

Selecting the optimal strategy for the adaptive rhythmic auditory cueing of parkinsonian walk

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Impaired gait in the middle stages of Parkinson's disease can be relieved to some extent by a repetitive acoustic signal, the popular term for which is rhythmic auditory cueing [1]. Auditory cueing consists in asking patients to walk together with a rhythmic stimulus, such as an isochronous sequence or musical beat. The repetitive stimulus compensates for gait disorders by increasing speed and stride length, and by inducing healthier dynamics. Traditional auditory cueing involve stimulation in which stimuli are presented at a fixed time interval. This fails to take into account the intrinsic variability inherent in any motor activity. By forcing patients to perform steps with no variability one is placing too high demand on performance whereby every step the walker needs to overcorrect for the variability in the previous step.

One way to improve the effectiveness of auditory cueing is to adopt a stimulation embedding variability. Another way is to provide stimulation, which responds in real time to patients' motor performance. There are a number of possible adaptation strategies and which one is optimal has to be decided on the basis of empirical and theoretical considerations. If facilitating the walker's synchronization to the beat is the ultimate goal, then coordination dynamics has to inform the design of the assistive device.

In addition to searching to optimize auditory cueing techniques by incorporating coordination dynamics and variability in the stimulation, the current project expands the standard technique to a third dimension. Musical rhythm affords synchronization. Music offers an acoustic environment that is richer than a mere metronome by involving multiple embedded periodicities, thus being particularly well-suited to foster motor synchronization. Thus stimuli with different rhythmic complexity (e.g., a metronome vs. music) are examined.

In the first clinical study the statistical properties of the beat variability were addressed. The role of coordination dynamics was investigated in a second clinical study, in which variable and adaptive auditory cueing was provided to patients. Performance was quantified by way of the typical spatio-temporal gait parameters and a range of additional measures akin to complex systems. The central role of synchronization in inducing the beneficial effect of rhythmic auditory cueing its interaction with other aspects of gait variability are discussed.

Reference

Lim, I.V., Van Wegen, E., De Goede, C., Deutekom, M., Nieuwboer, A., Willems, A., ... & Kwakkel, G. (2005). Effects of external rhythmical cueing on gait in patients with Parkinson's disease: a systematic review, *Clinical rehabilitation*, 19(7), 695-713.

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