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Electrophysiological and Behavioral Working Memory Differences Between Musician and Non-Musicians

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Introduction

The current study is an examination of P300 differences between musicians and non-musician groups during a visual odd-ball task in addition to behavioral subtests of the TOMAL-II measuring visual and auditory working memory. Fluctuations of P300 amplitude and latency activity near frontal and parietal areas have been used to quantify differences in updating processes of working memory. The current study is designed to partially replicate a method previously implemented by George and Coch (2011) in order to contribute to the body of research describing how music experience may be associated with differences in visual processing as well as auditory working memory. Behavioral data will be collected using six standardized subtests of the TOMAL-II, followed by ERP recordings during a visual odd-ball task.

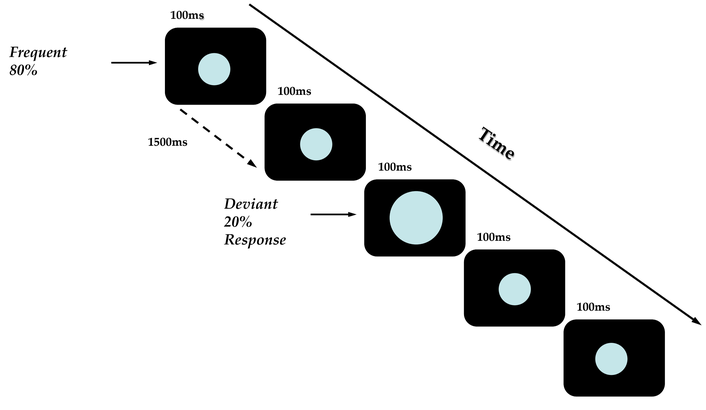
Methods

- Participants: 18 neurologically healthy individuals. 10 Musicians (*M* age = 27.9, *SD* = 3.76) and 8 Non-Musicians (*M* age = 21.75, *SD* = 1.54). Musician's were defined as those that met criteria of at least 7 years of consistent practice in the same musical modality up to the time of the study and currently play in a group or take lessons.
- Neurophysiological Measure: Visual Odd-ball ERP Detection Task.
- Measures: Brains Response to frequent and deviant stimuli.
- Behavioral Measure: TOMAL-II and Reaction Time.
- TOMAL-II Measures: Working memory performance on 6 subtests, Digits Forward (DF) and Letters Forward (LF) subtests targeting phonological memory, Abstract Visual Memory (AVM) and Memory for Location (MFL) subtests targeting visuospatial memory, and the Digits Backward (DB) and Letters Backward (LB) subtests targeting executive working memory.

Research Hypotheses

- **H (1)**: Musicians will produce higher scores on all subtests of the TOMAL-II.
- **H (2)**: Musicians will produce P300 waveforms with a earlier peak latency and higher peak amplitude compared to non-musicians, mainly at frontal and parietal electrode sites.
- **H (3)**: Musicians will record a faster reaction time during the odd-ball task to the deviant stimuli compared to non-musicians.

Visual Odd-Ball Task



TOMAL – II Standard Scores [Mean and (SD)]

	AVM	MFL	AvgV	DF	LF	AvgP	DB	LB	AvgE
Musician	12.19	12.45	12.32	**12.17***	**11.59***	11.88	**11.81***	11.67	11.74
	(.582)	(1.02)	(.8)	(.867)	(.877)	(.87)	(.808)	(.896)	(.85)
Non-Musician	10.36	10.38	10.37	**8.38***	**9.0***	8.69	**8.13***	9.13	8.63
	(.596)	(1.059)	(.83)	(.889)	(.898)	(2.67)	(.828)	(.918)	(.87)

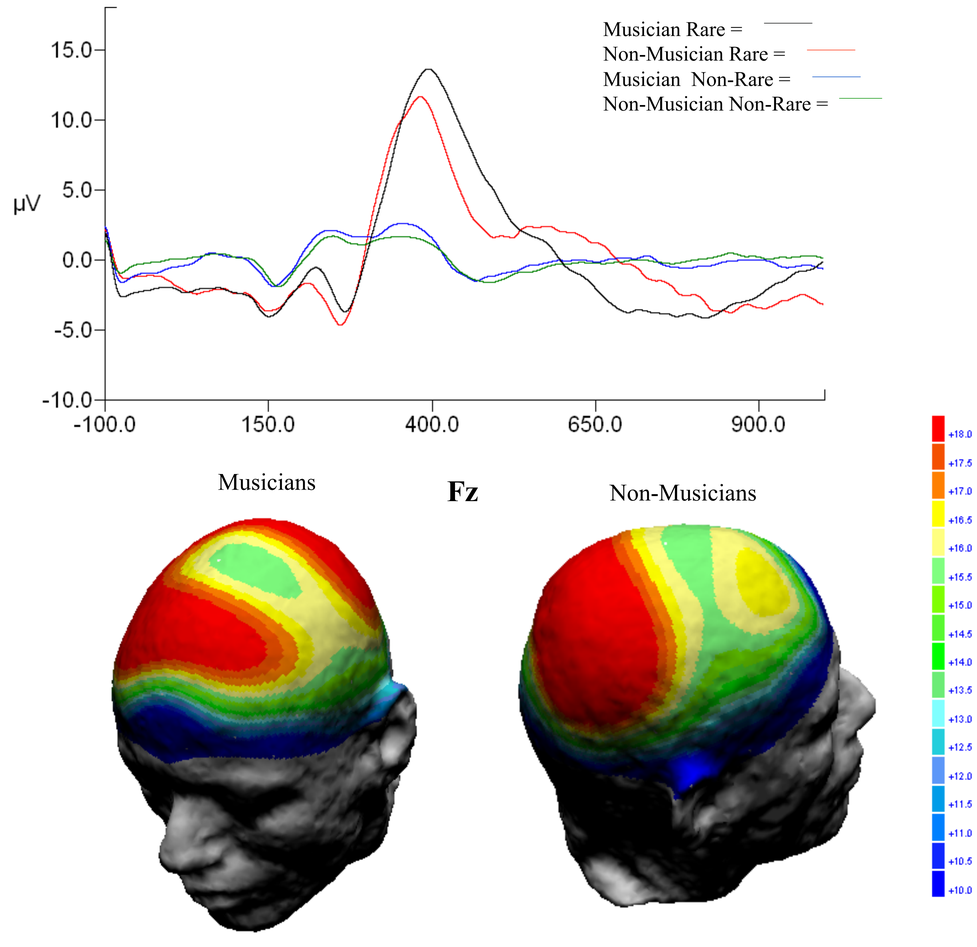
* Indicates significance at $p<.05$

Reaction Time in msec

	M	*SD*
Musicians	375.76	24.38
Non-Musicians	385.18	24.98

* Reaction Time between groups was non-significant

ERP P300 Grand Averages and Topography



Analysis

- TOMAL-II: A 2x2 MANOVA was performed using six subtests of the TOMAL-II and reaction time as depended variables, and Musician Status and Gender as independent variables. Follow-up ANOVAs compared each test independently.
- ERP: Created Grand Averages for both deviant and frequent stimuli. Compare peak latency and peak amplitude.
- Omnibus one way ANOVAs Between Groups
  - Compared Musician Status with peak amplitude and peak latency at midline, hemispheric and anterior/posterior site differences.
  - Additionally examined correlations between years of music experience and performance on TOMAL-II working memory tasks.

Conclusions

- TOMAL-II results reveal that musicians scored significantly higher on three of the six subtests (Digits Forward ($F(1,14) = 9.328$, $p<.05$, $\eta^2 = .4$), Letters Forward ($F(1,14) = 5.532$, $p<.05$, $\eta^2 = .28$), and Digits Backward($F(1,14) = 10.134$, $p<.05$, $\eta^2 = .42$)).
- Reaction time results reveal no significant difference between groups.
- ERP results indicate significant peak latency differences between Musicians and Non-Musicians with non-musicians recording earlier peak latencies (*M* = 394.96, *SD* = 2.7) than musicians (*M* = 405.5, *SD* = 2.7). Musicians recorded significantly higher peak amplitudes at frontal sites (*M* = 13.7 for Fz, and *M* = 17.5 for Pz) while non-musicians recorded significantly higher peak amplitudes at parietal sites (*M* = 11.7 for Fz, and *M* = 18.6 for Pz).
- Greater activation at frontal sites as well as higher scores on DB in musicians suggest an increase of executive function processes related to greater amounts of music experience. Slower average peak latencies in musician compared to non-musicians are interpreted as representing more complex stimulus evaluation.

References

George, E., M., & Coch, D. (2010). Music training and working memory: An ERP study. *Neuropsychologia, 49*. 1083-1094.

Acknowledgements

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