Ilkogretim Online - Elementary Education Online, 2021; Vol 20 (Issue 1): pp. 5461-5470
http://ilkogretim-online.org
doi: 10.17051/ilkonline.2021.01.579

3-D Motion Analysis Of The Upper Body Of Cricket Batsman At The Execution Pull Shot

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ABSTRACT

The kinematics of cricket batsmen's upper extremities during the draw shot is investigated in this study. After watching movies for additional kinematics analysis, Eighteen Malaysian national cricket batsmen performed 8 pull shots, two of which were successful and two of which were unsuccessful. For repeated trials, the ball machine was utilized to manage the ball's speed, bounce, and uniformity. The pull shot activities were filmed by two high-speed video cameras. Kinematic analysis was performed using Analysis Software. The kinematics of the upper extremities at successful and unsuccessful pull shots were compared using repeated measures (ANOVA). The height of the bat, the distance of the ball from the head at the contact, and the extension of the left elbow were all significantly higher when the pull was successful. The rapid movement of the shoulders and arms, on the other hand, brings the batsman's position closer to the line of the short-pitched ball for a good pull shot. To perform a successful pull shot, instructors and batters should concentrate on the faster extension of the joints of the upper body segments.

Keywords: Pull shot, cricket batting, short pitch ball, body segments

INTRODUCTION

The pull shot is executed by swinging the bat in a horizontal arc to achieve the short-pitched ball's direction (Land & McLeod, 2000). A batsman's elbows should be extended to keep the bat in line with a short pitch ball for a pull shot (Robson, 2003). The faster the arms travel, the better the possibility of a successful shot (Cross, 2009), since it puts the upper body in line with the short pitch ball (Lund & Heefner, 2005). According to cricket experts, the downward draw stroke keeps batters avoid being caught out by opposing fielders (Knight, 2007; Woolmer, Noakes, Moffett & Lewis, 2008).

The flexion and extension of the upper extremity joints affect the accuracy of the pull shot. The proper execution of the pull shot has a positive association with the angular kinematics of the elbows (Bagchi, 2012). The downward pull shot is related to faster elbow extension (De Villiers, 2015), whereas the failed pull shot is associated with a slower bat swing (Regan, 2012). According to Mann, Sprat ford, and Abernethy (2013), elite batsmen performed better than short-pitched club batsmen. The angular kinematics of upper body segments during the pull shot was qualitatively explained by (Kelly et al., 2003). The pull shot technique has been discussed by cricket instructors and specialists, but biomechanical details about the stroke have not been provided (Bradman, 1958; Woolmer, Noakes, & Moffett, 2008; Pyke & Davis, 2010). These coaching manuals only provide a rudimentary understanding of the upper body's kinematics during the pull shot's execution.

Following a review of the literature, it appears that quantitative analysis is required to compare the kinematics of successful and unsuccessful pull shots. As a result, videography analysis is required to explain the kinematics of the pull shot technique used in previous cricket batting analysis (Elliott, Baker, Foster, & Source, 1993; Stretch, Buys, Dutoit, & Viljoen, 1998; Stuelcken, Portus, & Mason, 2005), as well as baseball batting analysis (Elliott, Baker, Foster, & Source, 1993; Stretch, Buys, Dutoit (Escamilla, et al., 2009; Inkster, Murphy, Bower, & Watsford, 2010). To compare the kinematics of the upper extremities during successful and unsuccessful pull shots in senior, under nineteen, and under sixteen professional cricket players, this study was conducted.

Methods and Material

This is a semi-experimental research project. The study included eighteen Malaysian leading cricket batsmen aged senior, unde rnineteen, and under sixteen. The permission form was obtained to ensure their willingness to participate in this study as volunteers. At the Kinrara Oval Cricket Stadium in Kuala Lumpur, Malaysia, data was compiled.

Instruments and their Locations for Data Collection

For repeated testing, the ball machine (BOLA, Stuart & Williams, UK) was utilized to control the ball speed, bounce, and uniformity (Headrick, Renshaw, Pinder & Davids, 2012). To capture the pull shot actions, two high-speed video cameras (Sony, Tokyo, Japan) with a 1.40-meter height from the ground were operated at 60Hz. The first camera was positioned 13 meters in front of the batsman, while the second was positioned to the side near the bowling crease. For video capture volume, a 24-point aluminium calibration frame was set (Stuelcken, Portus, & Mason, 2005). The calibration volume was set at 3 meters on the X-axis for sagittal plane motions, 1.5 meters on the Y-axis for frontal plane movements, and 2 meters on the Z-axis in the vertical direction for transverse plane movements (Stuelcken et al., 2005).

As previously stated, thirteen reflective markers were inserted at the upper body joints (Taliep, Galal, & Vaughn, 2007). To track the kinematics of the shoulders, two markers were implanted at the right and left acromioclavicular. To find the extension and flexion of elbow joints, two markers were put at the lateral epicondyle. To track the linear and angular displacements of wrist joints, two markers were implanted at the right and left radial styloid. Two spots on the bat handle and four at the blade's corners were digitized following industry standards (Stuelcken et al., 2005). A marker was placed on the helmet to measure head movement.

The Data Collection Methodology

Each batsman acclimatized to the experimental conditions by hitting warm-up shots against the ball machine before the start of the trials. The ball projection machine was set 17.68 meters from the batting crease (batsman performance area) with a ball release point height of 2.30 meters, comparable to the fast bowlers in the other study (Renshaw et al, 2007). The ball speed was varied between 25 and 30 m/s, like in previous front foot shot studies (Renshaw, Oldham, David, & Gold, 2007; Pinder, Davids, Renshaw, & Arajo, 2011). Before being fed into the ball machine, each ball was displayed to batsmen to ensure that they were ready.

After watching films for further kinematics research, the qualified coaches selected two successful and two unsuccessful pull shots from each batsman. "The stroke is played with the whole face of the bat, downward and toward the square leg side of the ground," the successful orthodox pull shots stated (Bradman, 1958; Woolmer et al., 2008). The failed stroke is not correctly executed, with the ball skying in the air to create catching opportunities for the surrounding fielders. The stance, the back lift of the bat, and the bat-ball contact were the three phases of the pull shot's kinematics.

Data processing

A kinematics study was performed using the Aerial Performance Analysis Software programme (Wormgoor, Harden, & Mckinon, 2010; Stuelcken, Portus, & Mason, 2005). The pull shot movies were downloaded to the computer and synced to discover a similar moment of action for both cameras. For digitising the markers of the body parts and bat, a 15-point model was constructed (Stuelcken et al., 2005). The stick figure was used to digitise all of the selected footage of the pull shots. The direct linear transformation (DLT) method was used to convert the digitised data into 3-D coordinates (Abdel-Aziz, Karara, & Hauck, 2015). A cubic spline low filter pass was used to smooth the raw 3-D data. At a cut-off frequency of 13 Hz, the body parts were smoothed, whereas the bat was smoothed at 14

Hz (Stuelcken et al., 2005; Escamilla et al., 2009). Following the smoothing of the raw data, the true score of linear and angular kinematics was calculated.

The height of the bat and the batsmen's centre of gravity were measured from the ground surface to vertical in the Y-axis direction. In the direction of the X-axis, the head and ball distances at bat-ball impact were examined. The bat's displacement was measured along the X-axis in the direction of the incoming short-pitched ball. The joints' angular kinematics were specified as 180 degrees in full extension and zero degrees in full flexion (Inkster et al., 2010). The intersection of the hips to the shoulder vector and the shoulder to elbow vector was used to define the shoulder angles. The intersection of the shoulder to elbow vector and the elbow to wrist vector was used to define the elbow angles. The bat angle was defined as the distance between the upper corner of the bat and the lower corner of the bat toe vector, as well as the distance between the lower corner and the ground surface's vertical position direction as a vector.

The variability of kinematics data was decreased by calculating the mean score of two successful and two unsuccessful pull shots using the formula (Mullineaux, 2007). The video data's dependability was tested using the digitizing and re-digitizing process. The inter-tester dependability of the actual digitised and re-digitized scores was tested using the coefficient of variation (CV). Bat height is 5.4 percent, bat velocity is 8.1 percent, the bat-ball impact is 6.2 percent, bat angle is 7.8 percent, shoulder angle is percent, elbow angle is 6 percent, and wrist velocity is 8 percent. As described, the linear kinematics range was 3.1 to 10.7 millimetres, and the angular kinematics range was 3.1 to 10.7 degrees (Stuelcken et al., 2005).

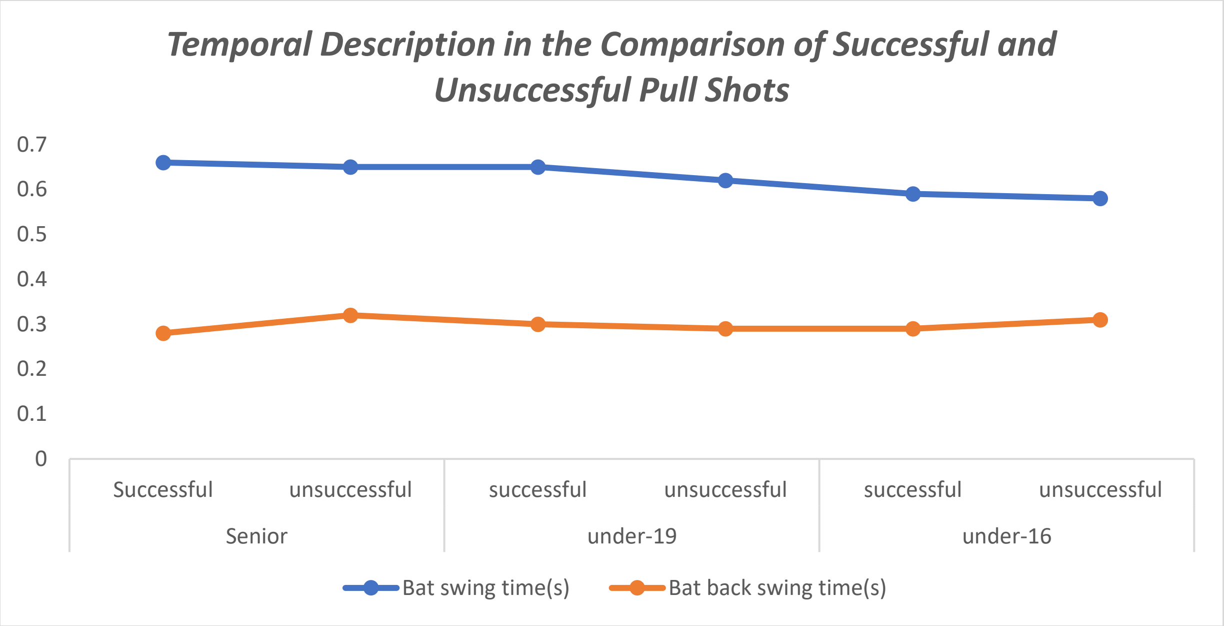
Statistical analysis

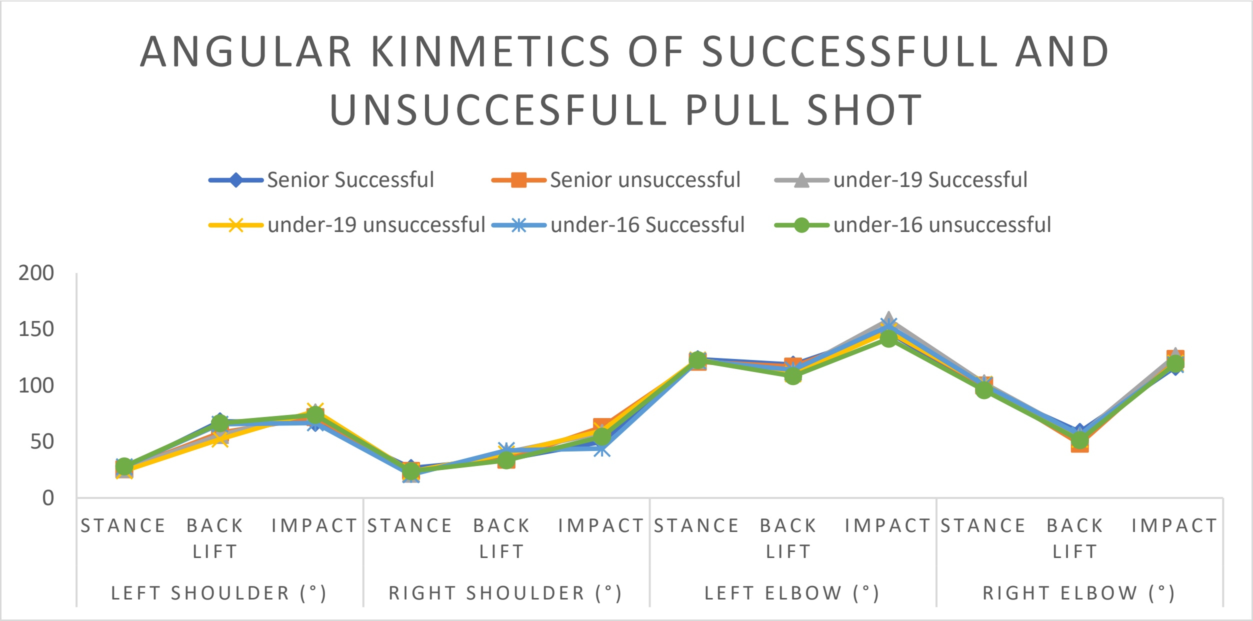
For linear and angular kinematics variables, descriptive statistics such as mean and standard deviation were used. ANOVA with repeated measures was used to examine three groups (senior, under nineteen, and sixteen) x three levels (stance, back lift, and impact) x two circumstances (successful vs unsuccessful shot). Data normality, homogeneity of variance, and multicollinearity assumptions were verified (Pallant, 2007; Field, 2009). The significance of the difference between successful and unsuccessful pull shots was determined using Tukey's post hoc analysis. For all variables, the significant level was set to ($P<.05$).

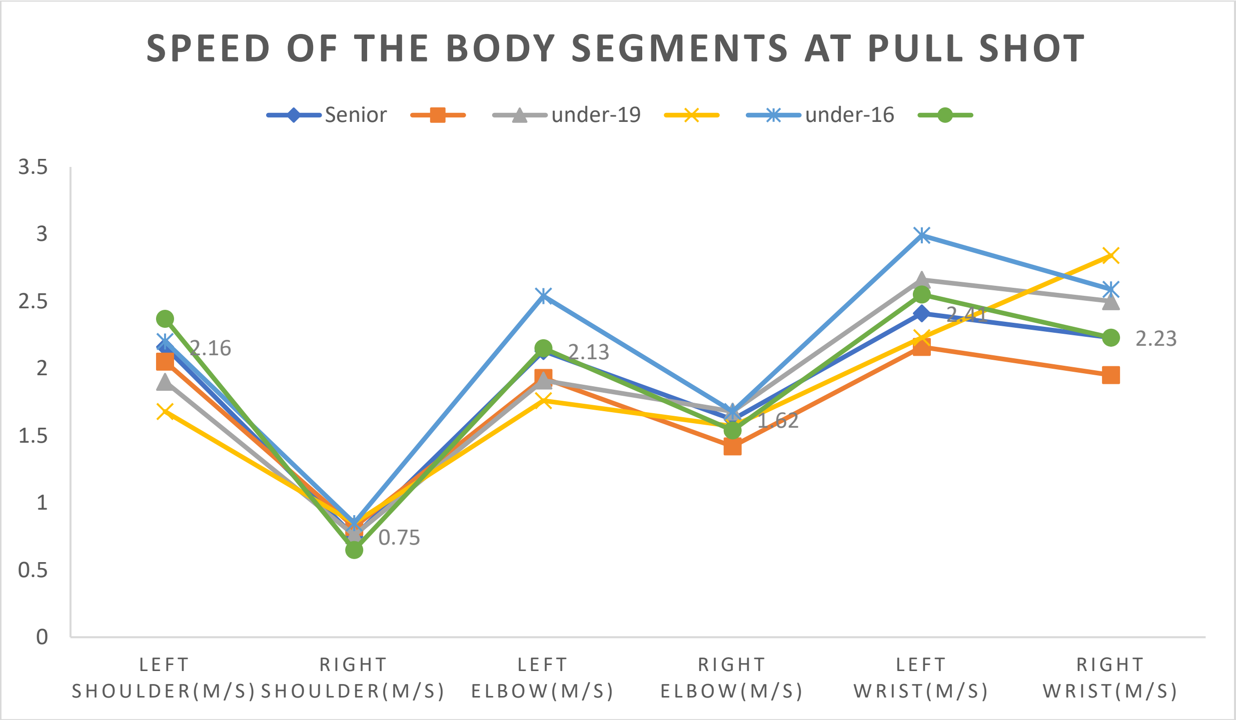
RESULTS

Figure two shows that the bat height during successful and unsuccessful pull shots had a significant main impact within-groups $F(2, 15) = 9.97$, $P < .01$. The bat height was substantially higher at successful pull shots than unsuccessful pull shots, according to a post hoc analysis. At the left shoulder angle during successful and unsuccessful pull shots, there were significant main effects within-groups F (2, 15) = 5.15, P < .04. The extension of the left shoulder was substantially higher at successful pull shots than unsuccessful pull shots, according to Tukey post hoc results. At the left elbow angle for successful and unsuccessful pull shots, there was a significant main impact F (2, 15) = 7.98, P < .01. The extension of the left elbow was substantially higher at successful pull shots than unsuccessful pull shots, according to Tukey post hoc analysis. At the right elbow angle, there were significant main effects within-groups F (2, 15) = 9.96, P < .01. The extension of the right elbow was substantially higher at successful pull shots than unsuccessful pull shots, according to Tukey post hoc results.

Figure three revealed a significant main effect at the velocity of the left shoulder for successful and unsuccessful pull shots, F (2, 15) = 4.75, P < .05. The left shoulder velocity was substantially faster on a successful pull shot than on an unsuccessful pull shot, according to Tukey post hoc results. A significant difference in right shoulder velocity between groups F (2, 15) = 3.99, P < .04. The right shoulder velocity was substantially faster during a successful pull shot than during a failed pull shot, according to Tukey post hoc data.







The right elbow velocity during successful and unsuccessful pull shots had significant main effects within-groups F (2, 15) = 6.60, P < .02. The right elbow of veteran batsmen was much faster during successful pull shots than unsuccessful pull shots, according to Tukey post hoc data. The left wrist velocity during successful and unsuccessful pull shots had significant main effects within-groups F (2, 15) = 7.46, P < .02. The left wrist velocity was substantially faster during a successful pull shot than at a failed pull shot, according to Tukey post hoc data. The velocity of the right wrist at successful and unsuccessful pull shots had significant main effects within-groups F (2, 15) = 7.46, P < .02. The right wrist velocities were substantially faster for successful pull shots than unsuccessful pull shots, according to Tukey post hoc data.

DISCUSSION

Based on their personal experiences, the cricket professionals describe the causes of successful and poor pull shots, although they were unable to provide research-based mechanical evidence of the strokes. As a result, the goal of this study was to analyse the kinematics of successful and unsuccessful pull shots made by national-level cricket players. For video analysis of the strokes, the Ariel Performance Analysis System (APAS) software suite was used. The statistical difference between the successful and unsuccessful pull shots was investigated using repeated measure ANOVA. The kinematics variables were chosen from the stance, back lift, and bat-ball impact phases of the pull shot.

Batsmen's bat height was (plus .05 meters) higher when they attempted a successful pull shot than when they failed. The recent research backs up the coaching theory that the bat's toe shifted vertically above the stumps at the right shoulder (Knight, 2013). The batsmen benefit from the high backlift because they can execute the short-pitched ball from a higher position (Pyke & Davis, 2010). Senior batsmen (minus .37 meters), under nineteen batsmen (minus .37 meters), and under-16 batsmen all begin their downswing from the back lift, and their height lowers at impact (minus .41 meters). This distinction demonstrates how it helps a batsman make a safe draw stroke rather than skying, which allows opponents to catch the ball.

The successful shot had more elbow flexion at the back lift (minus 10.48 degrees) than the unsuccessful shot. The batsman can keep the bat in a higher position at the right shoulder thanks to the higher flexion elbows (Stuelcken et al., 2005). The higher the flexion of the elbows during the back lift, the higher the extension of the elbows at bat-ball collision. In the current study, successful pull shots result in more elbow extension than unsuccessful pull shots. The batsman's elbows are extended further, allowing him to keep his bat swing trajectory parallel to his shoulder and collide with the short pitch ball. The new study backs up DeVillior's (2015) findings that higher elbow extension is linked to a successful pull shot.

The successful pull shot had much more shoulder extension than the unsuccessful pull shot. The current study backs up (Fortenbaugh et al., 2011)'s findings that a higher shoulder extension keeps the bat swing trajectory parallel to the delivered ball. Bat velocity is also increased by the higher extension shoulders (Aruparayil & Chattopadhyay, 2013).

The velocity shoulders are crucial in bringing the arms and bat into line with the short-pitched ball. The successful pull shot had a faster shoulder velocity than the unsuccessful pull shot. The results of this study back up the coaching theory that faster shoulder movement is linked to a successful pull shot (Bradman, 1958; Woolmer et al., 2008).

A successful pull shots, the elbows were faster (+.39 m/s) than at unsuccessful pull shots. To execute a successful pull shot, it is established that faster elbow movement keeps arms straight. The new study backs up Cross (2010)'s findings that straightening the arms faster and more quickly pulls the bat's handle, increasing the bat's velocity. The results of this study back the coaching advice (Breen, 1967; Swimley, 1964) that faster elbow extension brings the bat closer to the line of the short-pitched ball.

A successful pull shots, the wrists were faster than at unsuccessful pull shots. The batsman's speedier wrist helps him roll over the bat as he makes contact with the ball. The wrist roll plays a key role in executing a successful downhill pull stroke. The rapidity of the bat swing is similarly linked to the faster wrist movement. This study demonstrates that the bat's speed is critical for executing a successful shot (Lund & Heefner, 2005).

Conclusion

When comparing successful and unsuccessful pull shot attempts, the kinematics factors revealed significant differences. The successful pull shot is linked to the bat's vertically higher position. A batsman's shoulders are extended to help him perform a successful pull shot in front of his chest. The higher extension of the elbows, on the other hand, allows a batsman to retain his arms and bat position parallel to the trajectory of a short-pitched ball. The new study's findings back the coaching advice that the arms and bat should be straight to the ball's trajectory to execute a successful pull stroke (Bradman, 1958; Woolmer et al., 2008; Pyke & Davis, 2010).

The faster wrist movements, on the other hand, bring the bat in time as well as rollover the bat to execute a pull shot downward rather than up into the sky. The faster movement of the shoulders, elbows, and wrists is linked to the bat's increased velocity. Future research should be undertaken in match-like situations rather than in a clinical setting to examine batsmen's pull shot performance organically.

Acknowledgement

The Sultan Idris Education University in Malaysia and the Malaysian Cricket Association were both helpful in allowing the study to be carried out.

References

Abdel-Aziz, Y. I., Karara, H. M., & Hauck, M. (2015). Direct linear transformation from comparator coordinates into object space coordinates in close-range photogrammetry. Photogrammetric Engineering & Remote Sensing, 81(2), 103-107.

Aruparayil, S., & Chattopadhyay, M. T. (2013). Relationship of selected anthropometric and biomechanical variables to the technique of back foot off drive in cricket. International Journal of Movement Education and Social Sciences, 2(1), 25-27.

Bagchi, A. (2012). Relationship of selected anthropometric and biomechanical variables to the technique of front foot on – drive in cricket. International Journal of Science and Research, 352-354.

Bradman, D. (1958). The Art of Cricket. London, UK: Hodder & Stoughton.

Breen, J. L. (1967). What makes a good hitter? Journal of Health, Physical Education, Recreation, 38(4), 36-39.

Cross, R. (2009). Mechanics of swinging a bat. American Journal of Physics, 77(1), 36-43.

DeVilliers, A. B. (2015). http://www.cricketyard.com/pull-shot. Retrieved from http://www.cricketyard.com/home.

Elliott, B., Baker, B., Foster, J., & Source, D. (1993). The kinematics and kinetics of the off-drive and the on-drive in cricket. Australian Journal of Science & Medicine in Sport, 25(2), 48-54.

Escamilla, R. F., Fleisig, G. F., DeRenne, C., Taylor, M. K., Moorman, I. C., Imamura, R., . . . Andrews, J. R. (2009). A comparison of age level on baseball hitting kinematics. Journal of Applied Biomechanics, 25(3), 210-218.

Field, A. (2017). Discovering statistics using SPSS. Sage publications.

Fortenbaugh, D. M. (2011). The biomechanics of the baseball swing. Miami: (Doctoral dissertation, University of Miami).

Inkster, B., Murphy, A., Bower, R., & Watsford, M. (2010). Differences in the kinematics of the baseball swing between hitters of varying skill. Journal of Science and Medicine in Sport, 12, 1050-1054.

Kelly, M. G., Curtis, K. M., & Craven, M. P. (2003). Fuzzy recognition of cricket batting strokes based on sequences of body and bat postures. Proceedings IEEE Southeastcon, (pp. 140-147).

Knight, J. (2007). Cricket For Dummies. Chichester, West Sussex, England: John Wiley & Sons, Ltd.

Land, M., & McLeod, P. (2000). From eye movements to actions: How batsmen hit the ball. Nature Neuroscience, 3(12), 1340–1345.

Lund, R. J., & Heefner, D. (2005). Training the Baseball Hitter: What Does Research Say? Journal of Physical Education, Recreation & Dance, 76(3), 27-33.

Mann, D. L., Spratford, W., & Abernethy, B. (2013). The head tracks and gaze predicts: how the world’s best batters hit a ball. PloS one, 8(3), e58289.

Mullineaux, D. R. (2007). Research methods: sample size and variability effects on statistical power. In Biomechanical Evaluation of Movement in Sport and Exercise (p. 153).

Pallant, J. (2007). SPSS survival manual: A step-by-step guide to data analysis using SPSS version 15. Maidenhead, Berkshire, England: McGraw-Hill Education.

Pinder, R. A., Davids, K., Renshaw, I., & Araújo, D. (2011). Manipulating informational constraints shapes movement reorganization in interceptive actions. Attention, Perception, & Psychophysics, 73(4), 1242-1254.

Pyke, F. S., & Davis, K. (2010). Cutting edge cricket. South Australia, Australia: Human kinetics.

Renshaw, I., Oldham, A., David, K., & Gold, T. (2007). Changing ecological constraints of practice alerts coordination of dynamics interceptive action. Journal of Sports Sciences, 7(3), 157-167.

Regan, D. (2012). Vision and cricket. Ophthalmic and Physiological Optics, 32(4), 257-270.

Robson, T. (2003). The hitting edge. Champaign. Human Kinetics.

Stretch, R., Buys, F., Dutoit, E., & Viljoen, G. (1998). Kinematics and kinetics of the drive of the front-foot in cricket batting. Journal of Sports Sciences, 16(8), 711-720.

Stuelcken, M. C., Portus, M. R., & Mason, B. R. (2005). Off-side front-foot drives in men's high performance cricket. Sports Biomechanics, 4(1), 17–36.

Swimley, P. S. (1964). A cinematographic analysis of two selected baseball swings. Unpublished master's thesis, Sacramento State College, Sacramento, CA.

Taliep, M. S., Galal, U., & Vaughn, C. L. (2007). The position of the head and center of mass during the front-foot off-drive in skilled and less-skilled cricket batsmen. Sports Biomechanics, 6(3), 345-360.

Woolmer, B., Noakes, T., & Moffett, H. (2008). Bob Woolmer's art and science of cricket. London, UK: New Holland Publishing.

Wormgoor, S., Harden, L., & Mckinon, W. (2010). Anthropometric, biomechanical, and isokinetic strength predictors of ball release speed in high-performance cricket fast bowlers. Journal of sports sciences, 28(9), 957-965.