

Neural and Behavioral Evidence of Working Memory Differences in Musicians and Nonmusicians

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INTRODUCTION

While it has been suggested that music training improves working memory (e.g., Moreno & Besson, 2006), little research has been conducted to investigate the specifics of this relationship. For example, it is unclear which domain(s) of working memory might be affected: executive control, auditory, or visual working memory. The P300 component of the event-related potential (ERP) is sensitive to updates of working memory in oddball paradigms: In a series of standard stimuli, deviant targets reliably elicit more positive responses (P300) than standards (e.g., Polich, 2007). We measured and compared the P300 in visual and auditory oddball paradigms in musicians and nonmusicians.

METHODS

Participants

32 subjects: 16 musicians (8 female), 16 non-musicians (8 female)

Average age: 20;1 (musicians); 20;4 (nonmusicians) ($p = .617$)

Monolingual; right-handed; no history of language, hearing, or neurological disorders; normal vision

Musicians: 9-16 years training, currently practiced 3-15 hours/week (none professional)

Nonmusicians: < 5 years training, prior to age 14

Standardized Behavioral Testing

Test of Memory and Learning (TOMAL-2)

Phonological Memory Subtests: Digits Forward (DF), Letters Forward (LF)

Visual Memory Subtests: Abstract Visual Memory (AVM), Memory for Location (MFL)

Executive Memory Subtests: Digits Backward (DB), Letters Backward (LB)

Stimuli

Auditory: 50 ms 800, 840 Hz tones; ISI 1450 ms

Visual: 50 ms  ,  ; ISI 1450 ms

800 standards, 160 deviants per condition

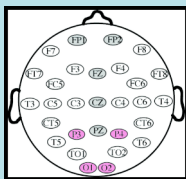
Button press detection of deviants

EEG Recording

Bandpass .01-100 Hz

Sampling rate 4 ms

29 active electrodes

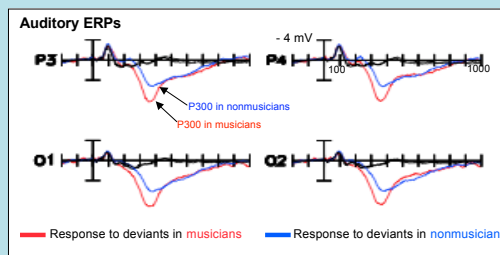


ERP Data Analysis

ANOVAs on ERPs to deviants [with factors group (musician, nonmusician), hemisphere (left, right), anterior-posterior (6 levels), lateral/medial]; main effects of group reported here

P300 peak amplitude and peak latency in auditory (250-550 ms) and visual (300-750 ms) conditions

RESULTS



Auditory P300 Peak Amplitude

Musicians: mean 5.62 μV ($SD = 2.09$)

Non-musicians: mean 3.49 μV ($SD = 3.26$)

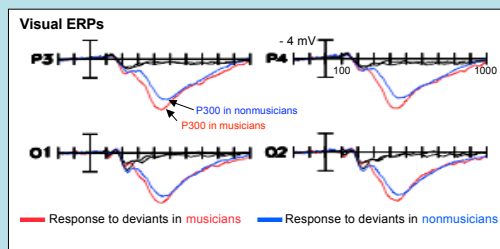
Effect of group: $p = .036$

Auditory P300 Peak Latency

Musicians: mean 362.23 ms ($SD = 37.34$)

Non-musicians: mean 403.63 ms ($SD = 55.97$)

Effect of group: $p = .01$



Visual P300 Peak Amplitude

Musicians: mean 7.55 μV ($SD = 2.44$)

Non-musicians: mean 6.11 μV ($SD = 2.78$)

Effect of group ns ($p = .131$)

Visual P300 Peak Latency

Musicians: mean 454.87 ms ($SD = 52.81$)

Non-musicians: mean 513.17 ms ($SD = 64.99$)

Effect of group: $p = .004$

Behavioral Tests: Effects of Group

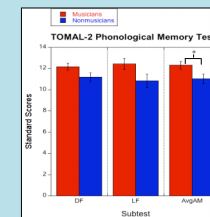
Digits Forward (DF):

$p = .06$

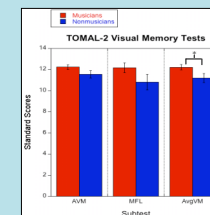
Letters Forward (LF):

$p = .07$

Auditory Memory Average (AvgAM): $p = .039$

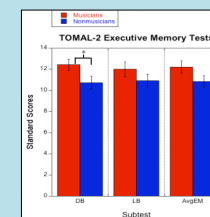


Visual Memory Average (AvgVM): $p = .05$



Digits Backward (DB):

$p = .046$



CONCLUSIONS

- Musicians demonstrated faster auditory and visual working memory updating
- Musicians allocated more neural resources, reflecting greater sensitivity to the standard/deviant difference, only in the auditory condition
- Musicians scored higher on standardized subtests of visual, phonological, and executive memory
- Music training was associated with selective improvements in working memory, on both neural and behavioral levels

REFERENCES

- Moreno, S. & Besson, M. (2006). Musical training and language-related brain electrical activity in children. *Psychophysiology*, 43, 287-291.
- Polich, J. (2007). Updating P300: An integrative theory of P3a and P3b. *Clinical Neurophysiology*, 118, 2128-2148.

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