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The effect of piano playing experience on tapping synchronization to different sensory modalities

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Abstract: Previous studies have demonstrated that tapping synchronization is more accurate in the auditory than visual modality in the experienced piano players. In addition, they synchronize their finger taps with stimuli remarkably better than the novice especially when the ring or little finger is used. However, it is currently unclear whether or not piano playing experience would affect the ability to synchronize with visual or auditory stimuli presented by an electronic metronome, which is commonly used in piano lessons. In this study, seven piano players and seven novices synchronized their finger taps with visual, auditory, or visual-auditory metronomes at 1 Hz. Tapping was performed with the index or ring finger on a force transducer. We analyzed temporal asynchrony between tap onset and metronome onset. In the novices, mean asynchrony was larger during tapping with the ring than index finger. Also, their standard deviation of asynchrony was larger when synchronizing with visual stimuli using the ring finger as compared to the index finger. These differences were not apparent in the piano players. Our findings suggest that long-term piano training enhances tapping synchronization of the ring finger.

Keywords: tapping; sensorimotor synchronization; piano experience

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1. Introduction

Previous studies have demonstrated that tapping synchronization is more accurate in the auditory than visual modality [1]. In addition, the synchronization stability is higher in the musicians than in the novices [2]. However, it is currently unclear whether or not piano playing experience would affect the ability to synchronize with visual or auditory stimuli presented by an electronic metronome, which is commonly used in piano lessons. Since the difference in motor control between the musicians and novices is remarkable particularly for the ring or little finger [3], it is possible that piano playing experience improves the synchronization stability using these fingers.

The present study investigated whether or not piano playing experience would affect the synchronization ability during synchronization tapping to stimuli from an electronic metronome using the index and ring fingers.

2. Materials and Methods

Seven piano players (2 males and 5 females, mean age = 21.6 ± 0.5 years) and seven novices (4 males and 3 females, mean age = 23.0 ± 2.8 years) synchronized their finger taps with visual, auditory, or visual-auditory metronomes at 1 Hz. The piano players had, on average, 12.4 ± 4.9 years of piano experience. Written informed consent was obtained after

full explanation of the experiment, which was conducted to principles of the Declaration of Helsinki.

Tapping was performed with the right index or ring finger on a force transducer. In the auditory condition, participants were instructed to tap to the metronome tones that were presented through a headphone. In the visual condition, participants looked at the screen of the electronic metronome and were instructed to tap when a line moving like a pendulum reached one of the edges of the screen. They also performed tapping to combined auditory and visual stimuli (combined condition). They performed 30 taps in each condition, and the order of the conditions was randomized across participants. The signals from both the force transducer and the electronic metronome were recorded and stored on a personal computer through an analog-to-digital converter. We analyzed temporal asynchrony between tap onset and metronome onset. We calculated a standard deviation (SD) of asynchrony to evaluate the asynchrony stability.

3. Results

Figure 1. shows results of mean asynchrony. A three-way repeated measures ANOVA revealed a significant interaction of Experience × Finger ($F [1,13] = 6.689$, $p = 0.013$) on asynchrony. A post hoc analysis indicated that asynchrony was larger with the ring finger than with the index finger in novices ($p = 0.004$).

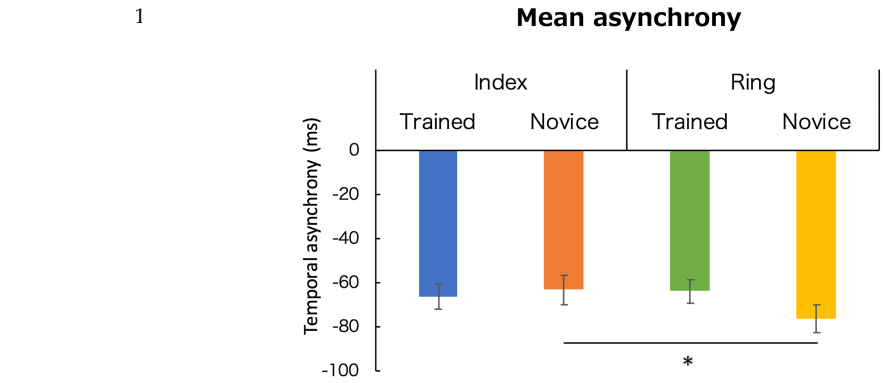

Figure 1. Mean asynchrony (± SE). Asterisk indicates $p < 0.05$.

Figure 2. shows SD of asynchrony: trained (a) and novices (b). A three-way repeated measures ANOVA revealed a main effect of Task ($F [2,13] = 4.927$, $p = 0.016$) and an interaction of Experience × Task × Finger ($F [2,13] = 4.289$, $p = 0.026$) on SD for asynchrony. In the novices, there was a significant interaction of Task × Finger ($F [2,13] = 4.676$, $p = 0.032$). A post hoc analysis revealed that SD of asynchrony was larger in the visual condition than in the auditory condition for the ring finger ($p = 0.01$) and that SD of asynchrony was larger with the ring finger than with the index finger in the visual condition ($p = 0.01$). These differences were not apparent in the trained.

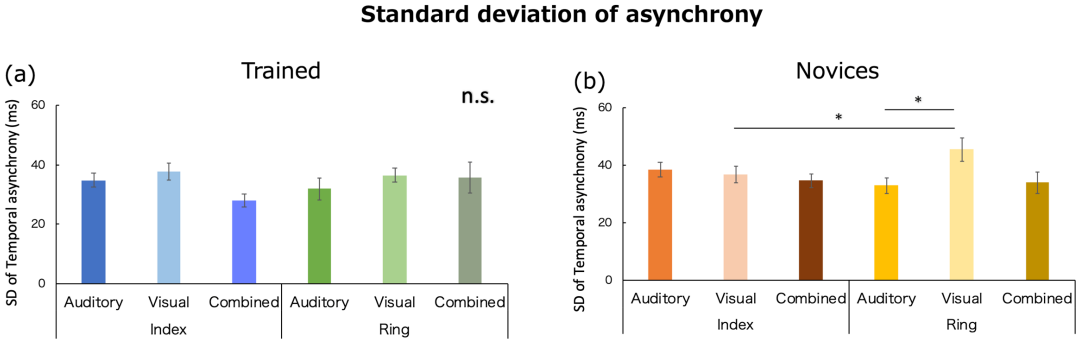

Figure 2. Standard deviation of asynchrony (± SE): trained (a) and novices (b). Asterisk indicates $p < 0.05$.

4. Discussion

In this study, we found that mean asynchrony was larger with the ring finger than with the index finger only in the novices. Additionally, SD of asynchrony was particularly large when performing synchronization tapping to visual stimuli with the ring finger in the novices whereas no effect of the finger or the modality of stimuli was found in the piano players.

Generally, the ring finger has a motor constraint because of its strong interconnections with the middle finger [4]. Meanwhile, the activation of premotor area is higher when tapping to auditory stimuli than to visual stimuli [5]. These evidences indicate that both motor execution and sensory processing might affect the present results. Our findings suggest that long-term piano training enhances motor control of the ring finger and visual processing.

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