Neurofeedback training of complex listening

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Abstract: Speech recognition in noise is a hard task that involves multiple stages of cortical processing including acoustic feature extraction, auditory grouping, working memory management and attention. Among those processes, we aimed to investigate whether auditory selective attention ability affect speech-in-noise understanding performance, and whether the neurofeedback training of selective attention can improve speech-in-noise understanding. Selective attention enhances the strength of auditory N1 response to attended sounds while suppresses the responses to ignored sounds, which forms an evidence of sensory gain control theory. We hypothesized that the N1-amplitude guided neurofeedback can strengthen the cortical sensory gain control, which in turn will improve selective attention performance and may result in better speech-in-noise understanding. With a single-blinded, between-subjects design including a control (placebo) group, subjects were asked to attend to one of two simultaneous auditory streams of single-word repetitions (e.g., five ‘‘up’’s and four ‘‘down’’s from left and right loudspeakers). Single-trial EEG responses were classified using template-matching method with pre-defined ideal EEG patterns of attention to each stream (either ‘‘up’’ or ‘‘down’’ stream). A visual feedback was provided after each trial to demonstrate whether the EEG signal was correctly classified or not. This attention-driven brain-computer interface (BCI) worked well and all subjects inspected that their selective attention was decoded by EEG with real time. The group of listeners with 4 weeks of this neurofeedback training improved their ability to understand speech-in-noise, whereas the placebo group did not consistent improvement. To the best of our knowledge, this is the first report of selective-attention training enhancing speech-in-noise understanding ability.