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ABSTRACT
Change-of-direction speed (CODS) is an important quality to performance in multi-direction sports. The purpose of this study was to examine two methods used by basketball players to change directions when playing defense to see if one technique was faster than the other. Within basketball, there are two commonly taught methods of changing directions when playing defense: the drop step and the hip turn. Fourteen female college basketball players participated in this study. The study used a 2x2 (movement x direction) within-subjects repeated measures ANOVA to analyze the average differences between the time to change directions using a drop step compared to a hip turn. There was a significant difference between the two techniques in a novel test, with the hip turn faster than the drop step (F = 117.568, p < .0001). These results suggest that the hip turn compared to the drop step may be a quicker means of changing directions for female basketball players when playing defense.

Key words: Change-of-Direction Speed, Coordination, Defensive Techniques, Female College Basketball

INTRODUCTION
Change-of-direction (COD) technique is influenced by the context and the constraints of the game [1]. Basketball requires multidirectional movement skills, and the ability to stop and start quickly. Offensive players combine acceleration, deceleration, and COD movements to evade defenders, create an opening for a pass or shot, avoid a foul, or track a rebound, whereas defenders combine acceleration, deceleration, and COD movements with backpedaling and shuffling [2-4]. These general movements have sport-specific names within basketball like v-cuts, l-cuts, and defensive slides. Their execution is context specific [1], as the choice of movement depends on the situation within the game.

The context for basketball differs between offense and defense in one primary way: Offensive players are directed toward their basket, whereas defensive players face away from...
the basket. Whereas offensive players move forward and attempt to evade defenders, defensive players spend the majority of each possession moving backwards or laterally. Nearly 41% of playing time in an U-19 boys’ basketball game was spent completing “specific movements”, which were defined to be “principally shuffling as well as any foot action that is different from ordinary walking or running” [2, p. 70]. The majority of these shuffling movements occur when players are on defense. Despite the prevalence of these actions, little is known about the best way to teach them.

There are two primary ways to change the angle of movement when playing defense in basketball: the drop step (DS) and the hip turn (HT). To change directions in relation to an offensive player who is dribbling, the traditional instruction has been a DS [5-9]. The DS is a reverse pivot [8]. The player executes the reverse pivot on the rear foot while swinging the contralateral elbow and foot in the direction taken by the offensive player [5, 8]. After completing the DS, the defender returns to a defensive slide [8]. For example, if a defender is moving to his or her right and must change directions and angles, the defender plants and pivots on the right foot and steps with his or her left foot in the new direction. The left leg becomes the lead leg and the right leg becomes the trail leg as the defender step-slides to his or her left.

The DS has been the more widely taught technique. Coaches drill this technique for hours and hours from the time that players start organized basketball. However, more recently, some coaches have begun to advocate and teach the HT [10]. The HT is a quarter turn that occurs with the feet in the air [10]. The player hops off of the lead leg, rotates in the air, and lands on two feet [10, 11]. For example, as the defender moves to his or her right, he or she hops off the right foot and rotates in a counter-clockwise direction, landing with the right leg as the trail leg and the left leg as the lead leg. The directional change occurs with both feet off the ground, whereas with the DS, the directional change occurs with one foot planted on the ground.

There is a paucity of research on movement specific to basketball defense. The purpose of this study was to measure the speed of a COD task similar to playing defense in basketball using a DS and a HT. Based on video inspection of basketball games, the hypothesis was that participants would change directions more quickly using an HT compared to a DS. The second hypothesis was that there would be no difference in COD when moving to the right compared with to the left.

**METHOD**

**PARTICIPANTS**
The participants were female college basketball players (n=14) from one team in the western United States. The participant characteristics were: age 19.29 +/- .99 years old, height 175.08 +/- 8.94 cm, weight 68.13 +/- 8.39 kg. The participants were Caucasian (n = 9) and African-American (n = 5). None of the participants had sustained a significant ankle, knee, hip, or back injury in the prior 6 months. The head coach of the players volunteered her team for the study. No males were used in the study because the men’s team was unable to participate. The study was approved by the University Institutional Review Board, and written participant consent was completed prior to data collection.

**STUDY DESIGN**
The study employed multiple within-groups counterbalanced 2x2 (movement x direction) repeated-measures analyses. The study consisted of two change of direction movements (DS and HT) and two directions (right and left). Each participant completed 3 trials of each
condition for a total of 12 trials, and the average of the 3 trials for each condition was used in the analyses.

The first trial for each participant was completed without any instruction with regard to technique. Participants were told that it was their first trial and to complete the test as quickly as possible, but this trial was used to determine their intrinsic dynamics, which reflected their inherent coordination tendencies or preferential movement style [12]. The initial direction was determined by the researcher and randomized for participants. If the technique (DS or HT) was unclear, the participant performed a second trial. Thirteen participants used the DS as their preferential movement style, and one used the HT. An attempt was made to determine the participants’ intrinsic dynamics, as their preferential movement style could affect the results. Once determined, participants were given a demonstration of each technique and completed several sub-maximal and one maximal practice trial to familiarize themselves with the test and the technique. Several participants needed multiple trials to become comfortable with the HT. After the familiarization period, the participants completed three test trials of each condition. Participants were given 60-90 seconds to recover between trials [13].

PROCEDURES
Participants reported to the college’s basketball arena for testing. Participants wore their team’s practice uniforms including shoes. Upon arrival, the participants presented a signed consent form, and filled out a survey that asked for their height, weight, race, and age. Next, the test was explained; the test is shown in Figure 1. The explanation focused on the path of the movement and did not mention the COD techniques. The tester walked through the test so as not to bias the participants. Participants were told not to cross their feet during the lateral shuffle from point A to point B. After the explanation, participants performed their initial trials. After the preferential movement style was determined, both techniques were explained, and the participants had time to familiarize themselves with the test and the techniques. The testing was conducted on the hardwood floor in the arena, and the test was marked with white athletic tape.

![Figure 1. The Test Step-up for the Tests to the Left](image-url)
There was one test, but four conditions (DSR, DSL, HTR, and HTL). The tests were drop step to the right (DSR), drop step to the left (DSL), hip turn to the right (HTR), and hip turn to the left (HTL). The direction was designated as the direction of movement prior to the change of direction. The DSR, DSL, HTR, and HTL were completed in a randomized order in one session. Each participant completed all three trials of one test condition before moving to the other condition to improve the short-term retention and to eliminate confusion between the two techniques. In a feasibility study, it was determined that trying to change back and forth between the two techniques caused confusion.

Pilot testing was used to determine the distances and the placement of the timing gates. The goal was to mimic game play as much as possible in a laboratory study. For the initial movement, a 2.74m (9 feet) distance was determined to be long enough to allow for the development of some speed, but also short enough to be similar to the game; longer distances often require basketball players to use a different method of footwork. In a study of U-19 male basketball players, specific movements, which included shuffling, averaged between 1.7 and 2.0 seconds [2]. Pilot testing suggested that this distance would allow the entire test to be completed within the 1.7-2.0s range.

Gate 1 was placed at the starting line; the time did not start until the participant crossed this line. Gate 2 was placed 15.24 cm (6 inches) prior to Point B. The time from Gate 1 to Gate 2 was measured as the shuffling time (ST); this was measured to ensure that participants executed the COD after a similar speed of movement. Gate 3 was placed 91.44 cm (36 inches) from Point B; this distance was measured on the same horizontal line as the distance from Point A to Point B. The gates were positioned so they did not capture data during the shuffle from Point A to Point B, and participants would not have to adjust movements for the gates. Gate 3 functioned as the finish line for the measurements. The time from Gate 2 to Gate 3 measured the COD time. This time answered the research question. A finish line was marked perpendicular to the starting line. The finish line was marked +/- 30.48 cm (12 inches) from the point that made a 45-degree angle with the line from Point A to Point B. Participants were told to finish through the finish line, though the total time was measured as the time from Gate 1 to Gate 3 or the sum of ST and COD.

For each test condition, participants started facing straight ahead and used a lateral shuffle (often called a defensive slide or step-slide in basketball) to move in the frontal plane. They shuffled and crossed Point B with at least one foot before shuffling through the finish line. At Point B, participants performed either a DS or a HT to change their body angle and position themselves to shuffle through the finish line. Participants were determined to have performed a DS if their outside foot remained planted on the ground as they changed their body angle. Participants were determined to have performed a HT if both feet left the ground as they changed their body angle. In the rare instance where it was difficult to determine the technique, the trial was repeated.

Times were collected with wireless timing gates (Brower Timing Systems, Draper, UT). After each trial, the ST and COD times were recorded from the TC-Timer. After the completion of the tests, the times were inputted into an Excel (Microsoft) file.

STATISTICAL ANALYSIS
Data were analyzed with SPSS version 20. All data were screened and tested to ensure that the data met the statistical assumptions. The data were checked for reliability and stability of the four conditions. A Pearson’s product-moment correlation was used to determine the relationships between the participants’ physical characteristics and the ST and COD tests. A Cronbach’s α was run to determine the internal consistency of each measurement for the 4
conditions. Multiple 2x2 within-subjects repeated measures ANOVA was used to analyze the initial shuffling time (ST) and the change-of-direction time (COD) in each direction. A preliminary analysis examined the ST because the ST could be a potential confounding variable. The second analysis examined the COD. Significance was set at .05 for the analyses.

RESULTS

PRELIMINARY ANALYSES
During the preliminary analyses to test for assumptions, one participant was an outlier in every test. She was the participant who used the HT as her intrinsic movement. Therefore, this participant was excluded from the subsequent analyses, leaving 13 participants. There were no significant relationships between the participants’ age, height, or weight and any of the measurements from the tests. There were no statistically significant differences for movement type (p = .059), direction (p = .559), or the interaction between movement type and direction (p = .853) for the ST, which eliminated ST as a potential confounding variable.

RELIABILITY AND STABILITY OF THE MEASURES
The tests had acceptable (DSL-COD; HTR-COD), good (DSR-ST; HTL-ST; HTL-COD), and excellent (DSL-ST; HTR-ST) internal consistency meaning they were reliable for this study. Only the DSR-COD had poor internal consistency. The tests showed good stability except the DSL-COD. The good stability of the tests provided further support for the reliability of the tests. The results are shown in Table 1.

Table 1. Internal Consistency and Stability of the Three Trials

<table>
<thead>
<tr>
<th></th>
<th>Cronbach’s Alpha</th>
<th>F</th>
<th>p</th>
<th>k</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSR-ST</td>
<td>0.893</td>
<td>2.476</td>
<td>0.105</td>
<td>3</td>
</tr>
<tr>
<td>DSR-COD</td>
<td>0.573</td>
<td>3.340</td>
<td>0.053</td>
<td>3</td>
</tr>
<tr>
<td>DSL-ST</td>
<td>0.938</td>
<td>0.682</td>
<td>0.515</td>
<td>3</td>
</tr>
<tr>
<td>DSL-COD</td>
<td>0.798</td>
<td>4.256</td>
<td>0.026</td>
<td>3</td>
</tr>
<tr>
<td>HTR-ST</td>
<td>0.930</td>
<td>0.636</td>
<td>0.538</td>
<td>3</td>
</tr>
<tr>
<td>HTR-COD</td>
<td>0.728</td>
<td>0.440</td>
<td>0.649</td>
<td>3</td>
</tr>
<tr>
<td>HTL-ST</td>
<td>0.809</td>
<td>2.202</td>
<td>0.132</td>
<td>3</td>
</tr>
<tr>
<td>HTL-COD</td>
<td>0.800</td>
<td>1.322</td>
<td>0.285</td>
<td>3</td>
</tr>
</tbody>
</table>

DS = Drop step; HT = Hip turn; R = right; L = Left; ST = Shuffle time; COD = Change of direction time

RESEARCH QUESTIONS
The means and standard deviations for the ST and COD measurements are shown in Table 2. The percent differences between the HT and DS for the ST and COD are also shown. The study found that the HT was 15.1% faster when moving to the right and 20.1% faster when moving to the left compared to the DS.

Mauchly’s Test indicated that the assumption of sphericity was not violated for the main effects of movement type and direction of movement and for the interaction between the movement type and direction. Participants changed directions more quickly using the HT compared to the DS, F(1, 12) = 117.568, p < .0001, η² = .907. Participants changed directions more quickly when their initial movement was to the left compared to when the initial movement was to the right, F(1, 12) = 6.266, p = .028, η² = .343. There was no interaction effect between the movement type and the direction of movement (p = .165).
Table 2. Mean±SD for the Drop Step and Hip Turn Techniques (n=13)

<table>
<thead>
<tr>
<th></th>
<th>Drop step</th>
<th>Hip turn</th>
<th>Hip turn percent difference from drop step</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shuffle time right (s)</td>
<td>1.029±0.071</td>
<td>1.069±0.082</td>
<td>3.9</td>
<td>0.065</td>
</tr>
<tr>
<td>Shuffle time left (s)</td>
<td>1.012±0.094</td>
<td>1.048±0.106</td>
<td>3.6</td>
<td>0.128</td>
</tr>
<tr>
<td>COD time right (s)</td>
<td>0.865±0.046</td>
<td>0.734±0.059</td>
<td>-15.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>COD time left (s)</td>
<td>0.862±0.063</td>
<td>0.689±0.036</td>
<td>-20.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total time right (s)</td>
<td>1.900±0.087</td>
<td>1.801±0.109</td>
<td>-5.2</td>
<td>0.009</td>
</tr>
<tr>
<td>Total time left (s)</td>
<td>1.874±0.118</td>
<td>1.739±0.104</td>
<td>-7.2</td>
<td>0.004</td>
</tr>
</tbody>
</table>

**DISCUSSION**

The purpose of this study was to determine whether female college basketball players changed directions more quickly using a DS or a HT in a task similar to playing defense in basketball. The findings supported the hypothesis that players would change directions more quickly when using a HT compared to a DS. The results indicated a medium to large effect, and a large practical significance. These findings were true even though the participants’ inherent coordination tendencies based on their biological constraints, development, and previous learning were to use a DS [12]. The findings from the study did not support the second hypothesis, as participants changed directions more quickly when their original movement was to the left than when their original movement was to the right. The findings from the study also found no significant difference for the ST in the DS and HT conditions. The lack of differences in ST increased the validity of the findings because the speed of movement prior to the HT and DS showed no significant differences.

Effective COD technique involves the correct body posture and foot placement [14]. Though beyond the scope of this study, the results suggest that the HT may enable a more optimal body posture and foot placement for a directional change than the DS. When shuffling laterally, “optimal braking alignment occurs with the foot, shin, and thigh of the lead leg pointing at a 45-degree angle to the direction of braking” [11, p.11]. In a DS, the ankle, knee, and hip may move separately, whereas the HT may enable a more coordinated triple extension of the ankle, knee, and hip upon ground contact due to this more optimal braking alignment. Trunk stability has been shown to be an important factor in COD performance [15]. When completing a lateral change of direction, players must maintain their center of gravity over their base of support rather than allowing their shoulders to move outside their base. It is possible that by enabling the more optimal braking alignment, the HT may maintain better trunk stability over the base of support when compared to the DS.

The results of this study supported other studies that examined similar footwork in different environments. A comparison of a False-Start Pivot (FSP), Forward-Moving Sidestep (FMS), and Pivoting Crossover (PC) in a 90-degree turn and sprint found the FSP to be superior to the FMS [16]. The FMS resembled a DS because the athlete maintained a more vertical alignment of the foot, shin, and thigh and initiated the movement with a step with the lead leg. The FSP resembled a HT because of the movement away from the desired direction and the preloading of the muscles of the trail leg.

One common criticism of the HT has been that the defensive player loses ground when using a HT compared with a DS; this was true of the FSP compared to the FMS. It was believed that the FSP allowed for the effective use of the stretch-shortening cycle (SSC) and a more forceful push-off, which more than compensated for the slight movement away from
the desired direction [16]. The FSP also may have positioned the body into a more optimal alignment for acceleration compared with the more vertical alignment of the FMS. One or both of these explanations - the more forceful push-off due to the SSC or the better angle created for acceleration - may explain the quickness of the HT compared to the DS.

In addition to performance improvements, the HT may be a safer movement than the DS for basketball players, especially female players. Approximately 7000 anterior cruciate ligament (ACL) tears occur annually in high school female basketball players in the United States [17], and knee injuries account for up to 91% of season-ending injuries and 94% of injuries requiring surgery in female basketball players [18]. Whereas the action most involved with non-contact ACL injuries is landing from a jump [19], cutting has been described as the most common or second most common action involved in non-contact ACL injuries in handball [20, 21], basketball [20], and Australian Football League [22]. Furthermore, a pivot task compared to a drop-jump or a sidestep cut was found to place higher loads on the knee joint [23]. Whereas the drop-jump and HT differ, both require reactive strength and are similar in their performance, though a HT involves less amplitude. Because the pivot task placed higher loads on the knee, the HT may be a safer COD technique than the DS for female basketball players.

Change-of-direction techniques similar to those used by offensive players in basketball have been investigated in rugby union [24], soccer [25], Australian Rules football [26], netball [27], football [28], multi-sport athletes [29], and a general male population [14], but this is the first known study to examine the COD movements used by defensive players in basketball. Further studies could examine the angles of the braking leg created by the two techniques, as well as the force of the push-off. This would enable a better understanding of the results and provide an explanation of the mechanism leading to the faster times for the HT compared to the DS. Also, an analysis of expert performers in games, and especially the defensive footwork of the best defensive players, would establish the validity of the HT or the DS. Finally, a comparison of participants’ defensive performance in a game and their performance on this test could add validity to the test used in this study.

There were several limitations in this study. The biggest limitation was the means of distinguishing the intrinsic dynamics. In a future study, this limitation could be avoided by examining video footage of games to determine the preferred movement style of the participants in similar situations. A second limitation was the participants, as the study was restricted to female players from one team. It is possible that male players move differently than female players, due to group differences in physiology or experience. Also, there may be group differences for the team due to the coaching the players had received. However, because these players played for many years on various teams prior to college, there may not be a team difference. A third limitation was the small number of participants, and specifically the lack of participants who used the HT as their preferred movement style. A final limitation was the variance in practice trials. Because the participants felt comfortable with the DS, they did not take many practice trials. However, some participants practiced the HT several times before they could execute it during a test trial. It is possible that these additional practice trials may have enhanced the speed of the HT compared to the DS. A future study could control for the practice trials for each condition.

CONCLUSION
The findings from this study suggest that the HT may be a quicker method of changing direction than the DS for female basketball players. This was found to be true in this study even with players who had adopted the DS as their inherent coordination. Whereas the study
utilized a novel test with considerable differences from a game, the test had acceptable to very good reliability and appeared to be a good starting point for the exploration of defensive footwork in basketball.

The implication from this study, if the results are generalizable, is that coaches should consider teaching a HT as the primary means of changing directions and angles when playing defense in basketball. The HT appeared to be quicker with female college basketball players, and it may place less stress on the knee than a DS or pivoting task. A second implication is that coaches may want to identify directional differences in their players, as the group in this study was faster when the test started with them moving to their left, possibly because they defend predominantly right-handed players.

REFERENCES
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