Effect of Auditory Stimulation with Popular Music on Visuomotor Integration, Rapid Alternating Movements, and Gait in Parkinson's Disease

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Introduction

Anecdotes about the salutary effects of music on movement in PD abound. Although recent studies of supervised entrainment, which explicitly synchronizes movements to beats embedded in music, demonstrate positive effects on gait, few systematic analyses of ambient music's spontaneous effects on movement are available. This pilot study serves to investigate ambient music's effect on visuomotor integration, gait, and rapid alternating movements (RAMs) in Parkinson's Disease (PD) using controlled, quantifiable methods.

Methods

Ten patients (5 mild PD, 4 moderate, 1 severe) performed two or more of the following tasks:

- **Donders Reaction Time (RT)** (n=9) between the randomized presentation of a visual target and a key press with the second digit of the dominant hand. Twenty trials were given per test, and the RT for each trial is measured (in milliseconds) and saved by the computer.
- **Finger-Tapping Speed** (n=6) with the same digit for a period of ten seconds per trial. Each test consisted of five to ten trials, the number of which is determined by a standardized procedure that considers the continuity of results obtained from each trial (Finger-Tapping Board Test, Laffayette Instruments). The other four subjects were tested using a less reliable, non-standard procedure, in which only one trial was conducted per test.
- **Modified Webster Step-Seconds Test** (n=8) of gait speed and stride. Subjects walk a measured 20-foot distance, make a half-turn, and walk back 20-feet to their starting position. Time and number of steps are measured for each test and are treated as separate components.

The **test condition** was music with a strong, metrical rhythm that each patient selected from a list of ten popular swing, latin, rock, and classical recordings (see ***Table 1*** below). Musical selections had medium tempos, confined to a range of 128-192 beats per minute. Each participant selected the test music based on personal preference.

Control conditions were either silence or ametrical instrumental music ("An Ending," by Brian Eno).

Test and control conditions were presented in random order using an **ABBA paradigm**, therefore each test was given four times, twice per condition.

TABLE 1: available musical selections for the test condition

- "Begin the Beguine," by Cole Porter, recorded by Tommy Dorsey
- "Stompin' at the Savoy," by Benny Goodman
- "In the Mood," by Glenn Miller
- "The Stars and Stripes Forever," by J. P. Souza
- "Concerto No. 3 in F major, 'Autumn': I. Allegro," by Antonio Vivaldi
- "Nutcracker Suite: Russian Dance (Trepak)," by Peter Tchaikovsky
- "Oye Como Va," by Tito Puente
- "Rock Around the Clock," by Bill Haley and the Comets
- "Hound Dog," by Elvis Presley
- "La Bamba," by Ritchie Valens

Statistical Analysis

RT tasks were evaluated within subject for statistical significance. Responses of <100ms, >1500ms, and outliers (>±2 standard deviations from the mean) were excluded from the data set. A **Mann-Whitney U** test was performed.

Finger Tapping Tests were scored according to the standard procedures, the two scores for each condition were averaged, and the conditions were compared using a **Wilcoxon Matched-Pairs Signed-Rank** test.

For each component of the **Webster Step-Seconds Test**, the two scores obtained for each condition (test, control) were averaged, and averages were compared using the **Wilcoxon Matched-Pairs Signed-Rank** test.

All tests were two-tailed.

Results

RT: 2 of 5 patients with mild PD (40%) were significantly faster in the test condition than in the control condition ($p \leq 0.02$). None of the 9 subjects performed significantly worse in the test condition. A plot of all data points for the two significant sets are shown in ***Figure 1***.

Finger-Tapping: In the 6 subjects for whom the standard testing procedures were used, 5 (83%) had increased RAMs for the test condition as compared to the control condition. However, the data did not obtain significance when subjected to the Wilcoxon Signed-Rank test (p=.37).

Webster Step-Seconds: Changes in walking time were neither consistent across subjects nor appreciable within subject relative to the precision of the test (~1 step,sec). However, one of the 4 subjects with moderate PD consistently walked faster and took bigger strides in the test condition (see Subject #010 in ***Table 2***). None of the subjects consistently performed worse in the test condition than in the control condition. With regard to step number, there was a modest overall improvement in the test condition (0.4 steps, 1.9%) which approached statistical significance (p=0.09, see ***Table 2***).

		Steps			Seconds		
Subject	A/B	**Test**	Control	Difference	**Test**	Control	Difference
001	**Valens**/Eno	27.5	28.0	1.8%	11.5	10.5	-9.5%
004	Silence/**Valens**	39.0	40.5	3.7%	23.4	23.9	2.1%
005	**Vivaldi**/Silence	21.5	22.0	2.3%	10.8	11.0	1.8%
006	**Presley**/Silence	17.5	18.0	2.8%	10.3	10.4	1.0%
007	Silence/**Haley**	16.0	16.0	0.0%	7.5	7.4	-1.4%
008	**Puente**/Silence	23.0	23.0	0.0%	13.0	13.0	0.0%
009	**Sousa**/Silence	22.0	21.5	-2.3%	9.5	9.0	-5.6%
010	**Trepak**/Silence	17.0	18.0	5.6%	9.5	11.0	13.6%
Averages		22.9	23.4	1.9%	11.9	12.0	0.8%

TABLE 2: Webster Step-Seconds Test data. The data items are averages of two test scores for each component (Steps, Seconds; units are the same) and each condition (Test, Control). Difference is the percent change of the test condition compared to the control. "A/B" refers to the stimuli used with respect to presentation in the ABBA paradigm (*e.g.* for Subject #001, the four tests are conducted for stimuli presented in the order Valens, Eno, Eno, Valens); the **bolded** item is considered the Test stimulus. For Steps, W(6)=+2.5,-18.5 (p=0.09); for Seconds, W(6)=+12,-16 (p=0.8).

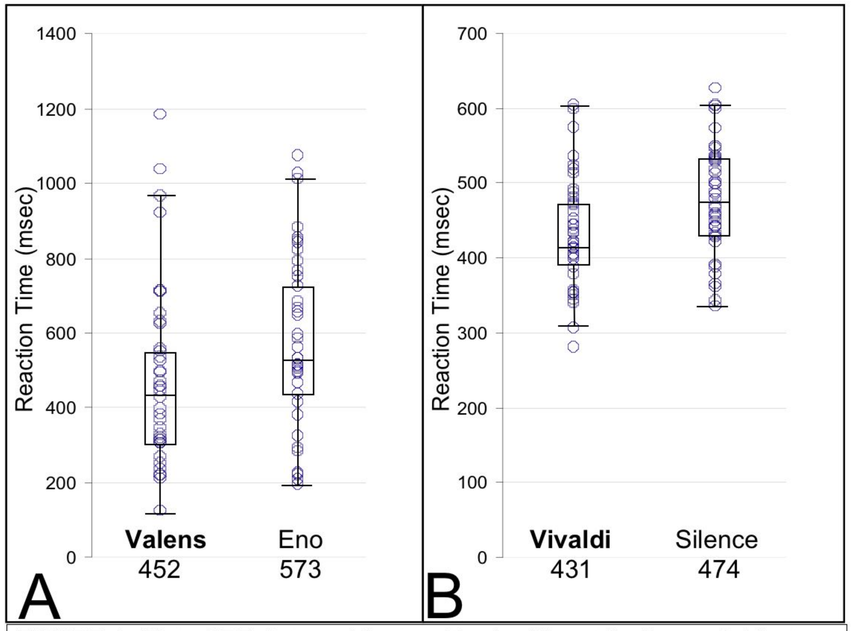

FIGURE 1: Plot of RT data, subjects with significant findings. Subjects #004 (A) and #006 (B) both had significant improvements during the test condition ($U(36,39)=460$, $p<0.02$; $U(39,39)=516$, $p<0.02$). Test stimuli are in **bold;** both subjects were tested as A/B::Control/Test in an ABBA paradigm**.** Box and whiskers refer to interquartile range, median, and endpoints of included data (within ±2SD from mean; note outliers); data points <100ms and >1500ms do not appear. Numbers below condition labels indicate the mean RT of included data in milliseconds.

Discussion

The data presented above support that ambient music may potentially benefit people with PD with respect to visuomotor integration, walking, and RAMs, three types of movements classically affected by PD. However, this data needs to be expanded upon. More subjects will improve statistical power and reliability of results, and extending the testing time beyond one hour may indicate a cumulative effect ambient music may have on these and other features of PD. It is interesting to note that stride length may have been increased by the test stimuli, a phenomenon that has been described previously in research on music and PD (see McIntosh *et al., JNNP*,1997,62:22-26.); including more sophisticated gait analysis in this paradigm may better describe what is occurring.

It must be mentioned that the study evaluator was not blinded to the test conditions, and despite best efforts bias may have been inadvertently introduced into the data; further continuation of this study should include either blinded evaluators or automated data collection (such as that used for the RT test).

Conclusions

Ambient popular music with a strong, metrical rhythm benefits visuomotor integration and gait, and may benefit RAMs, with zero risk in some patients with mild or moderate PD. More research needs to be conducted to better support these claims and elucidate the degree and reliability of benefit ambient music may provide people with PD.

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