



Comparing the Difficulty of Maintaining Rhythm on Bass Drum and Hi-Hat Pedals Using Prostheses and Drum Set Adjustments

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Introduction

Many people in the world, including people with lower limb loss, play drum set. On a standard five piece drum set, there are two pedals: one that controls the bass drum mallet hitting the bass drum and one that clenches and opens the hi-hat cymbals. Since the drum set is designed to utilize these foot pedals, some challenges arise for lower limb amputees. Each individual develops a method that best works for him/her when playing drum set. One of the essential aspects of playing the drum set is maintaining a steady beat/rhythm. Therefore, steadiness of rhythm was selected as the outcome variable to compare different interventions. By testing different options to accommodate for an amputee, the method that produces the steadiest beat was found.

Hypothesis

With steadiness of rhythm chosen as the outcome variable, it was hypothesized that a rearrangement of the drum set to allow one foot to control both pedals (Toe-heel model: Figures 1 and 2) would provide a consistency of rhythm closer to the consistency of playing with two able bodied feet than the rhythm produced using above-knee (Figure 3) and below-knee pseudo-prostheses (Figure 4). The rationale behind that hypothesis is that when controlling the pedal with the pseudo-prosthetic attachment, much more motion is required when involving the acetabular (hip) joint instead of utilizing the smaller motion of the talocrural (ankle) joint which the toe-heel model uses.

Methods

Protocol:

1. A bass drum and hi-hat stand were set up as they would be in a typical drum set
2. Metronome was set at 100 bpm (beats per minute)
3. The subjects listened to the beat through earphones, and were asked to play the same beat.
4. The rhythm was recorded using Audacity
5. 8 interventions (Table 1) were tested using the following protocol: 4 beats on the bass drum pedal, 4 beats on the hi-hat pedal, and 4 beats on both at the same time (repeat cycle until 24 beats are played)
6. The time between each beat for each trial was measured to compare the consistency
7. This series of interventions was then repeated for multiple subjects in a randomized order for each subject

Subject Requirements: The subjects that ran through the 8 interventions were able-bodied volunteers who were able to wear a pseudo-prosthesis, had no severe hearing loss, and had no cognitive impairment.

Data Processing and Analysis: The average deviation between the metronome and played beats was calculated for each trial of every subject. The resulting values represent the accuracy of the rhythm compared to the metronome. Post-hoc comparisons were undertaken as appropriate. A critical alpha of 0.05 was defined prior to data collection. The comparison was done by 2-way (condition x bpm) repeated measures ANOVA.

Table 1: All 8 Interventions That Were Put Into a Different Random Order for Each Individual Subject

Abbrev	Intervention
A100	Standard at 100bpm
A200	Standard at 200bpm
B100	Below- knee pseudo-prosthesis (Figure 3) on the bass drum pedal with typical foot on hi-hat pedal at 100bpm
B200	Below-knee pseudo-prosthesis (Figure 3) on the bass drum pedal with typical foot on hi-hat pedal at 200bpm
C100	Above-knee pseudo-prosthesis (Figure 4) on the bass drum pedal with typical foot on hi-hat pedal at 100bpm
C200	Above-knee pseudo-prosthesis (Figure 4) on the bass drum pedal with typical foot on hi-hat pedal at 200bpm
D100	Toe-heel model (Figures 1 and 2) with the toe on the hi-hat pedal and the heel on the bass drum pedal at 100bpm
D200	Toe-heel model (Figures 1 and 2) with the toe on the hi-hat pedal and the heel on the bass drum pedal at 200bpm

Results

Table 2: Description of Subjects in Sample

	Percussion Experience Level	Age
Subject 1	Percussion Experience	17
Subject 2	No Percussion Experience	47
Subject 3	Percussion Experience	17
Subject 4	No Percussion Experience	17
Subject 5	No Percussion Experience	26
Subject 6	No Percussion Experience	41
Subject 7	Percussion Experience	17

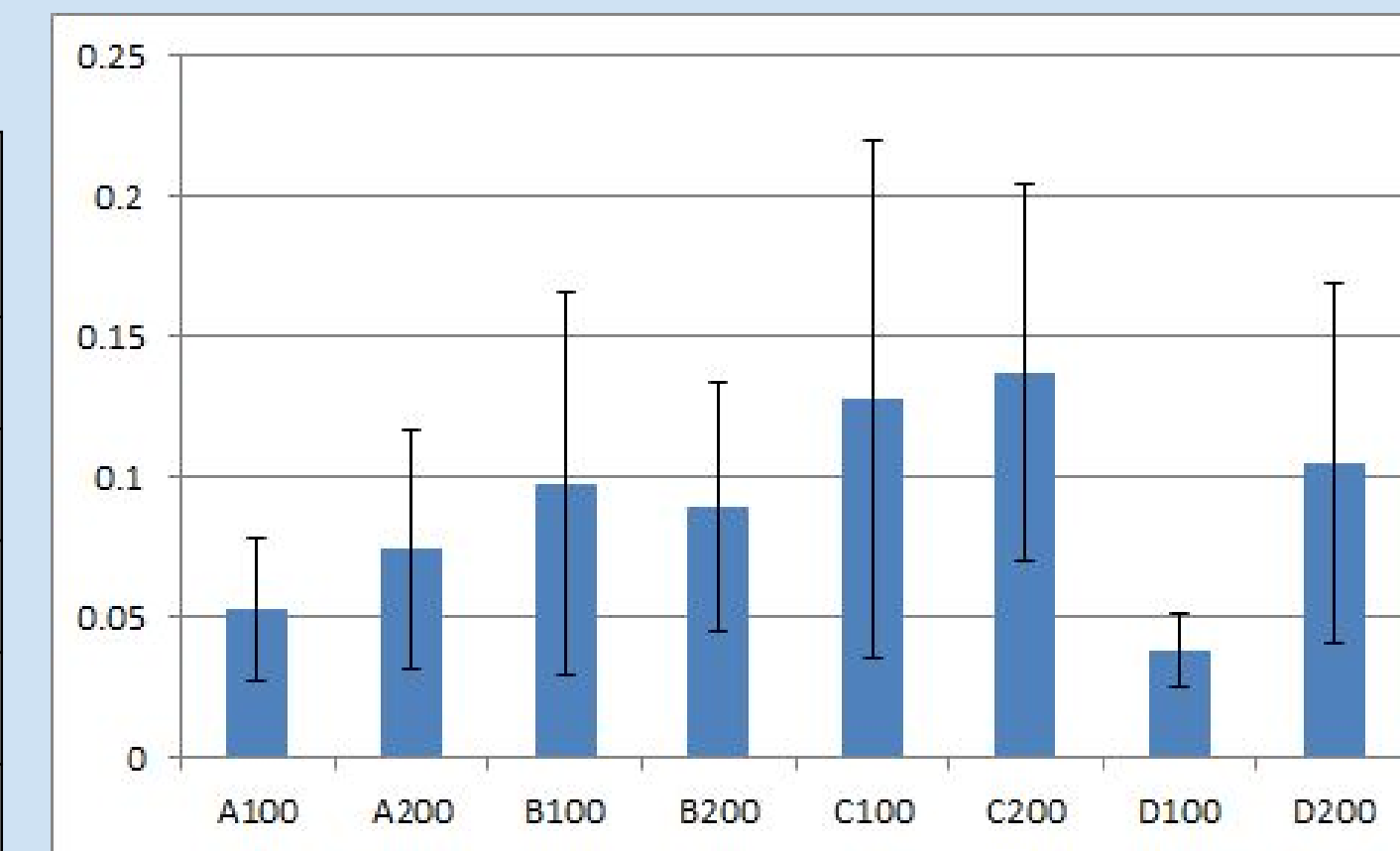


Figure 5: Mean and Standard Deviation in seconds for Each Testing Condition

P values were found for each condition. Condition, the main effect, was found to be significant ($p=0.006$), whereas neither the main effect of bpm ($p=0.119$) nor the interaction effect of condition and bpm ($p=0.350$) was significant at the 0.05 level. Post-hoc comparison showed that only condition C (above-knee pseudo-prosthesis) was significantly different at the 0.05 level from the other conditions.

Discussion and Conclusion

The hypothesis was confirmed for the above-knee pseudo-prosthetic attachment because it was less consistent than the accuracy of the toe-heel model. The rhythm maintained with the toe-heel model was not significantly different than the standard of playing with two typical feet. The hypothesis could not be confirmed for the below-knee pseudo-prosthesis because there was an insignificant difference between it and the standard condition.

Comparing the P values of condition C to the other conditions showed that it was significantly more difficult to maintain rhythm with the above-knee prosthesis than with the standard, below-knee prosthesis, and the toe-heel model. Therefore, those who use above-knee prostheses could improve their ability to maintain rhythm by using the toe-heel model. This model would allow performance comparable to the standard way of playing drum set with two feet, and would eliminate the need to use a prosthetic foot when playing drum set. The toe-heel model seems to be recommendable when playing drum set for individuals who have an above-knee prosthesis.

Adapting to activities of daily life after limb loss is important for the successful rehabilitation and the attainment of a normal quality of life. Our findings confirm the findings of Madison, Sioros, Witek, and Hove (2014) who found that an increase in synchronization of rhythm correlated with an increase in audience enjoyment and "groove". Our findings provide evidence on the most appropriate adaptation strategy for people who play the drum set. With this better accuracy of rhythm, the audience enjoyment could also increase. With the right strategy, drum set playing is a feasible activity for people with lower limb loss.

Further Reading

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The QR code to the right and the web address below lead to a video showing the study investigator demonstrating the experimental setup.
<https://pitt.app.box.com/s/i5jb5z7f7hlsb9k3fp6vjp3v8fi4b7ht>

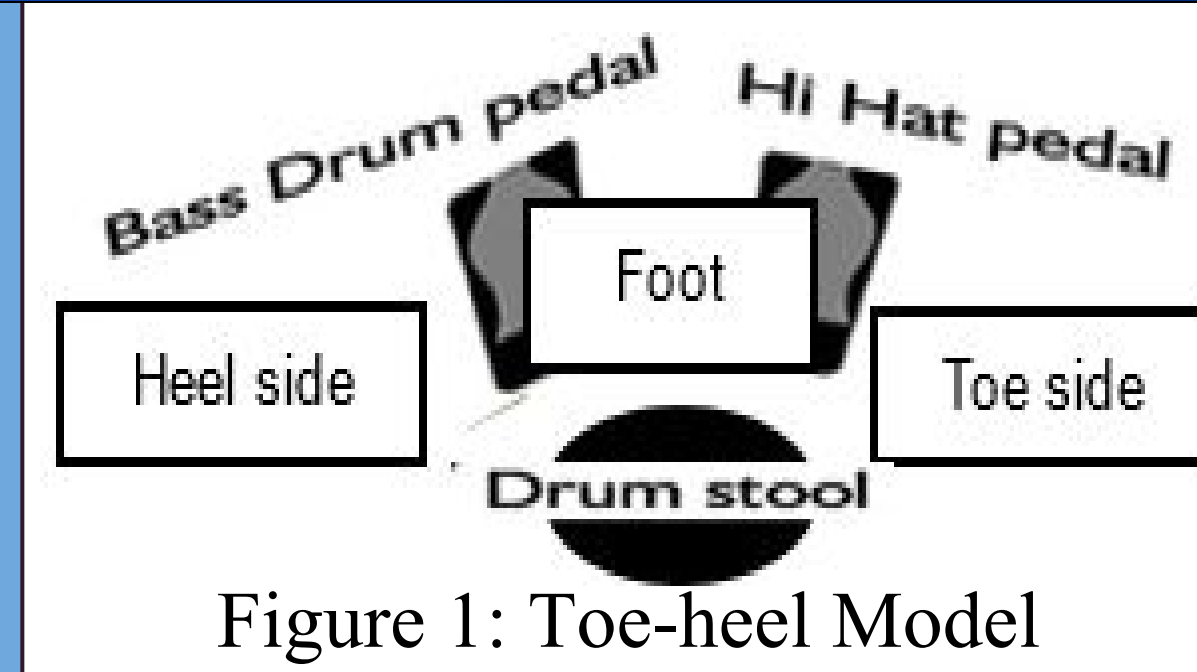


Figure 1: Toe-heel Model



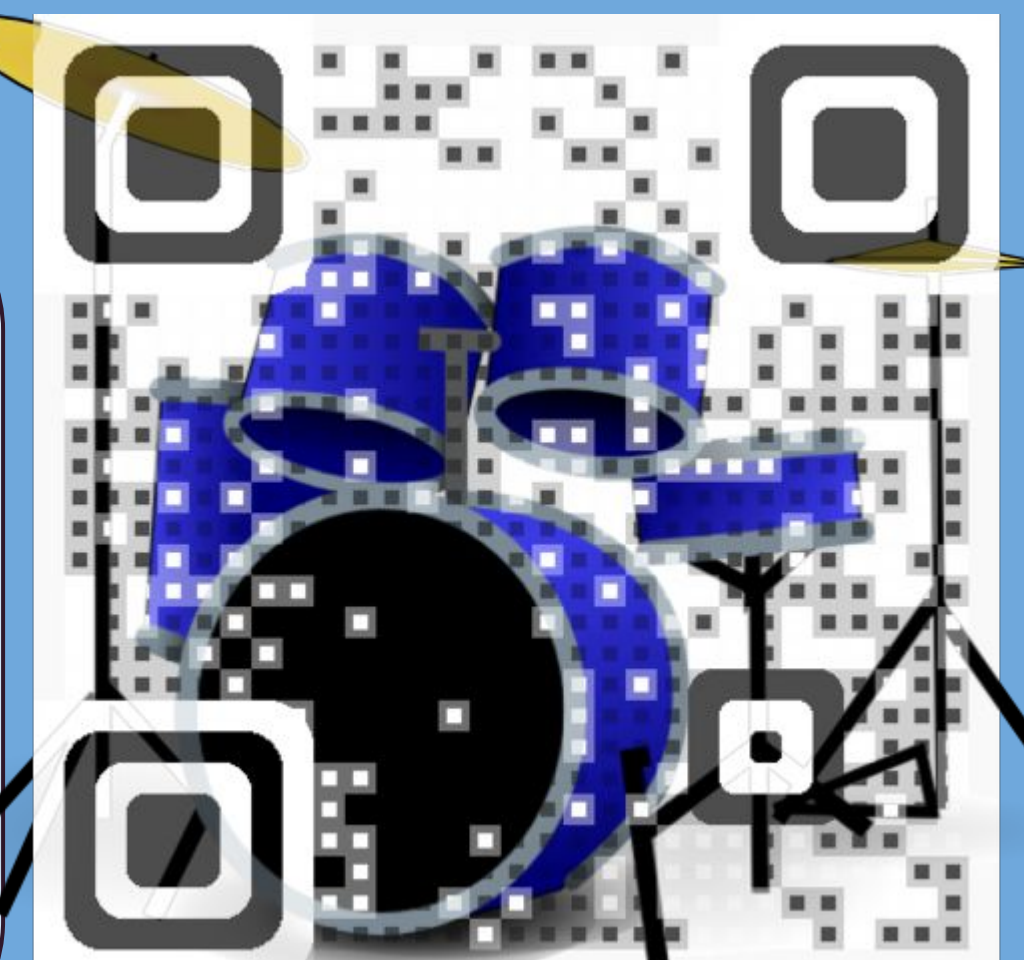
Figure 2: Toe-heel Model



Figure 3: Below-Knee Pseudo-prosthesis



Figure 4: Above-Knee Pseudo-prosthesis



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