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The Music Experience and its Influence on Cognitive Function Measured with EEG

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HYPOTHESES

This study aims to assess P3 ERP components from the Visual Oddball and Go/No-Go tasks in musicians and non-musicians. Musicians will elicit higher amplitudes and later peak latencies for the Go/No-Go and lower amplitudes and later peak latencies for the Oddball paradigm task.

Musicians will show significant correlations on responses to years and proficiency playing an instrument from a basic information questionnaire with innovative musical aptitude, commitment to music and reactive musical behavior components of the Brief Music Experience Questionnaire.

BACKGROUND

The P300 is an event-related potential (ERP) component that is measured using electroencephalography (EEG). Measuring the P300 with the Oddball Paradigm task is characterized by two components: amplitude and latency, which are triggered by two stimuli: a deviant stimulus that is rarely occurring with a low probability, and a standard stimulus that is consecutively repeated with a higher frequency (Ayala & Malmierca, 2013; Malik & Amin, 2017).

George and Coch (2011) used a standard visual and auditory oddball task demonstrating P300's with a shorter latency and a larger amplitude in college-aged non-professional musicians and nonmusicians. The study concluded that improvements in working memory extensively correlate with long-term music training .

The Brief Music Experience Questionnaire (Brief MEQ; Werner, Swope & Heide, 2006) is a self-report questionnaire with 53-items which measure different reactions to music. The Brief MEQ is focused on two principal factors relating to music experience including subjective/physiological reactions to music, as well as active involvement.

Moreno et al. (2014) used a nonverbal Go/No-Go task to assess how quickly and how accurately bilinguals and musicians respond to infrequent nogo trials. Increased amplitudes were noticed in N2 and P3 ERP components in no-go trials indicating that bilinguals and musicians are able to register response conflict and inhibition of a response quickly in comparison to monolinguals and nonmusicians.

METHODOLOGY

Table 1. Participant Descriptive Statistics: Sample Demographic Information

	N	Min	Max	Mean	SD		N	Percent	Freq.
Age of Participant	122	18	38	20.34	3.66	Female	122	80.3%	98
Education of Participant	121	2	17	13.05	1.62	Musician	100	29.5%	36
Age playing first instrument	49	0	21	10.96	4.15	Bilingual	122	54.1%	66
Average Years playing instrument	43	0	25	5.37	5.52	Born in U.S.	122	82.8%	101
Proficiency (0-10) in instrument	68	1	11	4.62	3.12	Vocal Training	85	18.8%	16

Materials:

Acti-champ EEG Amplifier and Acti-power battery will be used to measure P300 components. The P300 is generated by a distributed network of processes in the brain relating to operations of attention, context updating, and memory processes. EEG consisted of 32 Ag/AgCl electrodes.

Visual Oddball:

565 trials will be presented to participants with 80 deviant trials (14%). Four blocks of trials were presented with stimuli alternating between standard and deviant. Each stimulus was presented for 100ms.

Go/No-Go:

576 trials will be presented to participants with 153 no-go trials. Each stimulus was presented for 186 ms, with a white shape 75% of the time, representing the go trials, and a purple shape 25% of the time, representing no-go trials.

Brief MEQ Questionnaire:

The three measures of interest from the Brief Musical Experience Questionnaire (Brief MEQ) are commitment to music (subscale 1), innovative musical aptitude (subscale 2) and reactive musical behavior (subscale 6). These items are measured with a 5-point Likert scale (1 = not likely; 5 = most likely).

Innovative musical aptitude subscales include questions:

- I enjoy making up or composing tunes, songs or musical pieces.

Commitment to music subscales include questions:

- Music is the most important thing in my life.

Reactive musical behavior subscales include questions:

- I often sing, hum, or whistle along with recorded music.

Basic Information Questionnaire:

A Basic Information Questionnaire was used to to collect demographic variables including first instrument, average years playing an instrument, proficiency in playing instrument and questions regarding their vocal training

Statistical Analyses:

Correlations analyzed the associations between innovative musical aptitude, reactive musical behavior and commitment to music subscores on the Brief MEQ. MATLAB and ERPLAB were used to determine data statistics such as amplitudes and latencies across pilot participants.

Table 2. Correlations of musical instrument playing and components on the Brief MEQ

	Age playing instrument n = 49		Years playing instrument n = 43		Proficiency playing instrument n = 67	
	Pearson r		p		Pearson r	
Innovative Musical Aptitude Score	.06	.70	.39	.01	.65	<.001
Reactive Musical Behavior Score	.01	.93	.43	.004	.42	<.001
Commitment to Music Score	.09	.56	.17	.28	.36	.003

Table 3. Oddball ERP values for latencies and amplitudes at Electrodes 2 (Fz), 13 (Pz) and 24 (Cz)

Electrode:		Pz		Cz		Fz	
Pilot 005: Musician /Bilingual	Variable	Time (ms)	Potential (µV)	Time (ms)	Potential (µV)	Time (ms)	Potential (µV)
	Max	998	8.79	998	10.45	998	3.08
	SD	577.6	2.66	577.6	3.53	577.6	1.05
	Peak Lat.	450 ms		450 ms		300 ms	
Pilot 003: Nonmusician	Max	998	12.91	998	9.59	998	4.16
	SD	577.6	3.58	577.6	2.37	577.6	1.93
	Peak Lat.	350 ms		350 ms		420 ms	
Pilot 002: Musician	Max	998	6.09	998	5.03	998	2.39
	SD	577.6	2.93	577.6	1.81	577.6	1.51
	Peak Lat.	500 ms		405 ms		385 ms	

Figure 1. ERPs during Deviant Trials of the Oddball for electrodes Fz (Ch2), Cz (Ch24), and Pz (Ch13)

Table 4. No Go P3 ERP values for latencies and amplitudes for Fz, Cz and Pz

Electrode:		Pz		Cz		Fz	
Pilot 005: Musician/Bilingual	Variable	Time (ms)	Potential (µV)	Time (ms)	Potential (µV)	Time (ms)	Potential (µV)
	Max	998	13.40	998	16.51	998	18.55
	SD	577.6	4.91	577.6	4.47	577.6	5.71
	Peak Lat.	345 ms		351 ms		646 ms	
Pilot 003: Nonmusician	Max	998	6.79	998	9.99	998	9.15
	SD	577.6	4.44	577.6	2.87	577.6	3.46
	Peak Lat.	321 ms		339 ms		492 ms	
Pilot 002: Musician	Max	998	7.81	998	5.41	998	8.78
	SD	577.6	3.00	577.6	1.78	577.6	3.00
	Peak Lat.	285 ms		342 ms		581 ms	
Pilot 004: Nonmusician	Max	998	4.36	998	1.74	998	10.75
	SD	577.6	4.23	577.6	1.27	577.6	4.27
Pilot 004: Nonmusician	Peak Lat.	288 ms		340 ms		758 ms	

Figure 2. ERPs during No-Go Trials of the Go/No-Go for electrodes Fz, Cz, and Pz

RESULTS

Table 5. Behavioral Results for Neuropsychological Tasks for Pilot Participants

	Musician	N	Mean	SD
Go/No-Go Avg Reaction Time	no	3	228.51	16.18
Go/No-Go Num. Incorrect	yes	2	209.24	3.66
Go/No-Go Num. Incorrect	no	3	11.00	7.94
Oddball Mean Reaction Time	yes	2	14.00	4.24
Oddball Mean Reaction Time	No	2	449.43	61.53
Oddball Accuracy Percentage	yes	2	417.95	35.74
Oddball Accuracy Percentage	no	2	98.15	.92
Oddball Accuracy Percentage	yes	2	100.00	.00

DISCUSSION

According to the results, the experience of being a musician produces larger P3 amplitudes and shorter P3 latencies during both the Oddball Paradigm task and the Go/No-Go. Furthermore, our questionnaire results imply that the more proficient one believes themselves to be in their musical experience, the more innovative their musical aptitude, the more reactive they are to music and the more innovative they are in creating and producing music.

Limitations

Some limitations were encountered due to the spread of the COVID-19 virus. In particular, we were only able to run the EEG testing component of this experiment pre-COVID, leaving a small pilot sample to run data analyses on. We were unable to compare groups of musicians and nonmusicians and instead, participants were compared individually on their amplitudes and latencies.

Future Directions

As for future directions, a larger sample size would be very beneficial to future research as it would allow for more thorough analyses across both EEG and behavioral components. It may also be valuable to include analyses of different environmental factors such as musical study habits of musicians, hours spent practicing with others in a group setting, and taking into consideration whether the musician considers music their career or hobby.

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