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MEG visual gamma oscillations reflect individual differences in sensory sensitivity

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Introduction: Gamma oscillations arise from an interplay between excitatory (E) and inhibitory (I) neurons in the brain. Besides, visual gamma oscillations recorded with magnetoencephalo (MEG) have been characterized by high reliability and heritability. This makes visually induced gamma oscillations a promising candidate for a biomarker of the E/I balance, which is a key principle of neural information processing and is disturbed in many psychiatric conditions. Recently, our goup has demonstrated that the E/I balance regulation in the visual cortex is best reflected in the efficacy of this gamma power attenuation with the increase of motion velocity of high contrast gratings. However, little is known about how visual gamma oscillations are related to individual differences in perception and, in particular, sensitivity to sensory stimuli. In this study, we aimed to find the link between individual sensory sensitivity and the characteristics of MEG visual gamma oscillations.

Methods: 27 neurotypical females were recruited for the study. The subjects were asked to fill the Russian version of the Adolescent/Adult Sensory Profile questionnaire (A/ASP), which measures individual sensitivity to sensory stimuli in the everyday life. During MEG recording, our participants were presented with large (18° of visual angle) high contrast circular gratings, which were either static or moving with three velocities: 1.2°/s ('slow'), 3.6°/s ('medium'), and 6.0°/s ('fast'). For each participant and stimulus type, we estimated the gamma response (GR) power and frequency as well as the gamma suppression slope index (GSS) which measures GR power attenuation from 'slow' to 'fast' grating.

Results: We found that less efficient GR power attenuation in response to increase of motion of high contrast grating is associated with a greater general (Spearman $R_{(27)}$=.40, p=.038) and visual (Spearman $R_{(27)}$=.42, p=.028) sensory sensitivity. However, neither the GR power nor the GR frequency correlated with the A/ASP sensory sensitivity scales (all p's >.10).

Discussion: Our results suggest that it is not the absolute GR measures, such as the power of frequency, but rather the relative measure of the GR power modulation - the efficacy of GR power attenuation in response to visual stimulation of different intensities - predicts the individual differences in sensory sensitivity. As hypersensitivity is thought to reflect enhanced visual cortex excitability, we assume that intensity-related changes in the power of gamma oscillations may provide useful information about the E/I balance in the visual cortex. Therefore, we conclude that the GSS is a measure sensitive to the efficacy of the E/I balance regulation, which may provide useful information about the E/I balance dysregulation in patients with neuropsychiatric disorders, characterized by an E/I imbalance in the visual cortex.