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Emiliano Ricciardi

The study was implemented at Perm State University. 140 students took part. The first method, that was used is "Rapid diagnostics of the nervous system properties" by E.Ilin. The psychomotor test tracks temporal changes in the maximum rate of movement with a wrist. It allows to determine the type of force-weakness of the nervous system; identify the stability and endurance of the individual to a variety of long-lasting irritants. The second method was "Study of the psychological structure of temperament" (B.Smirnov). The questionnaire of temperament structure includes 48 questions, allows to diagnose polar characteristics: extraversion - introversion, emotional excitability - emotional balance, reaction rate (fast - slow), the level of activity (high - low).

The results of the study showed that the majority of students are dominated by the average type of nervous system (43%). The maximum tempo is maintained at approximately the same level during the entire operation time. This type characterizes the nervous system of medium strength. Equally, there are both strong (13%) and weak (14%) types of the nervous system.

The study of the psychological structure of temperament showed that among all students, extroverts (41.4%) and introverts (43.5%) are roughly equally encountered. Investigation of the properties of rigidity-plasticity determined a high (27%) and very high (31%) rigidity in the majority of respondents. Plasticity was observed in about 14% of respondents. Most of the students are characterized by high (39%) and very high (21%) emotional excitability. Emotional balance was observed much less often (about 11%). A significant proportion of students have an average rate of psychic reacts (43%) with an average level of activity (45%).

An individual personality profile of temperament properties was drawn up. Individual professional development trajectory assumes the account of features of the nervous system and temperamental characteristics in the selection of activities that will be the most comfortable environment for development in the profession. There were developed recommendations, that included the following information: recommendations on the organization of working hours, the selection of work schedules and further professional self-realization based on the diagnosis of temperament properties.

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Working Memory Updating Training Improves Children's Fluid Intelligence: An Evidence from ERPs

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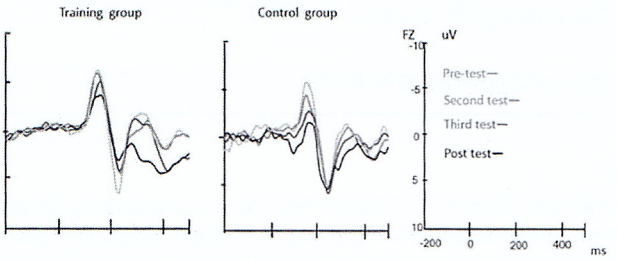
Introduction: working memory updating training possibly improve the fluid intelligence of children, but its mechanism remains unclear. Cumulative empirical evidences indicated that inhibitory control was an essential factor to account for the relationship between working memory training (WMT) and fluid intelligence. Neuroimaging studies also suggested that some common brain areas (e.g. prefrontal lobe and parietal lobe) were involved in inhibitory control and those cognitive functions. Inhibitory control can be divided into conflict inhibition and response inhibition. P200 is regarded as the component of attention regulation, and the P200 component induced by the frontal area is considered to reflect the inhibition ability of the individual to irrelevant information. The present study speculates that working memory updating training could improve children's inhibitory ability, showing a decrease in P200 wave amplitude, thus leading to the improvement of children's fluid intelligence.

Methods: A total of 45 children (aged from 9-11 years) were randomized into a WMT group (25) or a control group (20). All subjects were tested on the day before the training, the 10th day, 15th day and 20th day of the training, control group did not participate in the training stage. All children were asked to be tested in the Standard Progressive Matrices Test. Event-related potentials were recorded during the stroop task and go/on go task.

Results: the study showed that, the children in the training group outperformed those in the nontraining group in terms of accuracy in the Raven Standard Progressive Matrices scores (see Table1). The P200 amplitude of the training group decreased significantly in the go/nogo task (see Fig 1), However, the P200 effect disappeared in the stroop task.

Conclusion: the results demonstrate that working memory updating training improves fluid intelligence, which may be related to the improved inhibition ability, and has nothing to do with conflict inhibition ability.

Table 1 Test scores on the Raven Standard Progressive Matrices test



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Theta and beta oscillations dissociate two types of errors: a trial-to-trial correlational study

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Introduction: Mechanisms of cognitive control include monitoring and regulation of both task-specific attentional processes and non-specific motor threshold. Failures in one or the other of these two mechanisms may lead to different kinds of responses, post-response adaptations and, importantly, distinctive behavioral correlates. Slow responses can be interpreted as responses committed after attentional lapses and, therefore, during the state of uncertainty, while fast responses can be interpreted as responses committed in conditions of lowered motor threshold. Thus, slow and fast errors have different nature and require different brain adaptations.

The aim of the current study was to confirm the idea that modulations in oscillatory brain activity can distinguish between these two types of responses.

Methods: EEG was recorded during performance of the auditory two-choice condensation task, which requires sustained attention and does not require inhibition of prepotent responses.

Results: Increased frontal midline theta (FMT) power was observed during pre-response time interval for both correct responses and errors. Enhanced error-related FMT power was found in post-response and post-feedback time intervals. Increased frontal beta power was observed in post-feedback time interval.

We also observed significant positive trial-to-trial correlation between pre-response FMT power and response time (RT) for both correct responses and errors, negative trial-to-trial correlation between post-response FMT power and RT for errors, and positive trial-to-trial correlation between post-feedback frontal beta power and RT.

Discussion: Thus, slow erroneous responses characterized by high uncertainty were accompanied by increased FMT power before the response and by increased frontal beta power following the feedback; these effects, presumably, reflect enhanced cognitive effort and feedback processing, respectively. On the contrary, fast erroneous responses characterized by low uncertainty led to increased post-response FMT power, which, presumably, reflects internal error detection. Thus, this study confirmed the idea that RT can be a valid index of uncertainty level, with high uncertainty occurring due to attentional lapses and low uncertainty occurring due to failures to keep a sufficiently high motor threshold.

The study was implemented in the framework of the Basic Research Program at the National Research University Higher School of Economics (HSE) in 2018.

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Predictive Value of EEG-based Functional Connectivity Measures on the Outcome of Rehabilitation in Multiple Sclerosis Patients

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Introduction: Previous work indicates that Multiple Sclerosis (MS) patients are characterized by significant alterations in brain functional connectivity relative to healthy control subjects of matched gender and age. However, the potential relationship between connectivity measures and functional improvement induced by rehabilitative strategies remains unknown. Here, we specifically explored such interactions using two advanced EEG-based connectivity measures: the weighted Phase Lag Index (wPLI) and the weighted Symbolic Mutual Information (wSMI). These two measures are expected to have a different sensitivity for detecting linear and non-linear relationships between neural source dynamics. Therefore, we hypothesized that wPLI and wSMI may account for different aspects of training-related changes in motor performance in MS patients.

Methods: Sixteen MS patients completed a two-week task-oriented circuit training (TOCT). Before (T_0) and after (T_1) the training period, the Timed Up and Go (TUG) test was used to assess relative variations in motor performance. Moreover, patients completed 10-min EEG resting-state recordings (64 electrodes; Micromed) with eyes closed. For both EEG recordings (T_0 and T_1), indices of 'global' (whole-brain) connectivity strength were computed as the average wPLI and median wSMI connectivity for all channel combinations. To evaluate the relationship between connectivity values at T_0 or T_1, or connectivity variations T_1-T_0, and changes in motor performance (ΔTUG), an ANCOVA model was used, in which patients' age was included as between-subjects covariate.

Results: We observed a significant correlation between the alpha-band (8-12Hz) wPLI connectivity and ΔTUG at T_0 ($r = 0.61$; $p = 0.017$). However, no significant correlations were observed between T_1 and T_1-T_0 variation in connectivity and ΔTUG. Further analyses showed that only anteroposterior connectivity was correlated to improvement after treatment. The whole-brain broadband (1-45Hz) wSMI connectivity was found to be correlated with ΔTUG at T_1 ($r = 0.67$; $p = 0.009$) but not at T_0. Finally, a significant correlation was observed between the T_1-T_0 variation in wSMI connectivity and ΔTUG ($r = 0.70$, $p = 0.005$).

Conclusions: Our observations suggest that the tested connectivity measures account for different aspects of training-related functional changes. In particular, alpha-band-wPLI may represent a good indicator of whether a patient will positively respond to treatment, but does not reflect treatment-based changes in neural activity. On the contrary, broadband wSMI seems to account for changes induced by the treatment (e.g., increase in system complexity). Changes in broadband wSMI connectivity likely reflect the implementation or unmasking of (compensatory) mechanisms that are not active in patients before treatment.

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Fine-grained tonotopic architecture is retrieved from resting state connectivity in the auditory cortex

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Introduction: Brain connectivity at rest, measured by functional magnetic resonance imaging (fMRI), retains fine-grained properties of the retinotopic and somatotopic organization of sensory cortical areas[1,2]: voxels selective for specific stimulus properties (e.g., eccentricity) are more functionally connected to each other even in the absence of any stimulation. As far as the tonotopic architecture of the primary auditory cortex (PAC) is considered, only a very coarse parcellation (i.e., low vs high frequencies) has been retrieved from resting state functional connectivity maps to date[3]. We hypothesized that this limitation is due to the methodological approach rather than an actual property of PAC intrinsic functional organization. Thus, we employed representational similarity analysis[4] (RSA) to assess the spatial correspondence between a fine-grained tonotopic parcellation of PAC and voxelwise resting state functional connectivity maps within the same region.

Methods: We utilized resting state data from 61 subjects within a public repository (http://fcon_1000.projects.nitrc.org/indi/enhanced/index.html, Siemens 3T, GRE-EPI: 3x3x3mm, 897 volumes, TR=645ms, TE=30ms, FA=60°). Single-subject data were corrected for spikes, slice timing acquisition and head motion as well as smoothed to 6mm-FWHM. To ensure the validity of functional connectivity analysis, we adopted spike regression method and CSF signal regression. Data were transformed into the standard space using non-linear algorithm. Afterwards, group average signal was obtained by averaging single-subject data. Tonotopic maps were computed for a normally hearing subject (GE 3T, GRE-EPI: 2x2x2mm, 4 runs, 128 volumes, TR=2.5, TE=30ms, FA=75°) using an event-related design including 12 different frequencies with 4 repetitions each (48 events, range: 63Hz-6300Hz). Two separate representational dissimilarity matrices (RDMs) were derived from voxel-wise resting state connectivity and tones selectivity of PAC (t-values) using correlation distance. RSA tested the correspondence between these two RDMs; significance of the results was assessed using a permutation test.

Results: We identified PAC as voxels responding to all the tested tones ($p_{FDR}<0.05$) and we highlighted 12 tone-selective regions