Neuroscience Letters 683 (2018) 27–32

Contents lists available at ScienceDirect

Neuroscience Letters

journal homepage: www.elsevier.com/locate/neulet

Research article

The influence of moving with music on motor cortical activity

Elizabeth L. Stegemöller[a,*], Patricia Izbicki[a], Paul Hibbing[a,b]

[a] Department of Kinesiology, Iowa State University, Ames, IA, 50011, United States
[b] Department of Kinesiology, Recreation, and Sports Studies, University of Tennessee, Knoxville, TN, 37996, United States

ARTICLE INFO

Keywords:
Beta band
Music style
Music experience

ABSTRACT

Although there is a growing interest in using music to improve movement performance in various populations, there remains a need to better understand how music influences motor cortical activity. *Listening* to music is tightly linked to neural processes within the motor cortex and can modulate motor cortical activity in healthy young adult (HYAs). There is limited evidence regarding how *moving* to music modulates motor cortical activity. Thus, the purpose of this study was to explore the influence of moving to music on motor cortical activity in HYAs. Electroencephalography was collected while 32 HYAs tapped their index finger in time with a tone and with two contrasting music styles. Two movement rates were presented for each condition. Power spectra were obtained from data collected over the primary sensorimotor region and supplemental motor area and were compared between conditions. Results revealed a significant difference between both music conditions and the tone only condition for both the regions. For both music styles, power was increased in the beta band for low movement rates and increased in the alpha band for high movement rates. A secondary analysis determining the effect of music experience on motor cortical activity revealed a significant difference between musicians and non-musicians. Power in the beta band was increased across all conditions. The results of this study provide the initial step towards a more complete understanding of the neurophysiological underpinnings of music on movement performance which may inform future studies and therapeutic strategies.

1. Introduction

There has been growing interest in using music to improve movement in persons with neurological disease, including Parkinson's disease (PD). Learning and performing various styles of dance steps improved functional mobility, gait, and postural instability in persons with PD [1–4]. However, understanding how music impacts motor cortical activity remains limited. Current drug and surgical treatments undergo substantial investigation and much is known about how these treatments affect brain activity before they are considered safe. To establish music as an effective alternative treatment, it should be investigated in the same way, and to the same degree, as current standards of care. A basic understanding of how music modulates motor cortical activity in healthy young adults (HYAs) will provide the foundation for further examination of the effect of music in neurological diseases.

Listening to music is tightly linked to neural processes within the motor cortex and can modulate motor cortical activity in HYAs [5,6]. Moreover, the perception of auditory rhythms evokes activity in motor regions [7,8]. Less is known about how *moving* with music modulates motor cotrical activity in HYAs. Research has shown, though, that style of music affects the urge to move. Music with faster tempos, moderate syncopation, and a repetitive rhythm elicited a greater urge to move compared to music with slower tempo, excessive syncopation, and non-repetitive rhythms [9]. Moreover, Leman and colleagues showed that in HYAs, stride length increased when walking with activating music compared to relaxing music [10]. This suggests that style of music may play a role in how music modulates motor cortical activity.

Movement rate may also influence how music modulates motor cortical activity. Previous research has demonstrated that the rate of the intended movement influences movement performance in HYAs [11]. Movement performance on various repetitive finger tapping tasks changes around a rate of 120 beats per minute (BPM), which was associated with changes in motor cortical activity [12–14]. Thus, consideration of movement rate, specifically above and below 120 BPM, should be taken into account when exploring the effects of music on motor cortical activity during movement performance.

Previous music experience also impacts motor cortical activity. When listening to music, HYAs musicians demonstrated greater motor cortical activity than non-musicians [15]. Similarly, musicians demonstrated greater corticospinal excitability while listening to high-groove (i.e. tendency to make one move) music compared to low-

* Corresponding author at: 534 Wallace Road, Iowa State University, Ames, IA, 50011, United States.
E-mail address: esteg@iastate.edu (E.L. Stegemöller).

https://doi.org/10.1016/j.neulet.2018.06.030
Received 8 May 2018; Received in revised form 8 June 2018; Accepted 16 June 2018
Available online 19 June 2018
0304-3940/

groove music [6]. However, there is limited research comparing motor cortical activity in musicians and non-musicians when *moving* with music.

The primary purpose of this study was to explore the influence of music on motor cortical activity in HYAs. Participants performed a repetitive finger movement task in time with a tone only, and two differing styles of music at two movement rates (70 and 140 BPM). Electroencephalography (EEG) was recorded from electrodes over motor cortical regions, and power spectra were compared between the tone only condition and each music style condition at both movement rates. The secondary aim of this study was to explore motor cortical activity when musicians and non-musicians move with different styles of music at different movement rates. Thus, power spectra were also compared between musicians and non-musicians for each music style at both movement rates. Our primary hypotheses are that motor cortical activity would differ when moving to music compared to only a tone and that the difference between music and the tone would be modulated by the style of music and movement rate. Our secondary hypothesis is that music experience would influence motor cortical activity.

2. Methods

2.1. Participants

Thirty-two HYAs (17 men, 31 right hand dominant, mean age ± standard deviation age = 23 ± 2.9 years) with no history of neurological disorder completed the study. Handedness was self-reported. See Table 1 for detailed demographic information. All procedures were approved by the University Institutional Review Board, and all participants provided informed consent prior to data collection. This study has been performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments.

2.2. Experimental design

2.2.1. Music experience and music preference

Prior to EEG data collection, all participants provided information about their previous music experience. Participants were classified as musicians (≥5 years experience, n = 12, mean ± standard deviation = 8 ± 1.1 years) or non-musicians (< 5 years experience, n = 20, mean ± standard deviation = 1.5 ± 1.5 years). Music experience was defined as private lessons on an instrument or voice. See Table 1 for detailed information on music experience.

Participants listened to two recordings of original musical instrumental digital interface (MIDI)-generated pieces that were used later during the EEG data collection. Original pieces were composed to control for previous experience/familiarity with music. One piece featured an “activating” style (Style 1) while the other featured a “relaxing” style (Style 2). For Style 1, buoyant rhythmic patterns and major tonalities were intended to evoke an “active” feeling. The initial tempo for this piece was set at 140 BPM. For Style 2, the rhythm was slower and major seventh tonalities were intended to evoke a “relaxing” feeling. The initial tempo for this piece was set at 70 BPM. After listening to each excerpt, participants immediately rated how much they liked each piece using a ten-point Likert scale in which a score of ten designated the best music ever heard and one designated the worst music ever heard.

2.2.2. Finger tapping task

A speaker was used to present the auditory stimuli at each participant’s preferred loudness level. The dominant forearm and hand were secured in a partial brace in the pronated position. Participants were instructed to “tap your index finger along with the beat” using their dominant hand. The index finger flexion and extension movement was unconstrained (i.e. no tactile feedback). Data were obtained for the following six conditions; 1) Style 1 at 140 BPM, 2) Style 1 at 70 BPM, 3)

Table 1
Participant Demographics and Music Experience.

Participant	Gender	Age (years)	Ethnicity	Handedness	Music Training (years)	Instrument
1	M	33	Hispanic	R	1	Trumpet
2	F	23	African American	R	0	NA
3	M	24	Caucasian	R	2	Trumpet
4	F	24	Other	R	0	NA
5	M	22	Caucasian	R	2	Trumpet
6	M	24	Asian	R	0	NA
7	M	24	Caucasian	R	2	Trumpet
8	F	22	Caucasian	L	2	Voice
9	M	21	Caucasian	R	4	Trumpet
10	F	20	Caucasian	R	0	NA
11	M	25	Caucasian	R	0	NA
12	M	29	Caucasian	R	2	Violin
13	M	21	Other	R	3	Trumpet
14	M	25	Caucasian	R	0	NA
15	F	22	Caucasian	R	4	Flute
16	M	23	Caucasian	R	4	Voice
17	F	21	Caucasian	R	3	Flute
18	F	21	Caucasian	R	1	Flute
19	M	23	Caucasian	R	0	NA
20	M	21	Caucasian	R	0	NA
21	F	20	Caucasian	R	7	Saxophone
22	M	21	Caucasian	R	9	Euphonium
23	F	27	Caucasian	R	8	Guitar
24	F	20	Caucasian	R	8	Tenor Saxophone
25	M	26	Caucasian	R	6	Piano
26	M	24	Caucasian	R	7	Guitar
27	F	28	Caucasian	R	7	Piano
28	F	21	Caucasian	R	8	Flute
29	F	21	Caucasian	R	9	Piano
30	F	22	Caucasian	R	8	Flute
31	F	21	Caucasian	R	9	French Horn
32	M	22	Caucasian	R	10	Trombone

M = male; F = female; R = right; L = left; NA = not applicable.