The Effects of Handedness in Percussion Performative Gesture

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Abstract. Although there have been many studies investigating the nature of bimanual roles in percussion and music in general [6] [7] [16] [12], little research has been specifically devoted to the influence handedness exerts when concerning percussion performance gestures. Nevertheless, this effect on performative tasks could play an important role in producing realistic gesture models, and in acquiring accurate gesture based data from performers. This paper presents three instances where the effects of handedness in snare drum and timpani performance can be observed. These examples show that the handedness of a player can have a distinct influence over the symmetry of movement between the left and right hands.

Keywords: Handedness, Percussion, Gesture, Motion Capture

1 Introduction

On the surface, understanding the nature of percussion performance seems quite simple. A percussionist strikes an instrument with their hands or with a stick, and the object sounds accordingly. With a single stroke, any object can become a percussion instrument; perhaps this is why percussion instruments have been traced as one of the earliest musical instrument families in human history [11]. Despite the low entry fee [18] that percussion instruments offer their performers, the actions that execute the performative gestures involve complicated dynamic relationships between the performer's body and instrument(s) [5]. Godøy describes in [8] that, what may be seen as a single performative action, can contain many co-articulative elements within it. The notion of coarticulation demonstrates that intensive efforts are needed to fully understand the nature of musically influenced gesture.

Because of the complicated nature of percussion performance and due to the vast instrumental scope of the percussion family, studies of percussive gesture

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have generally been limited in focus to a particular instrument. Once more, few studies have examined the effects of handedness in percussion performance. Understanding the physical relationships between performer and instrument are crucial for the advancement of technology in gestural recognition, data acquisition, gestural modeling, and instrument design [1] [17] [14].

2 Technical Approaches to Handedness and Symmetry

The notion of symmetry in percussion is an inherent yet rarely addressed issue in learning, teaching, and performing. Previous research [6] [7] has shown that musical experience and practice reduces the asymmetry between maximum tapping frequencies between the left and right hands. Non-experienced performers tend to display a wider variance between maximum tappings, as well as phase-wandering (inconsistent phase-transitions). Experienced drummers often display no phase-wandering. In addition, previous findings suggest that while hand preference can remain the same, asymmetry between sides can be reduced over time with practice.

2.1 A Percussionist's Perspective of Symmetry

Asymmetry is an integral part of the interactions that take place between percussionists and their instruments, and can be observed in a variety of ways. This can be highlighted in four-mallet performance on the marimba, where the left hand is often required to work with a physically larger range due to the increased size of the bars in the lower register. The right hand is made to work with physically smaller intervals, requiring very different movements and fine-motor skills. These effects are exaggerated when it comes to multi-percussion performance, where collections of instruments have the potential to demand awkward leaps and close-quartered movement from the percussionist.

Symmetry can be easily seen in the circular playing surface of most membarne instruments. Although the sound and feel is dependent on the tuning of the lugs, in ideal conditions, a tom-tom can be approached from any side with the same technique by the performer when using matched grip (where the sticks are held similarly in each hand).

Until recently, asymmetrical techniques were also used on symmetrically shaped instruments like the snare drum. The traditional grip, as it is commonly called today, was born of military traditions and practices, and required completely different grips in the left and right hands. Following an investigation by [4], it was found that traditional grip requires a significantly greater number of muscles to properly execute.

2.2 Evenness in Percussive Pedagogy

Whether a performer is a novice or a professional, the snare drum is a staple instrument of percussion pedagogical practices, and an area of intense focus when developing technique.

In the beginning phase of learning percussion, many teachers instruct students to begin with simple, single strokes on the snare drum at a comfortable pace to gain an understanding of the physics of the drum. Beginning objectives often include learning how the stick rebounds from the drumhead, how the fingers and wrist respond to the bounce in order to gain control, and how the arms must react so that a new stroke can be initiated. All of these actions happen without much conscious thought, yet are crucial to developing a healthy, proper technique. When considering the concept of symmetry in the beginning phases of learning, many method books and teachers describe the desire for a player to produce even strokes with an even tone with little further description [4] [9].

Evenness is often used as a catch-all word, meant to address both the sound and performative technique of a player. While symmetry is not always directly addressed in method books and private lessons, players are taught to look for discrepancies between the left and right side. A lack of evenness between the two halves can result in a disproportionate use of the arms, as well as acts of compensation to balance the sound. This can result in pronged tension and injury, which is why evenness is crucial for developing a sustainable technique.

3 Handedness in Snare Drum Performance

This first example, which discusses the possible effects of handedness in percussion performance, stems from observations made by the author of his own snare drum playing. Observations from this trial spurred interest in the handedness phenomenon, which lead to the review of motion capture data presented in section 4. The motion capture session was conducted as a preliminary experimental trial, seeking to observe the possible effects of phase-transition [10] , in a simple snare drum exercise. Phase-transition in this sense refers to an abrupt shift in gait similar in nature to a walking-running transition. The study was modeled after research conducted by [17], in which a violinist and violist were asked to perform an *accelerando* and *deccelerando* while having their movements recorded by a motion capture system. In their report, the notion of *gestural continuity* was presented, which can be used to explain the subtle variations of performative gestures that occur when moving from one technique to the next (*e.g. detaché* and *martelé*).

The preliminary study performed by the first author further investigates the concepts of gesture continuity and phase-transition, with a slightly different task. Instead of performing an *accelerando* and *deccelerando* freely in time, the participant (the first author) performed a *crescendo* and *decrescendo* using a fixed tempo. In percussion, stroke speed is integral to the performance of both dynamics and tempo. To perform a *crescendo* and *decrescendo*, the percussionist must increase and decrease stick speed accordingly. The addition of a fixed meter forces the performer to exert more control over the stick, so that the desired change in dynamic levels fall within the specified time signature. When performing just an *accelerando* and *decelerando*, the rebound feeds more naturally into the percussionists movement since there is no need to evenly space each stroke. Therefore,

the performance of a smooth and aesthetically desirable change in dynamics in a fixed tempo requires a comfortable phase-transition from the performer. This study is focused on the percussionist's posture pre- and post- phase-transition, and displays how handedness can potentially alter the performance technique.

3.1 Methodology

This experimental trial consisted of a simple 5 measure exercise of straight sixteenth notes performed by a single participant, with a crescendo from pianissimo to fortissimo and back. The tempo for the exercise was held at 120 BPM, with a total length of 10 seconds. To record the movement of the performer, the exercise was conducted in the Performance and Recording Lab at CIRMMT using the Qualisys Motion Capture System. The movement was recorded with a sample rate of 210Hz using 11 Qualisys Oqus 400 cameras. A total of 26 markers were placed on the performer, with the markers on the arms and wrist corresponding to the Vicon Plug-in-Gait diagram [15].

3.2 Analysis

Upon reviewing the data from the exercise, differences between the left and right sides of the body were observed, even before any phase-transition took place. In Figure 1, differences in the height of the left and right wrists can be seen immediately. Furthermore, the effects of phase-transitions had separate effects on each hand. Before the arrival at *fortissimo*, the left wrist began to push down and then rise at a steeper rate than the right hand. It is also apparent that, despite the lack of an indication of stick ordering in exercise, the right hand always struck first. Given that the performer is right-handed, it could be hypothesized that the right hand began each exercise because of the preference given to the dominant hand when performing temporal tasks [16].

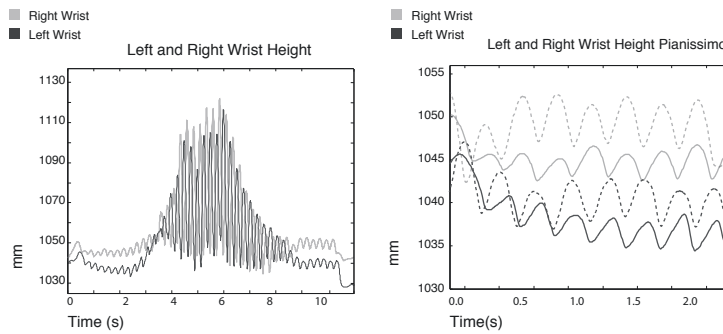

Fig. 1. Wrist height for the duration of the entire exercise and a comparison between *pianissimo* segments for each hand pre and post phase-transition. The dashed line represents the second pass of the *pianissimo* passage after two phase-transitions.

Percussionists are often trained to observe their technique in a mirror, to ensure that each limb produces a similar stroke. A lack of focus on the left-hand side could possibly be explained by preference in attention given to the dominant right-hand side, resulting in a less disciplined and technically unrefined left side gesture profile. In general, the right-hand side of the body performed a more controlled and technically efficient execution of the performative exercise. It can also be noted that the phase-transition had a similar effect on each half of the body when comparing the first and last measures of the exercise, which can be seen in the right side of Figure 1. Upon exiting the last phase-transition, each hand was performing the same *pianissimo* dynamic marking at a greater height compared to the beginning of the exercise.

4 Handedness in Timpani Performance

The next two examples borrow data from [2], which proposed novel analysis, modeling, and synthesis strategies for percussion performance. These examples display the movement of a right-handed professional timpanist and a left-handed undergraduate percussion student. In each exercise, the performer was asked to play *legato* timpani strokes, with a steady tempo of approximately 67 bpm and a *mezzoforte* dynamic level. This study is useful because it displays the motion of a simple stroke without any required change in tempo or dynamics, which can exaggerate differences in the left and right hands. Therefore, an accurate sense of the natural and relaxed striking gesture can be observed.

4.1 Methodology

The motion data was captured using the Vicon Plug-in-Gait protocol and a Vicon infrared motion tracking system in the Input Devices and Musical Interaction Laboratory at McGill University. The complete details on the motion capture protocol used to collect this data can be found in [2].

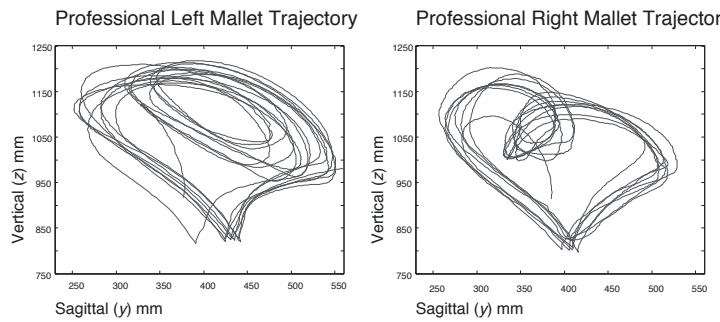

Fig. 2. The mallet trajectory for the duration of the entire exercise.

4.2 Analysis

In Figure 2, the tracing of each stroke with regards to distance and height (*i.e.* the y and z dimensions, where z is the height and y is the sagittal distance in front of the performer) can be observed. This graphical representation displays the gestural profile of the performer, where differences between the left and right hands can be clearly seen. Long and expressive movements characterize the trajectory of the professional's gesture as each stroke is executed with a high level of precision. Major differences between the left and right hands can be observed in upper half of each stroke. This area corresponds to an ancillary gesture which demonstrates qualities of expression. After each stroke, the right-handed professional timpanist lightly preps the mallet as if conducting with a baton. This motion is greatly exaggerated in the left hand as the mid-stroke loop is much larger. In comparison, the right hand experiences a much smaller range of movement. One such consequence of the larger movement found in the left hand can be observed in Figure 3, which was calculated using the *mirpeaks* function from the MIR ToolBox [13]. This graphic displays the peaks in recorded audio from the exercise. Given that each performer began with their dominant hand (undergraduate is left-handed and the professional is right-handed), a dissimilarity in dynamics between each hand can be found. Here, the left hand of the professional consistently plays a quieter strike.

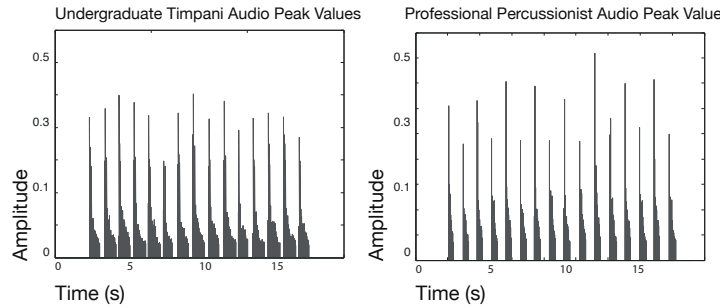

Fig. 3. Peak values for the professional and undergraduate timpanists.

While there are slight, yet obvious differences between the left and right hand sides in the professionals gestural profile, asymmetry is certainly magnified in the student example. Here, a left-handed undergraduate student performs the same performative task as the professional. By observing the results in Figure 4, the effects of handedness and lack of experience is apparent. While the left hand displays larger and more elliptical strokes similar to that found in the professional, the right hand moves in an inconsistent manner. Each stroke is approached from a different angle and mid-stroke movement is often erratic and unpredictable. This can be explained by excess rigidity in the non-dominant hand, resulting in

a lack of control when attempting to influence the rebound trajectory. An analysis of the peak data from the audio in this example also demonstrates a lack of comfortable control in dynamics as well. Through a simple visual analysis, handedness exerts an influence in determining the mallet trajectory and overall gestural profile of each timpanist, regardless of experience.

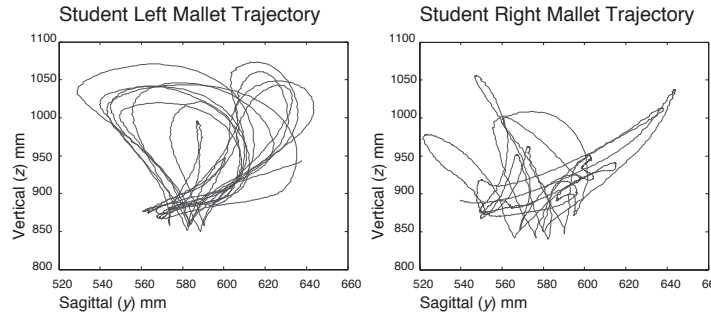

Fig. 4. Mallet trajectory for the duration of the entire exercise.

5 Conclusion

As discussed in this paper, the notion of symmetry and handedness in percussion performance is a complicated issue. The physiological tendencies of a performer's technique can differ greatly from player to player. Compromises are necessary and a natural part of learning how to play. For this reason, [4] states that percussion pedagogy should be *awareness-oriented*; goal-oriented learning is not as constructive. An individual performer's technique will always display aspects of asymmetry, resulting in a unique gestural profile.

With this in mind, technological efforts in gestural modeling, synthesis, and data acquisition would find it useful to further investigate this issue. In the study by [3], which introduced novel methods for producing a physical model of a timpanist, it was decided that the representation of the virtual percussionist's movements were exaggerated and unnatural. This can partially be explained because of the lack of attention given to the differences between the left and right sides of the virtual performer. Moreover, any effort to reproduce the gestural style of a given technique or player will have to take the natural differences caused by handedness into account. Studies seeking to acquire gestural information from a percussionist would also benefit from a deeper understanding of the possible differences caused by and influenced by handedness. Assuming that the differences between each hand are negligible is incorrect. Therefore, more research is needed to provide reliable theories in this area, especially with regards to comparing the differences in gestural profiles of left- and right-handed players and differences in mallet grip.

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