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Musical Feedback: a new strategy in gait training for Parkinson's Disease Patients

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Abstract

Rhythmic auditory stimulation (RAS) for gait training in Parkinson's disease has been applied successfully over the last three decades.
The purpose of this study is to investigate the effectiveness of an extended concept of RAS, which is not limited to musical stimulation, but also includes musical feedback.
In our study the comparison between RAS, musical feedback (MF), and no musical stimulation (NM) is conducted on a sample of 20 idiopathic Parkinsonian patients in a randomized cross-over design. Each patient has the task to walk for six minutes for each condition, focusing on stride length. The patient is instructed to make long steps and is connected with a software that is able to record stride length and cadence. In the RAS condition the patient listens to music with clearly accentuated rhythm. In the MF condition, as the stride length increases, the same musical piece used in the RAS condition goes through five different levels, ranging from a simple beat to a complete orchestral sound. The software records the percentage in which every music level is covered, with higher levels corresponding to longer strides.
Our preliminary results confirm the expectation that MF facilitates stride length increase in a faster and more stable way than RAS does.

Keywords: Gait training, Parkinson, Musical feedback, RAS

Introduction

The use of acoustic stimulation for the rehabilitation of gait disorders in Parkinson's disease (PD) has been developed in the 1990s under the concept of rhythmic auditory stimulation (RAS). The available literature supports its effectiveness systematically (e.g. Thaut 1996, Benoit 2014, Mainka 2015). RAS consists in a clear accentuated rhythm that can be either a simple metronome or a beat embedded into music, and is able to stimulate the production of rhythmical movements.

Patients suffering from idiopathic PD are unable to steadily generate regular steps on their own due to an impairment of the basal ganglia, but are able to couple external (especially acoustic) stimuli with the production of regular steps. Thus, over the last three decades, the use of RAS has become a standard protocol in the neurologic music therapy for gait training in Parkinson's disease.

Thaut and colleagues proved the effectiveness of musical RAS on Parkinson's patients (1996) and suggested that the musical texture may provide additional timing information to the beat embedded into it, and may therefore facilitate detection, anticipation, and synchronisation to the beat in a more effective way than a simple metronome does (1997). Moreover, music facilitates emotional involvement and motivated engagement in a task and might therefore be a more efficient stimulation than the dry metronome beat.

Based on these premises, we explore the effectiveness of two different kinds of musical stimulation on Parkinsonian gait.

We use functional music with a clearly detectable beat (RAS) and we compare it with an extended version of the concept of RAS, in which a sensory-based musical feedback responds directly to the patient's stride length - the main goal of our gait training protocol. To date, musical feedback has not been investigated in Parkinson gait training and could offer a valid integration for the traditional RAS protocols.

Methods

20 idiopathic PD patients take part in the study in a randomized cross-over design. All patients are recruited in the Neurological Hospital for Movement Disorders / Parkinson's of Beelitz-Heilstätten, Germany. The recruitment responds to the following criteria: Hoehn and Yahr ≤ 3; clinically manifest gait slowdown in on (UPDRS III, Item 29 = 1); no neurological or psychological comorbidity; no freezing episodes in the last half year; no RAS therapy in the last three days.

The experimental examination is conducted one hour after dopaminergic medication and lasts about one hour overall. First of all, two assessments are conducted. In the first, the patient is asked to walk at normal, comfortable speed for 20 steps. If his cadence is equal or greater than 112 bpm (beats per minute), the patient is excluded from the study, since such a cadence can be indicator of freezing or festination, both phenomena that would confound the outcome of the study. Otherwise, with cadence lower than 112 bpm, the patient continues with the second assessment, in which he is asked to walk speedy for 20 steps. Basing on this second assessment, the goals of the whole experiment are set: stride length is increased by 6% and cadence is set to the nearest value among the following: 95, 100, 106, 112, 118, 125 spm (steps per minute).

Once the goals are set, the patient performs three walks in a randomised sequence, each with a different acoustic stimulation: 1) only verbal commands with no musical stimulation (NM) (control condition); 2) functional music (RAS) with verbal commands; 3) musical feedback (MF) with verbal commands.

Each experimental condition consists of five minutes' stimulation and one final minute carryover, which allows to check whether the effect of the stimulation continues also right after the music has stopped. Between one walk and the following there is a ten minute wash-out phase.

The musical stimulation consists in an instrumental piece based on well-known German folk music, with a steady tempo corresponding to the set walking cadence.

In RAS condition the piece is played for five minutes without changes, while in MF the same musical piece ascents (or descends) through five levels depending on the patient's stride length, with higher levels rewarding him for making longer strides. The levels have a different, increasingly rich instrumentation: the first one has only bass (ensuring the presence of a clearly detectable beat all through the piece), in the second the piano accompaniment comes along, in the third come the drums, in the fourth come flute and French horn playing the melody, and in the fifth high timbered bells complete the orchestration.

For the whole duration of the experiment the patient wears two sensors fastened to each shoe and connected to a software, which measures in real time stride length and cadence. In the MF condition the software also reproduces the five musical levels depending on stride length. Otherwise it is used only for the measurement, in silent mode, while music or verbal commands are played through an extra MP3-player.

Moreover, the patient is asked four closed questions (two right after the MF walk and two concerning the whole experiment), in order to collect additional data for the interpretation of the measured parameters.

Results

Our preliminary results show that musical feedback facilitates stride length increase in a faster and more stable way than RAS and NM do. The mean stride length measured during the MF condition is greater than the corresponding value in the RAS and NM conditions.

Discussion

The focus of the present study is to compare the effects of two different kinds of musical stimulation, namely musical RAS and musical feedback, on gait training in PD, and thereby determine whether sensory-based feedback is more effective than classical RAS. Giving the patient an immediate feedback, MF steadily encourages him to reach the training goal. We suggest that MF activates a loop between perception and action and thus operates on a fast, nearly automatic level.

The study is still in progress and might undergo small changes as well as give different results as the ones collected so far. However, our preliminary results encourage further research on the role of musical

feedback as a therapeutic device and may therefore pave the way for a new trend of musical stimulation.

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