Effect of Dance Learning Experience on Audiovisual Information and Body Synchrony

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Abstract
This study aimed to investigate whether dance education experiences have any impact on reaction times and physical synchrony when responding to auditory and visual stimuli. The main focus of this study was on the relationship between auditory and visual stimuli in generating synchronized body movements. The study included 11 healthy adults who were asked to perform knee extension and flexion movements in reaction to visual and auditory stimuli. The stimuli consisted of circles moving up and down at different frequencies, and participants were instructed to perform the movements in response to the stimulus for a period of 1 minute per trial. The presentation of the stimulus was random and occurred at six different speeds: 0.2, 0.4, 0.6, 0.8, and 1.0/1.2 Hz to prevent participants from acquiring a sense of rhythm. The collection of audio and visual stimuli, as well as the corresponding knee joint movements, were continuously documented. This study was demonstrated that reaction times were more rapid when behaviors were prompted by visual stimuli as opposed to a combination of visual and auditory stimuli. Additionally, the study found that reaction time was prolonged when the knee was in an upward position with the knee extended, and in a downward position with the knee bent. These findings were observed in Japan, where dance education has recently been implemented. This suggested that performing the down rhythm of lowering the hips with sound may be more challenging.

Keywords: Motor Learning, Dance Education, Synchrony

Introduction

Rhythmic limb movements are often steered to a particular point or region during the movement cycle. The previously reported changes in reaction times due to tapping and vocal responses in rhythms. It is well known that the patterns of reaction times are clearly different between auditory and visual stimuli, and auditory stimuli are faster (Yoshioka & Ishikura, 1987). Movement coordination with external auditory rhythms plays a crucial role in dancing. Body movement coordination was performed using visual feedback. In terms of reaction time, auditory sound stimulation is faster than visual stimulation. However, when auditory and visual stimuli are varied in successive movements, there is insufficient data on which stimulus is more significant for tracking body movement.

There are two basic rhythm movements in street dance: down and up the hip, which involves bending the knees to the beat of the rhythm, and stretching, which involves stretching the knees to the beat of the rhythm. A previous study conducted experiments on professional dancers who performed these two types of rhythmic movements to a metronome at various speeds, and the results showed that anyone could easily perform down rhythmic movements at various speeds. However, it became clear that although it was possible to perform the upward rhythmic movement slowly, if you try to perform it quickly, it would unintentionally switch to the downward rhythmic movement. Street dance experts overcome the phase transition from top to bottom (Miura et al., 2018). This previous study focused on down and up movements by professional dancers but did not examine rhythmic changes in the difference between visual and auditory sensory input.

To examine changes in the rhythm of timing up and down the hip continuously in auditory and visual stimuli. The purpose of this study was to examine reaction times following successive changes in stimulus frequencies rather than simple responses to visual and auditory stimuli.

Methods

Subjects

Eleven healthy adults, comprising of four males and seven females, were recruited for this study, which had an average age of 22.3 years, with a standard deviation of 1.1 years. The male participants had an average height of 166.8 cm, with a standard deviation of 4.0 cm, and a weight of 68 kg, with a standard deviation of 9.4 kg. The female participants had an average height of 159.3 cm, with a standard deviation of 4.4 cm, and a weight of 51.9 kg, with a standard deviation of 5.7 kg. Only one female dancer actively participating in collegiate sports was included in the study. The study protocol was approved by the local ethical committee of Jissen Women's University.

Experimental Procedure and Protocols

The experimental tasks were developed using the programming language C# with UNITY (Unity Technologies). A program was created to serve as a visual stimulus, which projected a clear white circle on a black background with up-and-down motion at an arbitrary frequency on a computer screen. Additionally, different alarm tones were played at the peak of the up-and-down motion to provide auditory stimulation. Each subject participated in all three trials of the experiment (Figure 1).

1. Visual stimulation: In the image where the circle moves up and down in front of the monitor, a rhythm was created to go down according to the visual information.
2. Auditory stimulation: the position of the circle on the monitor was at the top when it moved up and at the bottom when it moved down, and a short notification tone was emitted to provide auditory information only, alarm sound.
3. Visual & Auditory stimulation: the positions of the markers moving up and down on the screen set off alarms in sync with the marker positions.

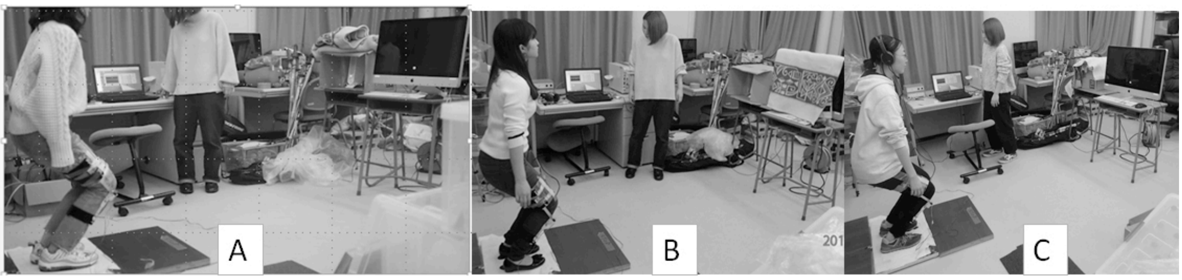

Figure 1: Experimental Settings,
A: Visual And Auditory Stimulus, B: Auditory Stimulus, C: Visual Stimulus.

Figure 2: Typical Experimental Scene Stimulus Maker in Bottom With Knee Down

The subjects were equipped with a potentiometer (Tokyo Cosmos Electric Co., Ltd., TCQ96A02, B103) on their right leg and performed bending and stretching movements (down rhythm) in response to the stimulation on the ground reaction force sensor (Kistler, Force Plate, 9286BA) at a sampling rate of 1KHz for 1 minute each trial. The stimuli were presented at six different speeds: 0.2/0.4/0.6/0.8/1.0/1.2Hz, and stimulus presentation was randomized for one minute, respectively.

Measurements and Analysis

The fluctuating control stimulus was coordinated with the vertical axis at the zenith and nadir points of the Force Plate and the knee goniometer. The reaction time was gauged by sequentially examining the X coordinates of the control stimulus and knee extension/flexion data. This was done by visually inspecting the X coordinates using Matlab scripts. The time difference from the zenith and nadir of the control stimulus, i.e., the variation in the X coordinate, was calculated and utilized as the reaction time, respectively. The mean and standard deviation of all the aforementioned parameters were determined. Analysis of variance (ANOVA) was initially applied for subjects, comparing the disparities among the three distinct conditions (visual and auditory stimulus, auditory stimulus alone, and visual stimulus alone). All tests were carried out using SAS (SAS Institute, USA), and the statistical significance was considered at a p-value lower than 0.05.

Results

Figure 3 depicts the individual reaction time of a single dance skilled student. Moreover, the time gap between stimulation and knee extension (i.e., the peak position or alarm sound) and flexion (i.e., the bottom position or alarm sound) was measured for all subjects.

Figure 3: Result of Individual Responses in Three Conditions,
College Dance Experience Subject

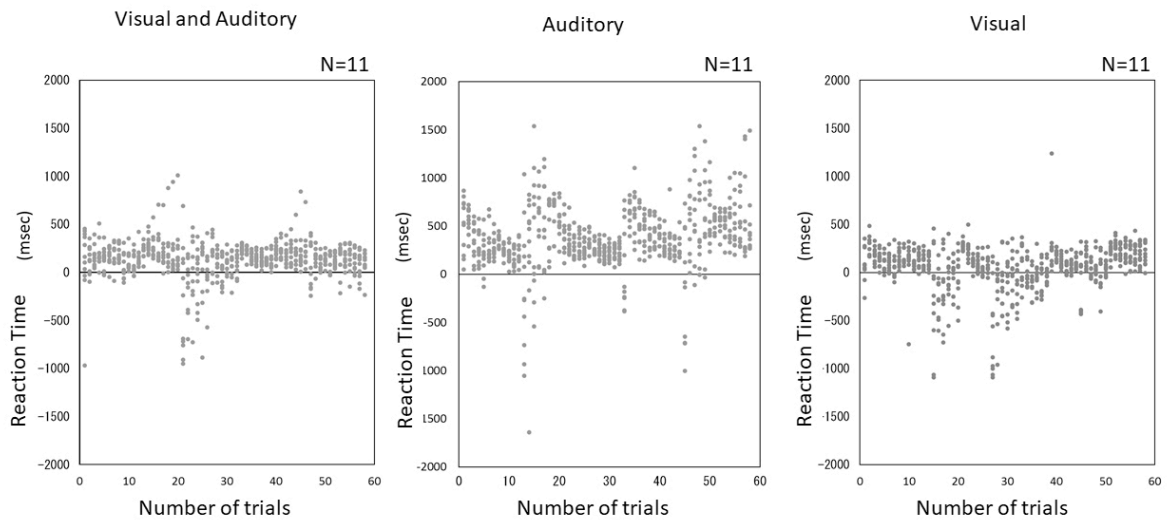

Figure 4: Result of Individual Responses for All Subjects

Reaction times to stimuli for all subjects were plotted in Figure 4, with faster movements to stimuli indicated by negative time zone in reaction times. Comparing Figures 4 and 5, it was observed that the early responses to the stimuli tended to be very less for the experienced. In the case of visual-only stimuli, it was often observed that the movement was faster than the stimulus.

As results, the average reaction time were showed that when the experiments were performed flexion and extension of the knee using only auditory stimuli, there was the greatest difference in reaction time with sound stimulation (Figure 5). There was significant difference between visual auditory stimulus and auditory, auditory and visual stimulus. Auditory stimuli had significantly longer reaction times.

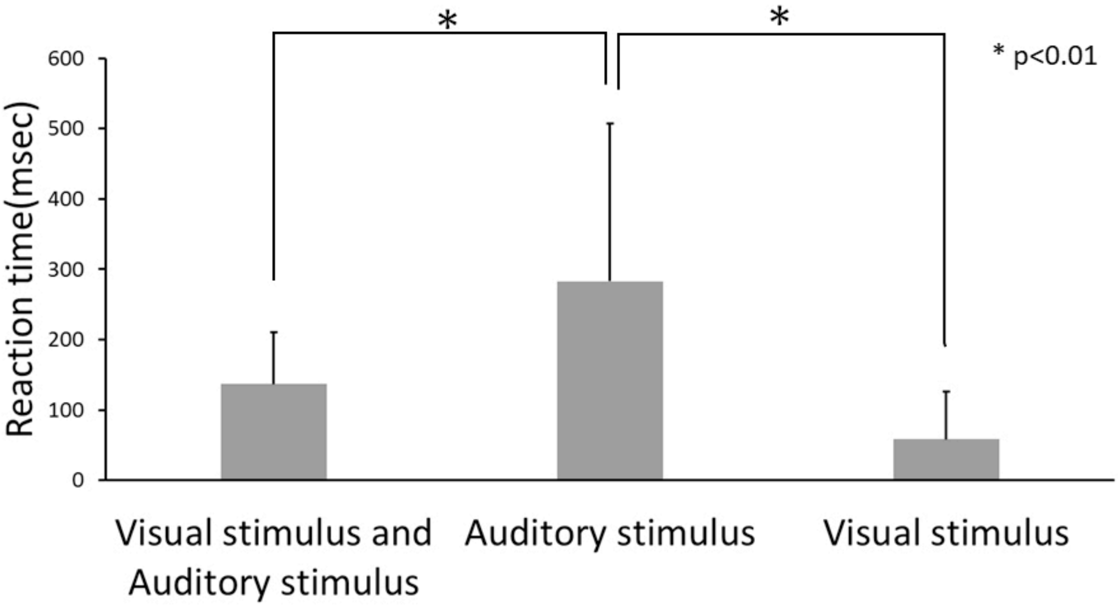

Figure 5: Results of Reaction Time for All Subjects

It was compared the reaction times when flexion and extension of the knee during flexion and extension exercises. It was the difference in reaction time that smaller when the knee was extended than when it was in all trials for visual and auditory stimuli, auditory stimuli, and visual stimuli. In other words, it could be said that synchrony was higher when the knees were flexion (Figure 6).

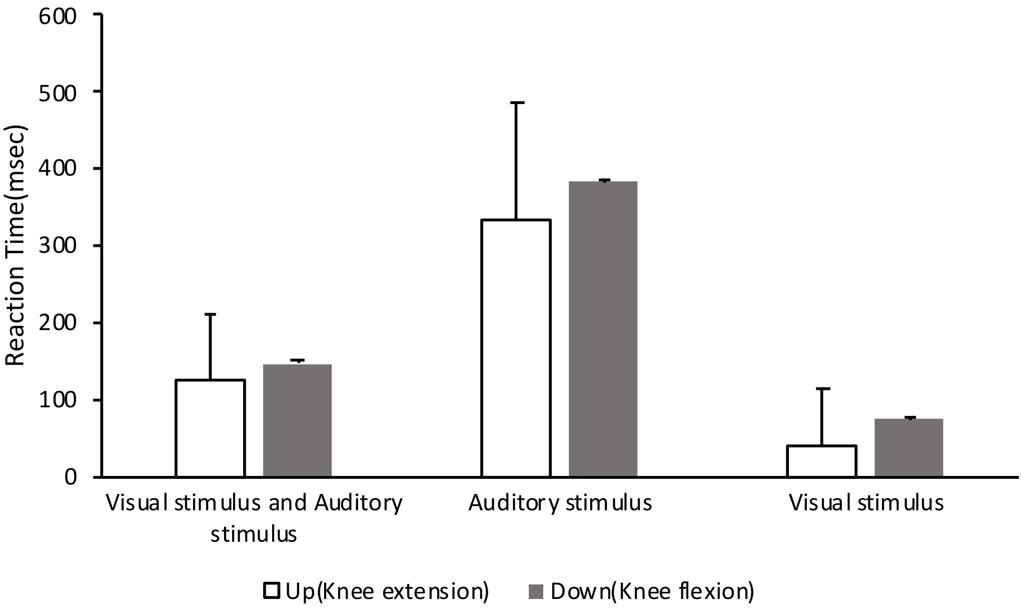

Figure 6: Average Reaction Time During Knee Extension and Flexion for All Subjects

Discussion

As a result of this study, we found that the difference between stimulus and reaction time was larger for auditory stimuli and smaller for visual stimuli. In other words, we showed that visual stimulation was important for synchrony. This was thought to be due to sensory-motor learning in which vision was dominant and synchronized the vertical movement and flexion/extension movements of the circle displayed on the screen. Mergner (1998) showed that rather it was meant as a plea to embed our knowledge, which has been accumulated in the past on human spatial behavior on earth and under microgravity, into a broad conceptual framework and to use this as a guideline for future research in space and under Ž. altered gravity conditions, such as on Mars. They demonstrated that this framework would be incomplete if it did not include biomechanics and multi-body dynamics, since these shapes our postural behavior and the related perception to a considerable degree, they assume that the down- and up-channeling mechanisms described here develop through experience of inertial and gravitational reaction forces. Also, the feedback Ž .and possibly feed-forward loops used for postural control still need to be worked out. They showed that the complexity of the human organism and its interaction with the environment may discourage researchers from adopting such a global approach. However, they hold that current developments in computer science and robotics provide us with a number of tools that allow an integrative approach to be taken, alternating in an iterative way between dynamic modeling and experimentation, thereby overcoming the immense complexity of the system. It was certainly distinct from the one which tries to solve the question of how the mechanisms were implemented in the Ž brain on a neural or molecular level a question which, conceivably, was considerably more difficult to solve. This suggested that learning the down rhythm was difficult because the difference in physical response time between knee extension and flexion was smaller when the knee is extended. In previous studies, it was said that the rhythm of the up movement was difficult, but since the subjects were professional dancers, it was thought that they had mastered the rhythm of the down movement.

Conclusion

In conclusion, visual information was important for synchrony. A large variation in reaction time for up and down was observed. It was difficult to learn the rhythm of down dancing. When the participants demonstrated physical coordination to follow the rhythmic changes caused by auditory and visual stimuli, it was found that, unlike previous studies, visual stimuli had the shortest reaction time and could be followed more accurately. Since they created a program that could change the frequency of stimulation, it was thought that it could be applied to games for the elderly to prevent dementia in the future.

References

Mergner, T., & Rosemeier, T. (1998). Interaction of vestibular, somatosensory and visual signals for postural control and motion perception under terrestrial and microgravity conditions—a conceptual model. Brain research reviews, 28(1-2), 118-135.

Miura, A., Fujii, S., Okano, M., Kudo, K., & Nakazawa, K. (2018). Upper rate limits for one-to-one auditory–motor coordination involving whole-body oscillation: a study of street dancers and non-dancers. *Journal of Experimental Biology*, *221*(16), jeb179457.

Yoshioka, H., Ishikura, M. (1987). Auditory and Visual Reaction Times as a Function of Repetition Frequency. The Japan Journal of Logopedics and Phoniatrics, 28, 227-238.

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