



A Systematic Review of the Batting Backlift Technique in Cricket

by
*Habib Noorbhai*¹

There has been an extensive amount of research into the batting elements of cricket. However, there is limited research specifically on the batting backlift technique (BBT). Therefore, this review aims to provide an understanding and consensus of the BBT in cricket at varied skilled levels. A PRISMA flow chart revealed 38 studies that were reviewed (both coaching and scientific literature), which reported on the backlift in cricket. The databases searched were PubMed, Google Scholar, the Cochrane Library and Sabinet. This review shows that the lateral batting backlift technique (LBBT) is a likely contributing factor to successful batsmanship at all levels of cricket ability (junior, adolescent, semi-professional, professional, international and former elite/successful cricketers). It was also found that coaching a LBBT to young batsmen may be challenging to teach, and therefore, further coaching models should be developed to assist cricket coaches. As much as a LBBT may be a contributing factor for success, there is still a need to answer a number of questions through further in-depth biomechanical investigations and through interventions that are more meticulous. A way forward for further research in this area of cricket batting is documented at the end of the review.

Key words: *biomechanics, performance analysis, coaching, batters, cricketers.*

Introduction

Cricket batting is an incredibly complex motor task that requires the batsman to overcome, at times, highly challenging spatial and temporal constraints to effectively and successfully hit the ball (Noorbhai and Noakes, 2019a). The literature focusing on biomechanics has provided a series of studies that have, at times, advocated, and at other times questioned the prevailing coaching theories developed over many years (Sarpeshkar and Mann, 2011).

These results in themselves may fall short of being used in the most effective manner if they do not effectively inform, challenge, and change coaching practices with the development of sound theories for teaching and learning of cricket batting. Over the last few decades, there has been a paucity of literature on the biomechanics and motor control used in batting. The emerging scientific and coaching literature examining the

batting backlift technique (BBT) is useful in both informing and interpreting the current consensus on batting methods (Noorbhai, 2019b). This will be discussed later in the review.

In the cricket batting literature, there are four notable areas for research. It is firstly important to understand how the visual-motor system guides movements to be in the right place and time to hit an oncoming ball. Secondly, there is a need to investigate the visual-motor approaches that can be conducted by batsmen to overcome temporal constraints which could enhance this information. Thirdly, by studying biomechanical movements, this would enable skilled batsmen to perform at their best (Sarpeshkar and Mann, 2011). Fourth, how research translates to coaching practice and why motor skills demonstrate variability due to inherent biological limitations and the role of

¹ - 1. Department of Sport & Movement Studies, Faculty of Health Sciences, University of Johannesburg.

environmental constraints (e.g. the bowler, the pitch, etc.). It would seem prudent to consider the representative learning design (i.e. environment) and cricket batting research. For example, Pinder's (2011a) work highlights that a representative design is needed to understand whether findings from systematic design studies transfer to real-world performance and learning. These issues were further considered when batting was compared to a bowling machine, raising questions around the ecological validity of bowling machines and similar automotive-bowling modalities (Pinder, 2011b). Subsequent work has further expanded this area. A study by Headrick (2015) explored changes in movement timings from ball to ball, based on ball length. Furthermore, Connor et al. (2018) showed that a representative field-based skills test can distinguish between junior, amateur and skill cricket batters.

The focus of this review expands on the third point above, whereby biomechanical movements such as the BBT can either enhance or hinder performance of cricket batsmen at all levels. The rather redundant nature of motor organisation in batting, in which the same hitting outcome can be achieved by any number of different batting techniques, has made it difficult to find common biomechanical measures of success across different players, and different levels of skill (Noorbhai, 2017). This review also attempts to document the findings of the BBT of players at varied levels of cricket.

Former studies have shed light on the nature of expertise in hitting a cricket ball by taking a different methodical approach, including the use of within-participant designs and cross-sectional comparisons across skill levels and age-groups (Weissensteiner, 2008). In addition, research conducted in Australia by Stuelcken et al. (2005) was one of the very few studies documenting findings on the direction of the backlift in cricket in both the frontal and transverse planes. This review aims to build on what was found from their study and expand on the scientific understanding of the BBT in cricket.

Anecdotally, a key skill of elite batsmen is a reported ability to maneuver the ball away from the opposing fielders using fine manipulations of the batsman's wrist position. Sir Donald Bradman famously practiced his batting skills using a

cricket stump to repeatedly hit a golf ball against a corrugated iron tank (Fraser, 2009). He is notably the prime example of what is called a looped technique (the loop of the backlift in the lateral direction towards fielders standing behind and oblique to the stumps, prior to the bat being brought through for the downswing and impact with the ball). For the purpose of this review, the looped or rotary technique will be described as the lateral batting backlift technique (LBBT). The traditionally taught technique is known as the straight batting backlift technique (SBBT) (Noorbhai and Noakes, 2016a). To a large extent, Bradman's influence has provided a rationale for investigating whether batsmen who display elements of his looped action will have any factor of success in their careers (such as better averages, strike rates or career runs scored). Furthermore, coaching manuals in Bradman's era (aside from his own book in 1958) hardly addressed the issue of the BBT, and therefore, it is imperative to understand the BBT of current batsmen across varied levels of cricket ability.

There is also the growing awareness of coaches and scientists that elite cricketers do not play the way most coaching manuals suggest they should. As early as 1912 (when C.B. Fry shared his coaching theories on batting) until today, 105 years later, there is still no consensus of how the backlift in cricket batting should be coached (Fry, 1912; Penn and Spratford, 2012). Presently, as outlined below through both the scientific and coaching literature, the debate regarding the BBT in cricket continues (Woolmer et al., 2009).

Methods

A systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009).

Data Sources and Searches

While this was not intended to be a formal systematic review, a search strategy was used to identify the relevant literature. Scientific literature was identified by searching electronic databases such as Google Scholar, Pubmed, The Cochrane Collaboration, Sabinet and The University of Cape Town archives and Library with the keyword search of "cricket batting", "batting techniques", "coaching cricket batting", "biomechanics of batting", "backlift and

backswing in sport”, “backlift”, “batting backlift technique” and “batting backlift in cricket”. Due to the limited scope of the scientific literature on this topic, we opted to include all relevant articles and publications for all years (up to June 2019).

Coaching literature was identified by searching on electronic databases mentioned above as well as library archives for hardcopies of coaching manuals with the keyword searching of “cricket coaching”, “cricket batting”, “batting techniques in cricket”, “backswing in cricket”, “backlift”, “batting backlift technique” and “batting backlift in cricket”. The most relevant coaching literature on cricket batting was sourced between 1895 and June 2019.

The titles and/or abstracts were reviewed to exclude any clearly irrelevant studies. The full texts of the remaining studies were then retrieved and read in full, independently to determine whether the studies met inclusion criteria. The reference lists of studies that examined the topic of interest were checked for additional publications.

Inclusion criteria

In the search, both primary sources and systematic reviews were prioritised as these synthesise the evidence and are at the top of the evidence-based cricket batting literature as well as studies from the local context. As a second strategy, relevant key scholars from the literature review and institutions were identified, and searched for their recent critical publications, as well as new authors citing them, and which references they had used. Studies that were conducted to measure other variables of the backlift (height of the backlift, time to the commencement of a backlift, etc), or where review studies had included the backlift, were excluded. Coaching texts were also sourced as these were imperative resources utilised at the time where there were limited empirical sources.

Data extraction and synthesis

Using a standardized data extraction sheet, the following information (if available) was extracted and recorded from studies: authors and year of publication; sample size; performance level; study design; findings and conclusions or way forward. The findings analysed focused on consensus around the direction or angle of the backlift at any particular performance level.

Quality assessment

The PRISMA guidelines were used to examine the quality of the studies. These include adequacy of the study design; recruitment of the sample; and findings. The quality of the studies was not summarized with a score, as this approach has been criticized for allocating equal weight to different aspects of methodology (Jüni et al., 2001), but a formal assessment of the risk of bias and strength of evidence according to the Agency for Healthcare Research and Quality (AHRQ) guidelines was conducted (Owens et al., 2010).

Results

Study selection

The flowchart is shown in Figure 1. The literature search resulted in 4526 studies. After review of their titles and abstracts, 180 studies met the inclusion criteria and were retrieved for full reading of the text. Of these, 142 studies were excluded from the systematic review as they no longer met the inclusion criteria. A total of 38 studies were included in the systematic review, and the extracted data are summarized as coaching literature in Table 1 (30 sources) and scientific literature in Table 2 (8 studies).

What constitutes a successful batsman?

Before one can dive into the consensus of the BBT in cricket, we need to be reminded of the complex skill of cricket batting which includes a number of components and factors. Skilled cricket batsmen produce complex, full-body movements to aid them in overcoming the demanding constraints inherent in the game, with the ultimate goal of producing the most forceful stroke possible to score runs (Weissensteiner et al., 2011). When considering the force with which a ball is hit, full-body movements coordinating upper and lower-body segments allow for a more effective transfer of forces to be summated into a hitting action (Sarpeshkar and Mann, 2011; Weissensteiner et al., 2011).

Motor Skill Development

As mentioned above, cricket batting is an incredibly complex motor skill. An important area for future work lies in determining how the brain is capable of directly guiding the batsman’s movement based on the vision of an approaching ball (Montagne, 2005). One example is the

concept of 'neurobiological degeneracy' which describes functionally equivalent actions that can be achieved via different movement systems (i.e.: numerous degrees of freedom) (Thomas, 1967). It is postulated that there is no 'classical' technique for performance; each individual has a unique way of portraying their different learning dynamics as the interacting configuration of constraints will differ between learners (Chow et al., 2011). In addition, different movement patterns develop between individuals with similar performance outcomes that they achieve. It is imperative to recognise that individuals may perceive task activities or the environment differently, and that final performance measures may be similar due to the unique capabilities of each learner (Müller et al., 2006; Pinder et al., 2009).

In cricket, as in other interceptive sports such as tennis, badminton, and baseball, the batsman learns to 'read' the specific kinematic movements of a bowler to predict the characteristics of the delivery being bowled (Noorbhai, 2007). Investigations exploring the developmental histories of skilled batsmen suggest that the accuracy of a batsman's ability to anticipate the ball is most likely due to their exposure to bowlers across vast amounts of purposeful practice, and time spent in organised cricket (Weissensteiner et al., 2008, 2011).

Motor Control

There has also been a concurrent increase in the number of studies examining perception and visual-motor control in cricket batting. Many studies have made important contributions towards understanding the strategies used by batsmen to overcome the temporal constraints of batting. However, they fall short of informing us, if and how this information contributes to guide the movements of skilled batsmen (Sarpeshkar and Mann, 2011). Successful hitting requires the batsman to possess an efficient link between the perceptual and motor systems to ensure that precise information from both the opponent and the ball's flight-path is best used to adapt movements for optimal body-positioning and timing of the bat-swing to hit the ball.

Temporal Constraints of Batting

Despite the importance of motor control in sport, there is also a need to fully understand the temporal constraints of complex movements

such as batting. The examination of gaze behaviours while intercepting an approaching ball highlights the effective and efficient visual search strategy employed by skilled batsmen to obtain the information required to coordinate movement and overcome the temporal constraints of batting. At ball speeds commonly encountered by cricket batsmen (in excess of 25 m/s), batsmen visually track the initial 50–80% of ball-flight before making an anticipatory saccade (i.e. an eye movement in which gaze is shifted from one location to another) (Land and McLeod, 2000).

Irrespective of the control mechanisms used to guide hitting, the temporal constraints placed on the batsman are at times immense, and appropriate strategies are required to ensure that there is adequate time to successfully ensure bat-ball contact. One of the key strategies used by athletes (and specifically by cricket batsmen) to overcome these temporal constraints is through the effective identification and interpretation of advance kinematic information inherent in the movement of opponents (Stretch et al., 2000). The development of these anticipatory skills provides batsmen with the ability to predict the outcome of a movement sequence produced by the opposing bowler before the ball is released, and as a result may aid in preparing movement coordination at an earlier point in time to facilitate successful bat-ball interception.

Task Constraints of Batting

Task constraints are also imperative to understand cricket batting. This includes the physical, spatial and temporal constraints of batting, defined by the size of the bat and ball, the speed, line and length of the delivery, as well as any ball deviations after delivery release (i.e.: swing, seam and spin) (Stretch et al., 1998b, 2000). In essence, batsmen may execute appropriate cricket strokes within a matter of milliseconds, depending on the speed of the delivery (Glencross and Cibich, 1977; Land and McLeod, 2000).

Additional task constraints also include different ball types (e.g. Kookubarra and Duke) and innings (e.g. pitch deterioration) (Connor et al., 2019), the size of the playing field and rules of the sport, such as batting scenarios and from a tactical perspective: opposition field placements. Depending on match situations, batsmen may

play a variety of attacking or defensive strokes to achieve the specific goals of a particular scenario. The constraint of opposition fielders influences how batsmen will hit the ball, and the placement of specific cricket strokes. Additional challenges are provided as batsmen are expected to manipulate as many deliveries as possible around the field, avoiding opposition fielders, in order to score runs within a set amount of deliveries (Vickery et al., 2014).

Skill Acquisition

Batting is notably a highly complex interceptive action and complex skill requiring a combination of mental, perceptual, physical, technical and tactical skills in order to perform successfully (Weissensteiner et al., 2008). Due to the constraints of the sport (as noted above), elite batsmen are required to display a high level of perception-action and decision-making skills to ensure that each delivery is matched with the appropriate shot selection (Land and McLeod, 2000; Stretch et al., 2000). The ability to perceive, decide and produce an appropriate shot selection is also dependent on the interacting constraints of the individual, the objective or task at hand and the environment (Renshaw et al., 2010). Batsmen also have the option to leave a delivery that does not threaten to lose their wicket (be dismissed), therefore, forcing bowlers to deliver the ball closer to the batsman (or to the wickets), thereby reducing the risk of certain cricket shot selections.

In order for players to be successful in their performance, regardless of the sport, it is paramount to ensure that development of motor skills is achieved by means of effective training (Müller et al., 2006). Training plays an essential role in the growth and development of an individual's ability, and the refinement of particular techniques. Training within cricket includes a combination of different factors, such as strength and conditioning, awareness and decision-making as well as technique and skill development. As this paper focuses on training of a technical skill (backlift) of cricket batsmen, other factors shall be omitted.

Skilled cricket batsmen have demonstrated the ability to anticipate the type (e.g. the direction of swing and spin), and also the direction (or line), of an oncoming ball through the judicious observation of the

kinematic movement patterns of the bowler prior to ball release (Mann et al., 2010; Müller et al., 2006). For example, Müller et al. (2006) found that highly skilled batsmen were attuned to advance information from the bowler's hand, arm, and shoulder during the early period from the bowler's final back-foot impact prior to release, through to ball release.

On the other hand, lesser-skilled batsmen were found to extract information primarily from the bowling hand. Skilled batsmen were found to make use of their prior knowledge and experience of the type of a bowler. This allowed them to adopt a definitive search strategy by gathering subtle kinematic information from the head, shoulders, bowling arm, trunk, and hips in order to supplement the primary information derived from the bowling hand (McRobert et al., 2009). Many components as outlined above are important to consider prior to a batsman hitting an oncoming ball.

Major components for hitting a cricket ball

There are a number of major components that address the efficacy and success of hitting a cricket ball. The first is the phase of the cricket shot. A complete batting technique encompasses numerous phases such as the grip, stance, backlift, initiation, forward stride, downswing, bat-to-ball impact and follow-through (Stretch et al., 2000). The second is the enhancement of performance of a batsman to effectively hit a ball (Figure 2). Performance components of a batsman cannot be ignored; the art of coaching, strength and conditioning of a player throughout the season, interceptive actions (when players intercept a movement) and timing and motor skills of a batsman are all imperative for a batsman's success. The above two major components play a pivotal role in the effectiveness of batsmen hitting the ball.

The batting backlift technique in cricket

An important component of the overall batting technique is the backlift. It can be described as a technical component of the batting technique, traditionally defined as a movement in a linear plane (McLean and Reeder, 2000; Stretch et al., 2000). An additional factor which influences the proficiency of the backlift is the batting stance. The weight of the bat, the type of a helmet (which can affect the posture of a batsman), the grip of the bat and the state of hip

flexion could also affect the bat position (McLean and Reeder, 2000; Noorbhai and Noakes, 2015; Stretch et al., 2000). The most proficient run-scorsers of the game lift the bat in the direction of the slips, often causing the downswing path of the bat to deviate from its upswing (Stuelcken et al., 2005). Devising a detailed qualitative biomechanics model of the backlift could therefore do much to probe its underlying mechanics (Noorbhai, 2017).

Qualitative biomechanical analyses of movement in sports are key to its investigation (Kreighbaum and Barthels, 1996). Such a mode of investigation can provide important insights into the biomechanics of different techniques in sports, especially with regard to those skills that have to satisfy parallel performance outcomes by choosing from a kinematically redundant set of joint angle time-histories (Handford et al., 1997; Mullineaux et al., 2001).

Backlift and preparatory movements

Examinations of the backlift of the bat provide interesting insight into how skilled batsmen achieve control of the bat to effectively and efficiently swing their arms to successfully strike a ball. Many batsmen have been observed to adopt a backlift that is diverted away from their body, rather than positioning their bat directly behind them as is commonly advocated by the coaching literature (Tyson, 1994). This is contrary to what may be logically expected as the most efficient means of preparing for a straight and efficient downswing. Taliep et al. (2007) found that the angling of the backlift away from the body was common and similar across skilled and lesser-skilled batsmen. It has been proposed that this angle may provide a comfortable position for batsmen to place their hands in preparation for the subsequent downswing, and may allow for a more 'rotary' movement of the wrists by which the bat backswing and downswing can be performed in a continuous motion, rather than in two distinctive phases.

Research conducted in Australia by Stuelcken et al. (2005) on international batsmen ($n = 9$) showed that path tracings of the bat indicated a significant loop (rotary movement of the bat) that was unexpected (Figure 3).

There was no clear evidence provided by the authors to explain why there was a significant loop aside from the fact that a greater

diversity of strokes would be a possible outcome where batsmen would get used to hitting the ball. In addition, it was found that the path of the bat deviated laterally from the mean alignment of the shoulders reaching an average maximum angle in the transverse plane of 47° (after the batsman initiated the backlift). The study then indicated how this angle was reduced by a mean of 23° at the top of the backlift which showed that the position of the bat was increasingly lateral from an alignment that would enable the required bat plane for a drive to the off-side (Stuelcken et al., 2005).

Stuelcken et al. (2005) have also proposed that batsmen manoeuvre their bat using their wrists as a lever to position the bat close to the body's centre of mass. This may help to keep the centre of mass of the bat close to the batsman's base of support, and ultimately to allow a later downswing, helping to overcome the temporal constraints inherent in batting. If the wrists were to be moved away from the body in the backswing of the bat, more energy and more time would be required to produce the backswing and downswing. If the wrists are kept close to the body, the batsman is afforded a mechanical advantage as the moment of inertia required to move the bat at a given bat velocity is reduced. This decreases the amount of muscular effort required to play a stroke, and the bat can travel through a smaller swing arc to enable faster movements of the bat. If the downswing of the bat can be initiated at a later moment in time, the batsman is afforded a temporal advantage, as he or she is able to observe additional ball-flight prior to initiating the downswing to hit the ball (Stuelcken et al., 2005).

The initiation of the backlift

The most appropriate time to initiate the backlift is a key issue for players and coaches. Most coaching literature suggests that the backlift should be initiated as the bowler prepares to release the ball (Australian Cricket Board, 2000; Tyson, 1994). However, an alternate school of thought suggests that the bat should be lifted earlier and levered in the air to remove the need for a later backlift. A number of elite batsmen have adopted this newer modified backlift in an attempt to simplify the batting technique, supposedly to help in minimising the temporal constraints required when initiating a

later backswing (Sarpeshkar and Mann, 2011). It is therefore crucial to understand what the coaching literature suggests about the BBT in cricket.

Coaching literature on the batting backlift technique

Penn and Spratford (2012) investigated whether coaching recommendations for cricket batting techniques were supported by biomechanical research findings. The research showed that coaching manuals were important sources of information and guidance for coaches, and that it was a common practice for such coaching manuals to be written by former players and coaches of the game (Penn and Spratford, 2012). However, these coaching manuals are based on views and experiences of the professionals and lack the scientific rigour of evidence-based research.

One of the first principles of cricket batsmanship taught to cricketers is to play with a straight bat. This means that batsmen should lift their bats towards the wicket-keeper or in the direction of middle-stump on the initiation of the batting stroke with the bat face pointing towards the ground (Lewis, 1992; The MCC, 1962). This restricts the number of shot selections for players prior to impact with the ball (Beldam and Fry, 1905; Fry et al., 1903; Müller et al., 2015; Ranjitsinhji 1897).

In his book (1926), the South African all-rounder, Aubrey Faulkner subscribed to C.B. Fry's advice which was then promoted in South Africa:

"A batsman who persistently drives to cover point, and who picks up the bat wide of second slip must obviously be the poorest of stylists, and one might also add feeblest of players against bowlers of class" (Faulkner, 1926).

This straight backlift coaching philosophy received universal exposure with the publication of the first edition of the Marylebone Cricket Club (MCC) Coaching Manual in 1954. The text included the following statement:

"A correct backlift is not natural but can easily be obtained and too much attention cannot be given to getting it right, the bat should be taken back directly over the middle stump" (The MCC, 1954).

This explanation does not include any

reference to the direction in which the bat face should be pointing. The assumption may have been that the bat face must also point directly backwards. Forty years later, the 1994 edition of the MCC coaching manual (Boycott and Gower, 1994) continued with the same interpretation of teaching the backlift which should be directed towards the stumps to ensure that the bat will come down straight, in line with the stumps (Figure 4).

However, the same coaching manual also includes the contrasting statement of a former English opening batsman, Sir Geoffrey Boycott:

"If your stance is correct, it is a natural movement to pick up your bat in the direction of the slips, as the great batsmen do, such as Sir Donald Bradman. Then, at the top of the backlift, loop the bat and bring it down the line of the stumps. Many tutors teach more traditionally that, if you pick the bat up straight it will come down straight, so they suggest you take the bat back directly over the middle-stump. I feel that the best players have never done that. It simply is not a natural movement and it will let you down under pressure".

Expert coaches have frequently supported this notion, supporting the supposition that there is no necessarily 'right' or 'wrong' way to bat, and that many of the greater players have exhibited techniques not necessarily commensurate with those recommended in coaching manuals (Conn, 2009). For example, Sir Donald Bradman exhibited a highly unique 'rotary' technique, which was contrary to coaching convention, and is yet to be replicated (Glazier et al., 2005; Noorbhai, 2020).

The article by Boycott and Gower (1994) is accompanied by images of two established English batsmen, Graeme Hick and Graham Gooch, whose backlifts went directly backwards towards the stumps. The caption accompanying the image of Graeme Hick states:

"The backlift: the basis of a sound technique, the left arm has pushed the bat over the stumps; the face of the bat is open; eyes...No movement yet of the batsmen."

This caption is also placed directly over a picture of Sir Donald Bradman, whose backlift is directed towards second slip with the bat face pointing towards the off-side (Bradman, 1958; MacLaren, 1926). One could argue that it may be attributed to other factors in the backlift that determine this variance. However, it is clear that even the 1994 MCC Coaching Manual did not provide an unambiguous account of the technical components that constitute a correct backlift. This is probably due to the fact that the 1994 MCC Coaching Manual did not consider the importance or relevance of the technical components of the backlift.

There are a considerable number of coaching books and various archive sources that advocate that the backlift should be directed straight backwards towards the middle stump in front of the wicket keeper (Guha, 2016). In modern coaching manuals published after 2009, it has become a norm for batsmen to lift the bat in the direction of the slips (Noorbhai and Noakes, 2019c; Stuelcken et al., 2005). Table 1 displays a selection of 30 books based on their common use in the coaching literature and their specifications of the direction of the batting backlift technique in cricket.

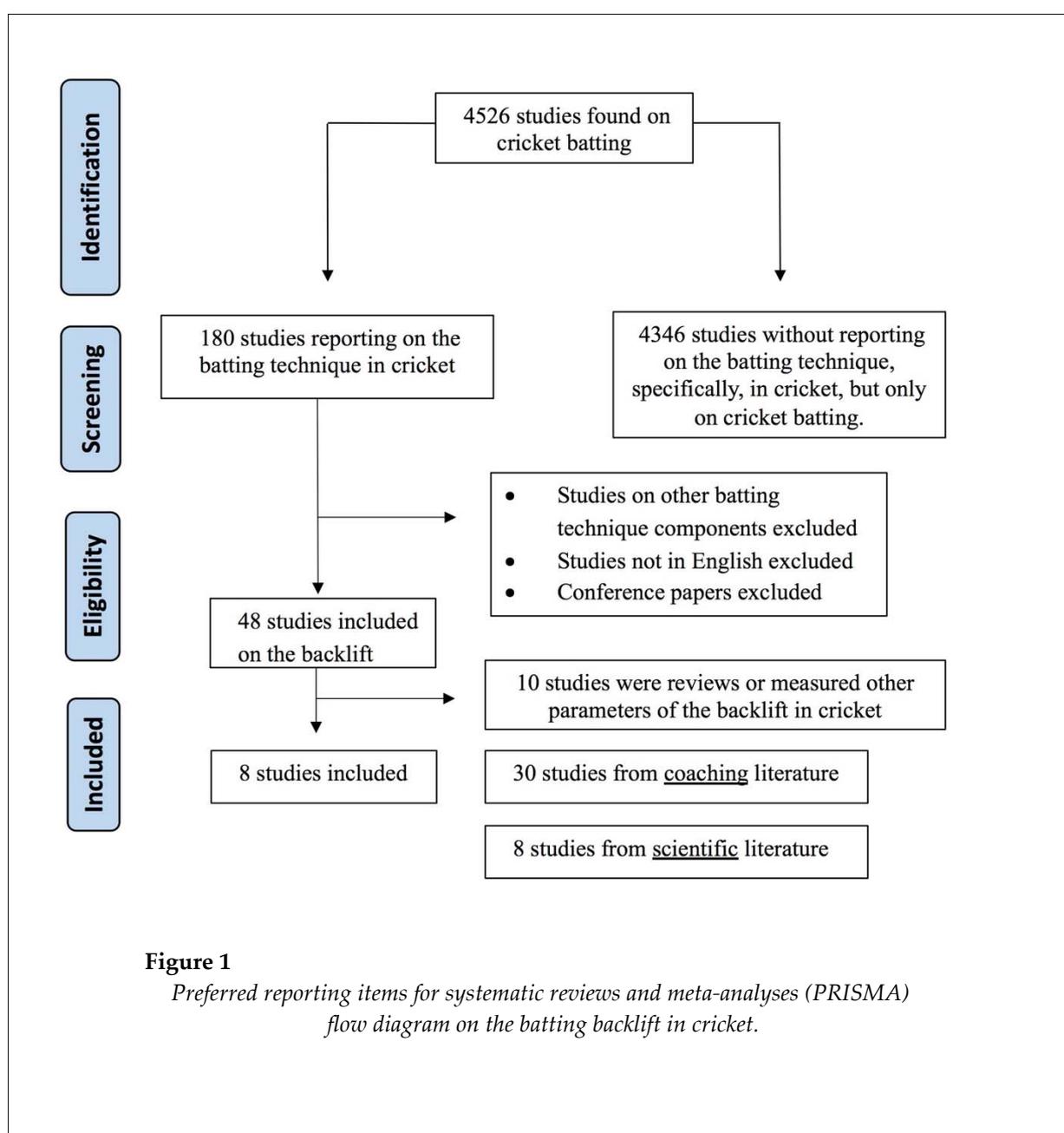


Figure 1
Preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram on the batting backlift in cricket.

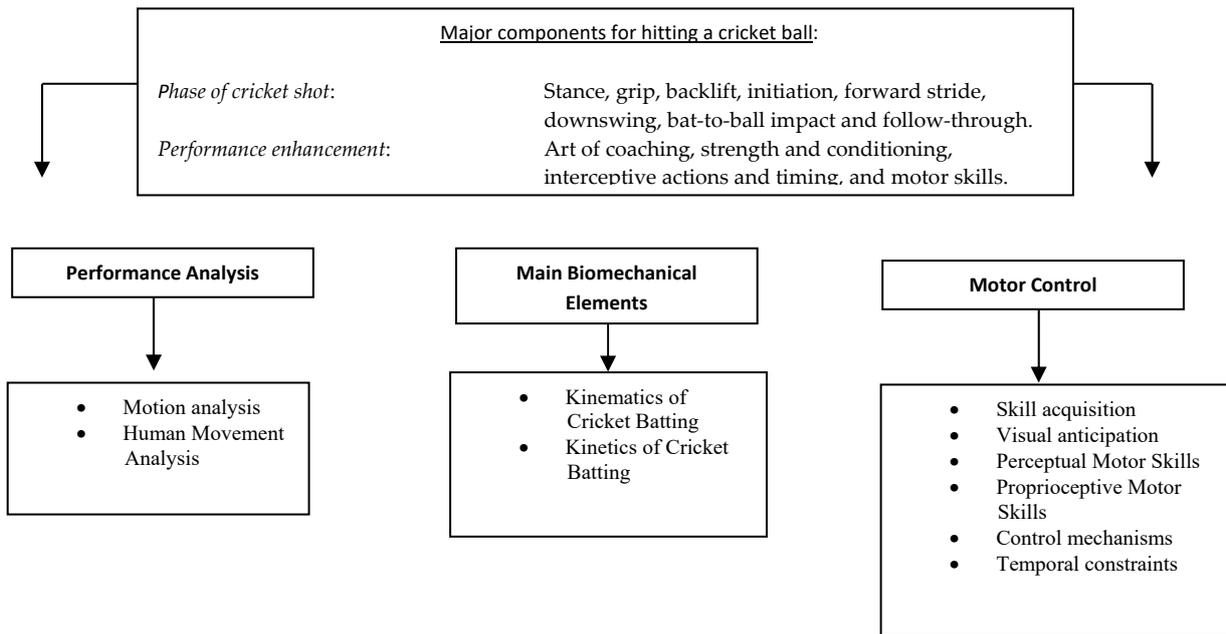


Figure 2

Major components for hitting a cricket ball

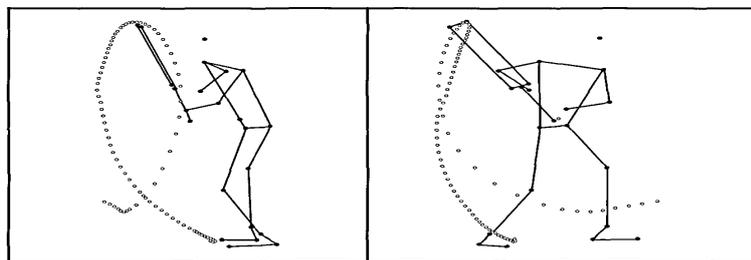


Figure 3

The loop of the cricket bat (From Stuelcken et al., 2005)

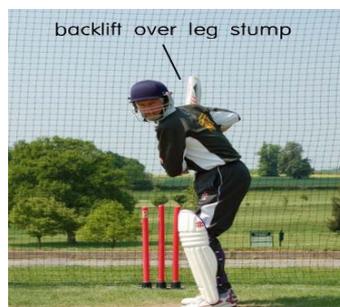


Figure 4

Backlift towards the stumps. The toe of the bat as well as the bat face point directly backwards towards the middle stump (Adapted and permission obtained from Pitchvision)

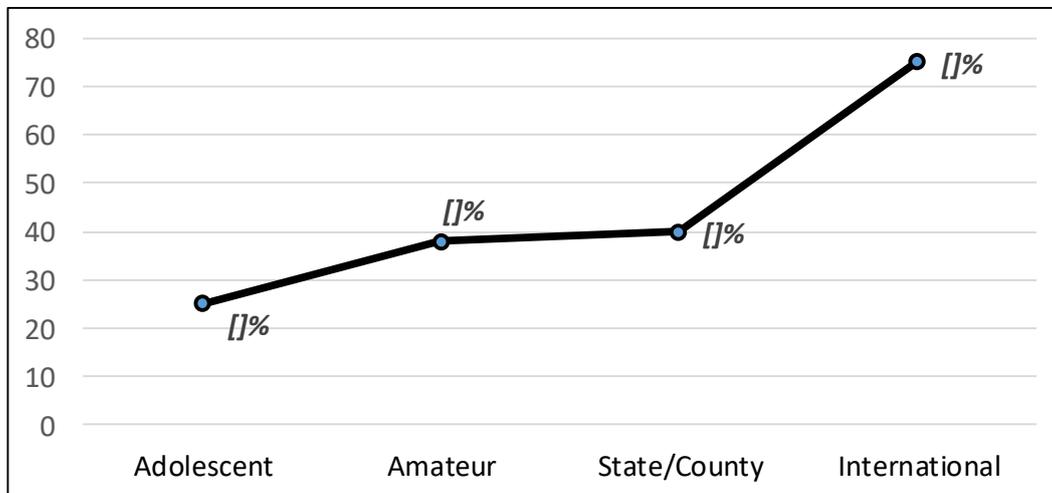


Figure 5
LBBT trend and percentage change across different levels of cricket

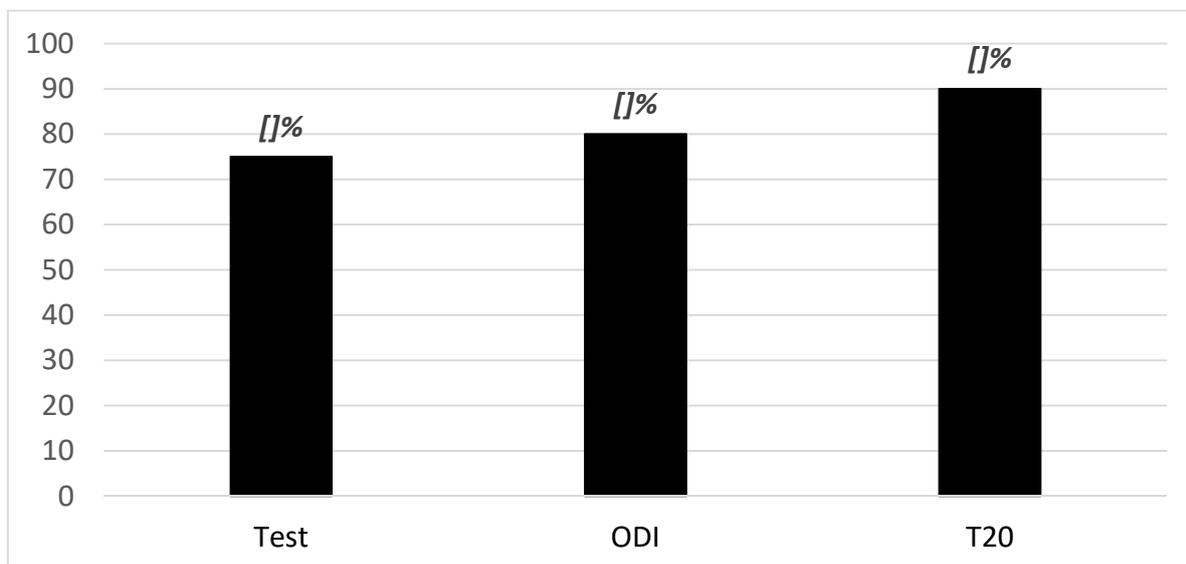


Figure 6
LBBT trend and prevalence across different formats of cricket
 ODI = one-day internationals; T20 = Twenty-twenty cricket

Table 1*Summary of relevant coaching literature on the direction or basis of the batting backlift technique*

| Author(s) (Year) | Title | Straight towards the stumps or wicket-keeper | Towards the first or second slip | In a looped or lateral technique |
|---------------------------------|--|--|----------------------------------|----------------------------------|
| Ranjitsinhji (1897) | The Jubilee Book of Cricket 5 th Ed | X | | |
| Giffen (1898) | With Bat & Ball | X | | |
| Grace (1899) | Cricketing Reminiscences & Personal Recollections | X | | |
| Beldam & Fry (1905) | Great Batsmen: Their methods at a glance | X | | |
| Fry (1912) | Cricket: Batmanship | X | | |
| Knight (1922) | First Steps to Batting | X | | |
| Armstrong (1924) | The Art of Cricket 3 rd Ed | X | | |
| Faulkner (1926) | Cricket: Can it be taught? | X | | |
| MacLaren (1926) | The Perfect Batsman: JB Hobbs in Action | X | | |
| Jardine (1939) | Cricket | X | | |
| Wheatley et al. (1948) | Cricket...Do it this way | X | | |
| The MCC (1954) | The MCC Cricket Coaching Book | X | | |
| Bradman (1958) | The Art of Cricket | | | X |
| Goodwin (1967) | Coming in to Bat | X | | |
| White et al. (1974) | George 'Atlas' Headley | X | | |
| Dellor (1990) | How to Coach Cricket | X | | |
| Ferguson (1992) | Cricket: Technique, Tactics, Training | X | | |
| Lewis (1992) | MCC Masterclass: The new MCC Coaching | | X | |
| Woolmer (1993) | Skillful Cricket | | X | |
| Boycott et al. (1994) | Batting Vivian Richards | | X | |
| Tyson (1994) | The Cricket Coaching Manual | X | | |
| Simpson (1996) | The Reasons Why: A decade of coaching, a lifetime of cricket. | X | | |
| Palmer (1999) | Cricket Coachmaster Batting Mechanics | X | | |
| Australian Cricket Board (2000) | Coaching Youth Cricket | X | | |
| Chappell (2004) | Cricket: The making of champions | | X | |
| Shillinglaw (2008) | The Bradman Phenomenon. Continuous 'Rotary' Batting Process. | | | X |
| Shillinglaw (2009) | Bradman Revisited 2 nd Edition 'The Simplicity of Nature' | | | X |
| Woolmer et al. (2009) | Bob Woolmer's Art and Science of Cricket | | X | |
| Borooh and Mangan (2010) | The "Bradman Class": An exploration of some issues in the evaluation of batsmen for test matches | | | X |
| Woolmer et al. (2010) | Bob Woolmer on Batting | | X | |
| TOTAL | 30 | 20 | 6 | 4 |

Table 2
Summary of relevant scientific studies on the direction or basis of the batting backlift technique (mean \pm S.D. unless stated)

| Author(s) | Sample (n) | Participants/Level | Study Design | Findings |
|------------------|------------|---|---|---|
| Stuelcken (2005) | 9 | International cricketers | Descriptive biomechanical analysis of variables that characterise the techniques of elite cricket batsmen while performing under match conditions. | Showed that path tracings of the bat indicated a significant loop (rotary movement of the bat) that was unexpected. It was also found that the path of the bat deviated laterally from the mean alignment of the shoulders reaching an average maximum angle in the transverse plane of 47° (after the batsmen initiated the backlift). |
| Taliep (2007) | 20 | 10 skilled and 10 less skilled right-handed batsmen | High-speed digital cameras were used to record the three dimensional kinematics of 10 skilled and 10 less skilled right-handed batsmen when playing a shadow front foot off-drive to realistic projected video footage. | There was no significant difference in the maximum bat angle out during the back-lift for the skilled and less-skilled batsmen during any point of the bowler's run-up. Expert batsmen had a distinctive looped bat path with a bat angle out during the back-lift, which approximates towards second slip. |
| Ashford (2013) | 8 | Senior Club (semi-professional) players; right-handed batsmen | A video camera set at 50 Hz was used to capture kinematic data of movements associated with each shot which included the path of the backlift | Bat angle during the backswing varied between the subjects, only 12.5% of subjects stuck to the 'coaching literature' backlift above the stumps, whilst 87.5% had a backlift ranging from first slip to the extremes of gully. |
| Noorbhai (2016a) | 65 | International | Analytical; measurement of a photo sequence with drawing tools and a static angle calculation of the batsman's technique using Kinovea™ (Version 0.8.15) | Showed that more than 70% of the greatest batsmen of all time did not adopt a SBBT. Instead, they adopted a more looped action: the movement of the bat (at the moment the bowler released the ball) was in the direction of the slips, or in extreme cases, the face of the bat pointed towards point. |
| Noorbhai (2016b) | 80 | Adolescent and amateur | Analytical; measurement of a photo sequence with drawing tools and a static angle calculation of the batsman's technique using Kinovea™ (Version 0.8.15). | Uncoached cricketers naturally adopted the LBBT whereas coached cricketers adopted the SBBT. If such players are not coached, they automatically hit the ball using a LBBT. This indicates that the SBBT is a direct consequence of early coaching. |
| Noorbhai (2018) | 161 | Cricket coaches at various levels. | A mixed-methods research study in which a survey using both closed-ended questions and an open-question was utilised among qualified cricket coaches (n = 161) located in eight of the different playing nations. | The majority of cricket coaches teach what is advocated in cricket coaching manuals. The study also showed that cricket coaches mostly teach the SBBT as opposed to the LBBT at the various levels of the game. It was also found that most coaches found it challenging to teach the SBBT. |
| Noorbhai (2019*) | 130 | Semi-professional, professional and international. | Analytical; measurement of a photo sequence with drawing tools and a static angle calculation of the batsman's technique using Kinovea™ (Version 0.8.15). | Showed that a LBBT is more common at the highest levels when comparing batsmen at the various levels of cricket (SP = 38%; CP = 40%; P = 40%; SAI = 75%); $\chi^2 = 39.02$, df = 3, $p = 0.001$. The study also demonstrated that batsmen who had a LBBT were better able to score runs to most parts of the cricket field. |
| Noorbhai (2019*) | 37 | Professional and international batsmen. | Analytical; measurement of a photo sequence with drawing tools and a static angle calculation of the batsman's technique using Kinovea™ (Version 0.8.15). | Showed that a LBBT was found to positively affect the stance and footwork of batsmen as most batsmen with a LBBT have an open stance at the crease and are able to anticipate the trajectory of the delivery more effectively. |

Studies conducted on the backlift in recent years

Given the paucity of studies on the BBT in cricket prior to 2016, this section will largely document the work conducted by Noorbhai and Noakes (2016 – 2019) on the BBT in cricket in recent years, by explaining the methodology and findings of each of the studies. The studies are mainly descriptive in nature, but also include biomechanical and analytical measures of different variables and parameters of cricketers, at varied proficiency levels (Table 2).

Methodology

Studies 1, 2, 3 and 4 were cross-sectional research studies in which both observational and analytical research methods were employed among past and present successful cricketers ($n = 65$), semi-professional (SP) ($n = 69$), professional (p) ($n = 48$), county professional (CP) ($n = 25$) and South African International players ($n = 12$), as well as uncoached and coached cricketers ($n = 80$). Biomechanical and video analyses were performed on all participant groups (Noorbhai and Noakes, 2016a, 2016b, 2019a, 2019b).

The analyses included the measurement of a photo sequence with drawing tools and a static angle calculation of the batsman's technique utilising the Kinovea™ (Version 0.8.15) software package. These frames were then used to determine the type of batting backlift technique for each type of delivery. The analysis was conducted in both practice and game situations, at the same eye-level.

Study 5 was a mixed-methods research study in which a survey using both closed-ended questions and an open-question was utilised among qualified cricket coaches ($n = 161$) located in eight of the different International Cricket Council playing nations. The questions were aimed to solicit which type of BBT coaches were teaching cricket players at varied proficiency levels (Noorbhai and Noakes, 2018).

Biomechanical and video analysis was conducted in both the frontal and lateral planes as the batsmen picked up the bat prior to the release of the ball and before making impact with the ball. Effect sizes were calculated to determine the effectiveness and the level of significance was set at $p < 0.05$.

Research Findings

Study 1 showed that more than 70% of the greatest batsmen of all time did not adopt the

traditionally taught SBBT. Instead, they adopted a more looped action: the movement of the bat (at the moment the bowler released the ball) was in the direction of the slips, or in extreme cases, the face of the bat pointed towards point. Since the vast majority of cricketers are not coached in this technique, these findings indicate that the LBBT is likely a contributing factor to effective batsmanship (Noorbhai and Noakes, 2016a).

Study 2 showed that a LBBT is more common at the highest levels when comparing batsmen at the various levels of cricket (SP = 38%; CP = 40%; P = 40%; SAI = 75%); $\chi^2 = 39.02$, $df = 3$, $p = 0.001$ (Figure 5) (Noorbhai and Noakes, 2019a). This finding is not as conclusive due to the average sample number ($n = 155$) across all the levels. In addition, this study demonstrated that batsmen who had a LBBT were better able to score runs to most parts of the cricket field. Furthermore, study 3 showed that a LBBT was found to positively affect the stance and footwork of batsmen as most batsmen with a LBBT had an open stance at the crease and were able to anticipate the trajectory of the delivery more effectively (Noorbhai and Noakes, 2019b). Again, this is not entirely conclusive due to the limited sample size. Additional analysis on more cricket teams (subject to approval) would need to be carried out.

Study 4 showed that uncoached cricketers naturally adopted the LBBT whereas coached cricketers adopted the SBBT. This suggests that cricket coaches should teach the basic fundamentals of batting techniques to cricketers and allow a young cricketer to play "naturally" without an overemphasis on playing with a straight bat. If such players are not coached, they automatically hit the ball using a LBBT. This indicates that the SBBT is a direct consequence of early coaching. However, this is likely to have detrimental long-term consequences as it will produce a batting technique that may be too restricted to achieve success at the international level (Noorbhai and Noakes, 2016b).

Based on the above four studies (which funneled down from the most successful batsmen of all time right down to groups of professional, amateur and coached/uncoached cricketers), we began to understand what BBT was being used at varied levels of cricket. If this

was the case, we were then intrigued to investigate what BBT was being taught at the varied levels of cricket by coaches.

The results from [study 5](#) showed that the majority of cricket coaches taught what was advocated in cricket coaching manuals. The study also showed that cricket coaches mostly taught the SBBT as opposed to the LBBT at the various levels of the game (Noorbhai and Noakes, 2018). It was also found that most coaches found it challenging to teach the SBBT. It was then decided to conduct an intervention through the use of a coaching cricket bat that could aid in the coaching of the BBT (while used during practice scenarios in cricket).

Based on the above, a growing trend of the LBBT has been shown in both the different formats and skill levels (or age groups) of cricket (Figures 5 and 6).

In Figure 5, we notice the subtle progression between the adolescent and state/county level (25 – 40%). However, one can notice a bigger increase between the state/county level and international level (40 – 75%; $p = 0.001$). This indicates that if batsmen want to be successful at the highest level of cricket, a LBBT is a successful contributing factor (among many of the other contributing factors for success in cricket batting) if adopted at the elite level. In Figure 6, we see a slight increase in the prevalence of the LBBT used between the different formats of cricket (5% between Tests and one-day international (ODI) cricket, and 10% between ODI and twenty-twenty (T20) cricket). This is, however, not statistically significant. However, sports performance generally states that even a 5-10% difference may yield positive performance outcomes (Bartlett, 2001). As such, one could postulate that the LBBT can assist batsmen in improved performance over the varied formats of cricket between Tests, ODIs and T20s. In addition, international batsmen are more likely to adopt a LBBT.

How has the LBBT contributed to the fields of cricket science, biomechanics, motor control and skill acquisition in relation to cricket coaching?

Much has changed in the last 50 years of the game due to the rapid adaptations of the one-day format. Although cricket has been in existence for more than 230 years (since 1788),

there have been considerable fluctuations in coaching and batting methods in the past century. This review has contributed to the field of cricket sciences, biomechanics and coaching by demonstrating that the backlift appears to be a key-contributing factor for successful batsmanship.

This review has also outlined the practices of the backlift at the various levels of cricket ability (school cricket, adolescent level, club cricket, semi-professional, professional and international cricket levels) as well as provided recommendations for both the coach and player. It has provided an understanding of why a LBBT is important and why it may be an essential component for success at the highest levels of the game. However, there are some batsmen who are still/will still be successful even though they use the SBBT. As such, coaches need to continue emphasising the importance of individuality (or individual variation) with a batsman as each player will be different.

Stating that the LBBT is an important determinant to success would be a bold statement as there are also other key components to consider, for example: the grip, stance, downswing, impact, follow-through, as well as the morphology, psychology and physical characteristics (fitness, physique and stature) of the batsman. It is crucial to understand that the BBT is a key contributing factor to successful batsmanship. This review has also discussed the existing understanding of coaching approaches as well as provided additional insights and experiences of how current coaches teach the BBT. This review has challenged some long-held beliefs of cricket coaching in both the scientific and coaching literature and is valuable for both coach education literature and the need for international cricket coaching courses to be updated and revisited.

Conclusion

Only few studies have investigated the BBT (partly or in its entirety). As such, there is a need to fully enhance our understanding on the BBT in cricket through in-depth biomechanical investigations. This review assists in advancing a foundational understanding and provides practical implications on the BBT in order to determine effective batting in cricket.

In summary, this review shows that the

LBBT is a key contributing factor to successful batsmanship at all levels of cricket ability. An optimal BBT would be based on what is naturally suited to the cricketer as an individual and the emphasis of the LBBT should be adopted if the SBBT proves to be challenging for the player. It would seem that early coaching of the commonly taught SBBT might prevent future success as a batsman in international cricket. It was also found that coaching a LBBT to young batsmen may be challenging to teach, and therefore, further coaching models should be developed to assist cricket coaches.

Directions for future research

This review has answered critical questions surrounding foundational and novel questions regarding the BBT in cricket. As such, further in-depth research (particularly, in-depth biomechanical investigations that are more meticulous) and questions need to be answered and investigated in the following areas:

1. In-depth qualitative research studies needs to be conducted to evaluate the teachings of cricket coaches for other elements of the batting technique (grip, stance, downswing, impact with the ball and follow through).
2. The batting backlift technique in women's cricket: Is it different to the practice of men's cricket? If so, what do women do differently? In essence, there has been a paucity of literature on cricket batting in women's cricket.
3. The grip of a batsman is key and the association of grip techniques with the BBT is fundamental for an in-depth investigation to be performed.

4. The fields of psychology, morphology and physiology also have an integral place in determining the success of cricket players. Previous studies have shown that the brain is a key regulator for human motion and abstract movements. As such, a key question to address is how the brain has an anticipatory effect on the backlift or subsequent movements of a batsman?
5. Is there a reduced risk of injury if batsmen adopt more of a LBBT instead of a SBBT, over a long-term period?
6. Given the role the environmental constraints play on cricket batting, such as opposition tactics, it would also seem necessary to investigate how batters adapt to such environmental constraints.

The above areas and questions would provide additional insights into the associated movements with the backlift as well as further understanding of other movements and components of the cricket batting technique. In addition, more innovative tools and coaching models need to be designed to assist and enhance performance of batsmen as well as coaching of batting in cricket.

Throughout the literature, there has been limited empirical evidence and more anecdotal information on the coaching of the backlift, mostly due to the complex skills associated with cricket. As such, a backlift cannot only be coached in isolation, as there are other elements that need to be amalgamated to produce an effective batting response in cricket, at all skill levels.

References

- Australian Cricket Board. *Coaching Youth Cricket*. Human Kinetics; 2000
- Bartlett R. Performance analysis: can bringing together biomechanics and notational analysis benefit coaches? *Intl J Perf Anal in Sport*, 2001; 1(1): 122-126
- Beldam GW, Fry CB. *Great Batsmen: Their methods at a glance*. New York: The Macmillan Company; 1905
- Bradman D. *The Art of Cricket*. London: Robson Books Ltd, Hodder & Stoughton; 1958
- Chow JY, Davids K, Hristovski R, Araújo D, Passos P. Nonlinear pedagogy: Learning design for self-organizing neurobiological systems. *New Ideas in Psych*, 2011; 29(2): 189-200
- Conn M. *A punk at the crease*. The Australian, p. 13. Cricket. C. London: Arthur Pearson Ltd; 2009

- Connor JD, Farrow D, Renshaw I. Emergence of skilled behaviors in professional, amateur and junior cricket batsmen during a representative training scenario. *Frontiers in psych*, 2018; 9: 2012
- Connor JD, Sinclair WH, Leicht AS, Doma K. Analysis of Cricket Ball Type and Innings on State Level Cricket Batter's Performance. *Frontiers in psych*, 2019; 10: 2347
- Faulkner GA. *Cricket: Can it be taught?* London: Chapman & Hall; 1926
- Fraser C. *Bradman... then daylight*. 2009. Available at: <http://www.bradmancopyrightmaterials.com.au/legend.htm> ; accessed on 17.03.2019
- Fry CB, Ranjitsinhji KS, Jessop GL, Townsend CL, Brann G. *Cricket*. London: Arthur Pearson Ltd; 1903
- Fry CB. *Cricket: Batsmanship*. London: Eveleigh Nash; 1912
- Glencross DJ, Cibich BJ. A decision analysis of games skills. *Aus J Sports Med*, 1977; 9(1): 72 -75
- Guha R. *The Picador book of cricket*. Pan Macmillan; 2016
- Handford C, Davids K, Bennett S, Button C. Skill acquisition in sport: Some applications of an evolving practice ecology. *J Sports Sci*, 1997;15: 621-640
- Headrick JJ. *Affective learning design: A principled approach to emotion in learning* (Doctoral dissertation, Queensland University of Technology); 2015
- Jüni P, Altman DG, Egger M. Systematic reviews in health care: assessing the quality of controlled clinical trials. *BMJ*, 2001; 323: 42-46
- Kreighbaum E, Barthels KM. *Biomechanics: A qualitative approach for studying human movement*. 4th ed. Boston: Allyn & Bacon; 199
- Land MF, McLeod P. From eye movements to actions: how batsmen hit the ball. *Nature Neuroscience*, 2000; 3(12): 1340-1345
- Lewis T. MCC Masterclass: *The new MCC coaching*. London: Orison Publishing Group; 1992
- MacLaren AC. *The perfect batsman: JB Hobbs in action*. London: Cassell and Company, Ltd; 1926
- Mann DL, Abernethy B, Farrow D. Action specificity increases anticipatory performance and the expert advantage in natural interceptive tasks. *Acta Psychologica*, 2010; 135(1): 17-23
- McLean SP, Reeder MS. Upper extremity kinematics of dominant and non-dominant side batting. *J Hum Mov Stud*, 2000; 38(4): 201-212
- McRobert A, Williams A, Ward P, Eccles D. Tracing the process of expertise in a simulated anticipation task. *Ergonomics*, 2009; 52(4): 474-483
- Moher D, Liberati A, Tetzlaff J, Altman DG. PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med*, 2009; 6: e1000097
- Müller S, Abernethy B, Farrow D. How do world-class cricket batsmen anticipate a bowler's intention? *Quart J Exp Psych*, 2006; 59(12): 2162-2186
- Müller S, Brenton J, Dempsey AR, Harbaugh AG, Reid C. Individual differences in highly skilled visual perceptual-motor striking skill. *Attention Perc Psychophys*, 2015; 77(5): 1726-1736
- Mullineaux DR, Bartlett RM, Bennett S. Research design and statistics in biomechanics and motor control. *J of Sports Sci*, 2001; 19: 739-760
- Noorbhai MH, Noakes TD. Advancements in cricket in the 21st century: Science, performance and technology. *Afr J Phys, Health Ed, Recr and Dance*, 2015; 21(4:2): 1321-1331
- Noorbhai MH, Noakes TD. A descriptive analysis of batting backlift techniques in cricket: Does the practice of elite cricketers follow the theory? *J of Sports Sci*, 2016a; 34(20): 1930-1940
- Noorbhai MH, Noakes TD. An analysis of batting backlift techniques among coached and un-coached cricket batsmen. *S Afr J Res Sport, Phys Ed Recr*, 2016b; 38(3): 143-161
- Noorbhai MH. *The batting backlift technique in cricket* (Doctoral dissertation, University of Cape Town); 2017
- Noorbhai MH, Noakes TD. An evaluation of the coaching methods of the batting backlift technique in cricket. *J Qual Res Sports Stud*, 2018; 12(1): 35-56
- Noorbhai MH, Noakes TD. Is the lateral batting backlift technique a contributing factor to success for professional cricket players at the highest level? *S Afr J Sports Med*, 2019a; 31(1): 1-9
- Noorbhai MH, Noakes TD. The lateral batting backlift technique in cricket: Does it affect other components of the batting technique? *Afr J Phys Act Health Sci*, 2019b; 25(2): 184-199
- Noorbhai H, Noakes T. Coaching implications of the lateral batting backlift technique in men's cricket: a discussion and food for thought. *BMJ Open Sport Exerc Med*, 2019c; 5:e000494

- Noorbhai H. A comparative analysis of Donald Bradman and Steven Smith - what are their secrets? *BMJ Open Sport Exerc Med*, 2020; 10.1136/bmjsem-2019-000720
- Owens DK, Lohr KN, Atkins D. AHRQ series paper 5: grading the strength of a body of evidence when comparing medical interventions – agency for healthcare research and quality and the effective healthcare program. *J Clin Epidemiol*, 2010; 63: 513-523
- Penn MJ, Spratford W. Are current coaching recommendations for cricket batting technique supported by biomechanical research? *Sports Biom*, 2012; 11(3): 311-323
- Pinder RA, Davids K, Renshaw I, Araújo D. Representative learning design and functionality of research and practice in sport. *J Sport Exerc Psych*, 2011a; 33(1): 146-155
- Pinder RA, Renshaw I, Davids K, Kerhervé H. Principles for the use of ball projection machines in elite and developmental sport programmes. *Sports Med*, 2011b; 41(10): 793-800
- Ranjitsinhji KS. *The jubilee book of cricket. 5th ed.* United Kingdom: William Blackwood and Sons; 1897
- Renshaw I, Davids K, Savelsbergh GJP. *Motor learning in practice: A constraints-led approach.* Routledge; 2010
- Sarpeshkar V, Mann DL. Biomechanics and visual-motor control: how it has, is, and will be used to reveal the secrets of hitting a cricket ball. *Sports Biom*, 2011; 10(4): 306-323
- Stretch R, Buys F, Toit E, Viljoen G. Kinematics and kinetics of the drive off the front foot in cricket batting. *J Sports Sci*, 1998; 16(8): 711-720
- Stretch R, Bartlett R, Davids K. A review of batting in men's cricket. *J Sports Sci*, 2000; 18(12): 931-949
- Stuelcken MC, Portus MR, Mason BR. Off-side front foot drives in men's high performance cricket. *Sports Biom*, 2005; 4(1): 17-35
- Taliep M, Galal U, Vaughan C. The position of the head and centre of mass during the front foot offdrive in skilled and less-skilled cricket batsmen. *Sports Biom*, 2007; 6(3): 345-360
- The MCC. *The M.C.C. Cricket Coaching Book.* London: William Heinemann Ltd; 1954
- The MCC. *The M.C.C. Cricket Coaching Book: Revised and enlarged.* London: William Heinemann Ltd; 1962
- Thomas G. The Co-ordination and Regulation of Movements. *Psyc critiques*, 1967; 12(9): 1
- Tyson F. *The Cricket Coaching Manual.* Victoria: Victorian Cricket Association; 1994
- Vickery W, Dascombe B, Duffield R. Physiological, movement and technical demands of centre-wicket Battlezone, traditional net-based training and one-day cricket matches: a comparative study of sub-elite cricket players. *J Sports Sci*, 2014; 32(8): 722-737
- Weissensteiner J, Abernethy B, Farrow D, Müller S. The development of anticipation: A cross-sectional examination of the practice experiences contributing to skill in cricket batting. *J Sport Exerc Psych*, 2008; 30(6): 663-684
- Weissensteiner JR, Abernethy B, Farrow D. Hitting a cricket ball: what components of the interceptive action are most linked to expertise? *Sports Biom*, 2011; 10(4): 324-338
- Woolmer B, Noakes TD, Moffett H. *Bob Woolmer's Art and Science of Cricket.* Cape Town: Struik Publishers; 2009
- Woolmer B, Noakes TD, Moffett H. *Bob Woolmer on Batting.* Cape Town: Struik Publishers. York: The Macmillan Company; 2010

Corresponding author:**Dr. Habib Noorbhai**

Department of Sport & Movement Studies,
Faculty of Health Sciences,
University of Johannesburg, Johannesburg, South Africa.
Tel: +27 11 559 6602
Email: habibn@uj.ac.za