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images and didn't represent personal experience of the participants. 7 pictures and 7 sounds were used. Each picture was matched with a corresponding sound. Experiment consisted of 5 sessions. In first session (1) only pictures and in second session (2) only sounds were presented with task to passively perceive stimuli. In third session (3) the picture and the corresponding sound were simultaneously presented with the same task and bimodal associations between a sheep's' 'faces' and bleats were formed. In fourth (4) session sheep's faces were presented and participant had to imagine corresponding sound, and in fifth (5) session vice versa. (4)>(1) and (5)>(2) contrasts as well as 1 to 5 series separately were analyzed (FWE $p<0.05$).

Results: We found increasing activation of insula (predominantly right) for both contrasts. In (1) and (2) control sessions alone activation of this area was not presented. This area was also activated in the third session when stimuli were presented simultaneously. This result corresponds to Bushara et al. (2003) results related to insula's role in audiovisual integration.

Conclusions: We found that insula can be treated as mechanism of forming of audio-visual bimodal complexes. These results suppose that this system starts to work after bimodal association between audio and visual parts of complex and it can be activated if only one stimulus from bimodal complex was presented.

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Resting heart-rate variability predicts susceptibility to mental fatigue in a demanding cognitive task

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Introduction: Studies of mental fatigue frequently use electrocardiogram (ECG) recording and heart-rate variability (HRV) calculations to assess the fatigue-related changes in parasympathetic nervous system activation. Specifically, most of these studies have examined changes in HRV during a prolonged performance of a task. Recently, however, it has been suggested that the level of resting HRV, and the magnitude of changes in HRV between two different time points during an experiment (i.e. phasic HRV) might reflect for different psychophysiological adaptation mechanisms (e.g. self-regulatory mechanism) [Laborde et al, 2017, Frontiers in Psychology, 8]. Therefore, in one experiment, we compared the predictability of phasic and resting HRV on the performance of a cognitively demanding and prolonged task.

Methods: We adapted a cross-modal switching task for Time-on-Task (ToT) paradigm [Lukas et al, 2014, Acta Psychologica, 153]. On each trial, participants were asked to decide whether the stimulus in the cued modality was presented for a short or a long duration. The experiment had three phases. First, participants ($N = 21$) completed questionnaires referring to sleepiness and fatigue, and a resting ECG was recorded (5 min.). Second, participants performed the task for 1.5 hours without rest. Subjective fatigue, reaction times, error rates, respiration, and ECG were recorded. Third, after a break (12 min.), an additional block of trials (12 min.) was administered. HRV was calculated in both the frequency- and the time-domain. Behavioral and HRV data were divided into five ToT intervals, and phasic HRV was defined as changes from resting to the first interval and the change from the first to the fifth interval.

Results: The analyses yielded increased subjective fatigue, compromised performance, and increment in HRV with increasing ToT. Separate ANCOVAs were performed on behavioral data with the resting, and the phasic HRV measures as covariates. Significant covariate effect was found for resting HRV: we found a positive trend between the level of resting HRV and the decline in performance with ToT. In addition, a significantly positive association was found between resting HRV and the increase in subjective fatigue.

Conclusions: The results suggest that a higher level of baseline HRV has a negative association with the compromised performance under fatigue. More specifically, a high level of parasympathetically mediated vagal nerve activity indexed by resting HRV reflects less effective resource allocation and self-regulatory mechanisms in a fatiguing cognitive task.

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Mouse tracking reveals new dimensions for the analysis of response-related potentials

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A response action consists of at least two stages: initiation and execution. Recording keystrokes and button presses is the method most commonly used in the field of cognitive psychophysiology; this method provides data on response accuracy and response time, which seem to be mostly related to the initiation stage. On the contrary, mouse tracking provides continuous data on response dynamics. Particularly, we assume that mouse movement duration is an important response parameter that is related to the execution stage of the response. Here, we applied this method to probe the functional significance of the response-related event-related potential (ERP) components such as correct-related negativity (CRN) and a P_e-like positivity.

We used the condensation task, which involves complex stimulus-to-response mapping: participants had to make responses to four auditory stimuli relying on the combination of two independent stimulus features. During each trial, participants had to respond to auditory stimuli by moving a computer mouse either to the top-left or to the top-right mousepad corner. EEG was recorded during the experiment. The following parameters of mouse movement were assessed: movement initialization time and movement duration. Within each subject, we divided the trials with correct responses into four quartiles for each of the mouse movement parameters separately. We compared ERP waveforms for trials within each pair of marginal quartiles.

Both movement initialization time and movement duration were higher for errors compared to correct responses. These mouse movement parameters were uncorrelated. We found that CRN amplitude within 10-110 ms time window was higher for early correct responses compared to late ones ($p=0.004$). In addition, we found a significant effect of mouse movement duration on ERP in early P_e time window (120-265 ms): amplitude of the P_e-like positivity was significantly higher for long correct responses compared with short correct responses ($p<0.001$).

We suggest that the early P_e-like component is not specifically related to errors; rather, both CRN and P_e-like component seem to be related to response uncertainty. Particularly, uncertainty during response execution stage seems to result in increased P_e-like component and prolonged mouse movement. We also assume that early correct responses are mostly premature responses, and increased CRN may indicate stronger performance monitoring arising after response initiation.

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The revealing of periods in Lempel-Ziv complexity of EEG signal

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Introduction: The human brain as a distributed nonlinear dynamical system can be efficiently represented with a set of its informational characteristics. Such characteristics measured through the brain electrical activity (EEG, or electroencephalogram) include the Shannon entropy (e.g., Bruhn, J., H. Ropcke, et al., 2000) and the Lempel-Ziv complexity (LZC) (Lempel, Ziv, 1976). In our present study, we have revealed new features of brain dynamics via the analysis of LZC for EEG signals.

Methods: We used EEG recordings from Cz lead made in the relaxed arousal state with open and closed eyes. We calculated Lempel-Ziv Complexity for alternating window width *w*. To do that, we fixed the initial point of the recorded EEG and found the corresponding LZC for the intervals of different lengths, starting from the interval of 10 samples length and then for 11 samples and so on up to the greatest interval of 3000 samples. We got the dependence of LZC value versus window width for the selected Cz EEG channel: *LZC(w)*, see Fig.1.

On Fig.1 one can observe, that the dependence *LZC(w)* has two distinct components: a trend that could be well approximated by the exponential function and a quasiperiodic component. To investigate the second one, we subtracted the exponential trend from LZC and constructed the power spectrum for the detrended time series. By Wiener-Khinchin theorem, we got the autocorrelation function of this component and applied Fourier transform to it.

Results: The Fourier image of the autocorrelation function for the de-trended LZC function is plotted on Fig.2.

Here one can clearly see quasi-periodical oscillations centered around the frequencies 0.33, 2 and 3.17 Hz. We have observed such oscillations in all de-trended LZC functions based upon the EEG-signals recorded for 10 subjects with open and closed eyes both.

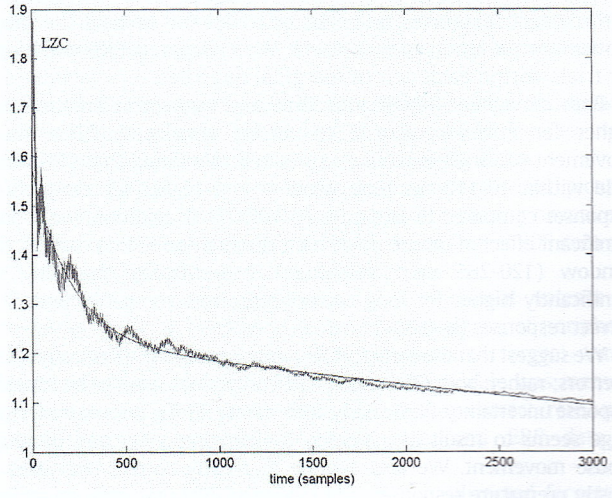

Fig. 1. Dependence of LZC value versus window width.

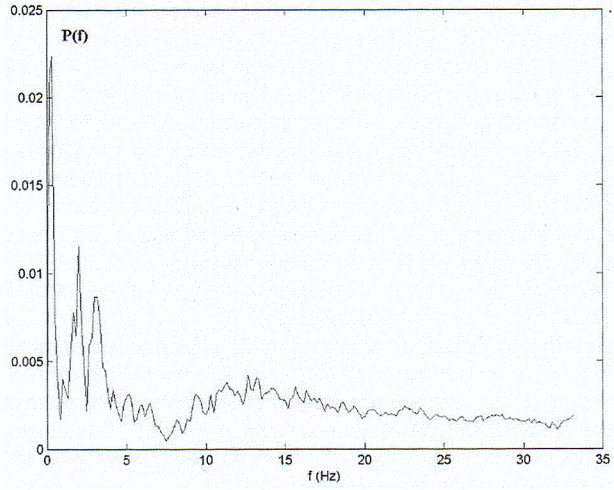

Fig. 2. Fourier image of the autocorrelation function for the de-trended LZC function.

Discussion: Among the three observed frequencies, the lowest one is most probably related to the length of the window: 3000 samples correspond to the period of oscillations 6 seconds with the frequency of 0.1(6) Hz, that is half of the lowest frequency on the spectrum plot. The nature of two other peaks can be originated in the inner dynamics of the brain processes. We consider these oscillations to indicate the periodical change of the EEG 'vocabulary' (a typical set of 'words', or signal codes). Interestingly, we have not found any significant difference between recording states of open and closed eyes.

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Gender bias when interacting with avatars

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Gender differences exist in almost every aspect of our life. Individuals have an array of different societal expectations in regards to behaviors, communication, appearances, attitudes, and roles in society, but these expectations tend to be based on the general principle of whether the individual is male or female. Currently a lot of social studies have been done with the help of virtual reality technologies. The effectiveness of their application was been proven in the studies of many social phenomena – in nonverbal communication, in training social skills, in rehabilitation of social anxiety and etc. A lot of attention has recently been paid to the problem of gender differences during social interaction with virtual partners – avatars. Unfortunately a problem concerning gender differences during interactions with avatars of different ethnic appearances has been little studied. The goal of our study was to investigate the gender peculiarities of the interaction with avatars of different ethnic appearances. Using the CAVE virtual reality system we studied gender features of interpersonal distances maintained with avatars. Four three-dimensional virtual scenes with avatars were designed. Four types of avatars with different ethnic appearances, were created, including avatars of Slavic, Asian, North Caucasian, and African-American appearance. All avatars were male. Forty-one participants (22 F, 19 M) (all positioned themselves as Russians) were tested. They were immersed in virtual environments with the help of the CAVE virtual reality system. Their task was to come to the avatar, to present herself/himself in a free form and to