

Perceived and actual performance in female volleyball players: Vertical and horizontal jump

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Abstract

Perception and action were so closely related that in many situations, affordance perception directly affected the control of movement. The aim of this study was to examine whether frequent practice and engagement, such as that which occurs for vertical but not horizontal jumps in volleyball, leads to more accurate perception of affordances. A total of 30 female volunteers, including 14 professional female volleyball players (age:18.71±5.41 years) and 16 female control participants (age:20.06±1.06 years), participated in two tasks. For the vertical jump-and-reach task, participants judged the maximum height they could attain if they were to run, jump up, and reach with their fingertips. For the horizontal jump task, participants judged the maximum distance they could leap using a standing broad jump. In both cases, participants first estimated their perceived ability and then performed the tasks. As expected given their greater height, jumping ability of volleyball players exceeded that of control participants for both vertical jump-and-reach ($p<0.001$) and horizontal ($p<0.001$) jumps. Volleyball players also exhibited smaller constant error ($p<0.001$) and absolute error ($p<0.001$) in their perceived maximum jumping ability for the vertical jump-and-reach task, but there were no differences between groups in either constant error ($p=0.131$) or absolute error ($p=0.334$) for the horizontal jump task. Thus, experience playing volleyball, a sport requiring frequent vertical but not horizontal jumping, was associated with judgement accuracy on the vertical but not horizontal jump task. The results suggest that volleyball training may be associated with improvement in opportunity perception, which leads also to improved athletic ability.

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Introduction

The concept of affordance is defined as the opportunity for action provided by the environment (Gibson, 1977). Affordances are opportunities for action that are available to a given animal in a given environment (Gibson, 2014). Examples include perceiving the ability to pass one's hand through a gap in a wall; determining when to cross a street according to the time interval between successive vehicles; and catching a ball coming out of the air. Each perception is related to the affordance offered by the perceiver within the environment (Stoffregen, 2018; Warren & Whang, 1987; Oudejans et al., 1996; Grechkin et al., 2013).

The environment in which an individual is located may offer more than one behaviour possibility. If the environment is a football field, for example, the area of the field makes it possible to stand upright and move or to kick the ball (Fajen et al., 2008). This concept provides a powerful way to understand how perception and action processes function (Davids & Araujo, 2010). When an athlete specializes in a particular sport, they may develop differences in the perception of affordances compared to other individuals, including novice athletes (Passos et al., 2009; Passos et al., 2011). These differences have led

coaches and sports scientists, who seek to identify methods of developing the ability of athletes, to determine how expert athletes perceive and maintain their performance at a high level under pressure and in complex sports environments (Crowther et al., 2023; Bayraktar, 2022; Peker et al., 2021).

Chang et al. (2008), for example, investigated the effects of age and experience playing racquet sports on perception of length. A total of 46 participants were asked to use invisible rods and estimate their length by adjusting a moving board to be equal to their estimate of the reachable distance of the rod. The results showed that experience playing racquet sports was more influential on accuracy of estimation than effect of age. Similarly, Higuchi et al. (2011) showed that compared to control athletes, athletes with experience playing American football performed more effective shoulder turns when running through narrow openings but not when walking through such openings. In their study, Peker et al. (2020) sought to evaluate the jumping abilities of children who had undergone comprehensive gymnastics training in comparison to children who had not participated in any athletic training. The findings indicated that prior

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gymnastics experience was associated with enhanced consistent judgment accuracy.

The Present Study

Previous studies demonstrate that experience in particular sports may lead to task-specific improvements in their ability to perceive opportunities related to that sport (Peker et al., 2021, Bayraktar 2022). If that is the case, it has implications both for training of athletes and for extension into other domains, such as training of children and professional drivers in road safety environments. To extend the literature, we considered behavior among highly experienced volleyball players. Volleyball offers a unique case example, as volleyball players frequently practice verbal leaps but rarely require horizontal leaps to play the sport at an elite level.

We assessed perception and performance of both vertical and horizontal leaping ability among a sample of elite-level (2nd league) female volleyball players in Türkiye. We hypothesized that both constant and absolute error would be smaller for volleyball athletes than for non-athletes, but that perceptual reports of vertical jumping ability and not horizontal jumping ability would be smaller. In other words, we expected volleyball players' judgements would be closer to their actual ability than non-athletes for both tasks given their athletic engagement, but especially for the vertical jump given their frequent practice at that perception and behavior. Finally, given expectations they would be taller, we anticipated both actual vertical and horizontal jumping ability would be greater in volleyball players than in non-athletes.

Given that task- or sport-specific differences in the perception of affordances have been observed (Higuchi et al., 2011), we also expected these differences in fit to be behaviour-specific (i.e. dependent on the type of jump). In particular, given that few volleyball events involve vertical jumps (e.g., block, spike, serve) and rarely involve horizontal jumps, we expected that volleyball players would adapt better to vertical jumping ability but less to horizontal jumping and reaching ability than non-athletes. Following other researchers (e.g., Cole et al., 2013; Johnson & Wade, 2007; Wagman et al., 2016) we addressed these questions by considering separate measures of constant or signed error and unsigned or absolute error.

Methods

Participants

A total of 30 people, including 14 volleyball athletes and 16 non-athletes, were recruited from community sources to

participate in the study. Volleyball athletes had a mean age of 18.71 ± 5.41 years, a mean height of 172.57 ± 6.02 cm, a mean body weight of 64.29 ± 7.22 kg, and a mean self-reported sports experience of 7.07 ± 5.41 years. The control group of non-athletes had a mean age of 20.06 ± 1.06 years, mean height of 162.37 ± 5.82 cm, and mean body weight of 52.87 ± 5.41 kg.

Volleyball athletes were eligible if they participated in training at least 3 days a week, and no serious injuries or neurological problems in the past 6 months and were elite-level volleyball players. They played on the same team. The control group was selected from individuals who did not partake in regular athletic activities; they also reported no serious injuries or neurological problems in the past 6 months.

All participants provided informed consent to participate. The study was conducted in accordance with the Declaration of Helsinki and was approved by the local ethics board of the Faculty of Sport Sciences at the Selçuk University (2024/46).

Procedure

All experimental procedures were conducted in a single session at a gymnasium measuring 30 m by 17 m. There were two tasks, the vertical jump-and-reach and the horizontal jump. The group of participants remained at the far end of the gymnasium, and individuals were called to the opposite end to participate one at a time (the participants were prevented from seeing each other).

In the vertical jump-and-reach condition, the apparatus shown in Figure 1A was used. Participants observed a ball (diameter = 17.8 cm) hanging from the ceiling at one end of the gym and positioned in front of a uniform black wall that could be adjusted in height by an experimenter using a pulley system within a vertical range of 7 m from the floor. A safety mat (1 m²) was positioned beneath the ball (Peker et al., 2021).

Participants stood at a marked observation point 5 meters away from the ball and estimated the maximum height at which they could touch the ball with their fingertips by running (from the observation point) and jumping directly under the ball, as depicted in Figure 1B. The method of adjustment was employed (Mark et al., 1997; Stoffregen et al., 1999). For each trial, the ball was initially positioned at the highest point (7 meters from the ground), and the experimenter gradually lowered the ball using a pulley (cf. Johnson & Wade, 2007). The participant indicated the ball height that matched their judgment of the point when they could jump to touch the ball. This process was repeated three times.

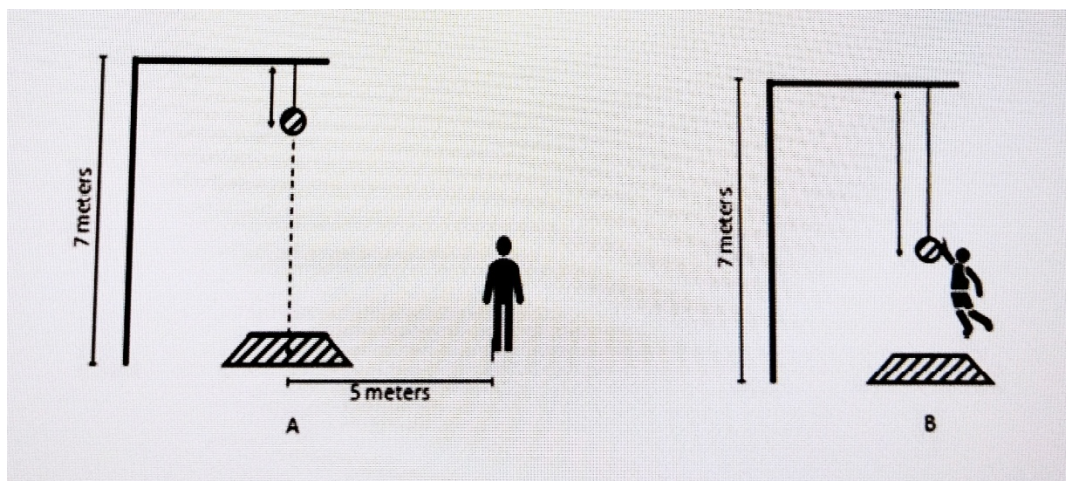


Figure 1. The vertical jump-and-reach task (Peker et al., 2021).

Participants made their three judgments in succession: all participants gave their first judgment, followed by the second judgment, and then their third, before attempting the tasks. After completing their judgments, the actual jumping ability of each participant was assessed. To do this, each participant attempted to touch the ball with their fingertips after running from the observation point. The maximum jumping height was evaluated using a stepwise procedure. For each participant, the ball was initially set at their judged maximum height. If they failed to touch the ball, it was lowered by 5 cm for the next attempt, continuing until the participant successfully touched the ball. During the assessment, a safety mat was placed on the ground directly below the ball. The participant began from the observation point, ran forward, and jumped directly under the ball.

In the horizontal jump condition, the participant stood behind a marked line on the floor and judged the maximum horizontal distance they could leap from a stationary position, while swinging their arms (i.e., a typical standing long jump; Figure 2). The method of adjustment was used again (cf. Walter et al., 2017). An experimenter held a wooden rod (1 m x 25 cm) and stood directly in front of the participant, facing them. The experimenter gradually moved backward. The participant

asked the experimenter to stop and place a marker on the floor at the point they judged to be their maximum jumpable distance. We then measured the distance from the standing line to the marker.

As in the vertical jump condition, participants made their three judgments in succession and then actual jumping ability was assessed. Jumping ability was assessed by asking participants to perform a jump from a standing position, swinging their arms, at the same location where they had made their judgments. Total jump distance was measured using a measuring tape from the starting line to the heel of the trailing foot, with measurements recorded to the nearest 0.1 cm.

Data Analysis

For the actual performance of the horizontal and vertical jump tasks, the distances reached in a single jump were used. For perceptual reports, 3 trials were averaged for both tasks. Perceptual reports were analysed for direction and magnitude of deviation from measured performance following Johnson & Wade (2007) Constant error was used to assess the direction of the difference between actual and perceived ability. Absolute error was used to assess the magnitude of the difference.

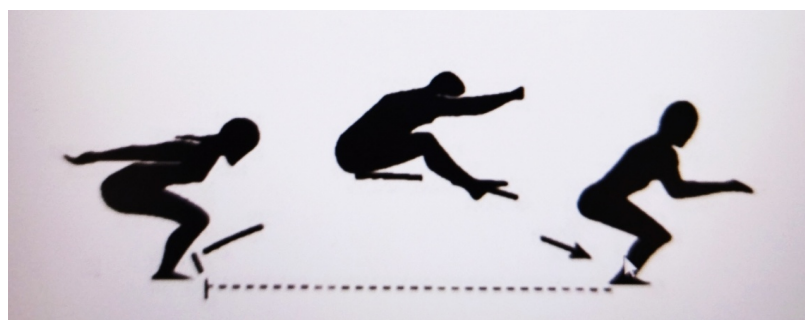


Figure 2. Horizontal jump (Peker et al., 2021).

Descriptive data for all variables were examined first, including normality analysis by Shapiro Wilk test. Next, Mann Whitney U tests (non-normal distributions) and 2 x 2 ANOVAs (normal distributions) were conducted to compare performance between the volleyball players and the non-athletes on all outcomes. Statistical significance level was set as 0.05. SPSS 27.0 package programme was used for all analyses.

Results

There was no significant difference in the mean age of volleyball players versus non-athletes ($t(28) = -0.890$; $p = 0.419$), but volleyball players had statistically significantly greater height ($t(28) = -4.707$; $p < 0.001$) and body weight ($t(28) = -4.937$; $p < 0.001$) compared to non-athletes.

Actual Physical Performance

Actual jump performance was considered first. The main effect of Task ($F(1,28) = 819.877$; $p < 0.001$; $partial \eta^2 = 0.967$) was significant but not meaningful for the purpose of this study, as we expected vertical leaps to be larger than horizontal ones. Group Main effects ($F(1,28) = 36.742$; $p < 0.001$; $partial \eta^2 = 0.997$) were found also, but subsumed by a Group * Task interaction ($F(1,28) = 5.057$; $p = 0.033$; $partial \eta^2 = 0.153$). Figure 3 shows that both vertical reach distance ($t = 4.588$; $p < 0.001$) and horizontal jump distance ($t = 5.029$; $p < 0.001$) were higher among volleyball players than non-athletes. The t-test for difference scores indicated that non-athletes were larger than volleyball players ($t = 2.249$; $p = 0.033$).

Constant Errors in Judgment

Constant error refers to continuous and systematic error that occurs during measurement; it causes the measurement to be consistently wrong in the same direction and by the same amount. Figure 4 shows that both athletes ($M = -7.55$ cm, $SD = 5.84$) and non-athletes ($M = -22.51$ cm, $SD = 11.34$) tended to underestimate their vertical jump ability, but the perception among volleyball players was lower than among non-athletes ($U = 24.000$; $p < 0.001$).

Interestingly, both athletes ($M = +13.50$ cm, $SD = 21.61$) and non-athletes ($M = +22.38$ cm, $SD = 18.62$) tended to overestimate their ability on the horizontal jump, and the constant errors of their estimations did not differ between groups ($U = 75.500$; $p = 0.131$).

In volleyball players, constant errors for perceptual reports of the vertical jump-and-reach task were higher than constant errors for perceptual reports of the horizontal jump task ($Z = -3.296$; $p < 0.001$). In non-athletes, the constant errors for the perceptual reports of the vertical jump-and-reach were higher than the constant errors for the horizontal jump task ($t = -8.425$; $p < 0.001$).

Absolute Errors in Judgment

Absolute error refers to the magnitude of the difference between a measurement and the true value. Absolute error is calculated without considering the sign, focusing only on the extent of error in either direction. Figure 5 shows that the absolute errors of volleyball players for the vertical jump perception were lower than those of non-athletes ($U = 24.000$; $p < 0.001$; $M = 7.55$ cm, $SD = 5.84$ for volleyball players; $M = 22.52$ cm, $SD = 11.34$ for non-athletes), suggesting volleyball players were better able to estimate

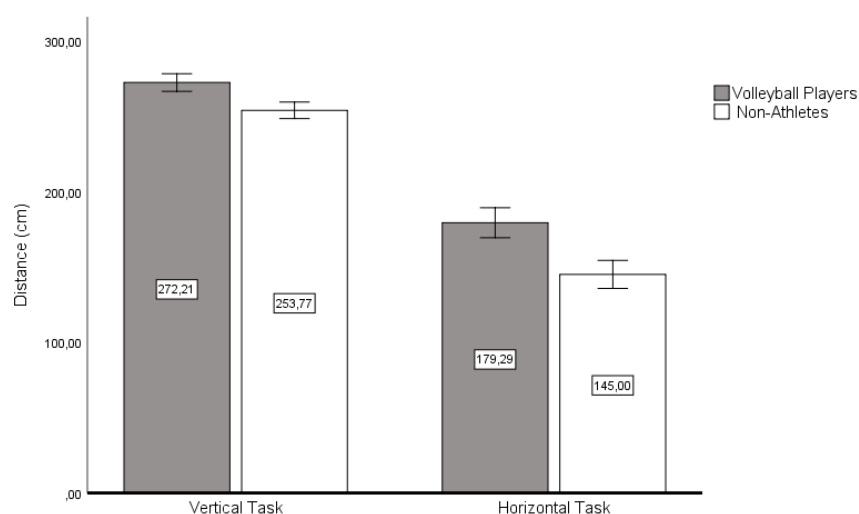


Figure 3. Performance in the horizontal and vertical jump tasks. Error bars indicate standard error of the mean.

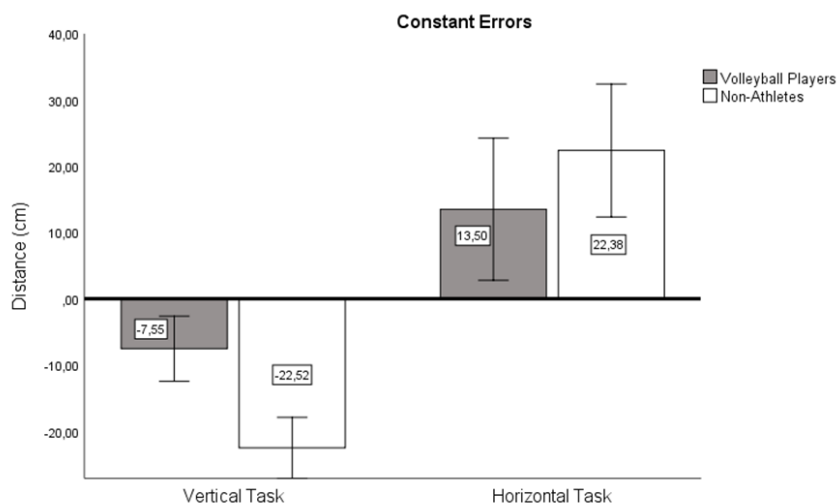


Figure 4. Constant error in judgments. Error bars represent the standard error of the mean.

their ability to jump vertically. However, there was no significant difference between the absolute errors of volleyball players and non-athletes for the horizontal jump task perception ($U = 88.500$; $p = 0.334$; $M = 16.21$ cm, $SD = 19.51$ for volleyball players; $M = 22.58$ cm, $SD = 18.35$ for non-athletes). The absolute errors for the perceptual reports of the vertical jump-access and horizontal jump tasks were not statistically different in volleyball players ($Z = -1.036$; $p = 0.300$). This was also true for non-athletes ($t = -0.012$; $p = 0.990$).

Discussion

This study evaluated perceptual judgment and actual performance on vertical and horizontal jumping tasks among accomplished female volleyball players and non-

athletes. In the vertical jump task, which replicated behavior common in volleyball play, volleyball players were more accurate in perceiving and judging their ability than non-athletes, measured either via absolute or constant errors. However, for the horizontal jump, no significant difference was found between the groups. This finding suggests that volleyball-specific experience enhances the vertical jump judgment accuracy of volleyball players.

Our findings concord with previous studies demonstrating child gymnasts were more accurate than non-athletes in perceiving the opportunities for horizontal jumping but not vertical jumping or reaching (Peker et al., 2020) and are consistent with Gibson's evolutionarily inspired theoretical approach, which argues that animals adaptively perceive opportunities in their environment.

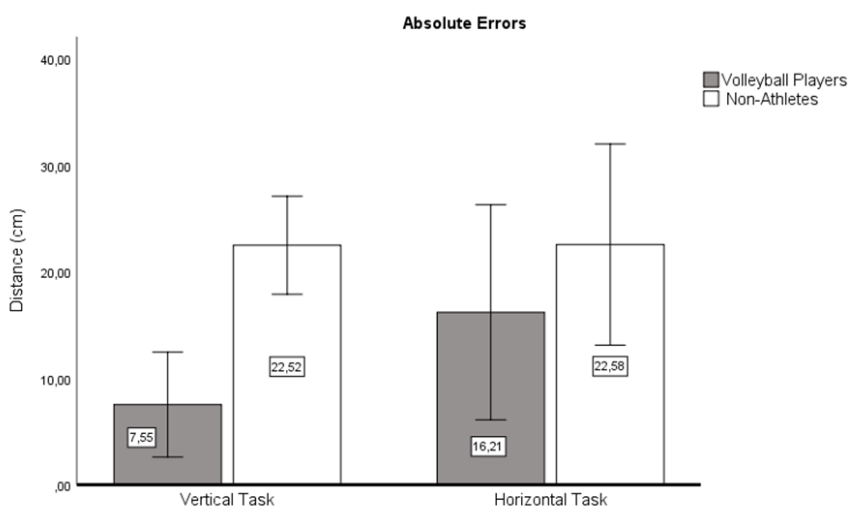


Figure 5. Absolute error in judgments. Error bars represent the standard error of the mean.

The primary aim of our study was to evaluate the perception of the affordances in sport. In this study we specifically investigated the perception of the affordances of two different jumps (vertical and horizontal). In our error analysis (Figure 4), the athletes' perception of fitness and their actual performance was closer. This is also more consistent with our hypothesis. Volleyball players were more accurate in perceiving the possibilities in the vertical jump, which is common in volleyball sport, whereas non-athletes did not have an advantage in perceiving the possibilities in both vertical and horizontal jump. Peker et al. (2021) found that gymnastics athletes were more accurate than non-athletes in perceiving affordances for the sport-specific horizontal jump, while they did not show a similar advantage in perceiving affordances for the vertical jump.

Our results have implications for athlete training and coaching. Our finding that volleyball players were more accurate than non-athletes in perceiving affordances for vertical jumping, a sport-specific activity that volleyball players engage in frequently, but not in horizontal jumping, which is a rare physical task in volleyball play, concurs with previous findings by Peker et al. (2021) among gymnasts, who also were more accurate in perceiving affordances for tasks common in their sport. Together, the results have critical implications for understanding how training and experience in specific sports could be conducted to optimize athlete training. In particular, repeated training at physical tasks required in the sport should yield better judgment of affordance amidst complex, dynamic, and rapidly changing athletic environments. For a volleyball player to successfully strike the ball, she must have precise timing of the affordance of the environment in relation to a moving ball and her own moving body which is propelled upward in a jump. Precision in perception and motoric action yields superior athletic performance. Influence the perception of opportunities in different contexts (vertical and horizontal jumps). The study extends the findings of previous research by highlighting the influence of sport-specific training on perceptual accuracy, emphasizing the idea that athletes' perceptual abilities are often linked to the specific tasks they train for.

We also report several secondary findings. First, as expected, volleyball players were able to jump higher and further than control non-athletes in both the vertical and horizontal jump tasks. This result was likely related to the fact that the volleyball players were taller than the non-athletes, although body size is not the sole determinant of physical ability (Witt, 2011) and sport-specific exercises plus the innate natural jumping ability that may have led

the volleyball players to spend time in their sport may have contributed to the superior actual performance of the athletes.

Second, in the absolute error analysis (Figure 5), we found a significant interaction effect between groups and tasks. In the horizontal jump, there were no differences between volleyball players and non-sport athletes, but in the absolute error of the non-athletes was higher than the athletes.

It has been long recognized that the ability to make decisions based on the perception of affordance can be significantly affected by experience and learning (Norman, 1988). The current study extends scientific understanding and application to the domain of athletic performance, demonstrating that experience and practice in the dynamic and complex environment of an athletic context like a volleyball court may yield better perception of affordance, and thus better performance in action while engaged in the athletic pursuit. Building on previous reports (Peker et al., 2021; Pepping & Li, 1997; Higuchi et al., 2011), our results suggest repeated practice at physical tasks like jumping for an object could help volleyball players, and other athletes whose sport requires such judgments, develop skill and become better players.

Our findings also reinforce the fact that task specificity plays an important role in how athletes perceive their abilities. The volleyball players were more accurate in their perception on the vertical jump task, but not the horizontal one. Previous research examined general athletic tasks and performance predictions (De Arruda et al., 2023; Mann et al., 2007), but our focus on task-specific perceptual accuracy in a sport with defined movements offers evidence for the adaptability and specificity of athletes' perceptual abilities for particular sport-related tasks. Athletic training might focus on those specifics to yield better performance.

In their study of female volleyball players, De Arruda et al. (2023) found that successful serve rate was higher in experienced female volleyball players than in the less experienced group, but the statistically significant interaction was only true when sideline serves were made. Researchers on determining the maximum height at which volleyball players can jump to block an opponent's shot found that even amateur volleyball players can accurately perceive the maximum height that can be blocked (Pepping & Li, 1997). Mann et al. (2007) asked elite athletes to predict their performance and found that experts were better than non-experts at picking up perceptual cues. This is consistent with our study. This study demonstrates that the ability to perceive affordances

is influenced not only by general athletic experience but also by the specific demands of the sport. It provides new insights into the specificity of perceptual skills and how these skills develop through the repeated practice of volleyball-specific actions.

Conclusion

This study evaluated perception and behavior among female volleyball players and non-athletes engaged in two tasks, a vertical jump and a horizontal jump. Volleyball athletes were more accurate than non-athletes in perceiving vertical jumping abilities, but not in perceiving horizontal jumping abilities and reaching opportunities. The results suggest that affordances are dynamic and task-specific, with differences emerging in the perception of affordances associated with volleyball play but not in tasks rarely used in volleyball. They imply that practice and training in a sport leads to more accurate perception of affordance in tasks specifically related to that sport, offering guidance to athletic trainers and coaches to improve athlete performance.

Authors' Contribution

Study Design: YA, NE; Data Collection: YA, NE, YB, AA; Statistical Analysis: NE; Manuscript Preparation: YA, NE, YB, AA DCS.

Ethical Approval

This study was approved by the local ethics board of the Faculty of Sport Sciences at the Selçuk University (2024/46).

Funding

The authors declare that the study received no funding.

Conflict of Interest

The authors hereby declare that there was no conflict of interest in conducting this research.

Data Availability Statement

Data supporting the findings of this study are available from the corresponding author [Y.B.] upon reasonable request.

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