

RITUAL AND MOTOR PERFORMANCE

by

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## INTRODUCTION

Before players shoot a free throw in a basketball game, the majority will do some sort of pre-shot routine or ritual. What is the purpose behind these routines? Do such rituals help players' free throw percentage?

Past research has examined pre-performance ritual to help determine if these rituals are important to successful free throw performance, and if so what factors are most important to success. Miracle and Southard (1993) found rhythm, or the relative timing of the behaviors, was more important than maintaining the overall time of the ritual behaviors. Participants in the study included eight female students who were members of a collegiate basketball team. Participants performed 15 free throws under four different conditions: 1) using their normal performance ritual; 2) performing their ritual with the same relative timing but in half the time; 3) performing their ritual with the same relative timing but in double the time; and 4) performing the ritual in the same time as normal but with different relative timing of the behaviors. Results indicated that relative timing was more important to the free throw performance than maintaining the absolute time of the ritual. This means the individual behaviors that make up the ritual have a consistent time when compared to other trials. They concluded that the relative timing of behaviors is "the operant of endogenous rhythms". That is, the pre-shot ritual prepares the motor system for performance by establishing a consistent rhythm (Miracle and Southard, 1993). The researchers determined that pre-shot routines act as zeitgebers. These are external rhythms that entrain the internal rhythms of the nervous system. A well-known example of a zeitgeber is circadian rhythm, which is the alternating pattern of activity between activity and rest that is the result of internal oscillators synchronizing with night

and day cycles (Trivers, 1985). Internal rhythm may be important to successful performances in activities that require consistency. By establishing and maintaining an internal rhythm, the pre-shot routine reduces variability in performance, which in turn should aid in accuracy of the free throw.

Southard and Amos (1996) examined ritual behaviors for three different sport performances: the basketball free throw, the golf putt, and the tennis serve, to determine if rituals before a performance maintain a consistent rhythm for different activities. Participants were male volunteers who were experienced in all three of the sports and had a pre-performance ritual. Participants performed 15 free throws, 15 golf putts, and 15 tennis serves with their normal pre-performance ritual. The researchers then determined the absolute and relative timing of the ritual behaviors and found a moderate to high correlation between performance success and the consistency of relative time of ritual behaviors. The data also indicated that a shorter ritual increased the likelihood of a successful performance. They concluded that consistent relative timing of ritual behaviors was important for a successful performance, supporting the findings of Miracle and Southard (1993).

Lobmeyer and Wasserman (1986) determined pre-shot routines contribute significantly to the accuracy of the free-throw shot. They examined 43 high school varsity and collegiate basketball players' free throw performance with and without performing their ritual. The results indicated players were more successful when allowed to use their ritual. Czech, Ploszay, and Burke (2004) found those athletes who performed and maintained the same pre-shot routine had a higher free throw percentage than those who did not maintain a pre-performance routine or ritual. They collected data for a

minimum of 10 free throws over five separate basketball games for nine men and seven women who competed on NCAA Division I collegiate basketball teams. Results indicated that players who maintained and consistently performed their performance ritual made 74% of free throws. Whereas those who did not maintain their ritual made 68% of attempted free throws. This difference in free throw percentage was significant in their study, and they concluded that consistent ritual enhances accuracy in a closed skill. Gayton, Cielinski, Francis-Keniston, and Hearn (1989) examined the effect on accuracy when participants were not allowed to perform their pre-performance routine. The participants were 25 male high school basketball players and they attempted 50 free throws alternating between 10 with their ritual and 10 without. Results indicated significantly more baskets were made in the ritual condition than when the ritual was removed. These results show ritual performance helps improve accuracy of free throw shooting.

Researchers have examined changing the tempo and behaviors of ritual activity as well as removing the ritual completely. However, there are no studies that have: 1) compared free throw success following the physical performance of the ritual with free throw success following the mental image of the ritual without physically performing the behaviors; 2) examined the mechanical analysis of performance characteristics with and without ritual; and 3) determined the motor pattern utilized in a ritual and non-ritual condition. This study seeks to determine if: 1) free throw percentage changes when the shooter physically completes a pre-performance ritual versus when he/she only thinks about the pre-performance ritual; 2) the kinematics (speed, height, angle of release) of a free throw change when physically performing and only thinking about a pre-

performance ritual; and 3) the motor pattern of the performer changes when rituals are and are not incorporated with the performance. It is hypothesized that: 1) successful free throw percentage will decline when performers do not physically perform their ritual; 2) free throw kinematics (speed, height, and angle of release) will change when the performer is not allowed to physically perform his/her ritual; and 3) there will be a difference in motor pattern when comparing ritual and non-ritual conditions.

## METHODS

### **Participants**

Ten experienced basketball players (ages 18-25 years; 7 males and 3 females) with an established pre-performance free-throw ritual were participants in this study. Experienced was defined as having played varsity high school or college level basketball. Participants signed a university approved consent form prior to participation.

### **Apparatus**

A Peak Motion analysis system was used to record performance rituals and free-throw data. One high-speed camera (60hz, F-stop 1/1000) was mounted on a tri-pod (1.8 meters above the floor) and placed 5 meters from the participant. The camera was located perpendicular to the principal plane of motion (X-axis). The single camera allowed for data collection in the X and Y axes. The system was calibrated using a two-dimensional calibration frame of known dimensions. Markers (harmless light reflective 2cm diameter balls) were placed on the tip of the participants' middle shooting finger, styloid process, lateral epicondyle of the elbow, gleno-humeral joint center, and axis bone of the neck. The basketball was also a data point but was digitized by locating the basketball's center rather than by attachment of a marker.

## **Procedure**

Participants reported to a TCU Recreation Center gym for all data collection sessions. The only people present during data collection were the participant, supervising professor, and the researcher. The participant's task was to shoot 10 free throws under two different conditions. The gym was marked with a standard free-throw area and participants were required to stand behind the free-throw line to perform the 20 free throws. Participants warmed up by shooting (no free-throws were allowed during warm-up) and jogging prior to participation. Following warm-up they completed two free-throw conditions, which were counterbalanced by participant. Conditions were completed on separate days with one week between sessions. In both conditions the participants placed the ball at their feet until given a verbal cue to pick up the ball and begin. Condition 1 required participants to complete 10 free throws using their normal pre-performance ritual. Participants were given the verbal cue to pick up the ball after which they completed their normal ritual and shot the ball when they were ready. Condition 2 required participants to complete 10 free throws without physically performing their pre-performance ritual. For Condition 2, participants were instructed to hold the ball at waist height and think about their ritual performance without actually performing the behaviors or moving the ball in any way. Participants in the no ritual condition were allowed to shoot at their discretion following the mental image of performing their ritual. For Condition 2 the participant was given a verbal cue to pick up the ball from their feet and begin thinking about their ritual behaviors and shoot the ball after he/she had completed mentally performing the ritual. Video of the ritual condition was recorded from the start of the ritual to release of the basketball to the goal. For Condition 2, video recording

began at the verbal cue and ended when the ball was released toward the goal.

Participants retrieved their own ball and returned to the free-throw line for their next trial.

### **Design and Analysis**

The design was a within-groups design, with each participant completing both experimental conditions (ritual, no ritual). The data was analyzed using a dependent t-test. The independent factor was condition, while the dependent variables were kinematic variables related to the parabolic flight path of the ball (speed of release, height of release, and angle of release), accuracy, and motor pattern. Accuracy was scored by assigning points: a score of 1 was assigned to balls that missed the backboard and rim, 2 to balls that hit the backboard but not the rim, 3 to balls that hit the rim but do not go through the basket, 4 to balls that hit the backboard and rim and pass through the net, and 5 to balls that hit only the rim or only the net when passing through the net. Speed of release, height of release, and angle of release of the ball were digitized from trajectory graphs that were commercially prepared by the Peak Motion Analysis System. Changes in motor pattern were determined by the point relative phase of peak velocity for the humerus, forearm, and hand during the shot. Point relative phase was used to determine distal lag for each segment relative to its proximal neighbor (forearm minus humerus, and hand minus forearm). A change in motor pattern was represented by a change in the relative position (positive or negative lag) of distal segments. A one-way MANOVA was completed for forearm and hand lag. Follow-up univariate ANOVA was used to determine the dependent measure responsible for significant MANOVA. Alpha level was set at 0.05 for all analyses.

A qualitative analysis of the ritual was represented by trajectory graphs of the displacement of the ball during the ritual over time. Consistency of ritual was demonstrated by graphs for the first, fifth, and tenth ritual trials of a selected participant. The consistency of velocity and displacement of the ball was represented by phase planes (velocity plotted by displacement) for the first, fifth, and tenth trials of the same subject used to generate the trajectory graphs.

## RESULTS

### **Accuracy**

The dependent t-test indicated no significant difference for accuracy between ritual and non-ritual conditions ( $F(198)=1.22, p>0.05$ ). See Figure 1 for graphic representation of accuracy means by condition.

### **Projectile Kinematics**

**Speed of Release.** The dependent t-test indicated a significant difference for speed of release between ritual and non-ritual conditions ( $F(185)=8.259, p<0.05$ ). See Figure 2 for a graphic representation of speed of release.

**Angle of Release.** The dependent t-test indicated no significant difference for angle of release between ritual and non-ritual conditions ( $F(185)=3.4, p>0.05$ ). See Figure 3 for graphic representation of angle of release.

**Height of Release.** The dependent t-test indicated no significant difference for height of release between ritual and non-ritual conditions ( $F(185)=2.222, p>0.05$ ). See Figure 4 for graphic representation of height of release.

### **Ritual Time**

The dependent t-test indicated no significant difference in time from the start of the ritual to the release of the ball for the ritual condition and the start of thinking about the ritual to the release of the ball for the non-ritual condition ( $F(49)=3.383, p>0.05$ ). See Figure 5 for a graphic representation of ritual time.

### **Moto Pattern**

**Lag.** A one-way MANOVA for the dependent measures of forearm lag and hand lag indicated a significant main effect for condition (Hotelling's Trace=0.038,  $F(2, 184)=3.51, p<0.05$ ). A follow up one-way ANOVA indicated that hand lag was responsible for the significant main effect ( $F(1,187)=5.28, p<0.05$ ). See Figure 6 for graphic representation of forearm lag and hand lag by condition.

### **Qualitative Analysis**

The trajectory graph indicates that ritual behaviors were consistent over time with no difference in behaviors and similar timing of behaviors over trials. Figure 7 is a trajectory graph of the ritual for participant 4 for the first, fifth, and tenth trials.

The phase planes in Figure 8 indicate that the position of the ball and ball velocity were consistent over trials. Note how there is little variance in the position of the phase planes for the three trials. This consistency shows the ritual being performed for each trial remained nearly the same.

## DISCUSSION

The hypothesis that free throw accuracy would decrease when the ritual was not performed was disproven. There was no significant difference in accuracy between the

ritual condition and the non-ritual condition. Results indicate that a mental image of performing the ritual is as effective as a physically performing the ritual relative to free-throw accuracy. The fact that the timing of the actual ritual was no different from the time to think about the ritual indicates that the absolute timing of the mental ritual and physical ritual were consistent. Relative timing of ritual behaviors was not examined for this study. However, the consistency of relative timing is a likely contributing factor for the lack of significance between the two conditions. The consistency of relative timing is supported by previous research that indicates relative timing of rituals is an important variable related to consistent and successful performance (Southard & Amos, 1996).

The hypothesis that free throw kinematics would change was also disproven for height and angle of release. However, there was a significant difference in speed of release. The speed of release increased in the non-ritual condition as compared to the ritual condition. Past research concerning accurate basketball shooting indicates that the speed of release changes as a result of changes in the height and angle of release of the basketball shot (Hay, 1993). For this study, there were no differences between height or angle of release by condition. Therefore, participants may be influenced to release the ball faster by virtue of the fact that no physical ritual was performed. It should be noted that the change in speed of release was not sufficient to affect the accuracy of the shot.

The hypothesis that motor patterns would change without the ritual was also disproven. There were no changes in the relative position of limb segments by condition. The significant change in absolute hand lag value was not representative of a pattern change. In order for a change in pattern to occur, the relative position (positive or negative distal lag) would have to be different for each condition. Given that the

kinematics of the shot were consistent by condition, the lack of significance by pattern is not a surprise finding.

The overall results indicate no difference between physically performing a ritual and mentally thinking about the ritual in terms of accuracy, overall kinematics, and motor performance of the shot. Future studies could examine the effect of physically performing the ritual, mentally performing the ritual, and performing the free throw without physically or mentally thinking about the ritual. Future studies might also examine whether the relative timing of the mental ritual is consistent with physically performing the ritual. Another point of focus motor pattern changes when the ritual is performed versus when no ritual is performed to see why there is a decrease in accuracy without ritual performance.

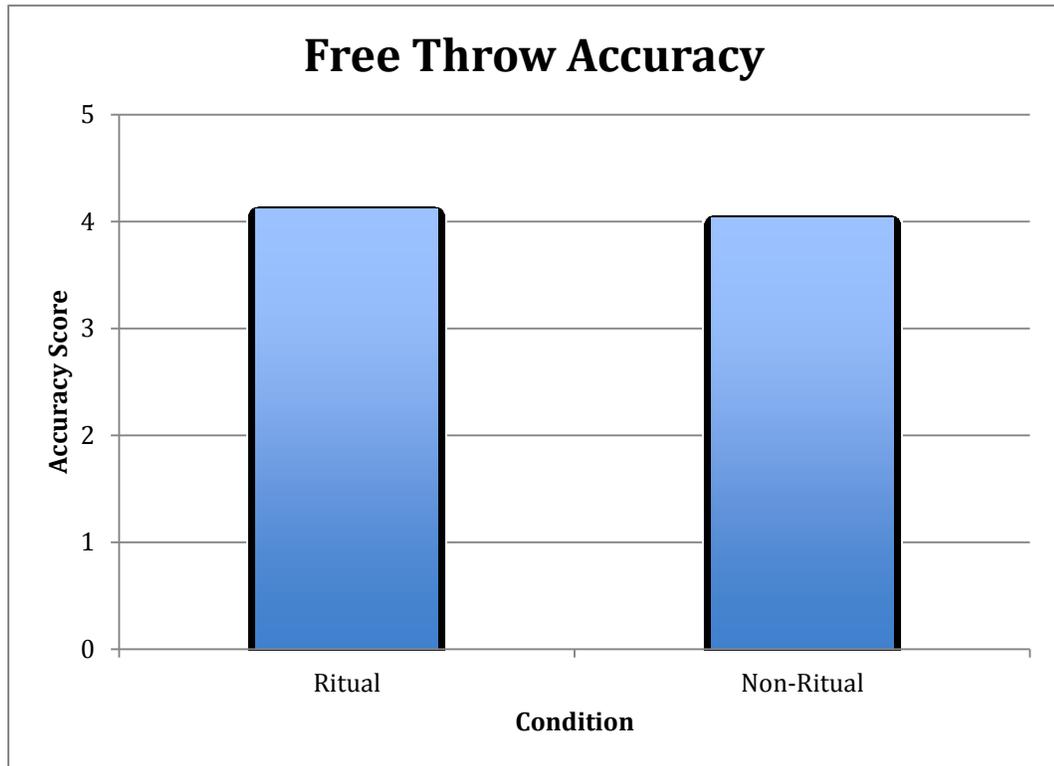
FIGURES

Figure 1. Mean free throw accuracy scores for ritual and non-ritual conditions. See text for an explanation of accuracy scores.

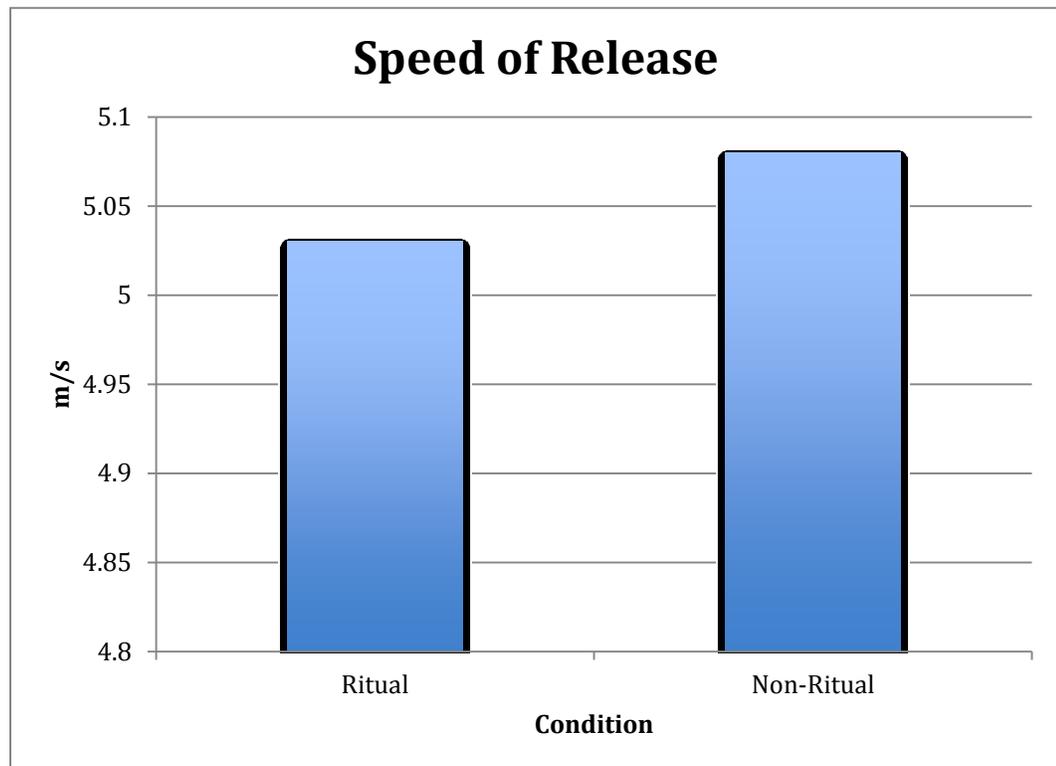


Figure 2. Mean values for speed of release for ritual and non-ritual conditions.

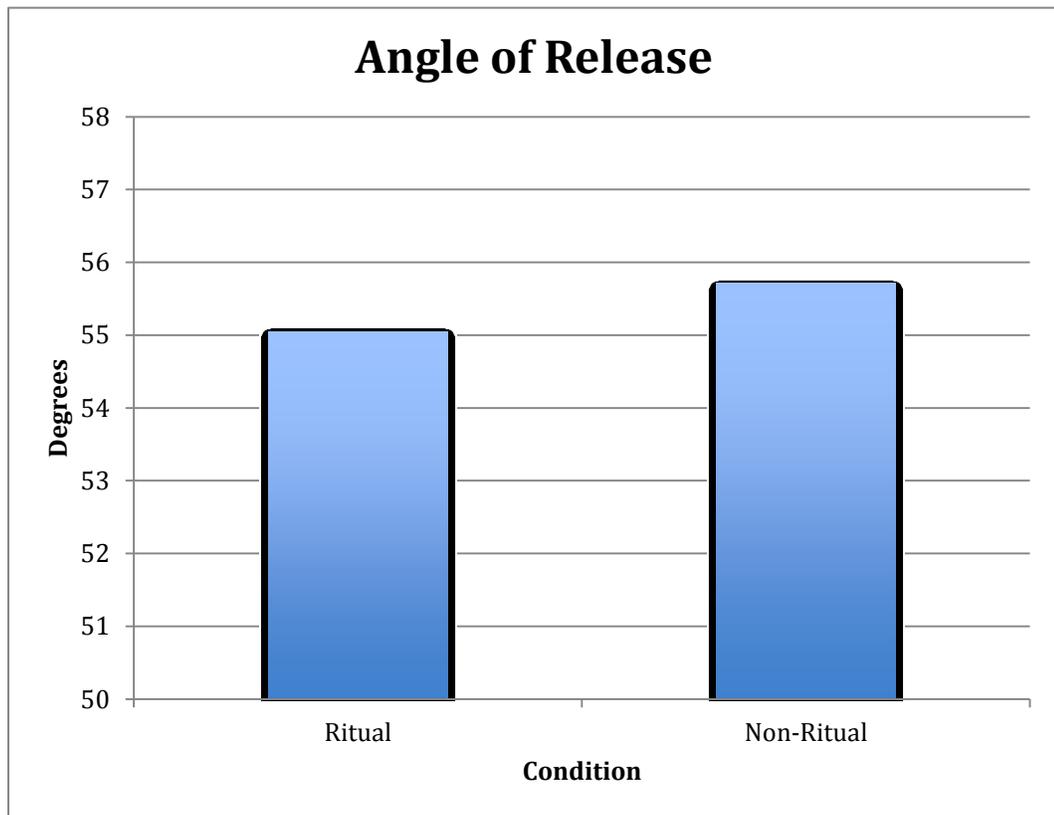


Figure 3. Mean values of angle of release for ritual and non-ritual conditions.

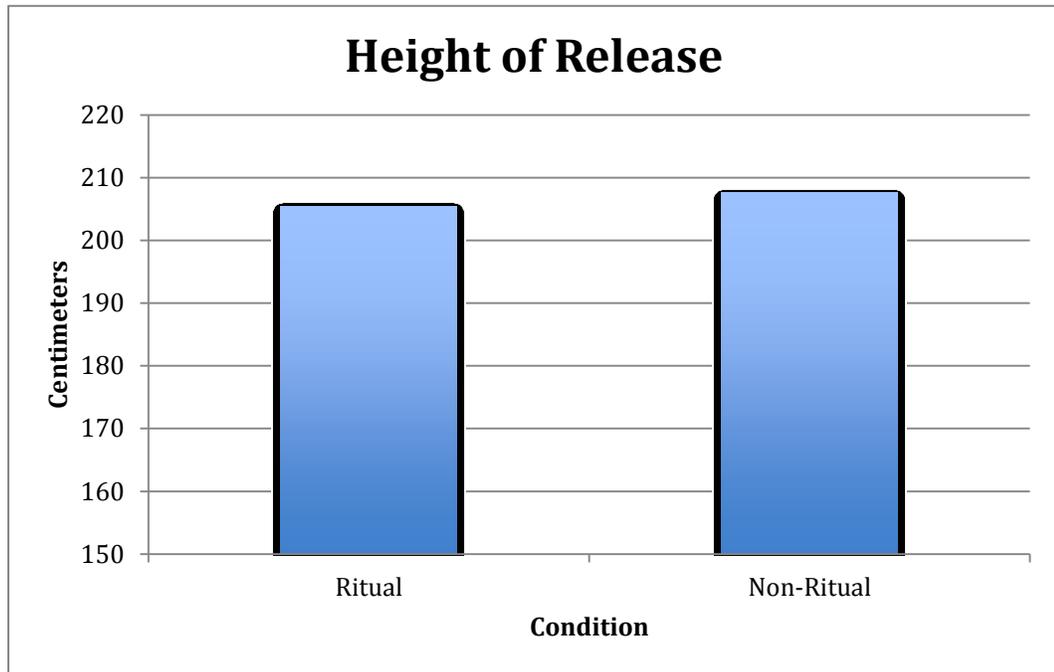


Figure 4. Mean values of height of release for ritual and non-ritual conditions.

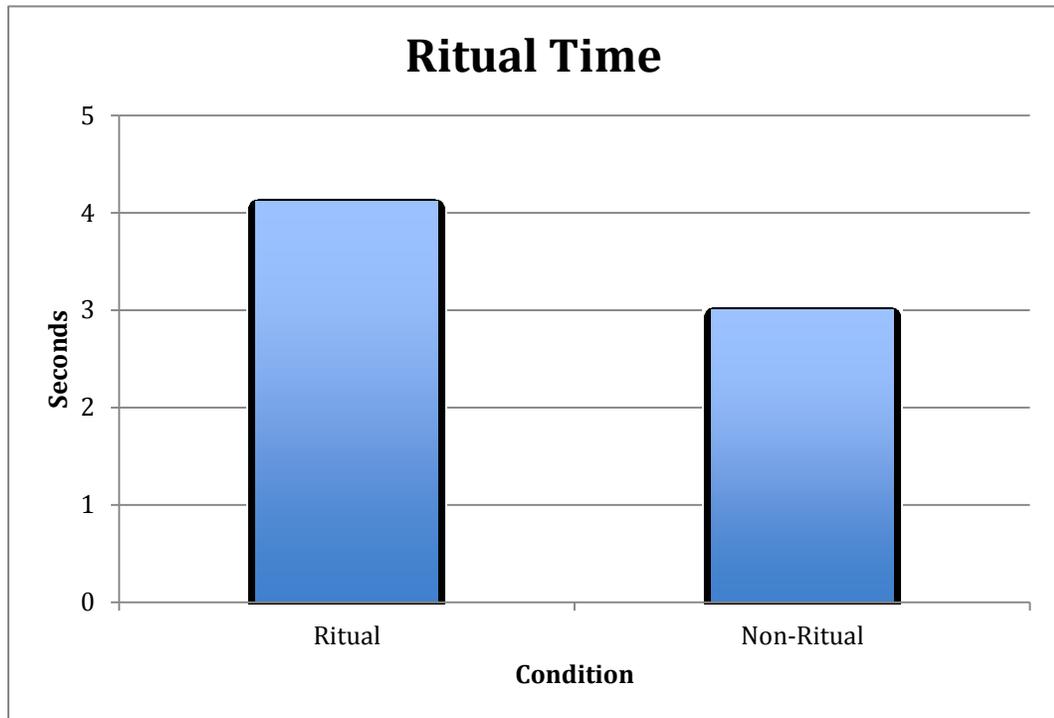


Figure 5. Mean values for ritual and non-ritual conditions of time of start to release of the ball.

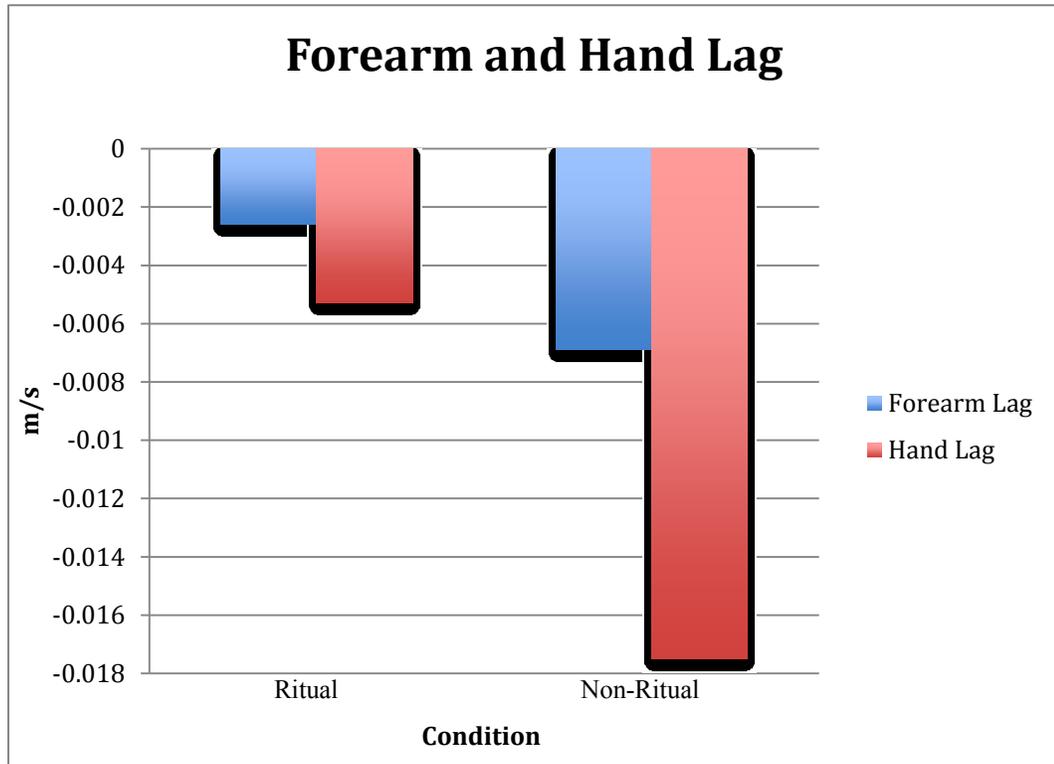


Figure 6. Mean values of forearm lag and hand lag for ritual and non-ritual conditions.

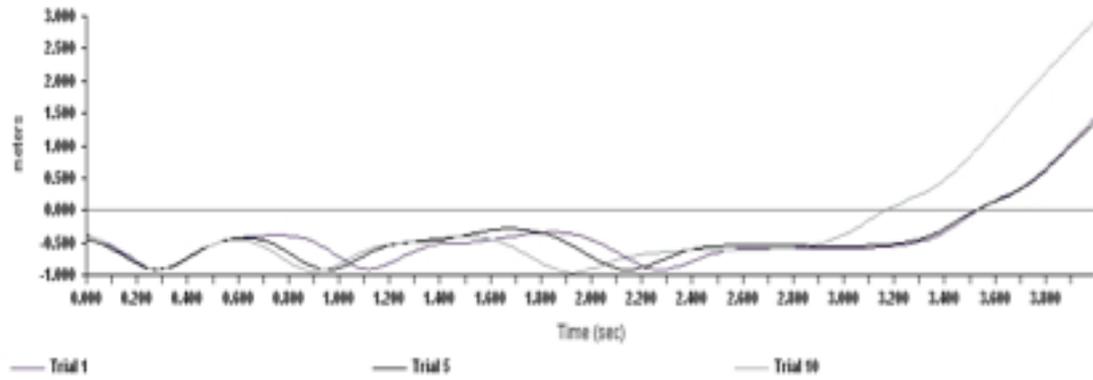


Figure 7. Trajectory graph of trials 1, 5, and 10 of Subject 1.

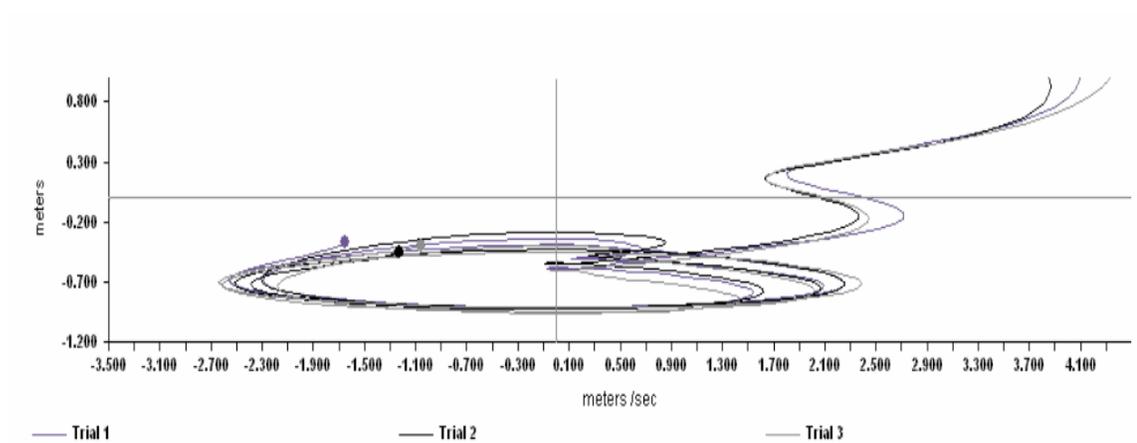


Figure 8. Phase plane of trials 1, 5, and 10 for Subject 1.

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## ABSTRACT

The purposes of this study are to determine if: 1) the kinematics (speed, height, angle of release) of a free throw change when physically performing and only thinking about a pre-performance ritual; 2) free throw percentage changes when the shooter physically completes a pre-performance ritual versus when they only think about the pre-performance ritual; and 3) the motor pattern of the performer changes when rituals are and are not incorporated with the performance. Ten (7 men and 3 women) experienced basketball players defined as having played varsity high school basketball or better, served as subjects for this study. Subjects performed 10 free throws under two conditions on two separate days. Condition 1 required subjects to use their normal free throw ritual. Condition 2 required the subjects to mentally think through their ritual with no movement prior to shooting. Kinematics of the shot (height, angle, and speed of release), free throw accuracy, ritual time, and motor pattern were dependent measures for the study. T-tests indicated a significant increase in speed of release, and one-way MANOVA indicated a significant difference between the conditions for absolute but not relative hand lag during the free-throw shot. It was concluded that there were no significant differences in accuracy, kinematics, or motor pattern when performers perform their ritual or only think about their ritual before shooting a free throw.