

THE IMPORTANCE OF DIRECTLY DERIVED INFORMATION IN THE BASKETBALL JUMP SHOT. A COMPARISON OF CHANGED VISUAL CONDITIONS FROM DIFFERENT SHOOTING SPOTS

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Abstract The basketball jump shot as a movement, allowing visual feedback based corrections, can be considered as a generalized or a specialized motor skill. The purpose of this study is to look into the connection between visual perception and the specialization of a motor skill. Therefore, six male basketball players were asked to perform jump shots under different viewing conditions from their favourite spot (sweet spot) and a second, middle-distance spot. The question was, if performance is affected by the changed visual conditions and whether the shooting spot plays a role in a potentially change in performance. The different visual conditions were first, a regular basketball hoop with no adjustment, second a regular basketball hoop with a covered backboard, and third a regular basketball hoop with a covered rim. Between the different visual conditions, performance did not differ significantly, neither from the sweet spot, nor from the neutral defined spot. However, players showed a significantly better performance from sweet spot than from the neutral spot under regular viewing conditions.

Key words visual perception, basketball, jump shot, generalized motor program, especial skills

Introduction

The jump shot is an elementary component of basketball. Its accuracy decides on victory and defeat. Shot quality depends on the performer's skill, the space and time the player got to execute the shot, and the distance to the basket (Clauss, Schmidt, 1996). Specific visual information before and during the action promotes a successful shooting performance, because the shooter accesses pre-programmed movements (Vickers, 1996). Shot selection depends on player's preferences (usually, every player has his own *sweet spot*, that describes a particular spot on the court, where the athlete feels most comfortable shooting). Research has shown, that changes of peripheral visual information do not affect performance (Keetch, Schmidt, Lee, Young, 2005). Whether visual information,

derived directly from the target, affects performance has not been examined yet. Therefore, the aim of this study is to evaluate if shooting performance is affected by changed direct visual information and if there is a difference in shooting performance between the sweet spot and a middle-distance spot.

The jump shot needs to be considered as a motor action that underlies dynamic processes, as there exists the chance of variation within the movement. Schmidt (2003) re-evaluates the *schema theory*, that describes movement patterns as a co-production of two systems – the Generalized Motor Program (GMP) and the *recall schema*. The GMP is represented in memory as a structure of movement, which can be executed in different ways and situations – it is generalized. The recall schema provides parameters to scale the GMP and gives information about the success of the action. Parameters can be adjusted to particular situations.

As a dynamic movement pattern, that includes several joints, muscles and neurological tissues, the jump shot holds the possibility of motor-output variability. Whereas rapid movements, which are defined as movements of maximum 200 msec duration, do not allow visual feedback based corrections during the action, longer movements, with a duration of at least 200 msec, do (Keele, Posner, 1968; Schmidt, Zelaznik, Hawkins, Frank, Quinn, 1979). Overall, the jump shot has a duration of about one and a half seconds on both misses and hits (Vickers, 2007). Therefore, the basketball jump-shot may allow visual feedback based corrections (e.g., Schmidt Zelaznik, Hawkins, Frank, Quinn, 1979).

Visual information can be provided by the environment. Research on the topic of contextual dependencies in motor skills showed, that the environment plays a role in acquisition and retention of a difficult motor task (Wright, Shea, 1991). If the task is simple, the change of environmental stimuli has no effect on execution quality. With increasing difficulty, the contextual dependencies gain importance. Referring to the basketball jump shot, Keetch et al. (2005) conducted an experiment, where skilled players executed one half of set shots under regular conditions and the other half while the floor was completely covered with a tarp material to eliminate peripheral information from the task. The shots were performed from a distance of 9, 11, 13, 15, 17, 19 and 21 ft from the centre of the basket. The intention was to discover a specific result from 15 ft (the foul line) under regular conditions and with absence of peripheral information. In contrast to the generalization of motor actions, the results of Keetch et al. (2005) support the idea of specificity in particular motor actions as a result of practice. The shot from the foul line (free throw) is executed the most in basketball training. The performance from the 15 ft distance was significant better than predicted by regression, supporting the idea of Keetch et al. (2005) of a specified movement pattern. Consistent with these findings, the results of a review by Shea and Wulf (2005) highlights, that the size of specificity effects appears to increase when the skill is practiced in large extent.

A consecutive study provides information, that the significantly better performance from free-throw range is not a product of habituation on the distance of 15 ft, but an especial skill from this particular spot (Keetch, Lee, Schmidt, 2008). The participants performed set shots from 15 ft distance to the basket from different angles. Supporting the idea of specificity in movement patterns, the participants performed best from free-throw range.

Keetch et al. (2005) did not address the connection between the specificity of a motor skill and direct visual information. A successful shooting performance depends on pre-programmed movements supported by specific visual information taken before and during the throwing process. An examination with female elite basketball players exercising free throws exhibited a fixation of gaze relatively long at the target before initiating the free-throw (Vickers, 1996). The phase of target fixation of experts lasts more than twice as long as non-experts and seems to be critical

in shooting successfully. Further on it was stated that the information acquisition is terminated as soon as the final movements of the shot phase are reached. Thus no information is gathered while conducting free-throws. However, free-throws appertain to static self-paced exercises whereas jump shooting appertain to dynamic non-self-paced exercises. According to Ripoll, Bard, and Paillard (1986) a stable fixation with head and eyes on the target leads to a higher chance of shooting successfully on the target. By aggregating visual information, the shooter perceives the ideal point of ball release hitting the target. Due to the dynamic movement pattern of jump shooting, the eye-head stabilization is here more important than in a static movement pattern (i.e., free-throw) because there is no time to fixate the target before launching the shot.

Contrasting the study of Vickers (1996), Oudejans, van de Langenberg, and Hutter (2002) ascertained basketball players gathering necessary information shortly before releasing the shot. Under several viewing conditions ten male expert basketball players were tested in performing jump shooting while wearing Plato Liquid Cristal goggles (vision-manipulating) and OPTOTRAK markers. At the first viewing condition the basketball players solely got vision until the ball passes the line of sight (early-vision), second the players got vision when the ball just passed the line of sight (late-vision), and in the last condition there were no visual constraints (full-vision). The result stated no significant distinction between late-vision and full-vision condition, while shooting performance under early-vision was significantly worse compared to late- and full-vision.

Subsequent investigations about online visual control during jump shooting are corroborating with Oudejans et al. (2002). De Oliveira, Oudejans, and Beek (2006) stated that basketball players even affect to fixate the basket as late as possible to gather necessary information. The authors assumed accumulating visual information as late as possible is crucial for jump shooting whereas pre-programming is less important (de Oliveira, Oudejans, Beek, 2006; de Oliveira, Huys, Oudejans, van de Langenberg, Beek, 2007; de Oliveira, Oudejans, Beek, 2008).

Once the time of information gathering is determined the further question is what information sources are used by basketball players during basketball shooting. The study of de Oliveira, Oudejans, and Beek (2009) involves several parameters altered in three experiments due to examine what information is necessary to shoot successfully. The last executed experiment included three visual conditions (fully light, only one light dot, and fully dark), two positional conditions (backboard position 4.43 m or 4.78 m away from the participant) and three target conditions (basketball hoop raised, standard, and lowered) unknown by the participants. The results suggest a crucial impact of the angle of elevation. This angle describes the position relatively to the performing person. If the target is close to the participant the angle becomes larger, and if the target is far away the angle becomes smaller. Therefore, it is evidenced that basketball players use online visual control to detect information about the target and if the target differs from acquainted conditions the result of shooting is less successful.

The approaches of schema theory, online visual control and especial skills describe the basketball jump shot from different perspectives. Each of those contributes to a further, better understanding of the cognitive and motor processes of the jump shot as a motor action. The importance of direct visual information was not of primary importance in the current studies. This is why our study combines different viewing conditions and spot preferences of basketball players. We expect the changed visual information to affect the shooters performance negatively. Moreover, it will be interesting, if the expected influence occurs also regarding the player's sweet spot, or if a specialization of that motor skill prevents the performance from decreasing.

Material and methods

As a result of an a priori power analysis, $N = 6$ male players of a 6th league (German: Bezirksoberliga) basketball team were recruited to take part in this study (Keetch, Lee, Schmidt, 2008). The average age of the participants was 22.5 years (range 16–27) and they had on average 11 years of basketball experience (range 2–10). Players position and height were no criteria for recruiting. Prior to the beginning of the study participants provided written informed consent. The study was conducted following the ethical guidelines of the local university.

A standard basketball backboard and hoop were used in the shooter's habitual training area. The shooting spots were marked with a 1×1 sq m area at the sweet spots (selected by the shooters) and the defined middle-distance spots (selected by the authors of this manuscript) at the top of the paint's edges. The middle distance spot was to be executed opposite to the sweet spot. Meaning, if the player's sweet spot was situated on the left side of the court, the middle distance spot would be determined on the right edge of the paint. The distance from the sweet spot to the basket varied depending on the players shooting preference, whereas the distance from the neutral shooting spot remained the same for each player. Thus, the distance of the sweet spot does not need to correspond with the distance of the neutral spot.

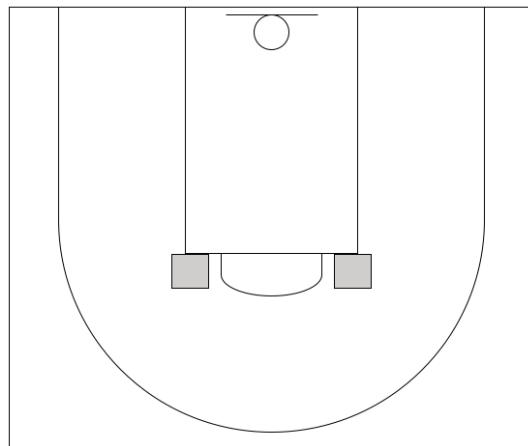


Figure 1. The experimental setup. The coloured areas represent the defined neutral shooting spots. Sweet spots are not marked. The left coloured square represents the neutral shooting spot for the players, that had their sweet spot on the right side of the court. The right coloured square represents the neutral shooting spot for the players, that had their sweet spot on the left side of the court

Three throwing conditions were chosen: In the first condition the regular basket was used (C_1). In the second condition the backboard was covered with a white sheet (C_2), and in the third condition the hoop was covered with conventional crepe tape (C_3). Vickers (2007) subdivides the movement into a *ball-up phase* and an *extension phase* plus the preparation. The participants were instructed to perform one dribble into the marked shooting area followed by the shot.

The quality of the shots was determined with a scale system, that rated the shot by its accuracy. The scale ranged from zero to six points. Six points represented the best score, where the ball was shot into the basket touching neither the backboard nor the ring. The shot was credited five points if the ball hit the inside of the ring before falling into the basket. If the ball fell into the basket bouncing off the backboard, the shooter received four points. Missed shots were credited three points, if the ball bounced off the inside of the rim and dropped out the basket. Two points were given for a shot failing the basket after touching the backboard. The shot was credited one point, if the ball hit the outside of the ring and failed the basket. Touching neither the ring nor the backboard, the participant earned zero points for the shot.

Inspired by Keetch et al. (2005) the performance scores were converted to a percentage score: $\left[\left(\text{total points}\right) / \left(6 \times \text{number of shots taken}\right)\right] \times 100$. By using the percentage score, the results are more comparable within the dataset and can also be related to similar experiences with the procedure from previous studies. Due to the research of Keetch et al. (2005), the percentage score is a known value in the field of basketball research addressing shooting issues. Moreover, does the percentage score depict the quality of the shot better than just distinguish between hit and miss. Both a miss and a hit can have different qualities (e.g., ring inside contact and out – air ball). By valuing the shot with determined criteria, a possible effect can be stated more precisely.

At the beginning of the experiment, the study's procedure and its value for the sport sciences was explained to each individually tested participant. To ensure that the participants understood the aim of our research, we received their written informed consent. After warming up, the experiment started.

Prior to the commencement of each block every player was instructed to take multiple warm-up shots. The participants performed three blocks of 20 shots, ten shots for each shooting spot. Each block was defined by one visual condition (C_1 , C_2 , C_3). Each visual condition was performed by every participant before switching to the next condition. Intermittent the execution prevents the shooter from fatigue and a resulting decrease of performance which could mislead the interpretation of our results.

During each block of ten shots the shooters were instructed to shoot in their own pace. The task was to make one dribble into the shooting spot, to jump up and take a jump shot. The first ten shots were performed from the personal sweet spot, the last ten shots were performed from the middle distance spot. The middle distance spot was to be executed opposite to the sweet spot. Meaning, if the player's sweet spot was situated on the left side of the court, the middle distance spot would be determined on the right edge of the paint. The players completed ten shots per shooting spot per viewing condition consecutively, in sum 20 shots per viewing condition.

A significance criterion of $\alpha = 5\%$ was defined a priori for all reported results. In order to test the main hypotheses, separate paired-samples t -Tests were calculated between each combination of experimental conditions. In case the t -Test revealed a significant difference, Cohen's d was calculated as effect size.

Results

It was hypothesized that the changed visual conditions affect the shooters performance negatively. Furthermore, we examined if the supposed effect occurs in both shooting spots. However, the results of an unpaired t -test revealed only a significant difference in shooting performance from the middle-distance spot and from the personal sweet spot under regular visual condition ($p = 0.0373$, Cohen's $d = 0.269$).

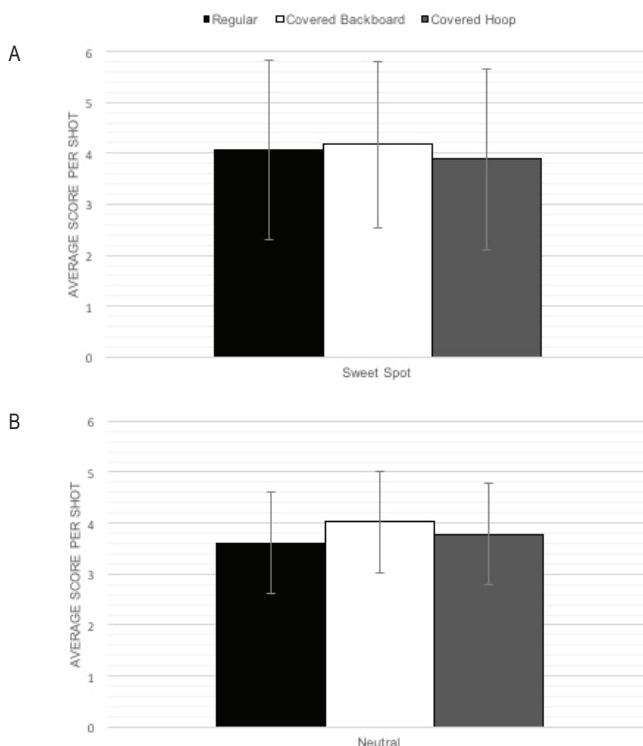


Figure 2. Average score per shot A – from the shooters personal sweet spot; B – from the neutral spot.
Each bar represents one visual condition (means \pm standard deviation)

Discussion

In the present study, we examined the influence of several visual conditions on the shooters performance from its personal sweet spot and a neutral spot from mid-range. Based on previous findings (Keetch, Schmidt, Lee, Young, 2005), we hypothesized that direct visual information affects the shooters' performance. More precisely, restrictions of visual information cause a decrease in shooting accuracy. Due to the fact that information is gathered during the shooting process (de Oliveira Oudejans, Beek, 2006; Oudejans, van de Langenberg, Hutter, 2002) we assumed that the shooter receives visual information directly from the aimed target.

Therefore, the players were instructed to take shots from each spot to each visual condition. By using the six-point-scale-system, the shot accuracy was evaluated. Hence, we were able to depict small differences in shot quality. The results showed, that the changed visual conditions did not affect shooting performance. According to the participants' statements, the visual restrictions had no influence on their shots. To strengthen the restrictions for condition two, where the backboard was covered with a white blanket, the backboard could be completely removed. Through this adjustment, the shooters cannot use the backboard as a point of reference.

Same applies to the third condition, where the hoop was covered with crepe tape. If the ring is not simply covered with crepe tape, but hidden behind a blanket or screen, height and distance are the only provided information. The exact position of the basket is unidentified and needs to be estimated. By adjusting these two independent variables, the habitual shooting situation is terminated.

The data analysis revealed a significant effect between shots from the sweet spot and the neutral spot under regular condition. Players shot significantly better from their personal sweet spots. This result supports Keetch's idea of a specialized skill that is acquired through a larger amount of practice from a particular spot (Keetch, Schmidt, Lee, Young, 2005; Keetch, Lee, Schmidt, 2008). There are two concerns we are facing: First, is the better shooting performance distance-specific and second, is the better shooting performance angle-specific. To confirm, that increased performance is linked to this particular spot, its accuracy needs to be compared to the accuracy of shots from either the same distance, but different angle, or same angle, but different distance. If shot accuracy varies within the different spots, Keetch's idea of an especial skill is supported. Further research could examine the differences in kinematics, motor output and innervation of the muscular system concerning this issue.

We acknowledge that statistical power could be increased with a larger sample size. However, performance from the sweet spot as compared to performance from different spots seems to be a strong and robust effect that occurs in a wide range of participants and is specific to (regular) viewing conditions. Nevertheless it would be fruitful to assess whether this effect depends on factors such as participants playing position, basketball expertise or alike.

As there exists a link between the sweet spot and the shot accuracy a practical implication could be derived. In tactical deliberations plays could be pertinent designed, so players shoot from their particular sweet spot to increase the chance of success. Particularly in match-winning situations where the hit decides between victory and defeat.

The present results demonstrate that visual constraints seem not to affect shooting performance, but that the shooting spot does play a role in shot accuracy.

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