstone in face recognition. Previous studies have provided mixed results regarding whether the N170, a face-sensitive component of the event-related potential, is sensitive to second-order relations. Here we investigated this issue in a gender discrimination paradigm following long-term (5 seconds) adaptation to normal or vertically stretched male and female faces, considering that the latter manipulation substantially alters the position of the inner facial features. Gender-ambiguous faces were more likely judged to be female following adaptation to a male face and vice versa. This aftereffect was smaller but statistically significant after being adapted to vertically stretched when compared to unstretched adapters. Event-related potential recordings revealed that adaptation effects measured on the amplitude of the N170 show strong modulations by the second-order relations of the adapter: reduced N170 amplitude was observed, however, this reduction was smaller in magnitude after being adapted to stretched when compared to unstretched faces. These findings suggest that early face-processing, as reflected in the N170 component, proceeds by extracting the spatial relations of inner facial features.

Developing an algorithm for automatic CAP detection

Klára Soltész-Várhelyi

Cyclic alternating pattern (CAP) is an oscillation in activation on the EEG signal during NREM sleep, a fluctuation between greater arousal level, measured as A-phases and lesser arousal level or background activity measured as B-phases. CAP events are part of the sleep regulation and protectors of the macrostructural integrity of sleep. Type A1 events are associated with increasing of cortical synchronicity and deepening of the sleep. Type A2 and A3 phases can appear both spontaneously and as a reaction to a disturbing event, and they are occupied by cortical desynchronisation therefore they are associated with waking or approaching of REM.

A-phases are easily distinguishable by the naked eye but parameters that define these events and can be used in automatic detection are much harder to determine because A-phases vary greatly in length, amplitude and shape depending on sleep stages. We are developing an algorithm for automatic CAP detection. The current version of our algorithm uses the following procedure: (1) determination of individually adjusted frequency bands set to each person's own spindle frequency (a method based on Bódizs et al. 2009) (2) finding potential A-phases using amplitude-ratios (based on Barcaro et al. 2004) and (3) discrimination of CAP A-phases using neural networks.

Correctness for recognition of type A1, A2 and A3 phases were 86% 79% and 81% respectively. We are currently analyzing the misclassified EEG segments to further understand the processes behind manual CAP detections.