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Repeated bout rate enhancement of finger tapping does not occur in musicians

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Abstract: When tapping with the index finger at a freely chosen rate, the tapping frequency can increase during the second of two consecutive tapping bouts. This phenomenon is termed repeated bout rate enhancement (RBRE) and has been reported to occur regardless of duration of the first tapping bout or rest time between the bouts. However, it is currently unknown whether RBRE occurs in musicians who can maintain rhythmic consistency better than novices. Accordingly, the aim of this study was to investigate whether musical training would affect RBRE. We recruited eight individuals who regularly play musical instruments (musicians) and seven individuals who have never experienced musical training (novices). They performed two three-min tapping bouts separated by 10 min rest. They were instructed to tap at a preferred rate while focusing on something other than the tapping task. As a result, the tapping rate increased from 115.1 ± 56.4 taps/min to 127.1 ± 58.7 taps/min in the novices. On the other hand, there was a decrease in the tapping rate from 96.1 ± 28.2 taps/min to 91.8 ± 31.2 taps/min in musicians. RBRE is considered to occur as a consequence of increased excitability in the neuronal network. Therefore, our findings may imply that musical training inhibits the neural systems. Further studies are needed to reveal the neurophysiological mechanisms underlying the RBRE.

Keywords: finger tapping rate; rhythmic movement; musician

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1. Introduction

When tapping with the index finger at a freely chosen rate, the tapping frequency can increase during the second of two consecutive tapping bouts [1]. This phenomenon is termed repeated bout rate enhancement (RBRE) and has been reported to occur regardless of duration of the first tapping bout or rest time between the bouts. However, it is currently unknown whether RBRE occurs in musicians who can maintain rhythmic consistency better than novices [2]. Accordingly, the aim of this study was to investigate whether musical training would affect RBRE.

2. Materials and Methods

We recruited eight individuals (1 male and 7 females, mean age = 21.8 ± 1.0 years) who regularly play musical instruments (musicians) and seven individuals (5 males and 2 females, mean age = 25.9 ± 5.1 years) who have never experienced musical training (novices). Participants received information about the procedure of the study, but they were not informed about the specific purpose and our hypotheses. This was to avoid conscious

control during the tapping task. Written informed consent was obtained from all participants, which was conducted to principles of the Declaration of Helsinki.

They performed two three-min tapping bouts separated by 10 min rest. They were instructed to tap on a force transducer at "a comfortable rhythm," and to "think about something else" during the task. The force data were analog-to-digital converted to be stored in a personal computer. Using MATLAB (Mathworks, USA), we detected the tap onset and calculated a tapping rate (taps per min) by dividing the number of taps by the tapping bout time (min).

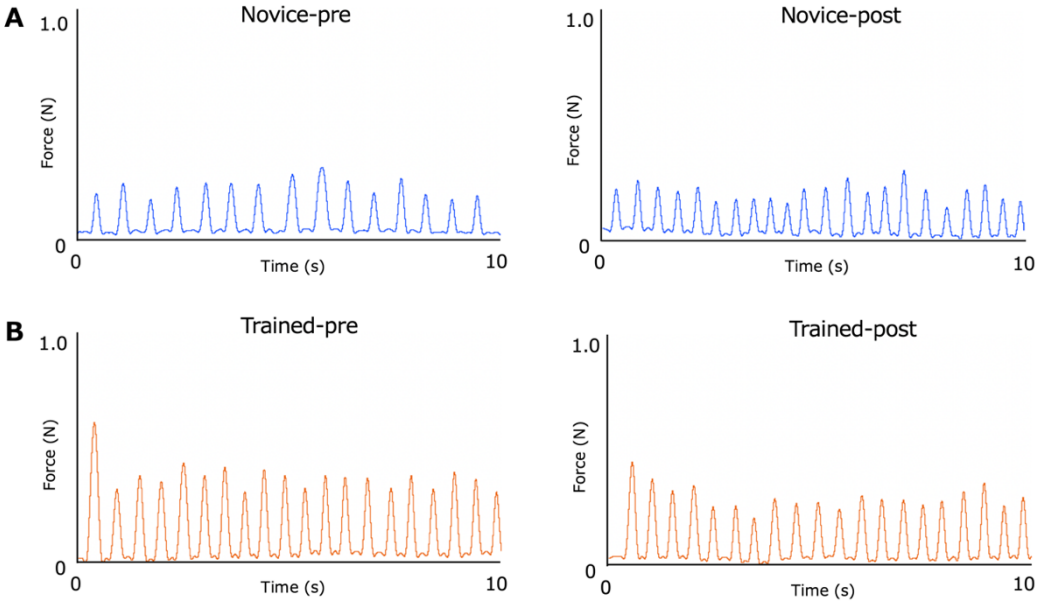

Figure 1. Representative data of applied force.

3. Results

Figure 1. shows representative data during the first 10 s of the task from one novice (A) and one musician (B). Left-side panels present bout 1 (pre) and right-side panels present bout 2 (post).

The average tapping rate is presented in Figure 2. A two-way repeated measures ANOVA revealed a significant interaction of Experience × Time (F [1,15] = 7.045, $p = 0.02$) on tapping rate. A post hoc analysis revealed that, only in novices, tapping rate increased after the rest (from 115.1 ± 56.4 taps/min to 127.1 ± 58.7 taps/min) ($p = 0.019$).

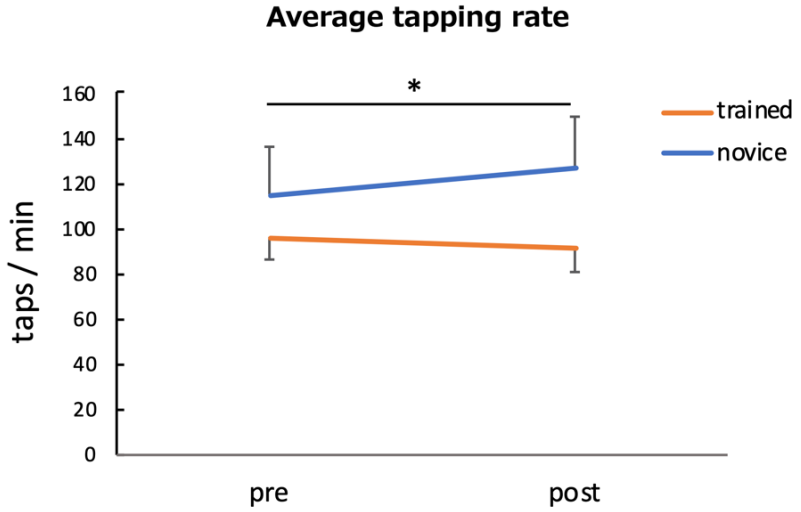

Figure 2. Average tapping rate (± SD). *$p < 0.05$ pre vs. post in novices.

4. Discussion

In this study, we demonstrated that repeated bout rate enhancement (RBRE), which was observed in individuals without music experience, does not occur in musicians. This result indicates that musical training can enhance the ability to maintain a tapping rate across trials.

RBRE is considered to occur as a consequence of increased excitability in the neuronal network. Previous studies have shown a difference in neuronal network between musicians and non-musicians during finger tapping [3]. Additionally, musical training facilitates the development of timing accuracy [4,5]. Therefore, our findings may imply that musical training changes the neural systems associated with the RBRE. A limitation of this study is that the sample size is small. Further studies with a larger sample size are needed to reveal the neurophysiological mechanisms underlying the RBRE.

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Conflicts of Interest: The authors declare no conflict of interest.

References

1. Hansen, E.; Ebbesen, B.; Dalsgaard, A.; Mora-Jensen, M.; Rasmussen, J. Freely Chosen Index Finger Tapping Frequency Is Increased in Repeated Bouts of Tapping. *Journal of Motor Behavior* **2015**, *47*, 490-496, doi:10.1080/00222895.2015.1015675.
2. Matthews, T.; Thibodeau, J.; Gunther, B.; Penhune, V. The Impact of Instrument-Specific Musical Training on Rhythm Perception and Production. *Frontiers in Psychology* **2016**, *7*, doi:10.3389/fpsyg.2016.00069.
3. Jancke, L.; Shah, N.J.; Peters, M. Cortical activations in primary and secondary motor areas for complex bimanual movements in professional pianists. *Cognitive Brain Research* **2000**, *10*, 177-183, doi:10.1016/s0926-6410(00)00028-8.
4. Janzen, T.; Thompson, W.; Ranvaud, R. A developmental study of the effect of music training on timed movements. *Frontiers in Human Neuroscience* **2014**, *8*, doi:10.3389/fnhum.2014.00801.
5. Scheurich, R.; Zamm, A.; Palmer, C. Tapping Into Rate Flexibility: Musical Training Facilitates Synchronization Around Spontaneous Production Rates. *Frontiers in Psychology* **2018**, *9*, doi:10.3389/fpsyg.2018.00458.