UNIVERSITY OF CINCINNATI

Date: 21-Sep-2009

I, Julie A Weast, hereby submit this original work as part of the requirements for the degree of:

Master of Arts

in Psychology

It is entitled:

Expert sensitivity to kinematic information in perception of affordances for others.

Student Signature: Julie A Weast

This work and its defense approved by:

Committee Chair: Kevin Shockley, PhD

Kevin Shockley, PhD

Michael Riley, PhD

Michael Riley, PhD

Sarah Cummins-Sebree, PhD

Sarah Cummins-Sebree, PhD
Expert Sensitivity to Kinematic Information in Perception of Affordances for Others

A thesis submitted to the

Division of Graduate Education and Research
of the University of Cincinnati

in partial fulfillment of the
requirements for the degree of

MASTER OF ARTS

in the Department of Psychology
of the McMicken College of Arts and Sciences
Autumn 2009

by

Julie A. Weast

Bachelor of Arts in Psychology
Ohio University, 2007

Committee: Kevin Shockley, Ph.D (chair)
Michael A Riley, Ph.D
Sarah Cummins-Sebree, Ph.D
Abstract

Humans can perceive affordances both for themselves and for others, and perception of affordances is a function of perceptual-motor experience that may result, for example, from playing a sport. Enhanced perceptual sensitivity resulting from sport experience may indicate a type of perceptual learning via attunement. Athletes have been shown to be more accurate at perceiving a sport-relevant action-scaled affordance for another person when compared to non-athletes, but are no better at perceiving sport-relevant and sport-irrelevant body-scaled affordances for another. The current study investigated the informational basis for this enhanced perceptual ability by evaluating whether kinematics inform perceivers about action-scaled, but not body-scaled, affordances for others, and whether athletic experience enhances sensitivity to kinematic information. Perceptual reports of basketball players for an action-scaled (reach-with-jump) affordance, but not body-scaled (standing-reach and sit) affordances, improved with exposure to kinematic information, while non-basketball players did not improve in any affordance reports after exposure to kinematic information. This indicates non-athletes may be less experienced in extracting relevant information from walking kinematics that specifies another person’s action capabilities. These results suggest action-scaled affordances may be specified by kinematic information to which athletes are already attuned by virtue of their sport experience.
Acknowledgments

I would like to sincerely thank my thesis committee, Drs. Kevin Shockley, Michael Riley and Sarah Cummins-Sebree, for their help and support while working on this project. I would also like to thank Kenneth Wright and Michael Tolston, for their help and good company during the data collection.
# Table of Contents

**List of Figures**........................................................................................................................................... vii

**Chapter I: Introduction**............................................................................................................................. 1

Affordances and perceptual-motor experience .............................................................................................. 1

Body-scaled vs. action-scaled affordances ........................................................................................................ 6

Expert sensitivity to kinematic information .................................................................................................... 8

**Chapter II: Methods**................................................................................................................................. 12

Participants...................................................................................................................................................... 12

Apparatus....................................................................................................................................................... 12

Procedure....................................................................................................................................................... 13

**Chapter III: Results**................................................................................................................................ 17

Participant self-ratings ................................................................................................................................... 17

Affordance reports ....................................................................................................................................... 17

**Chapter IV: Discussion**............................................................................................................................. 21

Perceptual learning....................................................................................................................................... 22

Kinematic influences on body-scaled affordances ......................................................................................... 24

Summary and conclusions ............................................................................................................................. 26

**References**................................................................................................................................................ 27

**Appendices**............................................................................................................................................... 31
List of Figures

Figure 1. Main effects of perceiver type and affordance target for accuracy of standing-reach reports (left) and interaction of perceiver type and affordance target for accuracy of reach-with-jump reports (right) for Weast et al. (2009).

Figure 2. Main effect of affordance target for accuracy of sitting reports for Weast et al. (2009).

Figure 3. Apparatus and position of participant, model and experimenter for standing-reach, reach-with-jump and sitting conditions.

Figure 4. Puzzle task in no-kinematics control condition (left) and walking task in kinematics condition (right).

Figure 5. Main effect of phase for accuracy of standing-reach reports.

Figure 6. Interaction of phase × information × perceiver type for accuracy of reach-with-jump reports.

Figure 7. Main effect of phase (left) and interaction of perceiver type × information (right) for accuracy of sitting reports.
Chapter I: Introduction

Affordances and perceptual-motor experience

A natural part of ordinary perception is the perception of affordances. Affordances are invariant combinations of surface/substance properties of our environment taken with reference to an animal’s action capabilities (Turvey, 1992); in other words, by describing the environment in terms of an animal’s action capabilities, affordances describe possibilities for action (Gibson, 1986). Affordances change with changes in one’s action capabilities, and affordance perception is accordingly dynamic. For example, Mark (1987) demonstrated that observers can perceive the maximum height at which they can sit, which corresponds to a rigid surface that is 45% of the observer’s eye height. Importantly, Mark also found that perception changes with experience. He showed that if a perceiver wears blocks on the feet, changing the maximum sit-on-able height to 50% of the perceiver’s eye height, the perceiver will initially provide inaccurate maximum sitting height reports based on the perceiver’s previous fit to the environment. However, after a brief experience of walking on the blocks, perceivers re-calibrate to this change in their action capabilities quickly, and accurately perceive the maximum height of what is sit-on-able with their “new legs.” This recalibration of perceptual boundaries is attributed to the perceiver’s ability to attune to eye-height scaled optical information about environmental properties (Mark, 1987; Mark, Balliett, Craver, Douglas, & Fox, 1990).

Previous research has also demonstrated that humans can perceive affordances for others (i.e., what the environment affords another person). Ramenzoni, Riley, Shockley, and Davis (2008b) have shown that observers are able to perceive how high another can reach overhead while standing as well as how high another person can reach while jumping. Likewise,
Stoffregen, Gorday, Sheng, and Flynn (1999) found observers can differentiate the maximum height at which different sized people could sit. These studies are evidence that observers are capable of distinguishing their own capabilities from those of others (see also, Mark, 1990; Mark et al., 2007; Ramenzoni et al., 2008b; Ramenzoni, Riley, Davis, Shockley, & Armstrong, 2008a).

Perception of affordances is also a function of perceptual-motor experience. Hove, Riley, and Shockley (2006) demonstrated that hockey players perceive which hockey sticks are better for power versus precision shots differently than non-hockey players. They differentially weighted hockey sticks and asked expert hockey players and novices to rate which sticks were suitable for making a power shot. The hockey sticks with the weights positioned distal to the grip were most effective for making a power shot. They discovered that novice hockey players reported proximally weighted hockey sticks to be optimal for a power shot while expert hockey players reported the distally weighted stick as optimal. This pattern of results persisted even after brief experience with the affordance in question. This is evidence that athletes appear to be differentially attuned to information specifying sports-relevant affordances when compared to non-athletes (e.g. object properties discovered while using dynamic touch to wield the hockey sticks) because of their extensive sport experience.

This perceptual sensitivity may indicate a type of perceptual learning via attunement—that is, perceptual-motor experience in a sport aids the discovery of information that is specific to a sport-relevant affordance (Abernathy, Gill, Parks, & Packer, 2001; Hove et al., 2006; Jacobs & Michaels, 2007). The implication is that experts in a particular sport may have over-developed capacities for perception and may, therefore, be more sensitive to perceiving affordances related to their skill domain as compared to non-experts (Fajen, Riley, & Turvey, 2008).
Given the fact that humans can perceive affordances for others and that athletes with extensive experience in a particular sport may be differentially sensitive to perceptual information about affordances related to their domain of sports, Weast, Wright, Tolston, Shockley, and Riley (2009) investigated whether basketball players are more accurate at perceiving basketball-relevant affordances than non-basketball players. Basketball players were hypothesized to be more accurate at perceiving basketball-relevant affordances (the maximum height one can reach overhand while standing and the maximum height one can reach overhand by jumping) than non-basketball players both for themselves and for another person. This hypothesis was motivated by the fact that basketball players have greater experience observing others jumping to reach basketballs or the rim, as well as observing others reaching overhand to receive passes, block, and guard. Basketball players were not expected to be more accurate than non-basketball players at perceiving a non-basketball-related affordance (the maximum height at which one can sit upon a surface) both for themselves and another, as their basketball experience does not entail any greater experience with sitting.

Accuracy of the participants’ affordance predictions was evaluated by Weast et al. (2009) using the ratio of the provided perceptual report divided by the actual affordance height of the subject or model for all three affordances (standing-reach, reach-with-jump, sit). For standing-reach reports, basketball players were significantly different than non-basketball players, and standing-reach reports for others were significantly different than those for self. Although basketball players were more accurate in their perceptual reports for self than non-basketball players, they still significantly underestimated maximum standing-reach height. In contrast to Weast et al.’s (2009) hypothesis, basketball players significantly overestimated standing-reach
reports for other, while non-basketball players’ reports were not significantly different from 1.00 (i.e., non-basketball players were accurate) (see Figure 1, left).

Figure 1. Main effects of perceiver type and affordance target for accuracy of standing-reach reports (left) and interaction of perceiver type and affordance target for accuracy of reach-with-jump reports (right) for Weast et al. (2009).

For reaching-with-jump reports, basketball players exhibited less error overall than non-basketball players. There was a significant interaction between perceiver type and affordance target, revealing a significant difference between basketball and non-basketball players in the accuracy of their perceptual reports for other but no difference in the accuracy of their perceptual reports for self. Specifically, basketball players’ reports for other were significantly more accurate than both non-basketball reports for other as well as non-basketball reports for self, but were not significantly more accurate than their (basketball players’) reports for self (see Figure 1, right). Basketball players’ reach-with-jump reports for other were the only reports with ratios not significantly different from 1.00 (i.e., the only reports that were accurate).

As predicted by Weast et al. (2009), basketball players were not significantly different than non-basketball players at perceiving the maximum height at which they could sit. Sitting reports for self were, however, more accurate than reports for other in both groups (see Figure 2), and all sitting reports were significantly underestimated.
Figure 2. Main effect of affordance target for accuracy of sitting reports for Weast et al. (2009).

Athletes know how to perceive and act in contexts related to their skill domain because they are closely coupled with their sport environment; presumably their specific perception and action experiences regulate their sports performance by attuning them to relevant perceptual information (Araújo & Davids, 2009). Because of their extensive experience in playing a sport, athletes have been found to be more sensitive to perceiving affordances related to their sport (Abernethy et al., 2001; Hove et al., 1999). Weast et al. (2009) demonstrated that basketball players were more accurate than non-basketball players at perceiving the experience-relevant affordance, maximum reach-with-jump height for another. However, basketball players were no more accurate at perceiving maximum standing-reach or sitting heights for another than non-basketball players.

The superior accuracy by basketball players in perceiving reach-with-jump affordances for others is evidence that athletes are differentially sensitive to information specifying this action possibility. However, the fact that basketball players were not more accurate at perceiving another basketball-relevant affordance, namely maximum standing-reach height, suggests that these two basketball-relevant affordances may be specified by different types of information. In order to gain insight on this issue, the current study investigated the nature of the information to which experienced basketball players are better attuned.
Body-scaled vs. action-scaled affordances

Fajen et al. (2008) have identified two categories of affordances—body-scaled affordances (e.g., step-on-ability, sit-on-ability, pass-under-ability) and action-scaled affordances (e.g., braking distance, jumping to reach) (see Fajen et al., 2008, for a review). Body-scaled affordances are a function of the relation between (usually geometric) properties of the environment and some (usually geometric) dimension of the body of the perceiver that determine whether an action is possible for the perceiver. For example, Warren (1984) demonstrated the relation of the height of a step and a person’s leg length determines if the step is climbable for that person (see also Cesari, Formenti, & Olivato, 2003; Konczak, Meeuwsen, & Cress, 1992). Action-scaled affordances are a function of the relation between properties of the environment and the action capabilities of the perceiver that determine whether an action is possible for the perceiver (e.g., Fajen, 2007; Ramenzoni et al., 2008a). For example, Ramenzoni et al. (2008a) demonstrated that the relation between the height of an object and the force-production capabilities of a person determines if the object is reachable by jumping. The perception of body-scaled affordances of an observer appears to be constrained by the body dimensions of the observer, whereas the perception of action-scaled affordances appears to be constrained by the action capabilities of the observer.

This distinction is important because it suggests that action-scaled affordances require perceptual information about forces (or the capacity to produce them), while body-scaled affordances do not. Accordingly, action-scaled affordances for others may be specified by a different type of perceptual information than body-scaled affordances, namely information in the others’ movement patterns (i.e., kinematic information [Runeson, 1977/1983]). Runeson (1994) proposed that because motion (i.e., kinematics) is lawfully related to the forces that generated
that motion, information about those forces is available for perceivers in kinematics (the kinematic specification of dynamics [KSD] principle). For example, Ramenzoni et al. (2008a) demonstrated that perception of the maximum reach-with-jump height for another becomes more accurate after observing the other walk. They asked perceivers to provide action-scaled affordance reports for an actor after watching her walk around a room in two separate conditions: once while wearing no weights on her ankles, and once while wearing weights around her ankles hidden beneath her pants to ensure participants were not explicitly aware of the weight manipulation. Participants provided reach-with-jump reports for the actor after watching her walk each time. Subjects reported significantly lower maximum reach-with-jump heights after watching her walk while wearing the weights, reflecting the actual decrease in her maximum reach with jump height that resulted from wearing ankle weights. These results suggest that the actor’s walking pattern revealed information (e.g. the motion of the joint centers on the actor’s body (Abernethy et al., 2001)) about the actor’s capacity to produce a different action, jumping to reach an object.

Results of Ramenzoni et al. (2008a) also suggest only movement that is related to the force production capabilities for the affordance in question is informative about that affordance. For example, Davis, Ramenzoni, Shockley, and Riley (2008) found that individuals become more accurate in their perception of the maximum reach-with-jump height for an actor after they are given the opportunity to watch the actor perform an action that is functionally related to the affordance in question (e.g. squatting) but do not become more accurate after watching the actor perform an action that is not functionally related (e.g. twisting). Kinematic information available in the movement patterns of the actor while he or she is using leg muscles to generate vertically-directed forces while squatting is informative about the actor’s force-production capabilities to
jump to reach an object, whereas information available in the movement patterns of the actor using torso muscles to generate rotational torque is not (Davis et al., 2008; Ramenzoni, Davis, Riley, & Shockley, under review).

*Expert sensitivity to kinematic information*

Perceivers might be informed about action-scaled capabilities of others via kinematics (i.e., the KSD principle; e.g., Ramenzoni et al., 2008a), while body-scaled affordances are specified by eye-height-scaled (geometric) information about environmental properties relative to perceiver properties (Mark, 1987; Ramenzoni et al., 2008a; Warren & Whang, 1987). Weast et al. (2009) found basketball players to be more accurate than non-basketball players at perceiving the basketball-relevant action-scaled affordance of reach-with-jump; however, they were not better at perceiving the basketball-relevant affordance of standing-reach or the basketball-irrelevant affordance of sitting, both of which are body-scaled affordances. Perhaps, through perceptual attunement, novices and experts rely on different informational variables when making judgments about another’s action capabilities (Abernethy et al., 2001; Jacobs & Michaels, 2007). Thus, greater accuracy by athletes in perceiving an action-scaled affordance (reach-with-jump) after exposure to kinematic information but no change in accuracy for perception of body-scaled affordances (standing-reach and sitting) may reflect greater sensitivity of athletes to kinematic information that captures the force production capabilities of others.

The goal of the current study was to evaluate whether kinematics inform perceivers about action-scaled, but not body-scaled, affordances for others, and whether athletic experience enhances sensitivity to the kinematic information. The central hypothesis was that the availability of kinematic information would enhance perception of an action-scaled affordance (reaching with jumping) for another. There were two possible outcomes for this hypothesis. It is
possible that providing basketball players with salient kinematic information available in the walking patterns of an actor will increase their accuracy in perceiving an action-scaled affordance for the actor, as they may be attuned to kinematic information specifying another’s action capabilities than non-basketball players as a result of their sport experience. If so, then perceptual reports of reach-with-jump heights by basketball players would be expected to improve with exposure to salient kinematic information, while non-basketball players would not be expected to improve (or not improve as much), as non-basketball players may not be attuned to the relevant informational variables available in a person’s walking patterns.

If basketball players became more accurate in their reach-with-jump perceptual reports with exposure to salient kinematic information and non-basketball players did not (or improve less than basketball players), and no differences were found between perceptual reports of basketball players and non-basketball players as a function of kinematic information for body-scaled affordances (standing-reach and sitting), this would support the hypothesis that action-scaled affordances are specified by salient kinematic information to which athletes are better attuned than non-athletes.

Alternatively, basketball players may be able to pick up less salient kinematic information from subtle movements in the actor (e.g. small movements while standing near the apparatus, etc.) and may already be attuned to the kinematic information specifying the action-scaled affordance of reach-with-jump. This perceptual sensitivity may explain why basketball players are better than non-basketball players at making reach-with-jump judgments without any salient kinematic information available (cf. Weast et al., 2009). If this was the case, perceptual reach-with-jump reports of non-basketball players would be expected to improve with exposure to salient kinematic information while basketball players would not be expected to improve, as
basketball players may be maximally attuned to the informational variables necessary for perceiving reach-with-jump affordances for others and would have little opportunity for improvement in accuracy. If non-basketball players became more accurate in their reach-with-jump perceptual reports with exposure to salient kinematic information and basketball players did not (or improved less than non-basketball players), and no differences were found between perceptual reports of non-basketball players and basketball players as a function of kinematic information for body-scaled affordances (standing-reach and sitting), this would support the hypothesis that action-scaled affordances are specified by kinematic information that athletes can detect without having to view more salient actor motions that are meant to reveal the information, allowing non-basketball players the opportunity for greater improvement in accuracy when compared to basketball players.

By hypothesis, action-scaled, but not body-scaled, affordances are specified by kinematic information. Therefore, a corollary hypothesis to the central hypothesis was that neither perceptual reports for standing-reach nor for sitting, both of which are body-scaled affordances, were expected to improve following exposure to kinematic information for both basketball and non-basketball players. Based on the findings of Weast et al. (2009), basketball players were not expected to be any more accurate at perceiving standing-reach and sitting affordances for others than non-basketball players in both the kinematic and no-kinematic conditions.

Hypotheses were evaluated by obtaining perceptual reports from basketball players and non-basketball players with (experimental group [kinematics]) and without (control group [no-kinematics]) exposure to the walking patterns of the actor for maximum reach-with-jump height (action-scaled), standing-reach height (body-scaled), and sitting height (body-scaled)
affordances. Participants provided perceptual reports for the model only; affordance estimates for self were not obtained.

Although all participants were expected to improve over the course of making successive estimations (i.e., from Phase 1 to Phase 2; e.g., Mark et al., 1990; Ramenzoni et al., 2008a), this improvement was not expected to vary as a function of kinematic information (i.e., the [experimental] group provided with explicit kinematic information was not expected to be different than the [control] group not provided with explicit kinematic information) for maximum standing-reach height and maximum sitting height.
Chapter II: Method

Participants

Forty-eight male undergraduate students at the University of Cincinnati participated in this study in exchange for course credit. Twenty-four participants had not played on an organized basketball team within two years prior to participating in the study (non-basketball players) and twenty-four had played on an organized basketball team within two years prior to participating in the study (basketball players). Basketball players ranged in height from 166.0 to 198.5 cm (mean = 182.2 cm, \(SD = 7.5\) cm) and ranged in eyeheight from 155.0 to 188.0 cm (mean = 171.9 cm, \(SD = 7.9\) cm). Non-basketball players ranged in height from 168.0 cm to 201.0 cm (mean = 179.2 cm, \(SD = 7.6\) cm) and ranged in eyeheight from 157.5 cm to 190.0 cm (mean = 168.5 cm, \(SD = 7.5\) cm). The model (for which perceptual reports were provided) had a height of 186 cm and an eyeheight of 175.5 cm.

Apparatus

A large wooden apparatus (325 cm high \(\times\) 95 cm wide) covered with a black tarp perpendicular to the floor was used as the backdrop for the moving object and plank (see Figure 3). For standing-reach and reach-with-jump reports the target was a small cylindrical object (5 cm \(\times\) 4 cm) suspended from the ceiling and attached to a pulley in front of the wooden apparatus (cf. Ramenzoni et al., 2008b; see Figure 3, left). For sitting reports, the target was a wooden plank (85 cm long \(\times\) 35 cm wide) attached to the same pulley (cf. Mark, 1987; Stoffregen et al., 1999; see Figure 3, right).
Figure 3. Apparatus and position of participant, model and experimenter for standing-reach, reach-with-jump and sitting conditions.

An additional room was also used in which tasks for both the control (no-kinematics) and experimental (kinematics) conditions were completed. The no-kinematics condition included a simple puzzle task for which participants were instructed to write as many differences as could be found between two pictures during a two-minute period (see Appendix A). The kinematics condition included no additional materials.

All participants completed two questionnaires regarding their past and current basketball experience after providing all perceptual reports. These included a Trait-Sport Confidence Questionnaire (Vealey, 1986; see Appendix B) as well as a Physical Self-Efficacy Questionnaire (Ryckman, Robbins, Thornton, & Cantrell, 1982; see Appendix C).

Procedure

Participants provided three types of perceptual reports for themselves and for a model actor. These estimates included the maximum height that could be reached overhand vertically while standing on the floor (standing-reach), the maximum height than could be reached overhand vertically by jumping from the floor (reach-with-jump), and the maximum height of a
sitting plank upon which one could sit without lifting the heels of the feet from the floor (sit). Standing-reach height was defined to participants as the maximum height at which the model could reach and touch the object with his fingertips while standing, without lifting his heels from the floor. Reaching-with-jump height was defined as the maximum height at which the model could touch the object with his fingertips while performing a vertical jump from a standing-still position. Sitting height was defined as the maximum height of the sitting plank upon which the model could sit without lifting the heels of his feet from the floor.

All participants were asked to remove their shoes for the duration of the study. Consistent with previous affordance studies of this type (Ramenzoni et al., 2008a; Ramenzoni et al., 2008b), participants stood 3 m from the front of the apparatus. The model stood directly beside the apparatus while observers provided perceptual reports, allowing participants to see the model clearly while providing all three types of reports.

For standing-reach and reach-with-jump perceptual reports, perceivers directed the experimenter (who was standing out of sight, behind the apparatus) to stop moving the small cylindrical object (which started at either a low height and moved up or a high height and moved down, with the starting position randomized across trials) when it was at the maximum height at which the model could reach it while standing or jumping (depending on the affordance in question). For sitting perceptual reports, participants were asked to report the maximum height of the plank upon which the model could sit without lifting the heels of the feet using the same procedure. After informing the experimenter to stop moving the target on the apparatus, the participant was allowed to make fine adjustments to the position of the target. The height corresponding to the participant’s perceptual reports (in cm) as indicated by occluded measuring tape attached to the apparatus was recorded by the experimenter.
Participants provided the three types of perceptual reports (maximum standing-reach, reach-with-jump, and sitting heights) for the model in two separate phases of eight trials each. During phase 1, all participants provided perceptual reports for the model that were randomized by block for each affordance type (standing-reach, reach-with-jump and sit) in order to determine baseline accuracy of perceptual reports for each affordance. Next, participants were brought into an adjacent room and randomly assigned to either a control condition with no exposure to kinematic information, or an experimental condition with exposure to kinematic information.

Participants in the no-kinematics condition completed a simple puzzle task in-between phases 1 and 2 during which they were instructed to write as many differences as could be found between two pictures during a two-minute period (an example picture is illustrated in Appendix A). Participants in the control condition never saw the model walk and thus had no access to salient kinematic information available in his walking patterns.

Participants in the kinematics condition watched the model walk in between phases 1 and 2. Participants were instructed to follow approximately 1 m behind the model as he walked in a circle around the room five times (cf. Ramenzoni et al., 2008a). After either completing the puzzle task (no-kinematics [control] condition) or watching the model walk (kinematics [experimental] condition), participants returned to the apparatus to provide a second phase of perceptual reports (in the same order as phase 1) for all three affordance types (see Figure 4).
After completing three blocks (one for each affordance type; standing-reach, reach-with-jump, and sit) of eight trials in each phase, the participant approached the apparatus to determine his actual maximum standing-reach and reach-with-jump heights. After determining actual standing reach and reach-with-jump heights, participants then completed two questionnaires regarding their basketball experience (see Appendix B and C). The actual maximum standing-reach height for the model was 230.0 cm, his maximum reach-with-jump height was 280.0 cm, and his maximum sitting height was 78.98 cm. Actual maximum sitting height of the model was calculated based on his measured eye height (175.50 cm) using Mark’s (1987) reported eye-height proportion corresponding to the actual maximum sitting height (maximum sitting height = 0.45 × eye-height).
Chapter III: Results

Participant self-ratings

Participant’s self ratings (see Appendix D and E) of basketball experience and skill were compared by submitting each participant’s score on the Trait-Sport Confidence questionnaire (Vealey, 1986; see Appendix B) and on the Physical Self-Efficacy scale (Ryckman et al., 1982; see Appendix C) to a 2 (perceiver type [basketball vs. non-basketball]) × 2 (information [kinematics vs. no-kinematics]) between-subjects analysis of variance (ANOVA).

A main effect of perceiver type was found for confidence ratings such that basketball players were significantly more confident about their basketball skills when compared to non-basketball players, $F(1,44) = 18.75, p < .0001, 1 - \beta = 0.99, \eta_p^2 = .30$ (1 – β refers to the observed power of the test). A main effect of perceiver type was found for self-efficacy ratings, such that basketball players had significantly higher physical self-efficacy scores when compared to non-basketball players, $F(1,44) = 5.83, p = .02, 1 - \beta = 0.66, \eta_p^2 = .12$. There was no significant influence of information on the confidence or physical self-efficacy ratings, as well as no interactions ($F$s < 1).

A main effect of perceiver type was found for the number of hours spent playing and practicing basketball per week such that basketball players spent significantly more time playing basketball ($F(1,44) = 10.10, p = .003, 1 - \beta = 0.87, \eta_p^2 = .19$) and practicing basketball ($F(1,44) = 14.06, p = .001, 1 - \beta = 0.96, \eta_p^2 = .24$) when compared to non-basketball players. There was no significant influence of information on the number of hours spent playing or practicing basketball per week, as well as no interactions ($ps < 1$).

Affordance reports
Accuracy of each participant’s perceptual reports was indexed using the ratio of the provided perceptual report divided by the actual affordance boundary height of the model for each of the three affordances (maximum standing-reach, reach-with-jump, and sit) as a function of phase (1 or 2), information (kinematic or no-kinematic) and perceiver type (basketball player or non-basketball player). Ratios less than 1.00 indicated an underestimation in affordance judgments, and ratios greater than 1.00 indicated an overestimation. An average ratio for each affordance type was obtained from the eight trials for each participant.

Mean ratios of perceptual report/actual affordance boundary height for each affordance type were submitted to a 2 (perceiver type) × 2 (information) × 2 (phase) mixed analysis of variance (ANOVA) with perceiver type (basketball vs. non-basketball) and information (kinematics vs. no-kinematics [i.e., control]) as between-subjects factors and phase (1 vs. 2) as a within-subjects factor.

For standing-reach estimates, there was no significant influence of information ($F < 1$) or perceiver type ($F(1, 44) = 3.36, p > .05, 1 - \beta = .43, \eta_p^2 = 0.07$) on accuracy of perceptual reports. There was a significant influence of phase, $F(1, 44) = 10.76, p < .005, 1 - \beta = .89, \eta_p^2 = 0.17$, with participants providing more accurate perceptual reports in phase 2 when compared to phase 1 (see Figure 3, left). There were no significant interactions (all $p > .05$).

-----------------------------

Figure 5. Main effect of phase for accuracy of standing-reach reports.
For reach-with-jump perceptual reports, there was a significant main effect of perceiver type, $F(1, 44) = 10.20, \ p < .005, \ 1 - \beta = .88, \ \eta^2_p = 0.19$, with basketball players providing more accurate perceptual reports than non-basketball players. There was a significant main effect of phase, $F(1, 44) = 15.30, \ p < .0005, \ 1 - \beta = .97, \ \eta^2_p = 0.26$, with participants providing more accurate perceptual reports in phase 2 when compared to phase 1. There was no main effect of information on accuracy of reports ($F < 1$). There was a significant perceiver type $\times$ phase $\times$ information interaction, $F(1, 44) = 4.51, \ p = 0.39, \ 1 - \beta = .55, \ \eta^2_p = 0.09$ (see Figure 3, center). Bonferroni-corrected post-hoc tests revealed basketball players in the kinematics condition were the only group to significantly improve in accuracy between phase 1 and phase 2 and were significantly more accurate than non-basketball players in phase 2 when kinematic information was available ($p < .00178$; all other $p > .00178$).

Figure 6. Interaction of phase, information and group (perceiver type) on accuracy of reach-with-jump reports.

For sitting perceptual reports, there was a significant main effect of phase with participants providing overall less accurate perceptual reports in phase 2 when compared to phase 1, $F(1, 44) = 7.63, \ p = .008, \ 1 - \beta = .77, \ \eta^2_p = 0.15$. There was also a significant perceiver type $\times$ information interaction, $F(1, 44) = 5.25, \ p = .03, \ 1 - \beta = .61, \ \eta^2_p = 0.11$ (see Figure 3, right). Bonferroni-corrected post-hoc tests revealed no significant differences between perceptual
reports of both basketball and non-basketball players in both information conditions (all $p > .0083$), however the pattern of results suggests that accuracy of non-basketball players was greater without kinematic information than with kinematic information, and that non-basketball players were more accurate than basketball players without exposed to kinematic information. No other interactions were significant (all $p > .05$).

---

Figure 7. Main effect of phase (left) and interaction of perceiver type × information (right) for accuracy of sitting reports.
Chapter IV: Discussion

The current study investigated the informational basis for the enhanced perceptual ability of basketball players to perceive maximum reach-with-jump height for others by evaluating whether kinematics inform perceivers about action-scaled, but not body-scaled, affordances for others, and whether basketball experience enhances sensitivity to this kinematic information. After being provided with salient kinematic information available in the walking patterns of a model, basketball players significantly improved in the accuracy of their reach-with-jump perceptual reports, whereas non-basketball players did not. Neither basketball nor non-basketball players showed improvement in the accuracy of their perceptual reports for standing-reach and sitting affordances (body-scaled affordances) with exposure to kinematic information. This pattern of results is consistent with the proposed hypotheses that action-scaled affordances are specified by kinematic information (i.e. via the KSD principle; Runeson, 1994), and that basketball players can more readily profit from salient kinematic information than non-basketball players, possibly because they are already attuned to this source of information about a basketball-relevant action capability of another.

Perceiving action-scaled affordances for another person is crucial in sports, as athletes need to be able to perceive the action capabilities of both their opponents and teammates within fractions of a second in order to be successful (Araújo & Davids, 2009; Fajen et al., 2008). Enhanced action-scaled affordance perception by basketball players is evidence that athletes, when compared to non-athletes, are better attuned to salient kinematic information that specifies action-scaled affordances for others as a result of their sport experience. However, the present study is limited in its ability to address the information to which athletes are attuned. It is possible, for example, that basketball players (and perhaps athletes overall) are attuned to
kinematic information specifying action-scaled affordances, generally, rather than sport-specific action-scaled affordance information. In order to address this possibility, performance of basketball players and non-basketball players on both a basketball-relevant, action-scaled affordance (e.g., reach-with-jump) and a non- (or less) basketball-relevant, action-scaled affordance (e.g., maximum long-distance jump) must be compared as a function of exposure to kinematic information. If basketball players are attuned to basketball-relevant kinematic information, they would be expected to improve more on the basketball-relevant, action-scaled affordance than the non-basketball-relevant, action-scaled affordance when exposed to kinematic information. Alternatively, if basketball players are attuned to kinematic information in general rather than kinematic information specifying sport-specific affordances, they would be expected to improve in both the basketball-relevant and non-basketball relevant action-scaled affordances.

Perceptual learning

Gibson (1986) claimed that information specifying affordances is public, available to perceptual systems in ambient energy array patterns that are directly perceived by the observer. Affordances permit behavior for a perceptual system, and importantly, they are properties of the environment that are specific to the perceiver. When perceivers become sensitive to an informational variable that is specific to the affordance in question, their ability to successfully act in their environment is enhanced. This change (also called “education of attention”; Jacobs & Michaels, 2007; Michaels & Carello, 1981) is a form of direct perceptual learning: by attuning to different informational variables that provide more useful information about the animal’s capability to perform an action, the animal changes (improves) its fit with the environment (Jacobs & Michaels, 2007).

In the realm of athletic expertise, perceptual learning by athletes appears “to be characterized by progressive perceptual discrimination, increased attunement to distinctive features in the opponent’s kinematics and, likely, the optimization of attention to the essential informative features” (Abernethy et al., 2001, p. 241). Their perceptual sensitivity may indicate perceptual learning by attunement to the appropriate informational variables available while perceiving another’s action capabilities as a result of perceptual-motor experience in their sport (Abernathy et al., 2001; Hove et al., 2006; Jacobs & Michaels, 2007). However, it is also possible that it is not experience with the action in question alone but rather their experience with direct feedback for the success or failure of the action in question that attunes athletes to the informational variables useful for perceiving affordances (Jacobs, Runeson, & Michaels, 2001; Withagen & Michaels, 2005). Providing feedback while learning to perceive an affordance stops the actor from relying on nonspecifying variables (e.g. informational variables that are not specific to the affordance in question) and instead rely on variables that do specify the affordance. Thus, athletes may have over-developed capacities for attuning to informational variables relevant to their sport, which renders them more sensitive to perceiving affordances related to their sport when compared to non-athletes (Fajen et al., 2008).

An alternative, but not mutually exclusive, possibility is that providing feedback allows calibration to informational variables to which perceivers are already attuned; that is, observers adjust their scaling of certain informational variables (Jacobs & Michaels, 2007). For example, feedback for perception of a particular action (e.g. jumping to reach) may not attune the observer to a different informational variable, but instead may allow calibration to occur such that the observer modifies their response to (e.g. perceptual reports corresponding to values of) an informational variable rather than relying on different informational variables (Jacobs &
Michaels, 2007). It has also been shown that perception of affordances can improve without explicit performance feedback. Mark et al. (1990) found that participants improved in their perception of their maximum sitting height over time without any explicit feedback; however, when the participants were restrained from making any movements (e.g. subtle movements in postural sway), their performance did not improve. Visual perception of affordances in both athletes and non-athletes must be further explored in order to determine the role of feedback in attuning observers to informational variables (Davis et al., 2008; Jacobs & Michaels, 2007; Mark et al., 1990; Ramenzoni et al., under review).

**Kinematic influences on body-scaled affordances**

There were two unexpected findings with respect to sitting reports in the present study. Participants, generally, became less accurate in phase 2 relative to phase 1, and accuracy of non-basketball players declined following exposure to kinematic information. These findings may be related to findings by Stoffregen et al. (1999) that observers were able to differentiate the maximum sitting height of a short and tall model after watching a point-light display video. Videos showed models standing next to a chair (upon which they were to sit) while marching in place, squatting, and sitting on an unseen stool next to the chair in question, as well as walking both towards and away from the camera with the chair alongside and in the middle of their walking path. This was evidence that kinematic information available in the actions of the models influenced the observer’s predictions about the actor’s maximum sitting height (a body-scaled affordance).

However, in another manipulation of the task, the chair was removed from the videos in which the models performed the same actions as in the previous experiments (marching in place, squatting, sitting on an unseen stool, and walking both towards and away from the camera).
Instead, the actual chair was placed next to the monitor on which the videos were shown to the observers, such that the physical chair was always in view while the videos were being watched but was not featured in the point-light displays. Observers were again asked to report the maximum sitting height of the models. Without the chair present in the video relative to the model, observers were unable to differentiate the sitting capabilities of the short and tall model. They concluded that “perception of relations between the actors and the chair that have consequences for the actors' behavior may depend on the availability of direct information about those relations, not on the independent availability of information about the component parts of the relation”, suggesting “information for the perception of affordances may be much different from information for the perception of the properties of events or objects” (Stoffregen et al., 1999, p.133).

These findings may help to explain findings of the current study, as all participants were never near perfect accuracy in their sitting reports for the model, and actually became less accurate in the second phase of the present study. Perhaps the availability of kinematic information without the chair in sight actually distracted the observers, which then influenced the accuracy of their sitting reports. This would explain the pattern of results in the accuracy of sitting perceptual reports by non-basketball players in the kinematics condition. If this is the case, however, the kinematic influence would only be expected to be present in terms of a difference between phases 1 and 2 as a function of kinematic information which was not observed for sitting reports. It seems more likely that the difference in performance as a function of exposure to kinematic information available in the walking patterns of the actor simply reflects a baseline difference between basketball and non-basketball players in their perception of a sitting affordance for the model.
Summary & Conclusions

The results of the current research contribute to a basic understanding of the role of perceptual-motor experience in affordance perception, which is fundamental in understanding the reciprocity of perception and action and their relevance to social cognition (Richardson, Marsh, & Baron, 2007). Importantly, these results support the development of a theoretical framework for research in sports science, as perceptual sensitivity to information about affordances is a significant contributor to an athlete’s success in a sport (Fajen et al., 2008).

The current study provided evidence that athletes were sensitive to kinematic information for an action-scaled affordance related to their sport. Future research may seek to examine whether athletes are differentially sensitive to action-scaled affordances not related to their sport of expertise. Moreover, the particular structure of the information available in kinematics that is specific to action-scaled affordances must be identified in order to demonstrate the perceiver is in fact sensitive to the informational variables in question. Presumably, there is an invariant relation among the moving joints and the corresponding (e.g., forward or vertical) motion of the actor that specifies the force production capabilities of the actor. A first step in identifying the relevant structure in the kinematics of a walker, for example, may be to present perceivers with a point light display of the walking kinematics of an actor both with and without a textured background, which would show forward progress of the movements of the actor relative to observable surface properties of their environment (cf. Stoffregen et al., 1999).
References


Appendix A

Examples of pictures used in simple spot-the-differences puzzle task in no-kinematics control condition.
Appendix B

Trait-Sport Confidence Questionnaire (adapted from Vealey, 1986) (total scores range from 13-117).

Think about how self-confident you are when you compete in basketball.
Answer the questions below based on how confident you generally feel when you play basketball. Compare your self-confidence to the most self-confident basketball player you know.
Please answer as you really feel, not how you would like to feel. Your answers will be kept completely confidential.
If you’ve never played basketball, please estimate to the best of your ability how you think you would perform while playing basketball.

When you play basketball, how confident do you generally feel? (circle number)

1. Compare your confidence in your ability to execute the skills necessary to play basketball successfully to the most confident basketball player you know.
2. Compare your confidence in your ability to make critical decisions while playing basketball to the most confident basketball player you know.
3. Compare your confidence in your ability to perform under pressure to the most confident basketball player you know.
4. Compare your confidence in your ability to execute successful strategy to the most confident basketball player you know.
5. Compare your confidence in your ability to concentrate well enough to be successful to the most confident basketball player you know.
6. Compare your confidence in your ability to adapt to different game situations and still be successful to the most confident basketball player you know.
7. Compare your confidence in your ability to achieve your competitive goals to the most confident basketball player you know.
8. Compare your confidence in your ability to be successful to the most confident basketball player you know.
9. Compare your confidence in your ability to consistently be successful to the most confident basketball player you know.
10. Compare your confidence in your ability to think and respond successfully during competition to the most confident basketball player you know.
11. Compare your confidence in your ability to meet the challenge of competition to the most confident basketball player you know.
12. Compare your confidence in your ability to be successful even when the odds are against you to the most confident basketball player you know.
13. Compare your confidence in your ability to bounce back from performing poorly and be successful to the most confident basketball player you know.

List the number of hours you spend each week doing the following:

Playing basketball,_________________________________
Practicing basketball,_________________________________
Watching basketball on television,_________________________
Watching basketball in person,___________________________
Appendix C

Physical Self-Efficacy Questionnaire (adapted from Ryckman, Robbins, Thornton, & Cantrell, 1982) (total scores range from 22-132).

Please indicate the most suitable choice for you, ranging from Strongly Agree (1) to Strongly Disagree (6).

<table>
<thead>
<tr>
<th>Questions</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Somewhat Agree</th>
<th>Somewhat Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I have excellent reflexes.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>2. I am not agile and graceful.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>3. I am rarely embarrassed by my voice.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>4. My physique is rather strong.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>5. Sometimes I don’t hold up well under stress.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>6. I can’t run fast.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7. I have physical defects that sometimes bother me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>8. I don’t feel in control when I take tests involving physical dexterity.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>9. I am never intimidated by the thought of a sexual encounter.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>10. People think negative things about me because of my posture.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>11. I am not hesitant about disagreeing with people bigger than me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>12. I have poor muscle tone.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>13. I take little pride in my ability in sports.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>14. Athletic people usually do not receive more attention than me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>15. I am sometimes envious of those better looking than myself.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>16. Sometimes my laugh embarrasses me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>17. I am not concerned with the impressions my physique makes on others.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>18. Sometimes I feel uncomfortable shaking hands because my hands are clammy.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>19. My speed has helped me out of some tight spots.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>20. I find that I am not accident prone.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>21. I have a strong grip.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>22. Because of my agility, I have been able to do things which many others could not do.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
Appendix D

Responses to Sports Skill Assessment Questionnaire (adapted from Vealey, 1986).

<table>
<thead>
<tr>
<th>Item Number</th>
<th>Nonball NoKin</th>
<th>Nonball Kin</th>
<th>Bball NoKin</th>
<th>Bball Kin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
</tr>
<tr>
<td>1</td>
<td>3.00 (2.09)</td>
<td>2.58 (2.07)</td>
<td>5.27 (1.74)</td>
<td>6.00 (1.95)</td>
</tr>
<tr>
<td>2</td>
<td>4.25 (2.99)</td>
<td>3.08 (2.35)</td>
<td>6.64 (1.57)</td>
<td>6.25 (1.60)</td>
</tr>
<tr>
<td>3</td>
<td>4.33 (3.26)</td>
<td>3.00 (2.41)</td>
<td>5.55 (1.29)</td>
<td>5.58 (2.39)</td>
</tr>
<tr>
<td>4</td>
<td>3.92 (3.09)</td>
<td>2.67 (2.23)</td>
<td>6.27 (1.19)</td>
<td>6.25 (1.76)</td>
</tr>
<tr>
<td>5</td>
<td>4.25 (3.14)</td>
<td>3.42 (2.57)</td>
<td>7.18 (1.08)</td>
<td>6.42 (1.44)</td>
</tr>
<tr>
<td>6</td>
<td>4.25 (3.05)</td>
<td>2.92 (2.43)</td>
<td>6.64 (1.43)</td>
<td>6.00 (1.71)</td>
</tr>
<tr>
<td>7</td>
<td>4.58 (3.32)</td>
<td>2.92 (2.39)</td>
<td>6.64 (1.36)</td>
<td>6.00 (2.04)</td>
</tr>
<tr>
<td>8</td>
<td>4.50 (3.29)</td>
<td>3.42 (2.97)</td>
<td>6.45 (1.97)</td>
<td>6.17 (1.99)</td>
</tr>
<tr>
<td>9</td>
<td>4.58 (3.40)</td>
<td>3.33 (2.77)</td>
<td>5.64 (2.11)</td>
<td>5.67 (1.83)</td>
</tr>
<tr>
<td>10</td>
<td>4.92 (3.58)</td>
<td>3.50 (2.88)</td>
<td>6.45 (1.29)</td>
<td>6.42 (1.62)</td>
</tr>
<tr>
<td>11</td>
<td>4.83 (3.56)</td>
<td>3.50 (3.06)</td>
<td>6.55 (1.69)</td>
<td>6.42 (2.02)</td>
</tr>
<tr>
<td>12</td>
<td>4.75 (3.47)</td>
<td>3.25 (2.70)</td>
<td>6.00 (1.34)</td>
<td>6.33 (1.97)</td>
</tr>
<tr>
<td>13</td>
<td>4.58 (3.73)</td>
<td>3.50 (2.88)</td>
<td>6.18 (1.60)</td>
<td>6.50 (2.02)</td>
</tr>
</tbody>
</table>
Appendix E

Physical Self-Efficacy Questionnaire (adapted from Ryckman, Robbins, Thornton, & Cantrell, 1982).

<table>
<thead>
<tr>
<th>Item Number</th>
<th>Nonbball NoKin</th>
<th>Nonbball Kin</th>
<th>Bball NoKin</th>
<th>Bball Kin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$ (SD)</td>
<td>$M$ (SD)</td>
<td>$M$ (SD)</td>
<td>$M$ (SD)</td>
</tr>
<tr>
<td>1</td>
<td>5.00 (0.74)</td>
<td>4.17 (1.19)</td>
<td>5.09 (0.54)</td>
<td>5.33 (0.49)</td>
</tr>
<tr>
<td>2</td>
<td>4.25 (1.60)</td>
<td>4.00 (1.21)</td>
<td>4.81 (0.98)</td>
<td>4.67 (1.37)</td>
</tr>
<tr>
<td>3</td>
<td>4.50 (1.38)</td>
<td>4.00 (1.54)</td>
<td>3.45 (1.57)</td>
<td>4.33 (1.61)</td>
</tr>
<tr>
<td>4</td>
<td>4.25 (1.36)</td>
<td>3.58 (1.08)</td>
<td>4.00 (0.89)</td>
<td>4.83 (0.94)</td>
</tr>
<tr>
<td>5</td>
<td>4.75 (1.36)</td>
<td>4.00 (1.41)</td>
<td>4.27 (1.49)</td>
<td>3.83 (1.52)</td>
</tr>
<tr>
<td>6</td>
<td>4.00 (1.54)</td>
<td>3.67 (1.23)</td>
<td>5.27 (0.90)</td>
<td>4.83 (1.64)</td>
</tr>
<tr>
<td>7</td>
<td>4.50 (1.31)</td>
<td>5.00 (1.13)</td>
<td>5.00 (1.18)</td>
<td>4.75 (1.06)</td>
</tr>
<tr>
<td>8</td>
<td>4.58 (1.16)</td>
<td>4.25 (0.97)</td>
<td>5.18 (0.75)</td>
<td>5.00 (0.95)</td>
</tr>
<tr>
<td>9</td>
<td>4.67 (1.23)</td>
<td>4.42 (1.00)</td>
<td>4.36 (1.21)</td>
<td>4.42 (1.51)</td>
</tr>
<tr>
<td>10</td>
<td>4.33 (1.30)</td>
<td>4.92 (0.79)</td>
<td>4.27 (1.49)</td>
<td>4.50 (1.17)</td>
</tr>
<tr>
<td>11</td>
<td>4.67 (1.61)</td>
<td>4.33 (1.37)</td>
<td>4.18 (1.89)</td>
<td>5.17 (0.93)</td>
</tr>
<tr>
<td>12</td>
<td>3.67 (1.56)</td>
<td>3.75 (1.14)</td>
<td>4.27 (1.27)</td>
<td>5.08 (0.97)</td>
</tr>
<tr>
<td>13</td>
<td>4.33 (1.67)</td>
<td>4.00 (1.48)</td>
<td>4.18 (1.40)</td>
<td>5.75 (0.45)</td>
</tr>
<tr>
<td>14</td>
<td>3.25 (1.48)</td>
<td>3.58 (1.16)</td>
<td>3.36 (1.21)</td>
<td>3.17 (1.34)</td>
</tr>
<tr>
<td>15</td>
<td>3.83 (1.53)</td>
<td>3.75 (0.75)</td>
<td>3.72 (1.62)</td>
<td>4.17 (1.47)</td>
</tr>
<tr>
<td>16</td>
<td>5.00 (1.21)</td>
<td>4.83 (0.58)</td>
<td>5.00 (1.18)</td>
<td>5.17 (1.03)</td>
</tr>
<tr>
<td>17</td>
<td>2.92 (1.51)</td>
<td>3.50 (0.90)</td>
<td>4.09 (1.51)</td>
<td>3.17 (1.70)</td>
</tr>
<tr>
<td>18</td>
<td>5.00 (1.48)</td>
<td>5.33 (0.89)</td>
<td>4.54 (1.69)</td>
<td>5.50 (0.52)</td>
</tr>
<tr>
<td>19</td>
<td>3.83 (1.11)</td>
<td>3.67 (1.44)</td>
<td>3.90 (1.45)</td>
<td>5.42 (0.90)</td>
</tr>
<tr>
<td>20</td>
<td>4.58 (1.00)</td>
<td>4.25 (1.29)</td>
<td>3.36 (1.43)</td>
<td>4.00 (1.28)</td>
</tr>
<tr>
<td>21</td>
<td>4.42 (1.00)</td>
<td>4.25 (0.75)</td>
<td>4.54 (1.04)</td>
<td>4.92 (0.90)</td>
</tr>
<tr>
<td>22</td>
<td>4.25 (1.60)</td>
<td>3.50 (1.09)</td>
<td>4.45 (1.04)</td>
<td>4.67 (0.98)</td>
</tr>
</tbody>
</table>

Hours Playing per Week 1.33 (1.30) 1.13 (3.44) 4.14 (2.01) 5.00 (5.88)

Hours Practicing per Week 0.67 (0.75) 0.04 (0.14) 2.27 (2.34) 2.17 (2.61)