PRIMENA METODE ERP U ISTRAŽIVANJIMA KOGNICIJE I SRODNIH FENOMENA

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Iako se metoda merenja i analize evociranih potencijala (eng. event-related potentials, ERP), izvedena iz starije metode elektroencefalografije (EEG), koristi u istraživanjima još od izmaka tridesetih godina XX veka, ekstenzivno korišćenje metode ERP u psihologiji počinje tek sredinom šezdesetih godina prošlog veka. Značajni primeri primene ERP-a u istraživanjima stranih autora beleže se već duže vreme, međutim sistematsko korišćenje ove metode u domaćim neuronaučnim i psihološkim istraživanjima počinje relativno skoro. Tema najvećeg broja radova u kojima je ova metoda primenjena u nas spada u oblast istraživanja kognicije i srodnih fenomena. Cilj ovog simpozijuma je da prvo upozna slušaoce sa osnovama ERP metode, a potom i sa našim istraživanjima odabranim tako da ilustruju doprinose metode ERP razumevanju različitih fenomena pažnje i kognicije, počev od onih bazičnih, poput vizuelne, motoričke i somatosenzorne detekcije, preko analize jezičkih fenomena, semantičke memorije, do ERP fluktuacije pažnje na radnom mestu i razumevanja mentalnih poremećaja poput shizofrenije.

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EVENT-RELATED POTENTIALS IN PSYCHOLOGICAL RESEARCH

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Event-related potentials (ERP) are voltage fluctuations of the brain which are time-locked to an event, such as appearance of a stimulus or a motoric response. They are studied using electroencephalography, and extracted by taking time epochs from the continuous recording. The epochs are then subjected to signal processing and averaged together to distinguish event-related activity from the remainder of neural activity and various sources of noise.

In psychological research, it is typical to record and study evoked potentials, ERPs that follow presentation of stimuli. An averaged ERP waveform is always a result of several distinct processes, which partially overlap. Therefore, the waveform is ordinarily partitioned into components, individual waves that are assumed to represent a single process or (more frequently) a combination of processes, whose functional, temporal, and topographical characteristics are

relatively well known. ERP components can be described with several measures of latency and amplitude, which can be used as variables in an experiment, and scalp voltage distributions can also be compared to examine differences between experimental situations or participant groups.

Two components that are likely the most widely known and used are P300, a positive deflection peaking at about 300ms, and N400, a negative wave peaking approximately at 400ms. P300 is part of a reaction to an unexpected (infrequent or novel) stimulus, and it includes several distinct subtypes. It is predominantly used in study of attention, memory, categorisation and psychopathology (schizophrenia research). N400 occurs during processing of meaning, mostly of words, but also of non-verbal stimuli, and its amplitude depends on semantic expectation of a stimulus within its preceding or surrounding context. It is especially relevant for researchers in the fields of psycholinguistics and semantic memory study.

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EVENT-RELATED POTENTIALS IN PSYCHOLOGICAL RESEARCH

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Our visual apparatus seems to be perfectly capable of triggering a percept effortlessly based on the spatially distinct elements, as Kanisza originally demonstrated with his Pac-Man-shaped illusions. Numerous studies were run since, linking this effect to early visual processing. In this study we wanted to examine the ease of detection of different illusory shapes in comparison to detection of the different shape orientation. To do so, we used an odd-ball paradigm, in which two stimuli were presented alternately (20:80, deviant to standard, respectively), we contrasted four critical experimental conditions: detection of illusory triangle amongst illusory squares vs. illusory squares within illusory triangles as well upright illusory triangles among inverted illusory triangles vs. inverted illusory triangle within upright illusory ones. As expected, we found that participants were quicker to detect the deviants in the first two experimental situations (when detecting different shape) in comparison to the third and fourth situation (when detecting different orientation). This results quite well match the observed ERP latency in the P300 effect, which starts around

200ms for detection of different shape in comparison to 120ms latter start of the P300 effect for the detection of the different-orientation of illusory contours. There were no differences in ERP amplitudes across the four experimental condition. These results demonstrate how behavioural and ERP data can fit together in detection of differences in seemingly similar and automated processes of illusory contours perception.

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DA LI NAM JE GRAMATIČKO PRIMOVANJE ZBILJA NEOPHODNO? UVID STEČEN PRIMENOM ODBOL PARADIGME

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Gramatičko primovanja vrsta je jezičkog primovanja u kojem primovi specifikuju vrstu i neku od gramatičkih kategorija mete. Ovaj postupak nameće potrebu da se, često arbitrarno, definišu proceduralni detalji poput trajanja ekspozicija prima i interstimulusnog intervala prim-meta. Ovi parametri pak presudno utiču na sud o dejstvu gramatičkog konteksta na obradu reči. Primenom odbol paradigme, pokušali smo da proverimo može li se koristiti jednostavniji postupak koji više odgovara uslovima svakodnevnog čitanja. Upotrebili smo parove reči koje su činili nasumično odabrani imenica i glagol kojima je u gramatički ograničavajućem kontekstu prethodio odgovarajući predlog (na loptu), odnosno lična zamenica (on pije), dok je istoj imenici i glagolu u gramatički neograničavajućem kontekstu prethodio veznik ili. Parovi su prikazani prvo kao devijanti (20%), potom kao standardi (80%). Tako su formirane četiri eksperimentalne situacije, po dve sa imenicom i sa glagolom. Zadatak je bio detekcija devijanta manuelnim odgovaranjem. Istovremeno, beleženi su evocirani električni potencijali putem CZ elektrode. Vreme reagovanja u svim situacijama bilo je jednako (Mdn=408 ms). Amplitude evociranih potencijala analizirane su u okvirima od po 20ms t-testovima razlika otklona za devijante i standarde. Imenica u neograničavajućem kontekstu kao devijant pobudila je razlike u intervalu 360-380ms do 420-440ms, dok je imenica u ograničavajućem kontekstu kao devijant razlike pobudila u opsegu 420-440ms do 480-500ms. Glagol u neograničavajućem kontekstu kao devijant pobudio je razlike u

opsezima 440-460ms do 480-500ms i 540-560ms do 600-620ms. Razlike pobuđene glagolom u ograničavajućem kontekstu kao devijantom nisu dostigle značajnost iako su bile istog smera kao u ostale tri situacije. Zabeleženi potencijali pripadaju gornjem opsegu P300, sa latencijama osetno dužim od onih koje se registruju u odbol eksperimentu sa vizuelnim stimulusima koji nemaju značenje. Nismo zabeležili ranije potencijale koji bi svedočili u razlikama pažnji i opažanju, te smo skloni da tvrdimo da su naši ispitanici semantički obradili obe reči u prikazanim parovima, na sličan način na koji se u Strupovom zadatku obrađuju nerelevantna svojstva stimulusa. Jednovremeno prikazivanje reči stoga bi moglo biti primenjeno u istraživanju dejstva gramatičkog konteksta. Ovakav način prikazivanja omogućio bi jednostavno merenje evociranih potencijala i izvođenje potpuno paralelnih eksperimenata sa ajtrekingom.

DO WE REALLY NEED GRAMMATICAL PRIMING? INSIGHTS GAINED THROUGH ODBALL PARADIGM

A two-stimulus odball ERP experiment was created to explore alternatives to standard grammatical priming. A noun and a verb with congruent preposition and personal pronoun respectively preceding them were paired to create grammatically constrained condition, while conjecture preceding both target words was employed to create unconstrained condition. The results pattern was the similar across situations, with stimuli chosen evoking clear P300 potential as deviants in three out of four situations. In each of the situations P300 peaked well after 400 ms, falling near the upper limit of P300 range usually reported. Such P300 latencies mark semantic processing and indicate subjects read and linguistically processed both words in pairs in a simple task of deviant detection. We conclude that simultaneous primes and targets presentation could constitute ecologically valid alternative in grammatical context on visual word processing research by circumventing some of grammatical priming procedure technical pitfalls.

COMPARING THE TEMPORAL DYNAMICS OF THEMATIC AND TAXONOMIC PROCESSING USING EVENT-RELATED POTENTIALS

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Taxonomic relationship refers to item pairs or objects that belong to the same semantic category based on the overlap in features or meaning (cow–donkey, apple–pear), whereas thematically related objects are objects that are related based on the complementary roles they play in the same scenario or event (cow–milk, nail—hammer). We report here the results of a study comparing the temporal dynamics of thematic and taxonomic knowledge activation in a picture-word priming paradigm using event-related potentials. Although we found no behavioral differences between thematic and taxonomic processing, ERP data revealed distinct patterns of N400 and P600 amplitude modulation for thematic and taxonomic priming. Thematically related target stimuli elicited less negativity than taxonomic targets between 280–460ms after stimulus onset, suggesting easier semantic processing of thematic than taxonomic relationships. Moreover, P600 mean amplitude was significantly increased for taxonomic targets between 520–600ms, consistent with a greater need for stimulus reevaluation in that condition. So far, ERP differences in thematic and taxonomic processing have rarely been reported, with several studies reporting no differences and a few studies reporting the similar pattern of results to the one obtained in our study. Thus, this result is among the first to offer strong evidence for the neural distinction of thematic and taxonomic thinking in early phases of conceptual processing.

MISMATCH NEGATIVITY EVENT-RELATED POTENTIAL AS A CLINICAL TOOL FOR ASSESSMENT OF BRAIN FUNCTION

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Mismatch negativity (MMN) or mismatch response is an electrophysiological signal measured by EEG/MEG and it occurs as mismatch in morphology of

event-related potential to an odd stimulus in a train of standard stimuli. From 1970s MMN has been employed for understanding the processes of pre-attentive detection of rule violations, considered a form of "primitive intelligence". Depending on evoking stimulus MMN can be auditory, visual and somatosensory (electrical, touch, vibration stimuli). Major advantage of MMN methods for assessing brain functions is its simplicity, usually not comprising any specific task concerning the series of evoking stimuli, and not requiring active cooperation/attention. MMN is a promising tool to detect abnormalities in neural system functioning and it has been proven to be modulated in neurological/mental disorders, vegetative state, with age or level of physical fitness. MMN is considered to be a potential biomarker for reliable diagnostics or outcome prediction in various disorders. However, translation into clinical practice requires standardization in recording techniques and disorder-specific normative data.

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FUTURE JOB POST: UTILIZING PHYSIOLOGICAL MEASUREMENTS IN QUANTIFICATION OF THE INTERACTION BETWEEN WORKER AND A WORKPLACE

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Wearables are becoming ubiquitous in everyday life. Humans are willingly accepting the technological advancement of sensing technology, mainly for improving their daily routines and well-being. This general trend consequently opened a whole set of new topics in the applied psychology research that were previously not exploited enough. The main reason for this was the lack of the lightweight equipment for physiological sensing, especially the equipment that can be used in free environment (outside the laboratory settings). Following this trend, the field of Human Factors and Ergonomic (HFE) became richer for the new discipline called neuroergonomics. The main objective of neuroergonomics is to investigate the brain functions during work and in everyday life (Parasuraman, 2003). It provides the possibility to objectively quantify the worker's cognitive state, through investigation of the covert cognitive processes, instead of the classical ergonomics methods that mainly relied on the qualitative assessment. Neuroergonomics is expected to especially benefit in future from the real-time data acquisition and processing. This provides the possibility to timely

investigate the how different workplace parameters are influencing the worker's cognition, which can provide a valuable input for the workplace optimization. We offer a brief insight in several tools that can be employed in future – all relying on electroencephalography (EEG) for brain states quantification. We showcase industrial neuroergonomics tools' implementation example, application in consumer market segment – retail store optimization, and a workload quantification demo, to be used for focus critical work posts.

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ERP STUDIES IN PEOPLE WITH SCHIZOPHRENIA

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Schizophrenia is a chronic brain disorder that affects about one percent of the population. Although it has been one of the most studied psychiatric disorder, it is still not known what causes schizophrenia, but is believed that a combination of genetics, brain chemistry and environmental factors contributes to development of the disorder. Neuroimaging studies show differences in the brain structure and central nervous system of people with schizophrenia. While researchers are not certain about the significance of these changes, they indicate that schizophrenia is a brain disease. Most people with schizophrenia show clear signs of cognitivne impairments, such as deficits of attention, concentration and memory, as well as decrease in academic performance. Event-related potentials (ERPs) are relevant markers of cognitive deficits in schizophrenia. Impaired P300 component, as well as impariments of late components (N400, P600) are consistent finding in people with schizophrenia, while studies of early components (P1,N1,MMN) show inconsistencies. One of the major problems in schizophrenia treatment is large time gap between first symptoms and final diagnosis, leading to delay in implementation of treatment protocols. The majority of ERP studies in schizophrenia have been conducted with heterogeneous samples of chronic patients. Over the last several years there has been a shift in performing studies with people experiencing first episode psychosis in order to determine distinctive properties of ERP components that potentially could be used as diagnostic predictors of schizophrenia.