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Auditory cueing in Parkinson's Disease: Effects on temporal processing and spontaneous theta oscillations

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Abstract

The beneficial effect of auditory cueing on gait performance in Parkinson's disease (PD) has been widely documented. Nevertheless, little is known about the neural underpinnings of this effect and the consequences of auditory cueing beyond improved gait kinematics. The therapy relies on processing the temporal regularity in an auditory signal to which steps are synchronized. We hypothesize that the benefits of auditory cueing involve a temporal processing network comprising the cerebellum, the thalamus, the basal ganglia as well as the supplementary motor area (Kotz & Schwartze, 2011; Schwartze et al., 2011). While deficits in temporal processing in PD have been discussed (Harrington et al., 1998; Pastor et al., 1992), recently there is increasing evidence of a widespread slowing of resting-state oscillations in PD (e.g., Stoffers et al., 2007), and that such oscillations are linked to symptom severity, cognitive decline and disease progression (Olde Dubbelink et al., 2013). In the current EEG study, we provide evidence that neural responses reflected in both task-induced and resting-state activity are sensitive to cueing therapy. Fifteen patients with PD were submitted to a one-month auditory cueing therapy (3 times/week for 30 minutes). Patients were tested before, immediately after, and one month after the end of the program (follow up session). In each testing session, patients were submitted to an EEG protocol consisting of 8 minutes of resting state (alternating 2 minutes of eyes closed and eyes open), followed by an auditory oddball experiment, and by another 8 minutes of resting state. In the oddball task, temporally regular (inter-stimulus-interval, ISI=800 ms) and irregular (random 200-1000 ms ISI) oddball sequences were

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presented. The sequences consisted of 360 standard (600Hz) and 90 deviant (660Hz) equidurational (200 ms) sinusoidal tones. The participants' task was to count the deviant tones. Previous studies using this paradigm showed enhanced P300 responses to deviant tones in the regular condition as compared to the irregular condition (Schwartze et al., 2011). Before the cueing therapy PD patients failed to show a difference between deviants elicited in the regular and irregular condition. They showed a comparable difference (to matched controls) between the two conditions after the therapy. Further analysis of the relative power of the resting state oscillations reveals that the relative change in theta power was negatively related to improvement in patients' walking patterns, suggesting a link between the effect of auditory cueing and functional connectivity in resting state networks. Neural responses associated with temporal regularity as well as spontaneous resting oscillations may provide further insight into compensatory mechanisms induced by auditory cueing in PD.

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Keywords: Parkinson; EEG; Temporal processing; Oscillations; Resting state; P300

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