THE BATTING BACKLIFT TECHNIQUE IN CRICKET

By

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Declaration

I, ***Mohammed Habib Noorbhai*** hereby declare that the work on which this dissertation is based is my original work (except where acknowledgements and reproduction indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

This thesis is submitted by publication(s) and most of the work would produce a high similarity index when submitted on Turnitin.

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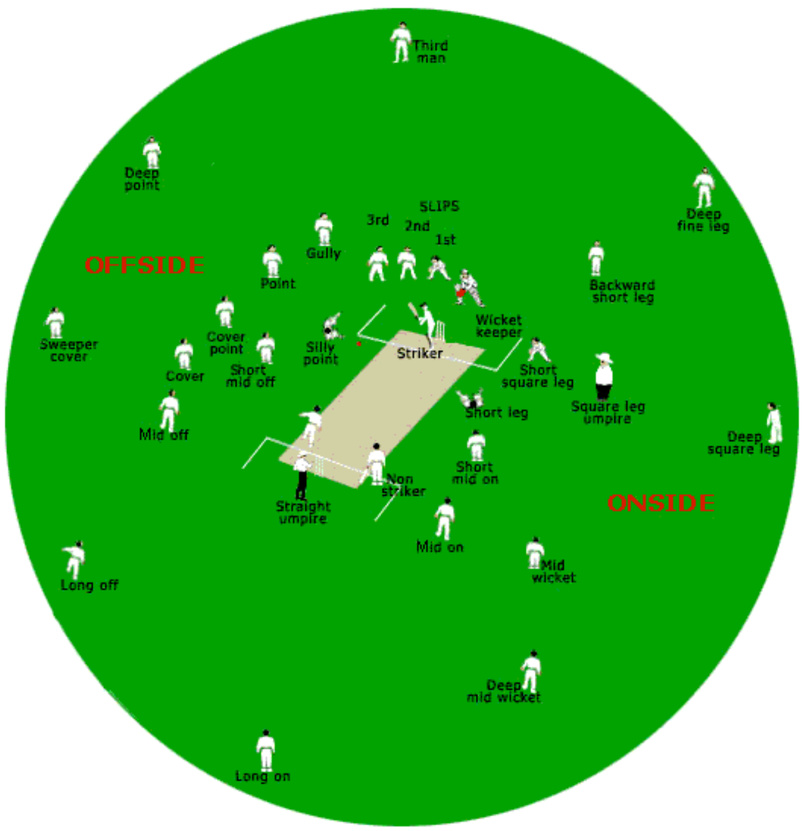
Glossary of Cricket Terminology used in this Thesis

- **Average** – the average runs scored each match by a batsman in his playing career.
- **Back-leg** - The batsman stands side-on facing the bowler. The leg which is farthest to the bowler and is usually located within or just outside the crease is called the back-leg.
- **Backlift** – the pick up of a batsman's bat before making contact with the ball.
- **Batsman** – the player who hits the ball and scores runs for the team.
- **Bowler** – the player who bowls the ball towards the batsman.
- **Cover drive** – the shot which is played (usually) with the use of the batsman's front-leg and the ball played through the off-side.
- **Crease** – the lines on the pitch between which the batsmen bat and run.
- **Cut** – the shot which is horizontally displayed and played through the off-side.
- **Downswing** – the downswing of a batsman's bat before making contact with the ball. This takes place after the backlift.
- **Fielder** – the player who fields the ball and either prevents the batsman from scoring runs or tries to catch batsmen out when the ball is hit in the air.
- **First Class** – professional level of cricket played over three or four days of play.
- **Follow-through** – the movement after the batsman hits the ball.
- **Front-leg** – The batsman stands side-on facing the bowler. The leg which is nearest to the bowler is called the front-leg.
- **Grip** – the way a batsman holds a bat.
- **Highest Score** – the highest runs scored by a batsman in his playing career.
- **Impact** – when the batsman makes contact with the ball.
- **Innings** – refers to the session where one team or one batsman bats and scores runs.
- **Leg glance** – the shot which is tucked off the batsman's legs towards the leg-side.
- **Leg-side** – the playing area on a cricket field which is perpendicular to a batsman's back.
- **List A** – professional level of cricket played over one day of play.
- **No-ball** – This is when a bowler either steps over the crease line on the pitch, or where the bowler bowls a full-toss delivery which reaches the batsman above waist height.
- *** = not out** – This sign usually denotes cases where a batsman has scored runs but has not got out by the bowling team. It can be used during or after the game to show that the batsman did not go out.
- **Off-side** – the playing area on a cricket field which is perpendicular to a batsman's chest.
- **On-drive** – the shot which is played between the bowler's run up and the leg-side.
- **One-day International (ODI)** – international level of cricket played over one day of play (50 overs per team).
- **Out** – This is when the bowling team dismisses a batsman in various ways (bowled, caught, run out, leg-before wicket, stumped, timed out or ball tampering). Upon being declared "out", the batsman has to return to his team either in the change room or pavilion.
- **Over** – A set of six consecutive balls bowled by a single bowler at one end of the pitch. The direction of bowling from one side of the pitch (i.e.: where the wickets are aimed at) alternates, changing after each over is bowled.
- **Pitch** – the playing surface on a cricket field where the ball is bowled and batsmen run.

- **Pull** – the shot which is maneuvered across the chest of a batsman towards the leg-side.
- **Slips** – the players who field alongside the wicket-keeper behind the batsman.
- **Stance** – the position of a batsman at the crease.
- **Strike rate** – the rate at which the batsman scores runs for every ball faced. Example: a batsman scores 80 runs facing 100 balls. His strike rate is 80/100 x 100 = 80%.
- **Test matches** – international level of cricket played over five days of play.
- **Trigger movement** – the intermittent movements of a batsman prior to playing the ball.
- **Twenty20 (T20)** – the shorter version of one-day cricket which has 20 overs per team (innings).
- **Wagon wheel** – scoring areas of a batsman's runs on a cricket field.
- **Wicket-keeper** – the player who fields directly behind the batsman and is responsible for catching the ball if it goes past the batsman.
- **Wickets / Stumps** – the wooden equipment used is situated behind the batsman. A batsman can be bowled out by the bowler hitting the stumps; a batsman can also be run out if the stumps are hit by the fielder throwing the ball while the batsman runs.
- **Wide** – This is when a bowler either bowls a ball which is considered a far reach for the batsman (passing the side crease on the pitch) or bowls a bouncer (where the ball goes over the batsman's head).

Field Placements in cricket



Adapted from Macgregor Cricket Club: http://macgregorcc.org.au/fieldpositions

List of Abbreviations

BBT = Batting backlift technique

BBTT = Batting backlift technique type

BICMA = Backlift In Cricket Mobile Application

CC = Coached cricketers

CP = County Players

CSA = Cricket South Africa

dpi = dots per inch

HS = Highest Score

ICC = International Cricket Council

IPL = Indian Premier League

LBBT = Lateral batting backlift technique

LTAD = Long-term athletic development

ODI = One Day Internationals

PP = Professional Players

SA = South Africa

SAI = South African international

SBBT = Straight batting backlift technique

SP = Semi-professional Players

T20 = Twenty 20

UC = uncoached cricketers

UK = United Kingdom

UML = Unified Modelling Language

List of Scientific Outputs from this Thesis

a) Articles in peer-reviewed journals

1. Noorbhai, M.H. & Noakes, T.D. (2015). Advancements of cricket in the 21st century: Science, performance and technology. *African Journal for Physical, Health Education, Recreation and Dance, 21*(4:2), 1321-1331.

2. Noorbhai, M. H., & Noakes, T. D. (2016). A descriptive analysis of batting backlift techniques in cricket: Does the practice of elite cricketers follow the theory? *Journal of Sports Sciences*, *34*(20), 1930 – 1940.

3. Noorbhai, M.H. & Noakes, T.D. (2016). An analysis of batting backlift techniques among coached and un-coached cricket batsmen. South African *Journal for Research in Sport, Physical Education and Recreation, 38*(3), 143 – 161.

4. Noorbhai M.H., Woolmer, R.C. & Noakes T.D. (2016). A novel coaching cricket bat: can it be used to enhance the backlift and performance of junior cricket batsmen? *BMJ Open: Sport and Exercise Medicine*, *2*(1), e000141.

5. Noorbhai M.H., Chhaya, M.M.A. & Noakes T.D. (2016). The use of a mobile application to predict the batting backlift technique among cricket batsmen. *Cogent Medicine: Sport and Exercise Science, 3*(1), 1214338.

b) Conference presentations emanating from this Thesis

1. Noorbhai, M.H. & Noakes, T.D. (2015). A descriptive analysis of batting backlift techniques among past and present cricket players. World Congress of Science and Medicine in Cricket, Sydney, Australia, 24 – 27 March 2015. (Oral Presentation).

2. Noorbhai, M.H. (2015). The modern era in cricket: How far has the game evolved? International Conference on Sports Science and Technology, London, 25 – 26 May 2015. (Oral Presentation).

3. Noorbhai, M.H. & Noakes, T.D. (2015). A biomechanical analysis of batting backlift techniques among coached and un-coached cricket players. Indo-European Arthroscopy/Arthroplasty Foundation 7th Conference (Sport Science track) Tamil Nadu, Chennai, India, 3-5 July 2015. (Oral Presentation).

4. Noorbhai, M.H. & Noakes, T.D. (2015). A qualitative and biomechanical analysis of batting backlift techniques among skilled, semi-skilled and un-skilled cricket players. South African Sports Medicine Congress, Johannesburg, 19 – 22 October 2015. (Oral Presentation).

5. Noorbhai, M.H. & Noakes, T.D. (2015). An evaluation of the teachings of backlift batting techniques among multi-level cricket coaches. South African Sports Medicine Congress, Johannesburg, 19 – 22 October 2015. (E-Poster Presentation).

6. *Keynote Address:* Noorbhai, M.H. (2016). The batting backlift technique in cricket. Scifest Africa, Grahamstown. 1 – 2 March 2016.

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ABSTRACT

The batting technique in cricket consists of various elements such as the grip, stance, backlift, downswing, impact with the ball and follow through. Whilst there has been an extensive amount of research into these batting elements, there is little research specifically on the backlift technique. Therefore, we aimed to investigate and provide a scientific understanding of the batting backlift technique (BBT) in cricket.

We aimed to investigate the BBT of the most successful batsmen (n = 65) in the last 120 years as well as players in the Indian Premier League (IPL) (n = 30). It was found that these batsmen did not conform to the current cricket coaching method that advocates a straight batting backlift technique (SBBT). Instead, 77% of successful batsmen and 90% of IPL batsmen employed a lateral batting backlift technique (LBBT) in which they lifted their bats in the direction of second slip or beyond with the bat face towards the off-side. Using this technique, both the toe of the bat and face of the bat points directly towards the off-side (usually between slips and point). The number of players using the LBBT was significantly greater than those using the SBBT ($\chi 2 = 19.2$, df = 1, $p < 0.001$). Given these findings, we were curious to determine whether this finding was similar at other levels of cricket.

The second study therefore employed biomechanical and video analyses to evaluate the BBT of current semi-professional, professional and international cricketers (n = 155) from South Africa and the United Kingdom. The backlift of these batsmen was then compared to their career statistics. It was found that a LBBT is more prevalent at the highest levels of the professional game and a likely contributor factor for successful batting at the highest level ($p \leq 0.05$). The LBBT was also found to positively affect other components of the batting technique such as the stance and scoring areas. We then proceeded to investigate the BBT amongst the lower levels of cricket (junior and adolescent cricketers).

The third study consists of an intervention study that employed a biomechanical analysis of coached and uncoached cricketers (n = 80). It was found that more than 70% of uncoached cricketers adopted a LBBT, whereas more than 70% of coached cricketers adopted the SBBT. Having found that the LBBT is a likely contributing

factor for past and current successful batsmen, it was then important to understand what BBT the current cricket coaches are teaching at various proficiency levels.

The fourth study explored the teachings of the BBT among international cricket coaches (n = 161) using a mixed methods approach through an online evaluation survey. This study was able to show that a majority of cricket coaches teach what is advocated in coaching manuals and mostly coach the SBBT as opposed to the LBBT at various levels of the game.

In the fifth and sixth studies, this thesis further describes two innovative coaching tools that can improve and assist with the coaching of the LBBT.

Firstly, a novel coaching cricket bat was investigated through a pilot and intervention study. In the pilot group, cricketers using the coaching bat scored approximately 1 more run per ball or an average of approximately three more runs in total when using the coaching bat than the normal bat ($F = 6.70$, $df = 1$, $p = 0.012$). In the intervention study, the experimental group scored double the total number of runs (an additional 16 runs) and an average of approximately 3 more runs per player in the post-match than in the pre-match, which showed a large effect ($ES = 5.41$) ($t = 3.32$, $df = 5$, $p = 0.021$). The coaching cricket bat might be used to coach young cricket players to hit the ball more effectively as well as how to adopt a more LBBT.

Secondly, a mobile application was developed, which can be used by players, coaches and scientists to analyse and improve the BBT among cricketers at all levels.

In summary, this thesis has shown that the LBBT is a likely contributing factor to successful batsmanship at all levels of cricket ability (junior cricketers, adolescent cricketers, semi-professional cricketers, professional cricketers, international cricketers and former elite/successful cricketers). Coaching a LBBT to young batsman may be challenging and therefore a coaching cricket bat has been developed and has shown to be a promising training aid for coaching the LBBT to young cricketers. A mobile application has also been designed and tested to assist in the coaching of the BBT in cricket. A way forward for further research in this area of cricket batting is documented at the end of the thesis.

1

A FUNDAMENTAL COMPONENT OF THE CRICKET BATTING TECHNIQUE: THE BATTING BACKLIFT TECHNIQUE

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PART A: INTRODUCTION & OVERVIEW OF THESIS

This thesis aims to develop a scientific understanding of the batting backlift technique (BBT) in cricket as well as provide practical implications of the backlift for cricket coaches and players. The backlift is one of the six components of the overall batting technique in cricket. The thesis firstly shows that the practice of successful batsmen does not match the theory of cricket coaching practice. Instead, batsmen adopted more of a looped action in which the direction of their bats was towards the slips or beyond and the face of the bat pointed towards the off-side. Our thesis documents and analyses which backlift type batsmen adopt across varied levels of cricket. In addition, two novel tools have emanated from the thesis: a coaching cricket bat (to enhance the backlift of young batsmen) and a mobile application (to assist players and coaches in analysing the backlift).

RATIONALE

Considering the popularity of the game of cricket across a considerable proportion of the world's population, there is a relative paucity of scientific research examining biomechanical and visual-motor behaviour integration in cricket batting. Sport scientists have found it difficult to isolate key elements common across batting techniques due to the wide variety of different techniques demonstrated by both skilled and lesser-skilled batters (Sarpeshkar & Mann, 2011).

In the cricket batting literature, it is firstly important to observe how the visual-motor system guides movements to be in the right place and time to hit an oncoming ball. Secondly, to investigate the visual-motor approaches that can be implemented by batsmen to overcome temporal constraints which can therefore enhance this information. Thirdly, by studying the biomechanical movements, this would enable skilled batsmen to perform at their best (Sarpeshkar & Mann, 2011). The focus of this thesis expands on the third point whereby biomechanical movements such as the BBT can either enhance or hinder the 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. This thesis also attempts to investigate the BBT of different players at various levels of cricket.

Recently, studies have begun to 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 (Thomlinson, 2009), and cross-sectional comparisons across skill-levels and age-groups (Weissensteiner, 2008). Our research is similar in the sense that we have used between-participant designs as well as both within-participant designs and cross-sectional comparisons across varied skill-levels and age groups regarding the BBT in cricket.

In addition, research conducted in Australia by Stuelcken, Portus & Mason (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 thesis aims to build on what was found from this study and expand on the scientific understanding of the BBT in cricket.

Anecdotally, a key skill of elite batters is a reported ability to manoeuvre the ball away from the opposing fielders using fine manipulations of the batter's wrist position. Sir Donald Bradman famously practiced his batting skills by using a cricket stump to repeatedly hit a golf ball against a corrugated iron tank (Fraser, 2009). Sir Donald Bradman is notably the prime example of the looped technique. For the purpose of this thesis, the looped or rotary technique will be described as the lateral batting backlift technique (LBBT). To a large extent, Bradman's influence has provided a rationale for investigating whether batters who display elements of his looped action will have any factor of success in their careers (better averages, strike rates or career runs scored). However, coaching manuals in Bradman's era (aside from his own book in 1958) hardly addressed this issue and therefore it is imperative to analyse the BBT of current batsmen across varied levels of cricket ability.

There is also the growing realisation by 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 & Spratford, 2012). Presently, as outlined above through both the scientific and coaching literature, the debate regarding the BBT in cricket continues (Woolmer, Noakes & Moffet, 2009). It is therefore essential that research should be conducted to determine the BBT of past and present cricketers as well as among cricketers playing in various proficiency levels. In addition, more emphasis needs to be focused on how the BBT can be effectively used in cricket by both coaches and players. This thesis therefore attempts to fill these research voids.

THESIS OUTLINE

Ten research questions are proposed to address the overall objective of this thesis: developing a scientific understanding of the BBT in cricket and providing practical and coaching recommendations (Table 1.1). Due to the paucity of work in this area of cricket batting, this thesis attempts to address foundational and novel questions that can pave the way forward in our understanding of the role of the backlift in determining effective batting in cricket.

In the rest of Chapter 1, a review is provided of the literature. The first half of this thesis (Chapters 2, 3 and 4) will document and analyse the practice of the BBT among past and present successful cricketers, professional, semi-professional, coached and uncoached cricketers. Chapter 2 focuses on successful elite cricketers in the last 120 years and aims to determine whether their BBT matches those described in the popular coaching literature. Chapter 3 establishes whether a LBBT is more common amongst cricketers at the highest levels of the game. Chapter 4 determines the differences in the BBT between coached and uncoached cricketers.

Table 1.1: Thesis outline and research questions

Chapter	Title	Research Questions
2	A descriptive analysis of batting backlift techniques among past and present cricketers: Does the practice of elite cricketers match the coaching practice?	*What is the direction of the batting backlift technique among elite cricketers?* *To where does the face of the bat point during the batting backlift technique?*
3	A descriptive analysis of the lateral batting backlift technique among professional cricket players: Does it positively affect other components of the batting technique?	*Is the lateral batting backlift technique more common at higher levels?* *Does a lateral batting backlift technique effect other components of the batting technique?*
4	An analysis of batting backlift techniques among coached and uncoached cricket players	*What is the direction of the batting backlift technique among coached and uncoached cricketers?*

5	An evaluation of the teachings of batting backlift techniques among cricket coaches at different levels	*What do cricket coaches at different levels of proficiency teach about the batting backlift technique?* *Do coaches teach what is advocated in cricket coaching manuals?*
6	The effectiveness of a novel coaching cricket bat among junior cricketers: A pilot study	*Can a coaching cricket bat enhance the batting performance and backlift technique of young cricketers?*
7	The use of a smartphone mobile application to analyse and improve the backlift technique of cricket batsmen	*Can a mobile application be used to analyse and enhance the batting backlift technique of a batsman?*
Appendix F	Beyond the backlift: understanding all aspects of cricket batsmanship	*What can coaches do to improve the batting backlift techniques of cricket players?*

The second half of the thesis will explore the current and modern coaching methods of the BBT among cricket coaches who are coaching at different levels of the game in a number of different countries (Chapter 5). In addition, two innovative items that has emanated from this thesis (a novel coaching cricket bat (Chapter 6); and a mobile application (Chapter 7)) will be introduced to show how these can be used by players, coaches and scientists in order to enhance and improve the BBT (and batting techniques in general) among cricketers at all levels of the game.

A summary of the thesis and a proposed way forward for further research in the batting techniques of cricket is provided in Chapter 8. This is followed by practical recommendations for both coaches and players on how to utilise and apply an effective BBT in cricket in Appendix F.

PART B: LITERATURE REVIEW

This section describes the findings from a literature review on what is already known about cricket batting and batting techniques. The scientific value of the study in terms of what we already know about the effectiveness of batting is brought in and what this study will add to the body of evidence in cricket batting, surrounding an important and foundational component of the overall batting technique: the batting backlift technique.

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 keywords search of “cricket batting”, “batting techniques”, “coaching cricket batting”, “biomechanics of batting”, “backlift and backswing in sport”, “backlift” 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 March 2017).

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 used.

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" and "batting backlift in cricket". The most relevant coaching literature on cricket batting was sourced between 1895 and March 2017.

AIM OF REVIEW

The aim of the review is to provide a broad overview on the game of cricket including areas of performance, cricket bats and training and a critique of the current knowledge of the BBT by examining the scientific literature. It is evident that there is an increased emphasis and reference from a coaching perspective on batting techniques in cricket and therefore the coaching literature will also be examined. This review starts by introducing the history of cricket followed by a brief outline on performance and injury prevention. It then leads on to the BBT after cricket bats and batting in cricket are explained.

Brief History of Cricket

Cricket has a known history spanning from the 16th century, with international matches being played since 1844, although the official history of International Test cricket only began in 1877 (Altham, 1962). During the late 1800's, the game developed in England into a sport which is currently played professionally in most of the Commonwealth countries (Altham, 1962). Cricket was first introduced to North America via the English colonies in the 17th century (Birley, 1999) even before it had reached the north of England. It had reached the West Indies and India by the first half of the 18th century (Birley, 1999; Bowen, 1970). Thereafter, it reached South

Africa in 1889 where the first game was played with an English touring team (Bowen, 1970).

Between these centuries, cricket was a sport merely played for passion and pure enjoyment. The administrators of the Georgian Age actively promoted and introduced the game (Box, 1868). The game continued for more than a century to emerge as a format of sport and was continuously regarded as a national symbol and community enterprise rather than a commercial enterprise (Box, 1868). Many years later, commercial interests began to identify potential global opportunities through diversified business ventures in the game (as well as in other sports played globally). Subsequently, cricket became a career not only for players, but for administrators, coaches, the media, health professionals, managers and the corporate world (Easton, 1996). There still however exists a clear distinction between amateur cricketers (those who regard cricket as just a sport) and professional cricketers (those who participate for entertainment and financial reasons) (Sandiford, 1985; Easton, 1996).

During the late 1900's, after the formalisation of Tests and One-day International matches, the shorter version of the game consisting of 20 overs played by both teams, termed twenty-twenty (T20), was introduced in order to attract greater crowds to stadiums. In addition, branding was introduced in order to sustain the new format of the game through televised viewing and broadcasting rights (Easton, 1996). One could argue that this venture was merely for commercial purposes or it could have been capitalised as a platform for the enhancement and performance of cricketers. It is also interesting to note the advancement of cricket equipment along the years, which has also contributed to the current enhancement and performance of cricketers.

Evolution of Cricket Bats

As the game of cricket evolved, the cricket bat is one example of cricket equipment that has advanced over the years (Harte, 1993). Figure 1.1 displays the changing design of the cricket bat that begins from the left (1729) (a) and ends towards the right (1930) (h). The straight bat (from 1774) (b) was introduced in response to the

pitched delivery but the original "hockey stick" style of bat was only effective against the ball being "trundled" or rolled along the ground (Box, 1868) (Figure 1.1).

(a) (b) (c) (d) (e) (f) (g) (h)

1720 → 1930

Figure 1.1: The evolution of bats used between 1720 and 1930

From the left to right the cricket bat started as a hockey stick and evolved to the modern cricket bad that has a flat surface area *(Adapted from the History of Cricket Bats: http://en.wikipedia.org/).*

As time progressed, cricket bats were adapted to the playing conditions and the evolving laws of cricket (Shillinglaw & Hale, 2008). Figure 1.1 shows the early curved bat in 1729 (a) followed by the curved bat in 1750 (b) and the early straight bat in 1774 (c). Further to the right, there is a bat known as the 'Little Joey' in 1792 (d) followed by the 'E. Bagot Skyscraper' in 1793 (e) and the 'Fuller Pilchs' bat in 1835 (f). One can notice the great W.G. Grace's bat (1901) (g) to the left of Jack Hobbs bat (1930) (h), which is towards the right end of Figure 1.1 (Barty-King, 1979). As shown in this figure, the first bats that were made, were more effective when the ball was rolled on the ground and not when the ball was thrown in the air. The game changed when the ball was thrown and therefore the bats evolved as the rules of the game changed in order to hit the thrown ball more effectively. Since the last bat developed in 1930, relatively small changes have occurred to the current cricket bat in the year 2017 in terms of its shape and dimensions, aside from the fact that modern-day cricket bats are stronger, lighter and more expensive (Noorbhai & Noakes, 2015).

Modern Performance and Science in Cricket

The science of cricket has also presently been significant in enhancing performances and improving injury prevention among cricket players through the use of technology, equipment, sports sciences and other techniques. Without focusing extensively on the published literature focused on injury prevention in cricket, it is worth mentioning the evolution of cricketers as high performance athletes. More than 10 years ago, Noakes & DuRandt, (2000) discussed the physiological requirements for cricketers and concluded that the fitness of cricketers may have increased over the last few decades, due to a number of factors. These factors relate to but are not limited to the increased participation patterns of players in one-day international and twenty-20 formats of cricket, enhanced participation, the science of cricket and recovery interventions for players (Weissensteiner *et al.,* 2008; Sarpeshkar & Mann, 2011; Noorbhai & Noakes, 2015).

Their risk of injury can also be reduced by more specific eccentric exercise training programmes (Noakes & DuRandt, 2000). Eccentric training can play an important role in injury prevention when included in an individualised strength and conditioning programme. However, a more specific programme can reduced the players' risk of injury (Noakes & DuRandt, 2000). Although the game of cricket has evolved along with other sporting codes with regards to its dosage and types of training and preparations for matches, current research in cricket has shown that both the performance and injury prevention models hardly speak to each other.

For example, most rehabilitation specialists are more concerned with the area of overloads and injury prevention in bowlers. In contrast, most sports scientists are concerned with the lack of studies to improve training efficiency for batsmen due to the focus on the increased risk of injuries sustained by bowlers (Orchard, James & Portus, 2006; Stretch, Bartlett & Davids, 2000). Therefore, a possible way forward in cricket research requires the focus on all the main elements in cricket such as performance, prevention of injury, psychology, morphology, physiology, biomechanics, motor control, coaching and strength conditioning to be applied in a proposed systematic performance model for cricket research (Figure 1.2) (Noorbhai & Noakes, 2015; Stretch *et al.,* 2000).

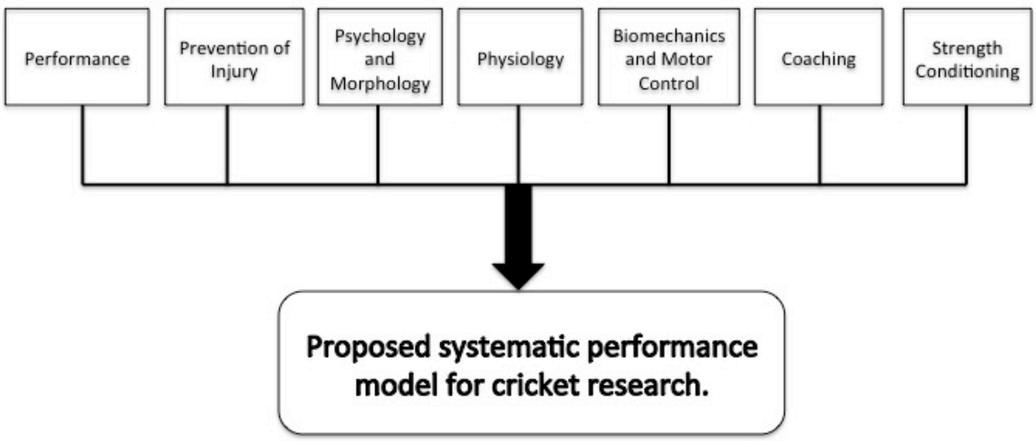

Figure 1.2: Research requires the application of a proposed systematic performance model that includes the main elements of cricket

Note: This is a proposed model and the veracity of the model would need to be tested and verified prior to its usage and application by experts and professionals in cricket

This would ultimately assist coaches, scientists and medical professionals in the management of players. Despite the emphasis on injury prevention and performance of cricketers, there is also a paucity of research into the biomechanics of batting for cricketers. Cricket researchers are therefore advised to direct more interest towards these areas (particularly batting) where there is a need for answers to many questions that have not been addressed.

Batting

Bearing the above developments in mind, one of the main advancements of the game and critical performance indicators has been in batting techniques (Stretch *et al.,* 2000). There are a number of reasons why one would regard cricket today as mostly a batsman's game. Firstly, in modern cricket, the bats are bigger and stronger than those used in the early era (Stretch *et al.,* 2000). Cricket fields are also currently smaller which provides batsmen with an added advantage of scoring runs easily and at a rapid rate (Noorbhai, 2015a).

In the early era (1895 - 1954), when batsmen faced bowlers they hit the ball more frequently with fewer dot balls (where no runs are scored off a bowler's delivery), whereas in test cricket today, batsmen are leaving more balls so that they hit the ball less frequently (Noorbhai, 2015b). This poses an important question: has the modern game of cricket made batsmen more passive? Limited overs cricket, especially T20, has counter-balanced the trend to keep batsmen scoring runs at a rapid rate. As such, with the modern evolution of technology and equipment made available to cricketers, T20 games have probably assisted in reducing the passivity of batsmen with regards to hitting the ball.

A notable time in cricket history when the issue of passivity among batsmen probably started was the Bodyline Series that began in the early 1930's (Le Quesne, 1983). Bowlers of the era developed the leg-side theory so that they would bowl 'bouncers' (balls approaching batsmen between shoulder and head height) to batsmen with the hopes of claiming their wickets once the batsmen had hit it to leg-slip (the left coordinate of the wicket) (Wheeler, 1983) (Figure 1.3). Facing this bowling attack, batsmen however sustained injuries to the head or upper torso area. Since then, there has been a concern with regards to the safety of the batsmen because not only were bowlers becoming increasingly intimidating but they were also bowling faster on improved playing surfaces (Le Quesne, 1983; Wheeler, 1983). Such factors led to the first helmets being used in the game in the early 1970s (Briggs, 2005). At present, helmets have also evolved but this is beyond the scope of this review.

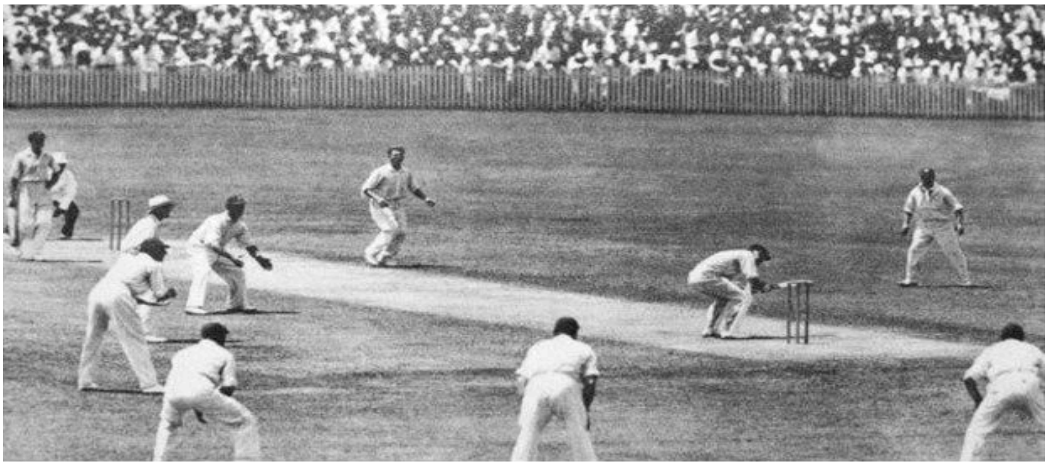

Figure 1.3: The 'leg-slip theory' developed in the 1930's

(Reproduced from http://en.wikipedia.org/)

The batting technique in cricket

Another approach to counteract the passivity of batsmen is to focus on improving the batting techniques of cricketers. 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. 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 & Mann, 2011). These results in themselves though 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 of teaching and learning. 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. This will be discussed and highlighted later in the review.

Differentiating between the backlift and the backswing in cricket

In the coaching literature, it appears that the term ‘backswing’ is mostly used as it refers to a more dynamic or encompassing movement whereas the term backlift refers to an element that is static or with less movement. Although the backswing would be the common term to determine or discuss the pick-up of a batsman’s bat, the backlift is mostly used in the scientific literature to describe the pick-up and direction of the bat prior to impact with the ball. In this thesis, the term ‘backlift’ will be used throughout.

What constitutes a successful batsman?

Skilled cricket batters 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 the hitting action (Sarpeshkar & Mann, 2011; Weissensteiner *et al.,* 2011).

Motor Skill Development

As mentioned above, cricket batting is an incredibly complex motor. An important area for future work lies in determining how the brain is capable of directly guiding the batter'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) (Bernstein, 1967; Pinder *et al*., 2013). 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, Davids, Hristovski, Araújo, & Passos, 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 environmental differently, and that final performance measures may be similar due to the unique capabilities of each learner (Muller *et al.,* 2006; Pinder *et al*., 2009).

In cricket, as in other interceptive sports such as tennis, badminton, and baseball, the batter learns to 'read' the specific kinematic movements of a bowler to predict the characteristics of the delivery being bowled. Investigations exploring the developmental histories of skilled batters suggest that the accuracy of a batter's ability to anticipate 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; Weissensteiner *et al.,* 2011).

Motor Control

There has also been a concurrent increase in the number of studies examining perception and visual-motor control in cricket batting with many studies making important contributions towards understanding the strategies used by batters 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 batters. Successful hitting requires the performer 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.

Two primary schools of thought for how skilled movements are controlled can be described, namely predictive control and prospective control (Montagne *et al.,* 1999). Predictive control allows performers to execute a highly reproducible motor programme at any given moment in time whilst prospective control allows performers to produce a unique motor solution to any given situation, which is constantly regulated over time. Despite these schools of thought the control mechanism for cricket batting is perhaps best conceptualised as a hybrid form of control between the two mechanisms. This can be best illustrated via an example of ball-flight for a cricket delivery. If we consider a short ball-flight of 450 ms, there is a 200 ms visual-motor delay to change the direction of the bat and the control mechanism for cricket batting (and for most forms of hitting). The ability of skilled cricket batters to account for the lateral deviations in ball-flight seen to occur either through the air, or as the ball bounces off the ground, is more easily explained and conceptualised using a prospective style of control.

Any system that responds to a given stimulus must have some form of inherent delay, such as the visual-motor delay. This term describes the time taken for the motor system to respond to a visual stimulus and has for some time been a significant area of conjecture in the field of motor control.

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 whilst intercepting an approaching ball highlights the effective and efficient visual search strategy employed by skilled batters to obtain the information required to coordinate movement and overcome the temporal constraints of batting. At ball speeds commonly encountered by cricket batters (in excess of 25 m/s), batters 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 & McLeod, 2000).

Irrespective of the control mechanisms used to guide hitting, the temporal constraints placed on the batter 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 batters) to overcome these temporal constraints is through the effective identification and interpretation of advance kinematic information inherent in the movement of opponents. The development of these anticipatory skills provides batters 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; Stretch *et al.,* 2000). In essence, batsmen may execute appropriate cricket strokes within a matter of milliseconds, depending on the speed of the delivery (Glencross & Cibich, 1977; Land & McLeod, 2000).

Additional task constraints also include 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 & 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, Davids, & Savelsbergh, 2010). Batsmen also have the option to leave a delivery that does not threaten to lose their wicket (be dismissed), thus forcing bowlers to deliver the ball closer to batsmen (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 & Rosalie, 2010). 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 and technique and skill development. As this thesis focuses on the training of technical skill of cricket batsmen, the other factors shall be omitted.

Skilled cricket batters 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 (Abernethy & Russell, 1984; Penrose & Roach, 1995; Renshaw & Fairweather, 2000; Muller *et al.,* 2006; Mann *et al.,* 2010). Muller *et al.,* (2006) found that highly skilled batters 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 batters were found to extract information primarily from the bowling hand. Skilled batters were found to make use of their prior knowledge and experience of the type of bowler. This allows 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 factors as outlined above are important to consider prior to a batsman hitting an oncoming ball. The next sub-section illustrates the major components of hitting a cricket ball.

Major components for hitting a cricket ball

There are a number of major components that addresses 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, Bartlett & Davids, 2000). The second is the enhancement of performance for batsman to effectively hit a ball (Figure 1.4).

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 imperative for a batsman's success. The above two major components play a pivotal role in the effectiveness of batsmen hitting the ball and all can be measured, monitored and analysed with performance analysis, biomechanics (kinetics and kinematics) and motor control, as outlined in Figure 1.4.

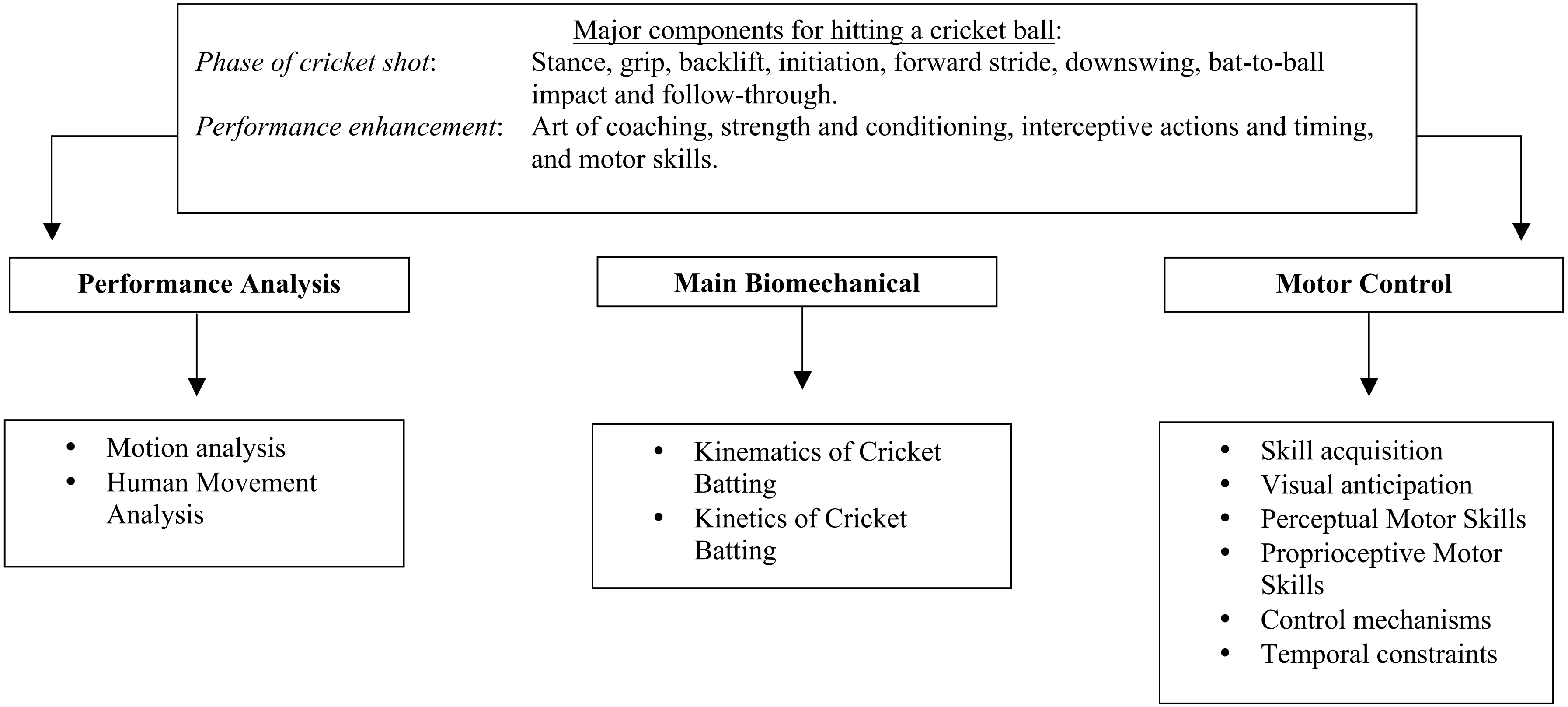

Figure 1.4: Major components for hitting a cricket ball

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 described as a movement in a linear plane (Stretch, Bartlett & Davids, 2000; McLean & Reeder, 2000). Additional factors which influence the proficiency of the backlift is the batting stance. The weight of the bat, the type of helmet (which can affect the posture of a batsman), the grip of the bat and the state of hip flexion could also affect bat position (Stretch, Bartlett & Davids, 2000; McLean & Reeder, 2000; Noorbhai & Noakes, 2015). The most proficient run-scorers 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.

The mechanics of the backlift in batting are poorly understood (Davis, 1983; Gibson & Adams, 1989). Qualitative biomechanical analyses of movement in sports are key to its investigation (Kreighbaum & Barthels, 1996). Such a mode of investigation can provide important insights into the biomechanics of different techniques in sports, especially with regards to those skills that have to satisfy parallel performance outcomes by choosing from a kinematically redundant set of joint angle time-histories (Gelinas & Hoshizaki, 1988; Handford, Davids, Bennett & Button, 1997; Mullineaux, Bartlett & Bennett, 2001).

Backlift and preparatory movements

Examinations of the backlift of the bat provide an interesting insight into how skilled batters achieve control of the bat to effectively and efficiently swing their arms to successfully strike a ball. Many batters 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 logically be expected to be 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 was similar across skilled and lesser-skilled batters. It has been proposed that this angle may provide a comfortable position for the batters 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, Portus & Mason (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 1.5).

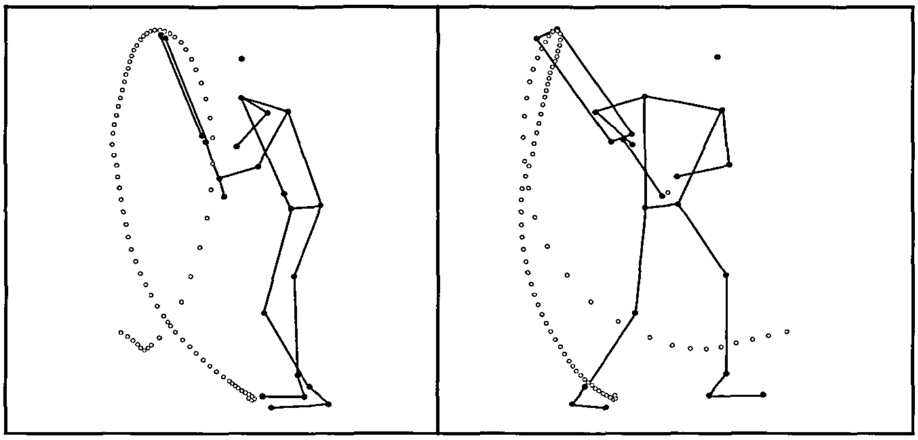

Figure 1.5: The loop of the cricket bat. *(From Stuelcken et al., 2005)*

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 batsmen 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, Portus & Mason, 2005).

Stuelcken *et al.,* (2005) have also proposed that batsmen manoeuver 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 batter'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 batter 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 batter 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 (Tyson, 1994; Australian Cricket Board, 2000). 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 batters 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 & 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 & Spratford, (2012) have investigated whether coaching recommendations for cricket batting techniques are supported by biomechanical research findings. The research showed that coaching manuals are important sources of information and guidance for coaches, and that it is a common practice for such coaching manuals to be written by former players and coaches of the game (Penn & Spratford, 2012). However, these coaching manuals are based on views and experiences of the professionals and lack the scientific rigour of evidence-based research. Therefore, this area of BBT of cricketers requires further in-depth 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 (Beldam & Fry, 1905; Lewis, 1992; The MCC, 1962). This restricts the number of shot selections for players prior to impact with the ball (Ranjitsinhji 1897; Fry, Ranjitinhji, Jessop, Townsend & Brann, 1903; Beldam & Fry, 1905; Müller, Brenton, Dempsey, Harbaugh & Reid, 2015).

In his 1926 book, 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 back-lift 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 & 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 1.6).

Figure 1.6: Backlift towards the stumps.

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

However, the same coaching manual also includes the contrasting statement of 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 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 (widely considered as the greatest batter of all time) exhibited a highly unique 'rotary' technique, which is contrary to coaching convention, and is yet to be replicated (Glazier *et al.,* 2005).

Boycott's article (Boycott & Gower, 1994; Bradman, 1958) 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 look squarely at the ball. 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). However, there are limited scientific articles that suggest where the ideal direction of the backlift should be (Penn

& Spratford, 2012). With modern coaching manuals published after 2009, it has become an acceptable norm for batsmen to lift the bat in the direction of the slips (Stuelcken, Portus & Mason, 2005) (Table 1.2). Table 1.2 displays a selection of 30 books in based on their common use in the coaching literature and their specifications of the backlift in cricket.

CONCLUSION

Due to the paucity of literature regarding the BBT, only several 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. This thesis will assist in advancing a foundational understanding and provide practical implications on the BBT in order to determine effective batting in cricket. This is crucial to note, especially with the rapidly evolving one-day international formats of cricket.

Table 1.2: Summary of relevant coaching literature on the direction or basis of the batting backlift technique in cricket batting

Author(s), Year	Title	Straight towards the stumps or wicket-keeper	Towards first or second slip	In a looped or lateral technique
Ranjitsinhji, K.S., (1897)	The Jubilee Book of Cricket 5th Ed	X		
Giffen, G., (1898)	With Bat & Ball	X		
Grace, W.G., (1899)	Cricketing Reminiscences & Personal Recollections	X		
Beldam, G.W. & Fry, C.B., (1905)	Great Batsmen: Their methods at a glance	X		
Fry, C.B., (1920)	Cricket: Batsmanship	X		
Knight, D.J., (1922)	First Steps to Batting	X		
Armstrong, W.W., (1924)	The Art of Cricket 3rd Ed	X		
Faulkner, G.A., (1926)	Cricket: Can it be taught?	X		
MacLaren, A.C., (1926)	The Perfect Batsman: JB Hobbs in Action	X		
Jardine, D.R., (1939)	Cricket	X		
Wheatley, G.A., Parry, R.H., & Barlee, J., (1948)	Cricket…Do it this way	X		
The MCC, (1952)	The MCC Cricket Coaching Book	X		
Bradman, D., (1958)	The Art of Cricket			X
Goodwin, C.J., (1967)	Coming in to Bat	X		
White, N., & Headley, G., (1974)	George 'Atlas' Headley	X		
Dellor, R., (1990)	How to Coach Cricket	X		
Ferguson, D., (1992)	Cricket: Technique, Tactics, Training	X		
Lewis, T., (1992)	MCC Masterclass: The new MCC Coaching		X	
Woolmer, B., (1993)	Skillful Cricket		X	
Boycott, G. & Gower, D., (1994)	Batting Vivian Richards		X	
Tyson, F., (1994)	The Cricket Coaching Manual	X		
Simpson, B., (1996)	The Reasons Why: A decade of coaching, a lifetime of cricket.	X		

Palmer, D., (1999)	Cricket Coachmaster Batting Mechanics	X		
Australian Cricket Board, (2000)	Coaching Youth Cricket	X		
Chappell, G., (2004)	Cricket: The making of champions		X	
Shillinglaw, T., (2008)	Don Bradman's "Continuous 'Rotary' Batting Process"			X
Shillinglaw, T., (2009)	Bradman Revisited 2nd Edition 'The Simplicity of Nature'			X
Woolmer, B., Noakes, T.D., & Moffett, H., (2009)	Bob Woolmer's Art and Science of Cricket		X	
Borooah, V.K. & Mangan, J.E., (2010)	The "Bradman Class": An exploration of some issues in the evaluation of batsmen for test matches			X
Woolmer, B., Noakes, T.D., & Moffett, H., (2010)	Bob Woolmer on Batting		X	
TOTAL	**30**	**20**	**6**	**4**

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2

A DESCRIPTIVE ANALYSIS OF THE BATTING BACKLIFT TECHNIQUE: DOES THE PRACTICE OF ELITE CRICKETERS FOLLOW THE CURRENT COACHING PRACTICE?

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ABSTRACT

Background

One of the first principles of cricket batsmanship that is coached from a young age is to play with a straight bat. Limited studies to date have examined whether top international batsmen use this traditionally described technique.

Methodology

We performed a descriptive, observational study of the backlift technique adopted by 65 of the most successful batsmen of all time as well as players from the Indian Premier League (IPL) based on their career averages, strike rate and runs scored. The batsmen were divided into two groups depending on whether they played the game before or after 1954. Pearson's Chi-squared tests were performed and analyses were performed using R at a significance level of $\alpha = 0.05$.

Results and Discussion

Surprisingly, more than 70% of these successful batsmen did not adopt the traditionally taught technique. Instead they adopted a more looped action in which the initial movement of the bat was in the direction of the slips, and in extreme cases it was towards the gully/point region, often with the face of the bat directed towards the off-side. The LBBT was the preferred technique over SBBT for both Test and ODI batsmen ($\chi^2 = 1.09$, df = 2, $p = 0.30$) as well as for IPL batsmen ($\chi2 = 19.2$, df = 1, $p < 0.001$). This suggests that traditionally taught coaching techniques may hinder, rather than enhance future cricketing performance.

Conclusion

Although the vast majority of cricketers are not coached in this technique, this suggests that the LBBT is likely a contributing factor to effective batsmanship.

Key words: Batting backlift techniques, biomechanics, successful batsmen, cricket batting, cricket

INTRODUCTION

One of the first to write on batsmanship, C.B. Fry described this method as:

> "the upward swing of the bat should be straight and the plane of the swing should be vertical so that a line drawn from middle stump to middle stump lies with it" (Fry, 1912; Fry, 1920).

According to this explanation, the toe of the bat would be pointing directly backwards in the plane of the batting surface throughout the backlift. However, an interesting collection of photographs captured by Fry in 1920 illustrate that few players actually adopted his teaching (Fry, 1912; Fry, 1920). Players such as W.G. Grace, Ranjitsinji, Trumper, Jack Hobbs and others lifted their bats so that the toe of the bat points towards the slips and with the bat face facing towards point. This suggested that the actual practice of the great players did not match this theory (Figure 2.1).

Figure 2.1a: W.G. Grace   Figure 2.1b: J. Hobb   Figure 2.1c: E. Paynter

Figure 2.1: Greatest batsmen lifting the toe of their bats towards the slips or with the bat face pointing to the off-side or horizontally downwards
(Adapted from: http://www.cricketcountry.com and http://www.youtube.com; accessed on 11 November 2014)

It is important to note that the filming of sporting events began only in the late 1800s (Fry, 1920), and therefore C.B. Fry could have analysed the batting technique using fast moving camera sequences. G.W. Beldam was one of the first men to pioneer fast motion photography in cricket. His book "Great batsmen: their methods at a glance" was available in the late 1800s. C.B. Fry was the co-author of this book and had access to high resolution images. Therefore, Fry should have been in a favourable position to evaluate the backlift correctly. However, it seems that Fry was relying on his preconceptions, perhaps on evidence from still photography (Gernheim & Gernheim, 1955).

To our knowledge, no study has yet attempted to analyse batting backlift techniques (BBT) of the greatest batsmen of all time. Whilst it is not possible to perform in-depth biomechanical analyses of deceased cricketers, it is possible to review films taken of their batting. Since the backlift direction can be readily detected with qualitative observations from the direction in which the toe of the bat is pointing even from two-dimensional photographs or videos, we considered it feasible to investigate the following specific questions:

- What was the direction of the backlift?
- Where did the face of the bat point towards during the backlift?

METHODOLOGY

Research Design

This is a descriptive, observational research study in which analytical and qualitative biomechanical research methods were employed. All cricketers were either current or past international cricket players who were or are still affiliated to the International Cricket Council (ICC) playing nations.

Analysis

For this study, video footage (http://www.youtube.com) of all batsmen (n = 65; 35 test batsmen and 30 ODI batsmen) classified into past (1895 - 1954) or recent eras (1955 - 2014) was analysed. These time frames were selected as 1954 was the year in which the MCC Coaching Manual was first published. The publication formed the majority of the formalisation of the straight backlift as the only correct method even though this method was subtly used in early Australia and England before the 1900s. In addition, players from the 2016 Indian Premier League (IPL) season was also analysed (n = 30). The analysis was done similarly to other studies (Stuelcken, Portus & Mason, 2005) whereby the initial movement of the batsman was determined from the first frame before the initiation of the backlift while initial movement patterns were assessed qualitatively by viewing the footage. The study showed that the backlift represented the period from the initiation of the backlift to the maximum vertical displacement of the toe of the bat. Similarly in this study, the video frame immediately before the bowler had released the ball was selected. The ball release was visible in all footage of all the batsmen analysed.

Comparing the straight and lateral batting backlift techniques

For the purpose of this study, the "lateral" batting backlift technique (LBBT) (Figure 2.2a) is one in which the bat is lifted laterally in the direction of second slip. Using this technique, both the toe of the bat and face of the bat points directly towards the off-side (usually between slips and point). With the straight (MCC) batting backlift technique (SBBT) (Figure 2.2b), the toe of the bat is directed towards the stumps and/or the face of the bat points towards the ground or the wicket-keeper.

Figure 2.2a: Sir Donald Bradman **Figure 2.2b: Neil Harvey**

Figure 2.2: Comparison of the lateral backlift (left) and straight backlift (right)
(Adapted from: http://www.oldstratforduponavon.com/)
Note: The toe of ***Sir Donald Bradman's*** *bat is pointing in the direction of the slips and the bat face also points to the off-side. The picture of* ***Neil Harvey*** *shows the toe of the bat and face of the bat pointing directly backwards towards the stumps.*

Classifiers

Classifiers were utilised to identify the type of BBT employed by all batsmen at the instant the bowler released the ball. These classifiers were coded as: 1 - toe of the bat directed straight back or towards first slip (between 0° – 25°); 2 - toe of the bat directed between second and third slip (between 25° – 45°); 3 - toe of the bat directed towards gully (between 45° – 80°) and the face of the bat facing towards the off-side. If the bat is directed straight back or towards the slips but has an open face of the bat, it is still classified as classifier number 3. The open-faced backlift was categorised based upon the direction of the toe of the bat irrespective of what angle it created, as long as the face of the bat was open. Classifiers 1 and 2 indicate a SBBT whereas classifier 3 (including any classifier with an open face of the bat) indicates a LBBT. No exact angle can be calculated, as the videos were not of a high quality, therefore angle ranges were conceptualised to determine these classifiers. Inter-raters were used in order to remove subjective bias of the researcher's interpretations of classifiers.

For the purpose of this study, the toe of the bat is defined as the vector orthogonal to the toe being the pointer (Glazier, Davids & Bartlett, 2003). This strengthens the validity and reliability of the analysis as the backlift can be readily detected and analysed at different positions and time points in the lift (Hopkins, 2000).

Right-hand batsman **Left-hand batsman**

Figure 2.3: Lines and vectors drawn to depict the angle of the backlift

Note: Both batsman on the left and right are examples of the lateral backlift batting technique. Both batsmen's angles to which the toe of the bat points is between 45^o – 80^o

Drawing a vector is a common approach in defining the toe of the bat and how it will point in a particular direction (Kreighbaum & Bartels, 1996). Lines and vectors were drawn 1) vertically from the head to the hands (green line), 2) a line drawn horizontally to show where the hands rest (blue line) and 3) a line drawn obliquely to show the direction of the bat during the backlift (red line). The still photo (which was captured from the video footage – the last frame just before the bowler had released the ball) was analysed when the ball had just been released from the bowler. These lines create an angle to show how far away the bat is from the body in the frontal plane and how much rotation has occurred before making impact with the ball (Figure 2.3). The researchers accounted for perspective error by limiting the type of videos observed with the various deliveries bowled to the batsmen (to the off-side, middle and leg-side; full length, back of a length and short length) as well as including horizontal lines in the background.

Search strategy and sources

Cricinfo (www.espncricinfo.com) was used to identify batsmen with the highest Test career averages and number of runs scored. Test batsmen (n = 40) were then divided into two time periods: 1895 – 1954 (top 20) and 1955 – 2014 (top 20). One-day international batsmen (n = 30) were selected between 1974 and 2014 as ODI cricket began in the 1970s (MacLaren, 1926). The top 30 batsmen from the latest IPL season of 2016 were also sourced through Cricinfo.

Defining successful Test batsmen

A test trial was conducted to evaluate the batting backlift techniques of worst performing batsmen (n = 20) and whether they had lower indices (career averages of runs scored, total runs scored in a career as well as strike rates). These batsmen were chosen based on their career average of less than 35 with more than 50 matches played. The batsmen who had the worst performing statistics based on their averages and number of matches played was selected. The trial indicated that most of these unsuccessful batsmen (80%) employed a straight batting backlift technique and had lower indices.

Therefore, for the purpose of this study, successful Test batsmen were defined as those who achieved any of the following:

i) A career average of more than 55 runs per innings

ii) A career average of more than 50 runs per innings and more than 2000 career runs

iii) Over 6000 runs scored

Defining successful One-Day International batsmen

One-day International (ODI) batsmen were either selected based on their career runs scored and/or the strike rate. If ODI batsmen had a high strike rate (>90%), they would need between 4000 and 8000 runs scored for consideration in the selection criteria. If ODI batsmen had a high-medium strike rate (>70%), they would need more than 8000 runs scored for consideration in the selection criteria. An ODI batsman with a high average of runs scored did not necessarily mean that they scored runs at an adequate strike rate. Therefore, unlike Test cricket, strike rate and runs scored were the key defining criteria when selecting ODI batsmen.

Therefore, for the purpose of this study, successful ODI batsmen were defined as those who achieved either of the following:

i) A strike rate of more than 90% with between 4000 and 8000 career runs scored

ii) A strike rate of more than 70% with more than 8000 career runs scored

Defining successful Indian Premier League batsmen

The top 30 batsmen from the latest Indian Premier League (IPL) season of 2016 were used because the IPL is a tournament that chooses the best twenty20 players from around the world. In particular, the tournament chooses batsmen that score runs at a rapid rate (such is the nature of twenty20 cricket) and only four international players are allowed to play for their team in each game at a given time.

Test batsmen were ranked according to their highest career averages of runs scored, whereas ODI batsmen were ranked according to the total number of runs scored in their career (once they satisfied the selection criteria). The IPL batsmen were ranked according to the total number of runs scored in the 2016 season. There is no scientific reference to the above selection criterion. It was conceptualised so that the best batsmen would be analysed.

Ethical Considerations

Ethical approval for the study was granted by the Human Research Ethics Committee of the University of Cape Town (HREC: 586/2014). This study conforms to the World Medical Association Declaration of Helsinki on Ethical Principles for Research Involving Human Subjects.

Data analysis

Percentage data of Test and ODI batsmen from 1895 – 2014 and 2016 IPL batsmen adopting either the LBBT or the SBBT were compared. Pearson's Chi-squared tests were performed to determine whether the frequency of the BBT differed over time and between Test, ODI and IPL batsmen. Analyses were performed using R (R Core Team, 2014) at a significance level of $\alpha = 0.05$.

Strengths and Limitations

A strength of this study was the ability to retrieve both completed batting records and photographic evidence of the batting backlift techniques of the 65 greatest batsmen of all time. A major limitation of this study was that the images of the batsmen, particularly those batsmen who were analysed before the year 2000, could not be obtained in the best resolution or dots per inch (dpi) quality. However, the quality of the images did not prevent the correct classification of the backlift technique of any batsman (Appendix E1). In order to support these correct classifications, validity and reliability were established by utilising an inter-rater. In addition, other limitations included different camera positions of video clips obtained, two-dimensional views in the frontal plane, perspective error, out of plane motion error as most videos were done in the frontal plane at varied camera distances. However, these did not limit the validity and reliability of the findings in this study as the classifiers were based on angle ranges and not exact angles. Furthermore, the researchers accounted for perspective error by limiting the type of videos observed and including horizontal lines in the background.

RESULTS

The results of Test batsmen between 1895 – 1954 shows that 80% adopted the LBBT whereas 75% of Test batsmen between 1955 – 2014 also adopted this technique (Table 2.1). Overall, 77% of all Test batsmen between 1895 - 2014 adopted the LBBT (Appendix E1 2.3 and 2.4). Similarly, 90% of ODI batsmen between 1974 - 2014 also adopted this technique (Table 2.1 and Appendix E1 2.5) Overall, LBBT was the preferred technique over SBBT for both Test and ODI batsmen (χ^2 = 1.09, df = 2, p = 0.30) and throughout the period from 1895 – 2014 (χ^2 = 2.05, df = 2, p = 0.36). The number of IPL players using the LBBT is significantly greater than those using the SBBT ($\chi2$ = 19.2, df = 1, p < 0.001). (Table 2.2, Appendix E1 2.6).

Table 2.1 Classifier characteristic and batting backlift technique type (BBTT) of Test and One Day International (ODI) batsmen.

Batting characteristic	Test		ODI
	1895 - 1954	1955 - 2014	1974 - 2014
Classifier			
1	13%	25%	7%
2	7%	35%	33%
3	80%	40%	60%
Total (n)	**15**	**20**	**30**
Batting backlift technique type			
SBBT	20%	25%	10%
LBBT	80%	75%	90%
Total (n)	**15**	**20**	**30**

Note: The above categorisation of the LBBT also includes the open face of the fat

Table 2.2: Mean (± Std error) performance statistics of the Top 30 IPL batsmen using the LBBT and straight SBBT batting backlift technique during the 2016 season

BBTT	N	Total runs	Average runs	Strike rate	No. of 4's	No. of 6's
LBBT	27	400 ± 35.96	38.3 ± 2.81	137.8 ± 3.21	38 ± 3.75	14 ± 1.65
SBBT	3	317 ± 25.36	29.9 ± 3.23	131.4 ± 7.89	35 ± 3.18	8 ± 4.40
Total	**30**	**392 ± 32.70**	**37.5 ± 2.58**	**137.2 ± 2.98**	**38 ± 3.39**	**13 ± 1.57**

DISCUSSION

The main finding of this study was that the vast majority of world-class batsmen since 1895 have adopted the LBBT. This suggests that this style of backlift, is one of the essential technical features of the most successful batting techniques. In addition, none of these successful batsmen would have been taught this technique by conventionally trained coaches. The question of the most interest is: Why did these players adopt a technique that is the opposite of that promoted by the official coaching manual? There are in fact, a number of reasons why this technique may be more effective than the SBBT.

The lateral batting backlift technique (LBBT)

The direction of the backlift identifies whether or not the batsman used aspects of the looped style batting technique (rotary style) exemplified by Sir Donald Bradman and many other great batsmen in the last century (Figure 2.4). This technique does not follow the guidelines on backlift that are advocated in the MCC coaching manual and many others before 2009 (MCC, 1954; Chappell, 2004; Woolmer, 2009; Palmer, 1999; Tyson, 1976; Woolmer, 1993).

Figure 2.4a: D. Bradman **Figure 2.4b: S. Tendulkar** **Figure 2.4c: B. Lara**

Figure 2.4: The 'Rotary Style' of batting

(Adapted from: Fig 6a: http://en.wikipedia.org/; Fig 6b, 6c: http://www.strengthspeedagility.com/)

Note: The toe of Bradman's, Tendulkar's and Lara's bat is pointing in the direction of the slips or the wicket-keeper but the bat face also points to the off-side which is a key distinguishing feature of the looped backlift.

Employing a comfortable, side-on stance at the crease, Bradman preferred to keep perfectly still as the bowler approached (Borooah & Mangan, 2010). Placing the bat between his feet (rather than behind his rear foot) was another defining feature of his technique (Chappell, 2004). All these elements combined to provide a looped backswing, in that the face of the bat pointed at the slips cordon (Figure 2.6a), rather than pointing straight backwards, as advised in the MCC Coaching Manual. This "crookedness" troubled his early critics, but Bradman resisted any major technical changes. His method became a focal point after he broke the record for the most runs in a Test series during the 1930 tour of England (Palmer, 1999; Fingelton, 1949). The techniques of Sachin Tendulkar (Figure 2.6b) and Brian Lara (Figure 2.6c), two of the most outstanding batsmen since Bradman show similar features as their bat face also points towards the off-side, more obvious in the case of Brian Lara.

It is of special interest that Sir Donald Bradman (the most successful batsman of all time with a test batting average of 99.94, at least 30% better than the second best average) agrees with Boycott's interpretation:

> "If videos were taken of all the greats of cricket then we would see that not one of them take their bats back directly towards the stumps" (Shillinglaw, 2009; Shillinglaw, 2008).

Bradman's opinion in a video interview also suggested that,

> "playing with a straight bat was great for defense but not for offence, and that a straight backlift will let you down under pressure".

An interpretation of a coaching video first produced in 1934 by Bradman explained that the straight backlift encourages players to play forward and to use heavier bats to generate power (Bradman, 1958; Shillinglaw, 2009; Borooah & Mangan, 2010) (Figure 2.6a). This would reduce their ability to play a range of shots with a cross-bat or off the back foot. As a result, they would have a more restricted range of scoring strokes and would be unable to score as rapidly as Bradman did (MacLaren, 1926). If Bradman is correct, then fast-scoring batsmen in the modern game must have adopted some elements of his looped action.

CONCLUSION

This study showed that more than 70% of the greatest batsmen of all time and 90% of IPL batsmen did not adopt the traditionally taught straight batting backlift technique. Instead they adopted a more looped action in which 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 was towards point. It was noteworthy to also see the distinctive loop in their backlift before downswing. Although the vast majority of cricketers are not coached in this technique, the findings indicate that the lateral batting backlift technique is likely a contributing factor to effective batsmanship. The findings from this study may challenge some long held beliefs in the cricket coaching literature. Future research is required to further explore the BBT adopted by batsmen at various ages and levels of cricket to determine if a LBBT is common at the highest levels.

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3

A DESCRIPTIVE ANALYSIS OF THE LATERAL BATTING BACKLIFT TECHNIQUE AMONG PROFESSIONAL CRICKET PLAYERS: DOES IT POSITIVELY AFFECT OTHER COMPONENTS OF THE BATTING TECHNIQUE?

ABSTRACT

Background

This chapter primarily aimed to investigate the batting backlift technique (BBT) among semi-professional, professional, county and current international cricket players. A key question was to investigate whether the lateral batting backlift technique (LBBT) is more common at the highest levels of the game. The secondary aim was to examine the extent to which the LBBT may affect other components of the batting technique (stance and preparatory movements).

Methodology

The participants in this study sample (n = 155) were South African semi-professional players (SP) (n = 69) and professional players (P) (n = 49), English County professional players (CP) (n = 25) and South African international professional players (SAI) (n = 12) Biomechanical and video analyses were performed on all participant groups. Classifiers were utilised to identify the batting backlift technique type (BBTT) employed by all batsmen. All statistics and wagon wheels (scoring areas of the batsmen on a cricket field) were sourced online. A Pearson's Chi-squared test, Student T-test and T-test were performed in this study. All analyses were performed using R (R Core Team, 2014) at a significance level of $\alpha = 0.05$.

Results and Discussion

This study found that a LBBT is more common at the highest levels of cricket batsmanship with batsmen at the various levels of cricket having percentages of the LBBT as follows: SP = 37.7%; P = 38.8%; CP = 40%; SAI = 75%; p = 0.001. This study also found that batsmen who used the LBBT were more proficient at scoring runs in various areas around the cricket field (according to the wagon wheel analysis). A LBBT was shown to positively affect the stance and footwork of batsmen whereby most batsmen have an open stance at the crease.

Conclusion

A LBBT is more common at the highest levels of cricket batsmanship. Cricket coaches should pay attention to the direction of the backlift with players, especially when correlating the backlift to various scoring areas on the field. Further research is required to investigate the BBT among batsmen at junior and adolescent levels.

Key words: Batting backlift techniques, semi-professional, professional, county, international, stance, scoring areas, cricket batting, cricket

INTRODUCTION

Since our previous chapter had analysed successful batsmen only at the highest international level, this chapter primarily aimed to investigate the batting backlift technique (BBT) among semi-professional, professional and current international cricket players. The findings of Chapter 2 suggest that the lateral batting backlift technique (LBBT) is likely a contributing factor to effective batsmanship. Therefore, a key question is to investigate to what extent batters at lower levels of the game use the LBBT? Our hypothesis would suggest that the LBBT acts as a selective factor among proficient batters.

The stance and grip are the first elements of a batting technique in a complete movement sequence, which is then followed by the backlift (Stretch *et al.,* 2000). With regards to stance, a number of coaching theories have advocated that batsmen should prepare their body for movement by maintaining equal distribution of weight between both feet to ensure stability. They have also suggested the importance of generating quick and efficient transfer of weight onto either the front or back-foot (Bradman, 1958; Tyson, 1994; Australian Cricket Board, 2000). In reality though, this theory may not match the practice of most batsmen.

Preparatory movements or trigger movements (where batsmen have preliminary intermittent movements prior to playing the ball) are commonly performed by batsmen who move their feet prior to the bowler's release of the ball (Sarpeshkar & Mann, 2011). It has been proposed that preparatory movements provide batsmen with a batting 'rhythm', enabling them to prime their foot movements in preparation for ball release (Woolmer, 1993). It is also thought that by establishing a rhythm, batsmen may be more accurate in the timing of their foot movements to place themselves in a most appropriate position from which to play their particular shots. In a study investigating these trigger movements, the most common movement for batters was to move their back foot backwards and across in front of the stumps, following common coaching advice to protect their stumps (Stuelcken *et al.,* 2005). According to Sarpeshkar & Mann, (2011), this preparatory movement may actually be advantageous in helping to overcome the temporal constraints of batting by reducing visual-motor delays such as reduced hand-eye coordination.

Therefore, the secondary aim of this chapter was to examine the extent to which a LBBT may positively affect other components of the batting technique. In particular, it aimed to assess the stance of the batsman, i.e. the use of preparatory foot movement by batsmen prior to ball release. Aside from biomechanical components of a batting technique, it is also worth investigating whether a LBBT has an effect on players' performances.

Aims and Objectives

To our knowledge, no study has yet attempted to analyse BBT of semi-professional and professional cricketers. Since the backlift direction can be readily detected with qualitative observations from the direction in which the toe of the bat is pointing and since there are additional gaps to explore with regards to the LBBT as highlighted above, we considered it feasible to investigate the following specific questions:

- Is a LBBT used more frequently by batters at the highest levels of the game, compared to batters at lower levels?
- Does a LBBT affect the stance of a batsman?

- Do batsmen using the LBBT score runs right around the cricket field as opposed to only scoring within selected areas of a cricket field? In other words, is there an effect on their scoring wagon wheels?

Hypothesis

We hypothesised that batsmen who adopted the LBBT would have the following characteristics:

a) An increased chance of succeeding at the highest levels of the game.

b) Other components of their batting technique would be affected such as their stance and footwork.

c) Scored more runs around the cricket field and in front of the wicket.

METHODOLOGY

Research Design

This was a cross-sectional research study in which analytical and qualitative biomechanical research methods were employed. All cricketers were either semi-professional or professional cricketers from South Africa and the United Kingdom.

Participants

Participants (n = 155) were South African semi-professional players (SP) (n = 69) and professional players (P) (n = 49) (Figure 3.1), English County professional players (CP) (n = 25) and South African international professional players (SAI) (n = 12) who played in the Cricket South Africa (CSA) domestic competitions, Cricket County Club Championships and International Cricket council (ICC) fixtures respectively. All players either represented their provincial, franchise/county or national teams.

Study Procedure

Various types of deliveries (n = 6; two short deliveries, two good-length deliveries, two full deliveries, either pitched on middle, leg or outside off-stump) were analysed from the SP, PP and CP batsmen when they faced either a fast, fast-medium or spin bowler. Any deliveries that were determined as a wide, a no-ball or a full toss were excluded from the analysis. Participants were required to bat using their usual batting technique in either a match or practice situation. For the SAI players, publically available video footage was obtained via YouTube (http://www.youtube.com).

Defining batsmen in this study (SP, PP, CP and SAI)

- Seeing that most batsmen in the tail order (among SP and PP) had a few fifties or hundreds in the current and past season of the CSA domestic competition, all batsmen in these groups were defined as batsmen (including bowlers and wicket-keepers). As such, all players in these groups were recruited and analysed for the study.
- Only the top seven batsmen were recruited and included for analysis in both the CP and SAI groups respectively.

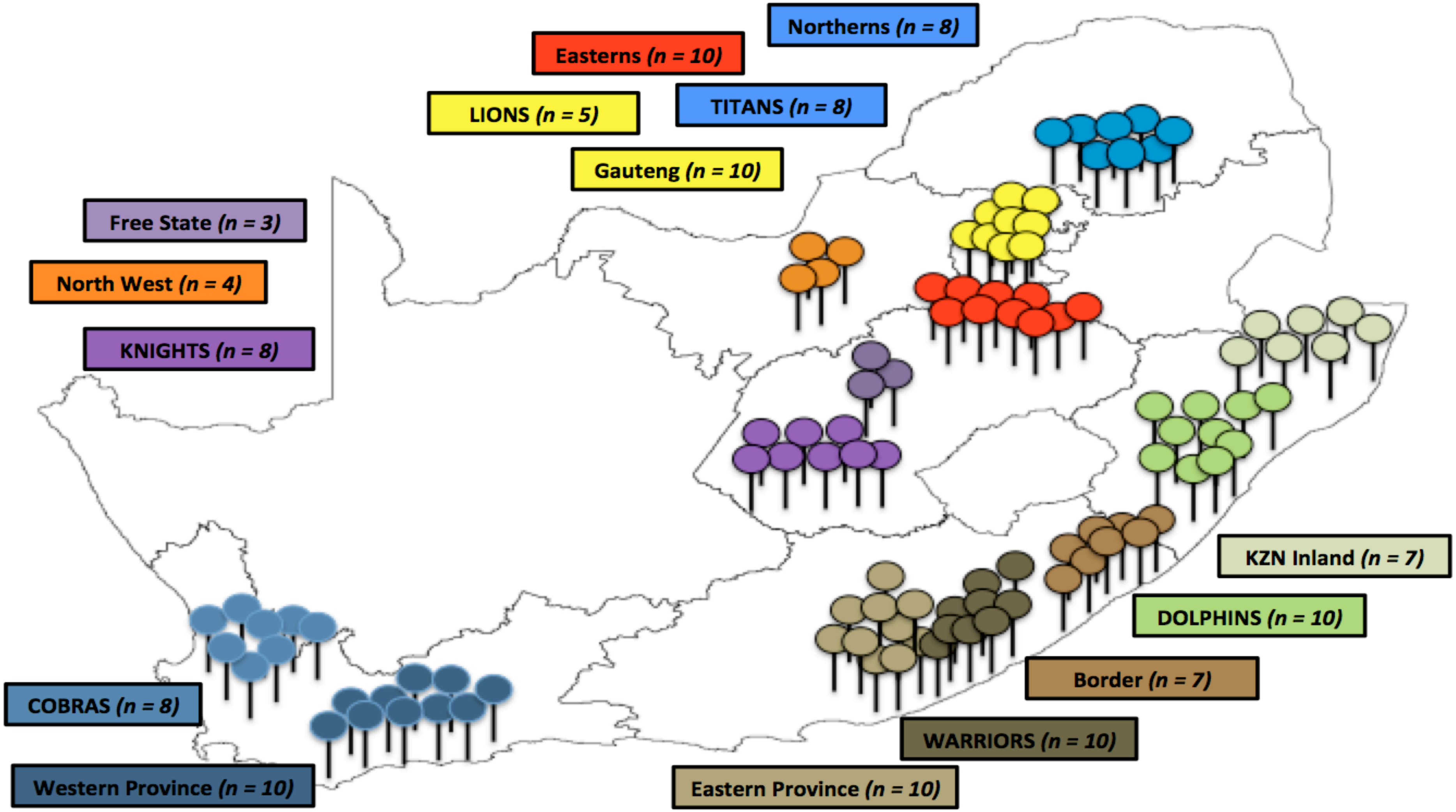

Figure 3.1: Semi-professional and professional cricket players from South Africa (n = 118)

Biomechanical and Video Analysis

The analysis was done similarly to the methods used specifically in Chapter 2:

a) The initial movement of the batsman was determined from the first frame before the initiation of the backlift while initial movement patterns were assessed qualitatively by viewing the footage using the Kinovea^{TM} (Version 0.8.15) software.

b) Classifiers were utilised to identify the batting backlift technique type employed by all batsmen prior to ball release.

Analysing stances of players

Stances of the players were analysed in the frontal plane using horizontal and vertical orthogonals. The vertical orthognal was in line with the front of the batsman's back-foot (the toe) and the stumps. The horizontal orthognal was drawn where the batsman's back-foot rests. An angle was measured where the batsman's front foot was positioned. If an angle was created (between the horizontal and vertical orthogonals) of more than 20^o, the batsmen were classified as having an open stance. If it was less than 20^o, the batsmen were classified as having a closed stance. This analysis is similar to those done in earlier studies (Stuelcken *et al.,* 2005 and Stretch *et al.,* 2000).

Search strategy and sources for players' career statistics and wagon wheels

Cricinfo (www.espncricinfo.com) was used to retrieve the career statistics of each player (matches played, highest score, career runs scored, averages and strike rates). South African domestic players' statistics were sourced from their First Class (three or four-day games) and List A (one-day games) results.

In addition, wagon wheels of the CP (Middlesex, Surrey and Durham) and SAI were also sourced via Cricinfo (www.espncricinfo.com) to determine the areas on the cricket field the batsmen were scoring their runs and to correlate those areas with their batting backlift type. Wagon wheels and video footage of the SAI were obtained from player's highest score in a test or ODI match. Unfortunately, wagon wheels of the SP and PP were not available. However, the picture frames from the video footage of the SP (Western Province, Eastern Province, Border, Kwa-Zulu Natal Inland, Northerns, Gauteng, Easterns, North West and Free State) and professional players (Cobras, Warriors, Dolphins, Titans and Knights) were used to analyse the batting backlift technique of the players.

Quantitative Data Analysis

A Pearson's Chi-squared test was performed to determine whether percentages of batsmen using LBBT differed between the levels of professional cricket. Student's T-test was used to compare highest scores, career runs scored, career averages and strike rates between batsmen with a LBBT and SBBT, respectively, at county professional (CP) and South African International levels. For SAI, T-tests could only be performed for Test matches as only a single batsman using SBBT had scored in ODI matches and means for this group could be calculated. All analyses were performed using R (R Core Team, 2014) at a significance level of $\alpha = 0.05$.

Ethical Considerations

Ethical approval for the study was granted by the Human Research Ethics Committee of the University of Cape Town (HREC: 586/2014). All participants provided signed consent prior to participating in the study (Appendix A). This study conforms to the World Medical Association Declaration of Helsinki on Ethical Principles for Research Involving Human Subjects.

RESULTS

The backlift

In this study, 38% of SP and 39% of PP used a LBBT, respectively (p>0.05) (Tables 3.1). Among the SP, 45% of players were classifier 1, 17% were classifier 2 and 38% were classifier 3 (LBBT). Among the PP, 35% of players were classifier 1, 27% were classifier 2 and 39% were classifier 3 (LBBT). There were 40% of CP and 75% of SAI (Table 3.1) who used the LBBT respectively. The percentage of cricketers using LBBT is significantly different to that using the SBBT across the different levels (χ^2 = 39.02, df =3, p = 0.001). The majority of batsmen at the international level (75%) use a LBBT, while only between 38 – 40% of batsmen on the other levels use the LBBT (Table 3.1). Despite the small differences in percentages of SP, PP and CP using the LBBT, this finding is nevertheless compatible with our interpretation that the LBBT is more common at the highest levels of cricket.

Table 3.1: Percentage of players across different professional levels applying the LBBT or SBBT, assigned to classifiers 1 - 3.

Level	N	Backlift batting technique (%)		Classifier (%)		
		LBBT	SBBT	1	2	3
Semi-professional (SP)	69	38	62	45	17	38
Professional (P)	49	39	61	35	27	39
County professional (CP)	25	40	60	36	24	40
South African International (SAI)	12	75	25	17	8	75
Total	**155**	**41**	**59**	**38**	**21**	**41**

Table 3.2: Mean (± Std error) performance per cricketer using lateral (LBBT) or straight (SBBT) backlift batting techniques at county first-class (CP) level.

BBTT	N	Total runs	Average runs	Strike rate	Not Outs	High Score
LBBT	10	7207 ± 1826.71	37.2 ± 2.19	51.7 ± 3.17	17 ± 4.32	205 ± 21.38
SBBT	15	5289 ± 953.39	33.0 ± 1.98	52.5 ± 3.32	22 ± 4.33	162 ± 11.04
Total	**25**	**6056 ± 924.89**	**34.6 ± 1.51**	**52.2 ± 2.32**	**20 ± 3.11**	**180 ± 11.34**

There was no significant difference in the total career runs ($t=1.02$, $p = 0.16$), average run rate ($t = 1.40$, $p = 0.09$), strike rate ($t = 0.18$, $p = 0.43$), not outs ($t = 0.85$, $p = 0.20$) and highest scores ($t = 1.16$, $p = 0.13$) between batsmen using LBBT or SBBT at the county professional level (Table 3.2).

Table 3.3: Mean (± Std error) performance per cricketer using lateral (LBBT) or straight (SBBT) backlift batting techniques at South African International (SAI) level.

BBTT	N	Test				ODI			
		Total runs	Average runs	Strike rate	High Score	Total runs	Average runs	Strike rate	High Score
LBBT	9	3181 ± 1189.48	48.4 ± 4.22	50.2 ± 3.11	174 ± 24.14	3445 ± 915.13	40.9 ± 2.88	92.7 ± 2.13	120 ± 15.21
SBBT	3	662 ± 293.45	34.1 ± 3.44	48.8 ± 2.66	112 ± 7.76	98 ± 0.00	24.5 ± 0.00	61.3 ± 0.00	42 ± 0.00
Total	**12**	**2341 ± 894.83**	**43.65 ± 3.66**	**49.7 ± 2.24**	**153 ± 18.76**	**3073 ± 808.28**	**39.0 ± 2.82**	**89.2 ± 3.49**	**101 ± 15.61**

For test matches, the average highest score for South African International batsmen using LBBT was significantly higher than that for batsmen using SBBT ($t = 2.34$, $p = 0.033$) (Table 3.3). However, the use of LBBT or SBBT had no significant effect on total career runs ($t = 1.70$, $p = 0.079$), average run rate ($t = 1.81$, $p = 0.056$) and strike rate ($t = 0.24$, $p = 0.41$).

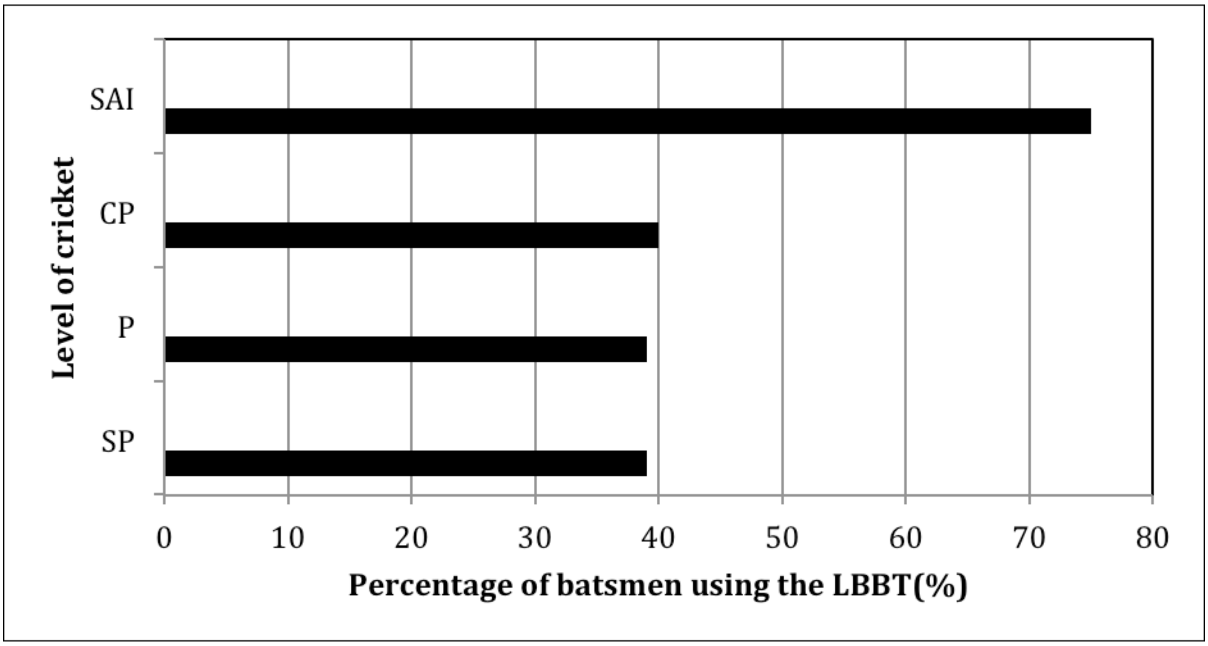

Figure 3.2: The percentage of batsmen using the LBBT among SP, PP, CP and SAI cricketers (n = 155)

CP = county players; PP = professional players; SAI – South African Internationals; SP = semi-professional players

Among the SP and PP groups, Appendix E2 (3.3 - 3.17) shows the backlift classifications and Appendix E2 (3.6 – 3.20) outlines the performance characteristics. Eastern Province is the SP team with the most batsmen adopting a LBBT (n = 5; 50% of sample) (Appendix E2 - 3.14) whereas the Dolphins is the PP team with the most batsmen adopting a LBBT (n = 5; 50% of sample) (Appendix E2 - 3.12).

Scoring areas

From CP cohort, batsmen with a LBBT either scored runs right around the field, or were more orthodox players scoring either only on the off-side or leg-side regions on the cricket field. Batsmen with a SBBT only scored in selected regions of the ground.

The SAI batsmen's wagon wheels show interesting findings. Batsmen with a LBBT were found to score runs is more areas around the cricket field and in front of the wicket. In contrast, batsmen with a SBBT scored runs in selected areas around the cricket field only and roughly in front of the wicket (mostly behind square with shots such as the late cut and leg glance).

Stance

Most of the CP batsmen with a SBBT had displayed a closed stance at the crease (n = 11/15; 73%; $p<0.05$). Among batsmen with a LBBT (n = 10), all display an open stance at the crease except for B. Stokes (n = 9; 90%, $p<0.05$)

With the SAI, it can be noticed that batsmen with a LBBT have an open stance at the crease with their front-leg being slightly open.

Career Statistics

There was no statistical difference in runs scored ($p = 0.3$) and averages ($p = 0.1$) between CP batsmen with a LBBT and a SBBT. Among the SAI batsmen, aside from Farhaan Behardien, three batsmen with a SBBT were found to have the lowest high scores. Although an individual high score may not be an indicator for success, the observed pattern does support the idea that batsmen with a LBBT might be able to score runs more rapidly than batsmen with a SBBT.

DISCUSSION

The main finding of this study has shown that a LBBT is more common at the highest levels of cricket. As some of the video footage of the SP and PP solely focused on their backlift (where their feet in some circumstances may have been omitted due to varied camera distances), this section aims to discuss the CP and SAI batsmen in terms of their BBT and their stance. In addition, wagon wheels were also only available for the CP and SAI groups and therefore scoring areas and career statistics of these players will also be interpreted. All figures can be found in Appendix E2.

County Cricket Players (n = 25)

The stances among the CP show variable results. Among batsmen with a LBBT (n = 10), all display an open stance at the crease except for B. Stokes (n = 9; 90%, $p<0.05$). When facing a spin-bowler, B. Stokes initiates a step and backlift movement to a short delivery and either cuts or pulls the ball. This initial movement tends to occur irrespective of where the ball will bounce; the batter can transfer weight onto the back foot following the short quick step forward when the ball is pitched further away from the batsmen (Thomlinson, 2009).

In addition, according to Sarpeshkar & Mann*,* (2011), some batsmen also adopt a 'forward press', by which the batsman moves forward in anticipation of a fuller-length delivery which will bounce close to the batsman, given that fuller-length deliveries are the most commonly occurring deliveries, and generally present the greatest threat of dismissal for the batsman. However, in this cohort, seeing that they were playing in the overcast United Kingdom county conditions where cricket balls tend to swing more compared to other countries and where there are hardly pitched full-length deliveries, this observation cannot be noticed with the cohort of the CP batsmen.

Most of the batsmen with a SBBT had displayed a closed stance at the crease (n = 11/15; 73%; $p<0.05$). Left-handed batsmen such as J. Simpson and N. Gubbins have a SBBT but with an open stance at the crease. This is due to the right-arm bowlers bowling to these left-handed batsmen over the wicket. Similarly, right-handed batsmen such as J. Roy, J. Burnham and S. Robson also have a SBBT but also with an open stance at the crease. This is also due to bowlers bowling to these batsmen around the wicket. From this evaluation, we can deduce that even when batsmen have a SBBT, their stance would become open if facing bowlers either over or around the wicket (Appendix E2 3.18).

Stretch *et al.,* (1998) found that provincial level batters tended to keep their front knee and hip directly over the front foot; the back knee, hip, and shoulder though were positioned 50, 70, and 90mm in front of the back foot, respectively. They have also been shown to position their head significantly further forward of their centre of mass, with the majority of the mass concentrated over the front foot (Taliep *et al.,* 2007).

In addition, there is a concern when batsmen are not aligned from their head to the position of their bat and to their feet. From this cohort, it can be noticed that N. Compton with a SBBT is not perfectly aligned. His head is not still (almost looking towards mid-on) which alters the way his shoulders and chest are positioned. Consequently, his feet are also closed which adversely causes a closed face of the bat. Surprisingly, this is also Compton's upright position just before the bowler releases the ball, which makes Compton a likely candidate for getting caught behind the wicket as he plays the ball a few split seconds late (Appendix E2 3.18). One can also argue that since he is right-eye dominant, this is probably causing him to shift his head obliquely in order to compensate his vision to see the delivery bowled.

This observation is supported by an interesting contrast between coaching and scientific literature, which lies in the side-on nature of the batting stance (Sarpeshkar & Mann, 2011). Batsmen are typically coached to stand side-on when facing the bowler, yet highly skilled batters have been shown to adopt a relatively open stance, displaying a mild degree of rotation of the front shoulder in the transverse plane of a mean of 26^{o} (Stuelcken *et al.,* 2005). It has been proposed that this degree of openness may allow the batter to observe the bowler and ball with both eyes, without requiring either a large degree of head rotation, or simply observing the bowler with just one eye (Sarpeshkar & Mann, 2011; Mann *et al.,* 2016). An interesting area is whether the dominant eye of the batsmen influences the stance and movements of the batsmen.

Anecdotally it is often suggested, in line with the recommendations of Farnsworth (2009), that it may be advantageous for a right-handed batsman to have a dominant left-eye as it has the unobstructed view of the oncoming bowler and ball. If a right-handed batsman were to have a dominant right-eye, there is greater reason for the batter to have a more rotated stance (in the case of N. Compton). A simple kinematic comparison may help to ascertain whether the stance and subsequent movements of batsmen are influenced by their ocular dominance (Sarpeshkar & Mann, 2011). From this observation, it can be highlighted that the head is the first and foremost technical element for a batsman.

Scoring areas

From this cohort of CP, batsmen with a LBBT either scored runs right around the field, or were more orthodox players scoring either only on the off-side or leg-side regions on the cricket field. Such orthodox batsmen with a LBBT were Stokes, Stoneman and Jennings. These batsmen were productive with cross-bat shots (the pull and the cut). A possible explanation for this observation is that English wickets are not slow wickets; neither are they conducive for full-pitched deliveries (Appendix E2 3.18).

Batsmen with a SBBT only scored in selected regions of the ground. However, batsmen with a SBBT who scored in most regions of the ground were J. Burnham and S. Robson. How is this possible since these batsmen had a SBBT? As highlighted above, these were the same batsmen who had an open stance, especially for bowlers who bowled around the wicket. It is a possibility that batsmen with an open stance (with either a SBBT or LBBT) are able to score runs in more areas around the cricket field. However, this would need to be justified with a larger sample number. This could be due to their trigger movement prior to impact with the ball, since their stance is open and their front-leg has room to either anticipate the trajectory of the delivery on the front foot or back foot.

Career Statistics

There was no statistical difference in runs scored ($p = 0.3$) and averages ($p = 0.1$) between batsmen with a LBBT and a SBBT.

South African International Players (n = 12)

Stance

With the SAI, it can be noticed that batsmen with a LBBT have an open stance at the crease with their front-leg being slightly open. In the case of Stiaan van Zyl, it can be noticed that his stance is also open. Although he has a SBBT, the open stance allows his backlift to be directed more towards first slip instead of towards the wicket keeper.

In the frames of Dean Elgar and Temba Bavuma (Appendix E2 3.19) who also have a SBBT, it shows that they have a closed stance at the crease. It can be argued whether these batsmen's backlift would be directed more towards first or second slip if their stance was more open, especially against a right-arm bowler bowling over the wicket (in the case of Dean Elgar). The other SAI left-handed batsmen with a LBBT (JP Duminy, Quinton de Kock, Rilee Rossouw and David Miller) all have an open stance at the crease also facing a right-arm bowler who is bowling over the wicket.

Scoring areas

The SAI batsmen's wagon wheels show interesting findings. Batsmen with a LBBT were found to score runs in more areas around the cricket field and in front of the wicket. In contrast, batsmen with a SBBT scored runs in selected areas around the cricket field only and roughly in front of the wicket (mostly behind square with shots such as the late cut and leg glance). Although the late cut to third man and leg glance to fine leg can be rewarding for batsmen, these are not shots that are commonly played by batsmen within an innings. Batsmen who are more defensive in their approach would score runs in selected areas around the cricket field whereas more aggressive batsmen would score runs in various parts of the cricket field.

Interestingly, wagon wheel examples of three left-handed SAI batsmen with a LBBT (Quinton de Kock, Rilee Rossouw and David Miller) show that most of their runs are scored in front of the wicket and not behind square. All of their productive shots were on the on-side (the pull and on-drive) as demonstrated in Appendix E2 (3.16).

In addition to the SAI batsmen's scoring areas, it is also worth noting their productive shots used during their highest scoring innings in either a Test or ODI. Batsmen with a LBBT (n = 9) had a pull as their most productive shot (the leg-side) whereas batsmen with a SBBT (n = 3) had a cover drive as their most productive shot (off-side). From this, we can deduce that batsmen with a LBBT are more likely to go at a ball harder in the high scoring zone (on the leg-side) as opposed to a less high scoring zone (on the off-side). From this, it is also important to consider the varied formats of the game. Batsmen would be more aggressive in one-day formats as opposed to the Test format. Further research is required in this area on whether there are variances in the batting backlift techniques of the same batsmen in all three formats of the game (Tests, ODIs and Twenty20).

Career Statistics

Aside from Farhaan Behardien, three batsmen with a SBBT were found to have the lowest high scores. Although an individual high score may not be an indicator for success, the observed pattern does support the idea that batsmen with a LBBT might be able to score runs more rapidly than batsmen with a SBBT. Furthermore, these three batsmen are part of the five batsmen from the SAI cohort that have the lowest strike rate in either Tests or ODI formats of the game. Although the strike rate statistic is more pertinent in the one-day format of the game, it still raises the question of whether batsmen with a LBBT are able to score runs more rapidly than batsmen with a SBBT.

Strengths and Limitations

A strength of this study was the ability to retrieve both completed batting records and video footage of all batsmen in this study. A second strength of the study was the sample number of 155 batsmen (SP: n = 69; P: n = 49; CP: n = 25 and SAI: n = 12). A further strength was the analysis of all the six South African franchise teams (n = 49 batsmen). Out of the 13 South African provincial teams, nine teams were available for analysis. The three teams that were not available for analysis were the South Western Districts, Northern Cape, Boland and Kwa-Zulu Natal. The reasons for non-availability were due to clash of match fixtures at respective venues, unfavourable weather or cancellations. Another strength of this study was that each group of participants played in the same environment and in the same month, which limited a seasonal effect. Biomechanical and video analysis of players was also obtained objectively and was not self-reported.

A limitation of this study was that not every piece of video footage was captured in the transverse plane in order to determine the open or closed face of the batsmen. However, as discussed in the previous chapter, this does not significantly alter the findings of this study. Another limitation of the study was that only wagon wheels of the CP and SAI could be sourced (n = 37). However, this sample was sufficient to correlate the runs scored on the field with the players' batting backlift type. In addition, the dots per inch (dpi) quality for some of the videos with the SP and PP appeared to be inconsistent due to the variances in weather when testing as well as varied camera distances. The researchers accounted for perspective error by limiting the type of videos observed and including horizontal lines in the background.

Coaching Implications

All batsmen are unique in their technique and approach, and will display attributes that are unique and suit them best as an individual player. As scientists and coaches, we should take the above into consideration in order to assist players with subtle discrepancies that may hinder their performance. A LBBT may not come naturally to some professional players. However, coaches must understand that players will compensate if their head and feet are not balanced or aligned accordingly. With this, coaches should also pay attention to the direction of the backlift with players, especially when correlating the backlift to various scoring areas on the cricket field. At semi-professional and professional levels, a coach can only do so much to ensure optimal performance and subtle technical optimisations.

CONCLUSION

This study found that a LBBT is more common at the highest levels of cricket batsmanship with batsmen at the various levels of cricket having percentages of the LBBT as follows: SP = 37.7%; P = 38.8%; CP = 40%; SAI = 75%; $p = 0.001$. Statistically, this study did not show a significance of batsmen scoring runs in various areas around the cricket field if they used a LBBT. Furthermore, batsmen who used a LBBT also had an open stance at the crease. As such, further investigation is required to explore why a LBBT is more common at the highest levels of cricket. In addition, further research is also required to investigate the BBT among batsmen at junior and adolescent levels.

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4

A BIOMECHANICAL ANALYSIS OF BATTING BACKLIFT TECHNIQUES AMONG COACHED AND UNCOACHED CRICKET BATSMEN

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ABSTRACT

Background

The previous studies have shown that a majority of the most successful batsmen adopt a lateral batting backlift technique (LBBT). However, no study has yet examined whether there are differences in the batting backlift techniques (BBT) of adolescent coached cricketers (CC) and uncoached cricketers (UC) to determine whether the straight batting backlift technique (SBBT) is a natural movement or whether it is learnt from a cricket coach.

Methodology

The study sample consisted of a UC group of young cricketers (n = 40), and a CC group comprising of both adolescent (n = 30) and amateur (n = 10) cricketers. Various types of deliveries were bowled to the participants utilising a bowling machine. Video analysis was performed on all three participant groups. Classifiers were utilised to identify the type of BBT employed by all batsmen. Pearson's Chi-squared tests were used to determine whether there was a difference in use of either BBT 1) between the age groups and 2) between the UC and CC groups. All analyses were performed using R (R Core Team, 2014) at a significance level of $\alpha = 0.05$.

Results and Discussion

More than 70% of uncoached cricketers adopted a LBBT whereas more than 70% of coached cricketers adopted the SBBT. The number of players using LBBT further declined to 20% among amateur coached cricketers. The difference in use of LBBT was significantly different between the three age groups ($\chi^2 = 32.6$, df = 2, $p < 0.001$). This difference in use of the two BBT between the uncoached and coached groups was also significant ($\chi^2 = 18.05$, df = 1, $p < 0.001$). The number of average runs scored in three-day matches was significantly higher, among cricketers using the LBBT than those using the SBBT (Table 4.2, $t = 4.46$, $p = 0.046$).

Conclusion

This study raises serious concerns about the advisability of coaching young batsmen to use the SBBT. Early coaching with the SBBT may be detrimental to the future prospects of young cricketers if the evidence supports the LBBT contributing to better performances.

Key words: Video analysis, batting backlift techniques, coached and uncoached batsmen, cricket

INTRODUCTION

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 type of the delivery being bowled (Sarpeshkar & Mann, 2011). Investigations exploring the developmental histories of skilled batters suggest that the accuracy of a batter'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). Furthermore, skilled cricket batsmen have also demonstrated the ability to anticipate the type and the direction of an oncoming ball through meticulous observations of the kinematic movement patterns of the bowler prior to ball release (Abernethy & Russell, 1984; Penrose & Roach, 1995; Renshaw & Fairweather, 2000; Muller *et al.,* 2006; Mann *et al.,* 2010).

In contrast, lesser-skilled batters were found to extract information primarily from the bowling hand, whereas skilled batters were found to make use of their prior knowledge and experience of the type of bowler to adopt a definitive search strategy by gathering subtle kinematic information from more locations (i.e. head, shoulders, bowling arm, trunk, and hips) to supplement the primary information derived from the bowling hand (McRobert *et al.,* 2009). In addition, Cote *et al.,* (2007) proposed that during the years of enjoyment and socialization (typically 6-13 years of age) activities such as backyard cricket may be advantageous in developing anticipatory strategies, as the task constraints are often exaggerated with the distance between the batter and bowler being much closer than those encountered in organised sport (Sarpeshkar & Mann, 2011).

In Chapter 2, it was shown that the majority of successful elite batsmen (77%) in the last century had used a lateral batting backlift technique (LBBT). We concluded that this technique could be a likely contributing factor for successful batsmanship (Noorbhai & Noakes, 2016). In Chapter 3, we showed that a majority of successful modern cricketers also use this technique and that the LBBT also affected other components of the batting technique such as their stance and footwork. The next question that arose was: how does coaching influence the choice of using either a LBBT or straight batting backlift technique (SBBT)?

Research Aims and Objectives

To our knowledge, no study has yet examined whether there are differences in the batting backlift techniques of coached and uncoached cricket players. Therefore, the aim of this research study was to investigate the BBT of coached and uncoached cricket players. Specifically, we wished to compare the proportion of coached and uncoached adolescent batsmen who used either the LBBT or SBBT.

Similar to Chapters 2 and 3, for the purpose of this study, the LBBT described by Bradman and Boycott is one in which the bat is lifted laterally in the direction of second slip or gully. Using this technique, the face of the bat faces towards point. In the SBBT, the bat is lifted towards the stumps or first slip and the face of the bat points towards the wicket-keeper or the ground.

Hypothesis

We hypothesised that uncoached cricketers would adopt the LBBT whereas coached cricketers would adopt the SBBT. The logic for this hypothesis is that the SBBT is not a natural movement and most probably has been taught to from a cricket coach.

METHODOLOGY

Research Design

This is a cross-sectional research study in which both observational and analytical research methods were employed.

Participants

All participants were young, adolescent or amateur cricketers residing in the Western Cape of South Africa. Young cricketers (both male and female) were between the ages of seven and eleven years who participated in the Calypso cricket programme in the Atlantis and Khayelitsha areas in the Western Cape (n = 40). Adolescent cricketers were between 12 and 18 years of age and belonged to the Western Province Cricket Club (n = 30). The number of cricketers among both the young and adolescent groups were equally represented in their respective age groups. Amateur cricketers between the ages of 19 and 29 years of age were players of the Western Cape amateur provincial team during the 2014/2015 season (n = 10). Amateur cricketers were aged between 19 – 28 years (average ± std deviation: 23 ± 3.02). For the purpose of this research study, adolescent and amateur cricketers were grouped as coached cricketers (CC) (where they have received cricket coaching), whereas young (Calypso) cricketers were grouped as uncoached cricketers (UC) (as they had not previously received any coaching).

Calypso cricket is a unique and an enjoyable adaptation of the conventional game of cricket (Burton, 1985). Utilising most of the rules of cricket, the game is usually played on the beach with two teams of ten players each. This competitive sport originating in the West Indian islands is played between different villagers that gather in their hundreds for the event (Midgett, 2003). It has proven to be an exciting method for promoting the game of cricket by introducing children to playing the game in a relatively unstructured format instead of being coached in a certain way of playing (Burton, 1985; Midgett, 2003).

Defining batsmen in this study (CC and UC)
All players in this study that were recruited and analysed were defined as batsmen.

Study Procedure

Various types of deliveries (n = 12; three short deliveries, three good-length deliveries, three full deliveries and three full-toss deliveries, either pitched on middle, leg or outside off-stump) were bowled to the participants utilising a bowling machine within indoor or outdoor nets. Participants were required to bat using their usual batting technique and ability. The speed of the deliveries for the adolescent group ranged between 70-90km/hour and for the amateur group, it ranged between 80-100km/hour. Ball machines and speed readings were not conducted for the Calyspo (uncoached) cricketers as the analysis was performed in street cricket conditions.

Studies examining the critical coupling between the perceptual and motor systems have found that batting behaviours are negatively affected by the removal of advance information, as experienced when batting against a ball-projection machine. Findings suggest that a significant decrease in the tight coupling between front-foot movements and bat-swing (Cork *et al.,* 2010) is evident, and subsequently results in an inferior quality of hitting (Pinder *et al.,* 2009). These findings suggest that the coupling between perception and action is dependent on maintaining a naturalistic linkage between the two systems. This is seen with the availability of advanced information which affords anticipation when batting against a bowler in situ, and ensuring the preservation of the functional couplings between perception and action (Farrow & Abernethy, 2003; Sarpeshkar & Mann, 2011).

Biomechanical Analysis

Biomechanical and video analyses were performed on both participant groups. This analysis was similarly done as in Chapters 2 and 3, which included the measurement of a photo sequence with drawing tools and a static angle calculation of the batsman's technique utilising the Kinovea^{TM} (Version 0.8.15) software package. The analysis was done similarly to other studies (Stuelcken *et al.,* 2005; Noorbhai & Noakes, 2016) in which the initial movement of the batsman was determined from the first frame before the initiation of the backlift, while initial movement patterns were assessed qualitatively by viewing the footage. The backlift represented the period from the initiation of the backlift to the maximum vertical displacement of the toe of the bat. The frame for analysis of the backlift direction was the video frame selected immediately before the bowler released the ball. These frames were then used to determine the type of batting backlift technique for each type of delivery bowled. Variables of interest included the direction of the backlift and where the face of the bat is directed during the backlift. The direction of the backlift was recorded with a Canon LEGRIA HF R506 HD Camcorder^{TM} video camera attached to a laptop computer. An external hard drive from the video camera was inserted into a laptop for further analysis using the Kinovea^{TM} software. All of the above was performed on both participant groups. All frames are presented in Appendices E4 (4.3 – 4.5).

Classifiers

Similarly to Chapters 2 and 3, classifiers were utilised to identify the type of batting backlift technique employed by all batsmen (Figure 4.1). These classifiers were coded as 1 (bat face facing straight back and towards the wicket-keeper or the ground), 2 (bat face facing first or second slip), 3 (bat face towards gully or point).

If the bat is directed fairly straight back or towards the slips/gully regions but has an open face of the bat, it is classified as classifier 3. Angle ranges were conceptualized to determine these classifiers (1: between $0^{o} - 25^{o}$), (2: between $25^{o} - 45^{o}$), (3: between $45^{o} - 80^{o}$).

Right-hand batsman

Left-hand batsman

Figure 4.1: Lines and vectors drawn to depict the angle of the backlift
Note: Both these batsmen use the LBBT

For the purpose of this study, the toe of the bat is defined as the vector orthogonal to the toe being the pointer (Glazier *et al.,* 2003). This strengthens the validity and reliability of the analysis as the backlift can be readily detected and analysed at different positions and time points in the backlift (Hopkins, 2000). Drawing a vector is a common approach in defining the toe of the bat and how it will point in a particular direction (Kreighbaum *et al.,* 1996). Lines and vectors were drawn 1) vertically from the head to the hands (green line), 2) a line drawn horizontally to show where the hands rest (blue line) and 3) a line drawn obliquely to show the direction of the bat during the backlift (red line). The still photo of the batsman was analysed while the ball had just been released from the bowler for the UC group. The still photo of the batsman was analysed while the ball had just been released from the bowling machine for the CC and amateur group. These lines create an angle to show how far away the bat is from the body in the frontal plane and how much rotation is performed before the bat makes contact with the ball. The researcher accounted for perspective error by limiting the type of videos observed as well as including horizontal lines in the background.

Data Analysis

The frequency of cricketers within the young uncoached (UC), adolescent coached and amateur coached (together, CC) using the LBBT or the SBBT were compared. Pearson's Chi-squared tests were used to determine whether there was a difference in use of either BBT 1) between the age groups and 2) between the UC and CC groups. Mean (± Std error) runs scored by amateur cricketers in one-day and three-day matches were also compared. Student's t-tests were used to determine whether the BBT used by these cricketers is associated with the mean total and average number of runs scored in these matches. All analyses were performed using R (R Core Team, 2014) at a significance level of $\alpha = 0.05$.

Ethical Considerations

Child assent as well as signed informed consent forms were obtained from parents and players prior to each child's and adult's participation (Appendix B). Ethical approval for the study was granted by the Human Research Ethics Committee of the University of Cape Town (HREC: 586/2014). This research study conforms to the World Medical Association Declaration of Helsinki on Ethical Principles for Research Involving Human Subjects. Since visual images and footage was collected, the identities of participants were easily recognisable, therefore digital technology was used to obscure the details such as their faces to protect their identity without distorting the visual detail relevant to the research objective (Flewitt, 2005). This has also been adopted in the publications emanating from the dissertation.

RESULTS

Seventy-five percent of the young uncoached cricketers adopted the LBBT (Table 4.1) whereas only 27% percent of the adolescent coached cricketers adopted the LBBT (Table 4.1). The number of players using LBBT further declined to 20% among amateur coached cricketers. The difference in use of LBBT was significantly different between the three age groups (χ^2 = 32.6, df = 2, p < 0.001). As players increase in age, the use of this technique may have decreased as a result of exposure to traditional coaching methods and philosophies.

Table 4.1: Percentage of young uncoached cricketers (UC), adolescent coached cricketers and amateur coached cricketers (together, CC) using lateral (LBBT) and straight (SBBT) backlift batting techniques and assigned to classifiers 1 - 3.

Cricketer group	N	Backlift batting technique (%)		Classifier (%)		
		LBBT	SBBT	1	2	3
Young uncoached (UC)						
Under-9	20	80	20	10	10	80
Under-11	20	70	30	10	20	70
Total	**40**	**75**	**25**	**10**	**15**	**75**
Adolescents coached						
Under-13	10	30	70	50	20	30
Under-15	10	30	70	50	20	30
Under-19	10	20	80	60	20	20
Total	**30**	**27**	**73**	**54**	**20**	**26**
Amateur coached						
Ages 19 – 28*	**10**	**20**	**80**	**30**	**50**	**20**
Coached cricketers overall (CC)						
Total	**40**	**25**	**75**	**47.5**	**27.5**	**25**

** As of February 2015*

This is corroborated by the finding that across all cricketers using the LBBT, 75% were uncoached (UC) and 25% were coached (CC) (Table 4.1). This difference in use of the two BBT between the uncoached and coached groups was also significant ($\chi^2 = 18.05$, df = 1, $p < 0.001$).

Among the amateur coached cricketers, batsmen using the LBBT achieved the highest mean total and average runs in both one-day and three-day formats of the game, respectively (Table 4.2). The number of average runs scored in three-day matches was significantly higher, on average, among cricketers using the LBBT than those using the SBBT (Table 4.2, t = 4.46, p = 0.046). However, the BBT was not associated with the total runs scored in three-day (t = 0.91, p = 0.52) or one-day matches (t = 0.9488, p = 0.52), or the average runs scored in one-day matches (t = 2.82, p = 0.12).

Table 4.2: Mean (± Std error) total and average runs in three-day and one-day matches by amateur coached cricketers (CC) using lateral (LBBT) or straight (SBBT) backlift batting techniques

BBT	Classifier	Three-day		One-day	
		Total runs	**Average runs**	**Total runs**	**Average runs**
SBBT	1	317 ± 242.5	12.6 ± 5.2	77 ± 47.7	24.1 ± 11.0
	2	1060 ± 597.6	22.1 ± 4.2	199 ± 98.3	13.6 ± 2.8
	Overall	782 ± 390.3	18.6 ± 3.5**	154 ± 64.8	17.6 ± 4.4
LBBT	3	3222 ± 2651.5	46.6 ± 5.2**	1128 ± 1024.5	41.6 ± 7.3

*** Denotes significant difference between groups at α = 0.05*

DISCUSSION

The main finding of this study was that more than 70% of previously uncoached cricketers adopted the LBBT whereas more than 70% of coached cricketers adopted the SBBT. This result showed that the natural movement of uncoached cricketers is to pick up the bat using an LBBT and hence a rotary action to strike the ball. Similar sports such as baseball, golf and tennis also have the player's "bat" pointed away from their body before impact and in an angular direction instead of being taken straight back (Welch *et al.,* 1995). The technique of baseball hitting shows that higher rotational velocities facilitate successful timing. If the rotational component of a body movement is emphasised when a player is in the side-on position then the centre of mass is aligned between both feet (Welch *et al.,* 1995). A wider arc of swing also produces a wide range of shot selection instead of predominantly forward defensive play (Borooah, 2010). Similarly in cricket, this would ensure more effective timing and power when hitting the ball allied to a greater possibility to place the ball to all parts of the cricket field.

To further elaborate on the angular direction of the bat, Figure 4.2 shows an enlarged four-way comparison of BBT among CC, UC and Sir Donald Bradman. Both Figures 4.2a and 4.2b of Sir Donald Bradman and the typical uncoached cricketer shows an increased angle of more than 60^o, whereas Figures 4.5c and 4.5d of coached cricketers shows a small angle of less than 40^o. We can deduce that cricketers who have a lateral angle of the backlift of more than 50^o might have a better chance of hitting the ball effectively.

a) Sir Donald Bradman	b) Young UC	c) Adolescent CC	d) Amateur CC
Angle of 60°	**Angle of 75°**	**Angle of 35°**	**Angle of 35°**

Figure 4.2: An enlarged four-way comparison of batting backlift techniques among Sir Donald Bradman, CC and UC
CC = coached cricketers; UC = uncoached cricketers

Another main finding of this study showed that as players increase in age, the use of the LBBT may have decreased as a result of exposure to traditional coaching methods and philosophies. Early coaching with SBBT may be be detrimental to cricketers future prospects if evidence supports the LBBT producing better performances. In addition, if such players are not coached, they automatically hit the ball using a LBBT.

Furthermore, in the amateur group, the number of average runs scored in three-day matches was significantly higher on average among cricketers using the LBBT than those using SBBT. Although this finding is promising, it warrants further investigation. As such, no conclusive findings can be drawn from this study due to the small sample number (n = 10) in the amateur group.

Strengths and Limitations

The strength of this study was the ability to capture videos for both groups of participants analysing a range of ball deliveries for each participant. Another strength of this study was that each group of participants played in their same environment and in the same month which limited a seasonal effect. Biomechanical and video analysis of the players were also obtained objectively and were not self-reported. A limitation of this study was that only one cricket club was used for the adolescent cricketers and perhaps only a few coaches had an influence on their coaching. Another possible limitation of this study was the paucity of statistics available for the adolescent group posing a challenge to conduct additional statistical analyses. Furthermore, the researchers accounted for perspective error by limiting the type of videos observed and included horizontal lines in the background.

CONCLUSION

Uncoached cricketers adopted the LBBT whereas coached cricketers adopted the SBBT. The coaching implications of this study are that cricket coaches should teach the basic fundamentals of batting techniques to cricketers, allow a young cricketer to play naturally and coach them based on their individual technique that they have developed. Given that a LBBT has been shown to promote better batting, our study suggests that early coaching emphasising the SBBT (one of the basic fundamentals of batting coaching) could be less favourable to the long-term success of young cricketers. Aside from the stance, grip, downswing and follow through of cricket batting, the backlift is a key contributor to effective batsmanship and therefore it should not be excluded in any performance analysis in cricket. Future research is required to evaluate the coaching methods of the BBT taught by coaches at various proficiency levels in most International Cricket Council countries as this can inform what the current practice of coaching the BBT is across varied levels of cricket ability.

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5

EVALUATING THE TEACHINGS OF THE BATTING BACKLIFT TECHNIQUE AMONG CRICKET COACHES AT DIFFERENT LEVELS

ABSTRACT

Background

Since the inception of the game, cricket coaches have been teaching batting techniques to cricketers at various levels using mainly cricket coaching manuals. Most of these manuals advocate the straight batting backlift technique (SBBT). However, the analysis of Chapter 2 suggests that the practice of elite batsmen do not match the theory of the backlift. This raises questions about the extent to which the coaches follow the manuals. The aim of this study was to evaluate how cricket coaches understand and teach the batting backlift technique (BBT).

Methodology

This was a mixed-methods research study in which a survey (using both open and closed-ended questions) was electronically distributed among qualified cricket coaches (n = 161). These coaches were from eight of the different International Cricket Council playing nations.

Results and Discussion

This study shows that the majority of cricket coaches' coach what is advocated in cricket coaching manuals. In addition, most of the cricket coaches also coach players on an individual basis. This study also showed that most cricket coaches (83%) teach the SBBT as opposed to the lateral batting backlift technique (LBBT) at various proficiency levels of the game. More so, towards the higher levels of cricket, most coaches understand the potential value of the LBBT but have challenges in coaching the LBBT.

Conclusion

A recommendation from this study is that all coaching cricket bodies should meet and agree on a common method for coaching the BBT in cricket. Since a high level of experience is generally required for coaching a LBBT, further research should be conducted on providing tools and support to assist coaches.

Key words: Batting backlift techniques, teachings, cricket coaches, mixed-methods study, cricket

INTRODUCTION

In Chapter 2, it was shown that a majority of successful batsmen adopted a lateral batting backlift technique (LBBT) whereas in Chapter 3, a LBBT was shown to be more common at the highest levels of cricket. However, as one moves through the levels of cricket ability (i.e. junior to adolescent cricket; Chapter 4), cricketers adopt more of a straight batting backlift technique (SBBT). This poses an interesting question of whether the backlift is coached differently between varied proficiency levels.

Since the inception of the game, cricket coaches have been teaching batting techniques to cricketers at various levels. A number of cricket coaching manuals including the Marylebone Cricket Coaching (MCC) manual state that batsmen should lift their bats towards the wicket-keeper or in the direction of the middle stump on the initiation of the batting stroke, with the bat face pointing towards the ground (Beldam & Fry, 1905; Lewis, 1992; The MCC, 1952). This traditional backlift, described as the SBBT, was recommended by one of the first cricket coaches, C.B. Fry, in 1912 (Fry, 1912).

Table 5.1 summarises the coaching literature on the recommended direction of the backlift from each coaching book or manual. Only a minority of the most notable cricket coaching manuals (13.3%) advocated that the backlift be directed beyond second slip or in a looped technique (i.e.: a LBBT). The remaining coaching manuals advised that the backlift be directed straight towards the stumps or towards first or second slip (i.e.: a SBBT; 86.7%) (Table 5.1).

Table 5.1: Summary of relevant coaching literature on the direction or basis of the batting backlift technique in cricket batting (Reproduced from Chapter 1)

Author(s), Year	Title	Straight towards the stumps or wicket-keeper	Towards first or second slip	In a looped or lateral technique
Ranjitsinhji, K.S., (1897)	The Jubilee Book of Cricket 5th Ed	X		
Giffen, G., (1898)	With Bat & Ball	X		
Grace, W.G., (1899)	Cricketing Reminiscences & Personal Recollections	X		
Beldam, G.W. & Fry, C.B., (1905)	Great Batsmen: Their methods at a glance	X		
Fry, C.B., (1920)	Cricket: Batsmanship	X		
Knight, D.J., (1922)	First Steps to Batting	X		
Armstrong, W.W., (1924)	The Art of Cricket 3rd Ed	X		
Faulkner, G.A., (1926)	Cricket: Can it be taught?	X		
MacLaren, A.C., (1926)	The Perfect Batsman: JB Hobbs in Action	X		
Jardine, D.R., (1939)	Cricket	X		
Wheatley, G.A., Parry, R.H., & Barlee, J., (1948)	Cricket…Do it this way	X		
The MCC, (1952)	The MCC Cricket Coaching Book	X		
Bradman, D., (1958)	The Art of Cricket			X
Goodwin, C.J., (1967)	Coming in to Bat	X		
White, N., & Headley, G., (1974)	George 'Atlas' Headley	X		
Dellor, R., (1990)	How to Coach Cricket	X		
Ferguson, D., (1992)	Cricket: Technique, Tactics, Training	X		
Lewis, T., (1992)	MCC Masterclass: The new MCC Coaching		X	
Woolmer, B., (1993)	Skillful Cricket		X	
Boycott, G. & Gower, D., (1994)	Batting Vivian Richards		X	
Tyson, F., (1994)	The Cricket Coaching Manual	X		
Simpson, B., (1996)	The Reasons Why: A decade of coaching, a	X		

	lifetime of cricket.			
Palmer, D., (1999)	Cricket Coachmaster Batting Mechanics	X		
Australian Cricket Board, (2000)	Coaching Youth Cricket	X		
Chappell, G., (2004)	Cricket: The making of champions		X	
Shillinglaw, T., (2008)	Don Bradman's "Continuous 'Rotary' Batting Process"			X
Shillinglaw, T., (2009)	Bradman Revisited 2nd Edition 'The Simplicity of Nature'			X
Woolmer, B., Noakes, T.D., & Moffett, H., (2009)	Bob Woolmer's Art and Science of Cricket		X	
Borooah, V.K. & Mangan, J.E., (2010)	The "Bradman Class": An exploration of some issues in the evaluation of batsmen for test matches			X
Woolmer, B., Noakes, T.D., & Moffett, H., (2010)	Bob Woolmer on Batting		X	
TOTAL	**30**	**20**	**6**	**4**

Sir Donald Bradman, who himself was the prime example of this 'looped' BBT (referred to as the LBBT in this thesis), wrote or was the subject of some of these books (Borooah *et al.,* 2010; Bradman, 1958; Shillinglaw, 2008; Shillinglaw, 2009). These books strongly supported the LBBT technique. However, the majority of the manuals supported the SBBT (Table 5.1). Despite Bradman's success, one could argue that those in favour of coaching the LBBT have been in the minority – at least as represented in published coaching manuals.

In 2012, Penn and Spratford investigated whether coaching recommendations for batting techniques were supported by findings from biomechanical research. Coaching courses on teaching cricket appear to be less utilised by coaches since the courses do not match the coaches' experiences as well as the teaching content from the coaching courses (Piggot, 2012). This area requires additional research; but the views of experienced coaches and players cannot be excluded, as they provide valuable insight into the reality of teaching the game of cricket by combining practical experiences with the theory. This is especially important in the modern game which is evolving rapidly (Penn & Spratford, 2012; Piggot, 2012; Wulf, 2012; Noorbhai & Noakes, 2015).

Research Problem and Aims

To our knowledge, no study has yet examined whether there are differences in the teachings of BBT of cricket coaches at any level. This mixed methods study will address how cricket coaches teach the BBT and to gain any additional insights of their understanding of how different backlift techniques may influence batting ability in cricket. A convergent parallel mixed methods design will be used, and it is a type of design in which qualitative and quantitative data are collected in parallel, analyzed separately, and then merged. In this study, quantitative and qualitative data will be used to explore the central phenomenon and test the theory of the teachings of the BBT by cricket coaches at various levels and in various countries. The reason for collecting both quantitative and qualitative data is to obtain different, multiple perspectives, or more complete understandings on the teachings and approaches of coaching the BBT in cricket.

We hypothesised that coaches at different levels of the game would teach the BBT the same. In particular, most junior cricket coaches would teach the SBBT whereas towards the higher levels of cricket, most coaches would understand the potential value of the LBBT.

METHODOLOGY

Research Design

Mixed methods is a research approach, popular in the social, behavioral and health sciences, in which researchers collect, analyse, and integrate both quantitative and qualitative data in a single study to address their research questions (Creswell, 2013).

This was a mixed methods study in which a survey was utilised that included both closed-ended questions and an open-ended question. A mixed-methods study combining both qualitative and quantitative analysis is found to be more effective and invaluable for gaining insights from coaches (Knudson, 2007). Therefore, this study is structured on a theory based on an evaluation gathered from cricket coaches on their teachings of batting backlift techniques in cricket (Figure 5.1).

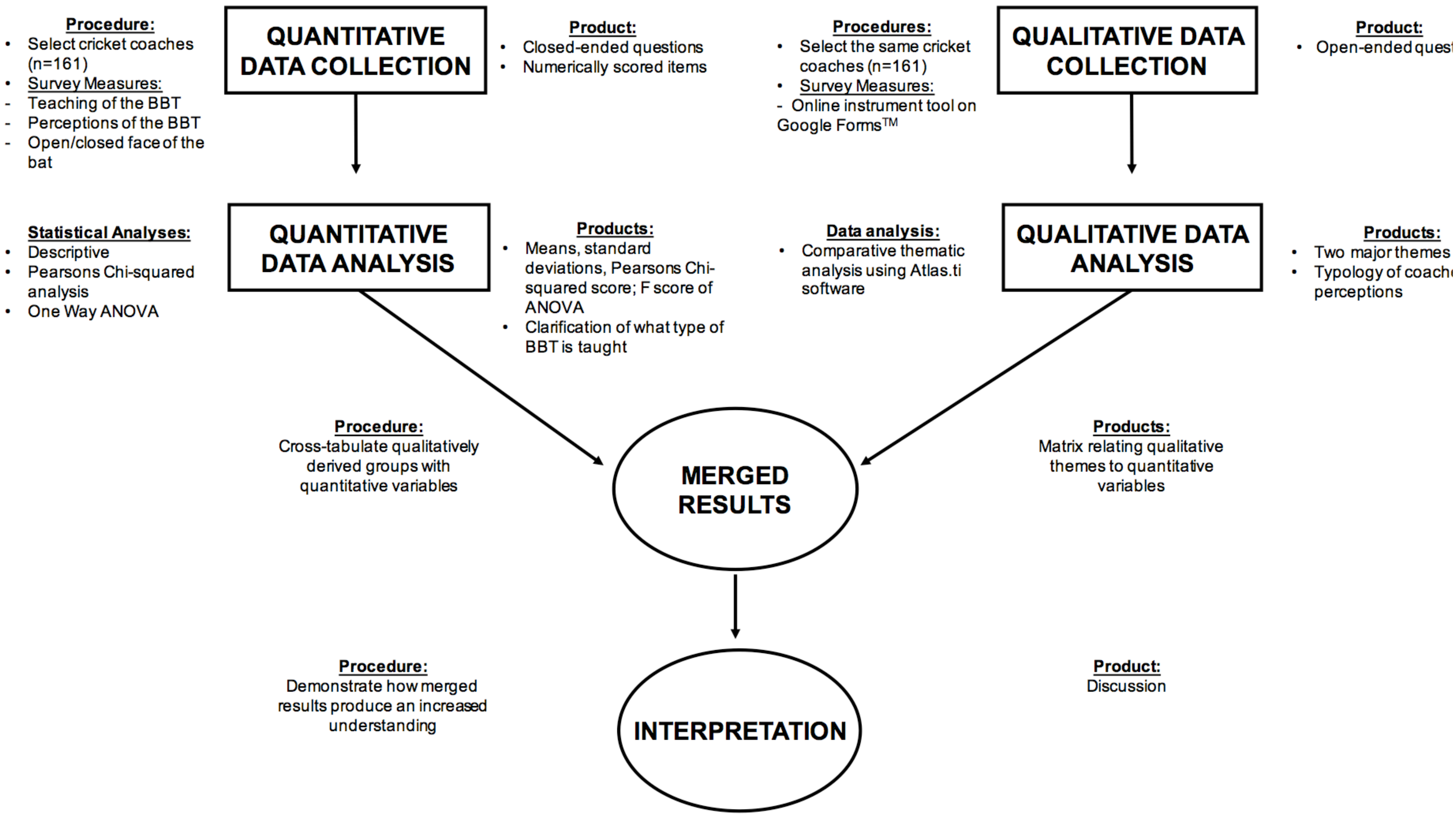

Figure 5.1: Design of mixed methods study to investigate the teachings of the batting backlift technique.
(Adapted from Creswell, 2013)

Research questions

Given that most of the coaching manuals and some of the cricket coaching courses advocate the teaching of the traditional SBBT, this theory does not match the practice of the great batsmen who adopt a LBBT, as shown in Chapter 2. The two important questions requiring attention are:

1) Are coaches aware of the LBBT?

2) What is the type of backlift that they are teaching (if any)?

Data Analysis

Quantitative Data Analysis

Data were captured automatically from GoogleSheets^{TM} and exported onto an online Microsoft Excel sheet upon submission of the coaches' responses. Pearson's Chi-squared tests were conducted to determine any significant trends in the answers obtained from the survey. One-Way ANOVAs were also conducted to determine whether coaches at different levels teach different betting techniques. All statistical analyses were performed using R (R Core Team, 2014) at a significance level of $\alpha = 0.05$.

Qualitative Data Analysis

The Atlas.ti Qualitative Data Analysis Software (Scientific Software Development GmbH, Berlin and Germany) was used for analysis for the open-ended data. Once the questionnaire was answered, open-ended answers gathered from the coaches were coded using a thematic coding framework. These codes were formulated from the answers provided by the cricket coaches to the open-ended question. The results are discussed as themes that arose from the quantitative data, which are supported by qualitative data in the form of quotes and insights provided by the cricket coaches.

Participants

All participants (n = 161) were qualified cricket coaches located in eight of the different International Cricket Council (ICC) playing nations (South Africa, Australia, New Zealand, England, West Indies, Zimbabwe, India and Pakistan). These cricket coaches have coached cricket players at various proficiency levels of the game from beginner and junior to elite level.

Procedures

An online survey was utilized, since this was the most appropriate manner by which to reach the participants who were located around the world. The questionnaire was compiled using GoogleForms™. The survey was emailed in the form of a hyperlink (http://bit.ly/1rgGG3G) to most of the cricket coaching bodies within each country (this is where Primary school, Secondary School, Club, Junior Provincial and Amateur/State B coaches were reached), and also to individual cricket coaches known to the researcher (mainly franchise and international coaches) who were also asked to disseminate the survey to other cricket coaches in their network. Participants provided consent via the information leaflet prior to the commencement of the survey (Appendix C) in which their answers were recorded online. Participants had the option either to remain anonymous or to disclose their names if they wanted to disclose their identity.

To ensure that all the important questions were completed in the survey, questions that had to be answered were denoted with an asterisk (*). The form could not be submitted without completion of all these required questions. Each survey required between 10-15 minutes for its completion. The questions asked were aimed to elicit cricket coaches' experiences, insights and perceptions of factors promoting and hindering the BBT.

The online survey

The online survey was validated before the questionnaire began, on the basis of what was found in both the previous literature on the backlift as well as the latest coaching manuals and cricket coaching courses. We focused primarily on the coaching manuals since these are the widely preferred sources of coaching information for coaches (Penn & Spratford, 2012). In addition, most cricket coaching courses offered worldwide provide vague information on the BBT, whereas the cricket coaching manuals and books appear to be much more specific (Gilbert & Trudel, 2001; Cushion *et al.,* 2003; Nelson & Cushion, 2006; Lemyre *et al.,* 2007). The questionnaire began with closed-ended questions. There was an open-ended question towards the end of the survey so that coaches could provide additional comments on the questions asked.

The closed-ended questions included the following:

- Demographics (age, country and level of coaching)
- Do coaches feel that what is advocated in coaching manuals for batting is what happens in actual play?
- Their perception of whether it is important to coach cricket players utilising a generic batting technique.
- Their perception of the value of batsmen using a particular, prescriptive batting technique or adopting their own natural style or ability.
- Their perception of the importance of coaching a cricket player utilising a generic batting technique or as an individual or by applying an approach promoted in a particular cricket book or coaching manual.
- Are they aware of what a 'looped/rotary' technique or lateral backlift is?

- Which backlift do they use to coach cricketers?
- Do they think it is necessary to emphasise the importance of the bat face being open or closed during the backlift?
- What do they advocate in terms of the bat face being either, open, closed or semi-open/closed during the backlift?
- Should the bat face be directed towards the off-side or towards the wicket-keeper/stumps during the backlift?

The open-ended question at the end of the questionnaire provided an opportunity for the cricket coaches to explain their individual approach to the coaching of the BBT. Having closed-ended questions might have limited the responses from coaches, but this section was included purposefully in order to analyse the instinctive responses from the cricket coaches based on their current understandings and teachings of the BBT.

Ethical Considerations

Information leaflets were distributed to participants and informed consent forms were obtained from cricket coaches prior to their participation in the survey. The consent form was presented online as the first page of the questionnaire. Ethical approval for the study was granted by the Human Research Ethics Committee of the University of Cape Town (HREC: 586/2014). This research study conforms to the World Medical Association Declaration of Helsinki on Ethical Principles for Research Involving Human Subjects.

RESULTS

Demographics

The majority of the cricket coaches who participated in this study resided in South Africa (n = 123; 77%) and the remaining cricket coaches were from Australia, England, India, Pakistan, New Zealand, West Indies and Zimbabwe respectively (Figure 5.2).

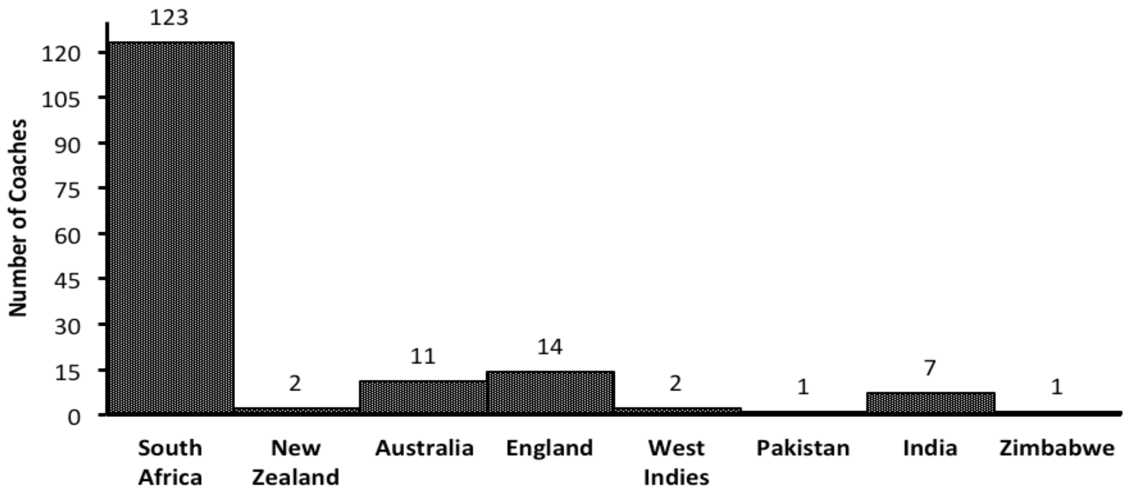

Figure 5.2: Coaches' participation and their country of origin

The response rate was relatively poor from nations outside of South Africa. This posed a challenge given that online communication was the only means for contact with these coaches. Despite the global availability of the questionnaire, it is not immediately clear why the response from South African coaches was so good, and with only few responses from coaches in other countries.

In addition, a majority of these coaches were found to coach at primary school (21%), secondary school (33%) and club (24%) levels (Figure 5.3). A minority of coaches coached at junior provincial, amateur/state, franchise/county and international level (22%).

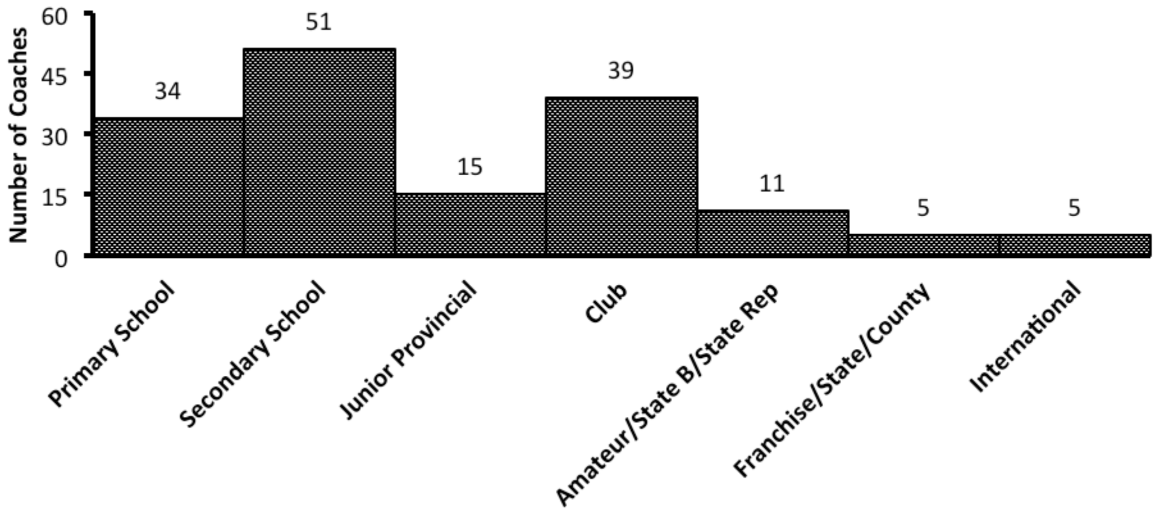

Figure 5.3: Number of cricket coaches represented at each level of cricket

Most of the coaches were in the 26 – 35 and 36 – 45 age categories (n = 94; 59%) whereas the remainder were in the 16 – 25 and above the 46-year age categories (n = 66; 41%) (Table 5.2). The sample of coaches in this study had an adequate spread of ages, ranging from 16-25 years to 56+ years.

Table 5.2: Age characteristics among cricket coaches who participated in an online evaluation of batting backlift techniques (n = 161)

Age Category	Number (N)	Percentage (%)
16 – 25	28	17.4
26 – 35	58	36.6
36 – 45	37	22.4
46 – 55	27	16.8
56 – 65	9	5.6
66+	2	1.2

Coaches Responses

Most of the cricket coaches (74.7%; $\chi^2 = 9.4$, $p = 0.009$) believed that only sometimes are current batting practices accurately reflected in modern cricket coaching manuals. A further 13% of cricket coaches concluded that the current batting practices are not accurately reflected in modern cricket coaching manuals (Figure 5.4).

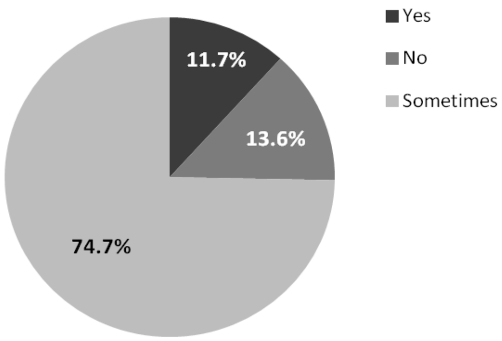

Figure 5.4: Coaches' response to the following question: Do you think what is advocated in coaching manuals for batting is what happens in actual play?

It would therefore seem that the coaches were generally quite skeptical about the extent to which coaching manuals reflect the reality of actual play. With this in mind, we found that a vast majority of cricket coaches indicated that the successful batsmen with whom they work have their own natural style for cricket batting (80.7%; $\chi^2 = 4.7$, $p = 0.02$) (Figure 5.5).

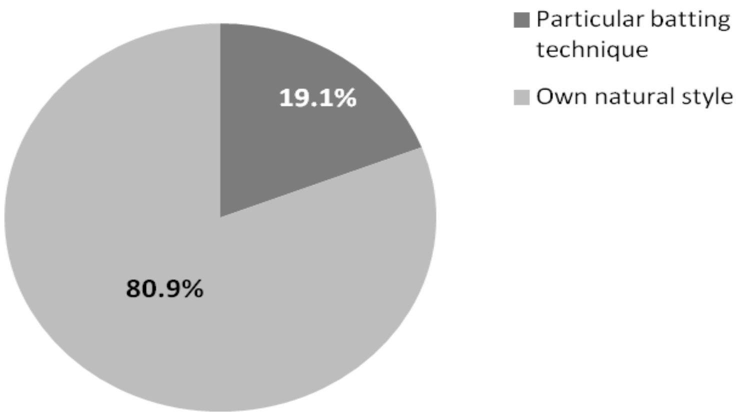

Figure 5.5: Coaches' response to the following question: Do you think successful batsmen use a particular batting technique or their own natural style?

Less than half of cricket coaches however felt that it is not advisable to coach cricket players utilising a generic batting technique (44.4%) (Figure 5.6).

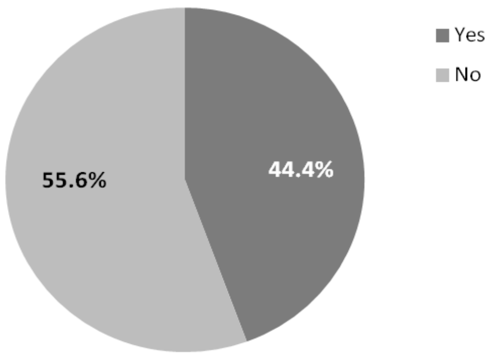

Figure 5.6: Coaches' response to the following question: Do you think it's important to coach each cricket player utilising a generic batting technique?

There was also a considerably high level of consensus that cricket coaches coach a cricket player as an individual and not by applying a textbook cricket approach (95%; $\chi^2 = 27.7$, $p = 0.0001$) (Figure 5.7). Most of the cricket coaches (65%) indicated in the survey that working with players on an individual basis by applying the basics of batting (head still, balance, hitting the ball with the full face of the bat and hitting through the line) is imperative.

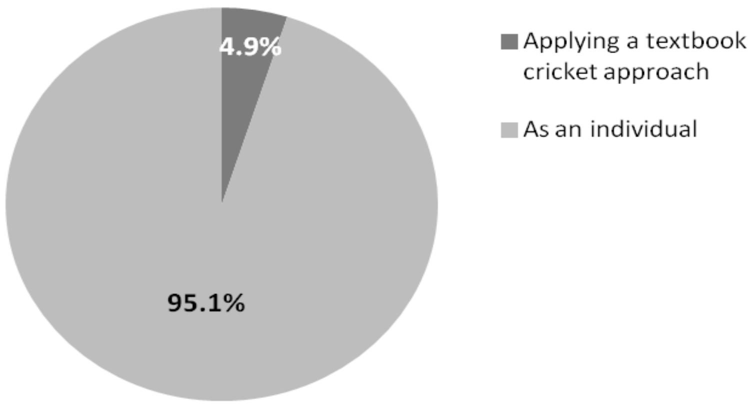

Figure 5.7: Coaches' response to the following question: Do you feel it's important to coach each cricket player as an individual or applying a textbook cricket approach?

When asked about what a 'looped' backlift or rotary style of batting, 68.5% of the cricket coaches were aware of this technique (Figure 5.8).

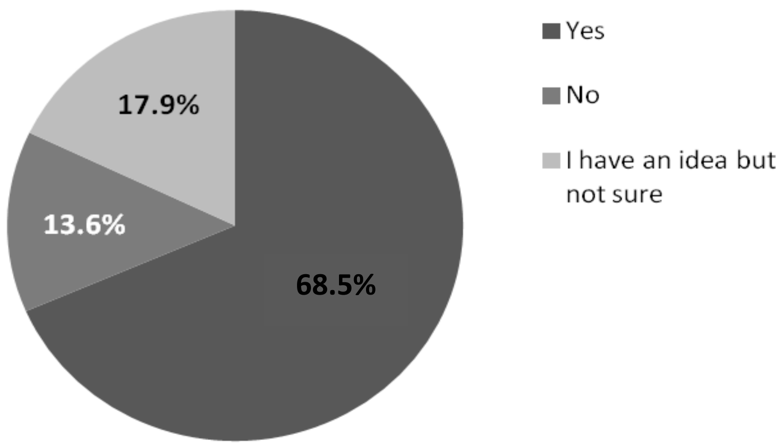

Figure 5.8: Coaches' response to the following question: Do you know what a 'looped' backlift or rotary style of batting is?

Most of the cricket coaches in this study taught the backlift of the bat to be directed towards first or second slip (68%; $\chi^2 = 10.6$, $p = 0.01$) (Figure 5.9).

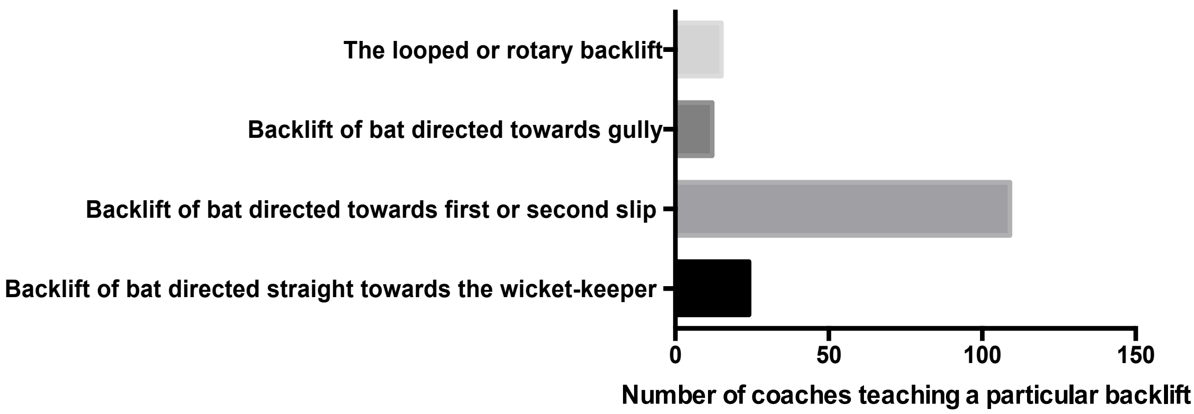

Figure 5.9: Batting backlift technique used by coaches to coach cricketers

Table 5.3: Percentage of coaches at various levels teaching batting backlift techniques in different directions when coaching cricketers.

	N	Wicket-keeper (%)	First or second slip (%)	Gully (%)	Looped /Rotary (%)
Primary	34	18	65	15	3
Secondary	51	20	69	6	6
Junior Provincial	14	0	71	0	29
Club	39	10	69	8	13
Amateur	11	18	64	18	0
Franchise	6	17	83	0	0
International	6	0	67	0	33
Total	**161**	**14**	**68**	**8**	**9**

Across all levels, the majority of coaches (64% - 83%) coach the bat to be directed towards the slips (Table 5.3). Significantly, more coaches on average across all levels teach the SBBT as opposed to the LBBT ($F = 7.28$, $df = 3$, $p = 0.001$). A further 10% - 20% of coaches at almost every level also coach the bat to be directed towards the wicket-keeper (Table 5.3).

Based on the classifiers described in Chapters 2, 3 and 4, a bat directed towards the wicket-keeper or the slips is classified as a SBBT. Verily, in practice, most coaches in this study (67% - 100% across all levels) are teaching the SBBT (82% overall), with the vast majority of coaches at the Secondary school level (83%) and all coaches at Franchise level teaching the SBBT. Since a vast majority of coaching manuals advocate for the SBBT, coaches in this study coach what is advocated in the coaching manuals. However, the average number of coaches teaching the SBBT across all levels is not significantly different from that teaching the other techniques ($F = 3.143$, $df = 2$, $p = 0.06$).

Aside from the direction of the backlift and other components of the batting technique, this research study also reflected that majority of the cricket coaches (74.5%; $\chi^2 = 16.3$, $p = 0.0003$) (Figure 5.10) emphasise the importance of the bat face being open. The face of the bat however, is not emphasised in coaching manuals.

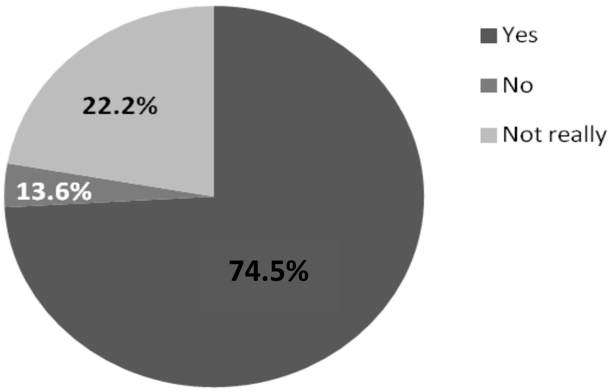

Figure 5.10: Coaches' response to the following question: With the backlift, do you think it is necessary to emphasise the importance of the bat face being open or closed?

Nearly half of all cricket coaches teach the open face of the bat (49%) and a third of cricket coaches teach the semi-open or semi-closed face of the bat (Figure 5.11). Only a number of cricket coaches in this study teach a closed face of the bat.

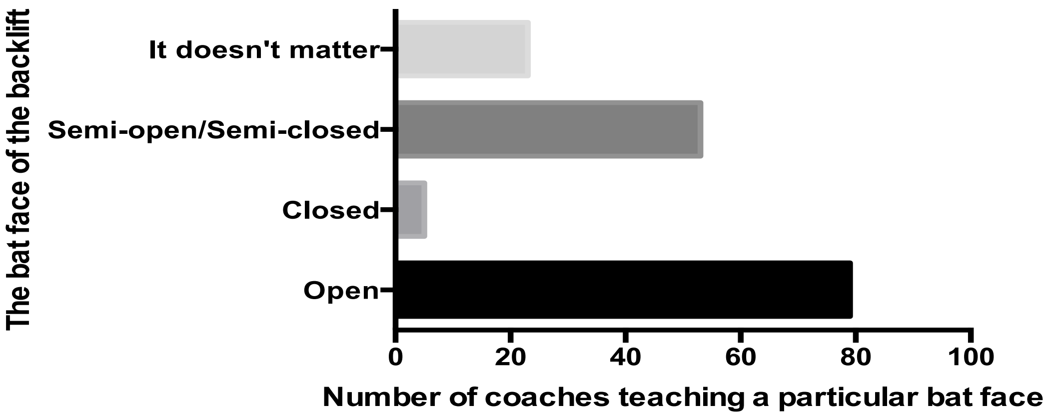

Figure 5.11: Number of coaches advocating if the bat face should be open, closed or semi-open/closed

A majority of the cricket coaches (78.4%) felt that the face of the bat should be directed towards the off-side and not towards the wicket-keeper or the stumps (Figure 5.12).

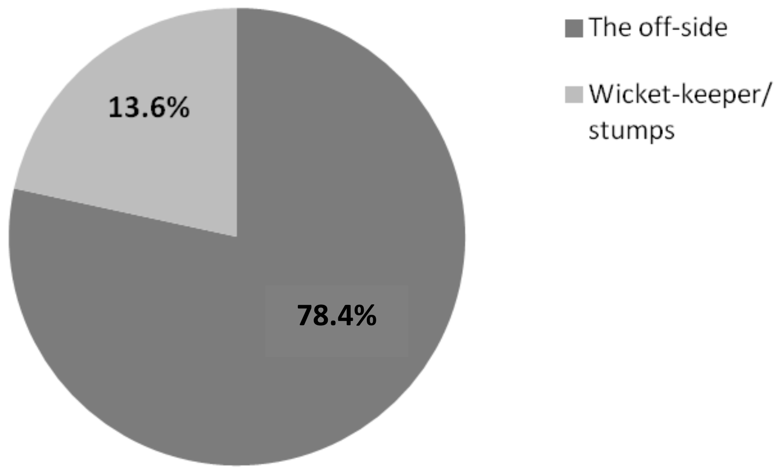

Figure 5.12: Coaches' response to the following question: Should the bat face of the bat be directed towards the off-side or towards the wicket-keeper/stumps?

DISCUSSION

The process of learning to coach has been subject to scrutiny over the past 20 years. Despite the increase in the number of coach education programmes implemented worldwide, Nelson *et al.,* (2006) argues that 'our understanding of coach learning and the acquisition of professional knowledge lacks a clear conceptual base'. Limited research does however suggest that coach learning is influenced by a mix of formal, non-formal directed and self-directed learning experiences developed by chance (Nelson *et al.,* 2006). It is argued that research has been more influenced by personal and methodological interests of scholars rather than an attempt to develop a conceptual framework as in the case of batting in cricket (Lawson, 1991). We will however draw on Coombs & Ahmeds's framework of formal, non-formal and informal learning as a basis for this discussion of results (Coombs & Ahmed, 1974; reviewed in Nelson *et al.,* 2006).

The main finding of this study showed that coaches tend to teach what is advocated in coaching manuals. This is supported by Coombs & Ahmeds (1974) framework of self-directed informal learning in which learning occurs beyond dedicated formal learning institutions such as by engagement of coaching manuals (Nelson *et al.,* 2006). This finding was drawn from the questions enquiring about the link between coaching manuals and practice as well as what type of backlift the coaches are teaching to players. Coaches resist the idea that their coaching approaches are restricted by manuals, but also indicate that they coach the individual and do not adhere to generic coaching guidelines.

A secondary finding of this study showed that coaches tend to teach more of the SBBT as opposed to the LBBT at all proficiency levels. This is expected since coaches tend to teach from coaching manuals, which has focused on the teaching of the SBBT (refer to Table 5.1). This was drawn from the questions enquiring about their knowledge of the looped backlift, their approach to the direction of the backlift and the emphasis of the face of the bat, being open, semi-open/closed or closed. These two main findings are further discussed below.

The link between coaching manuals, practice and the individual player

Coaches felt that the game has changed over the years, and formalising a specific technique may not be ideal for most purposes. This is supported by Renshaw *et al.,* (2010) who states that a key feature in enhancing performance is variability. In addition, coaches felt that using the coaching manuals for players at a younger level provides a foundation for the acquisition of skills. When players are older, beyond their teenage years, coaching manuals would not provide some of the answers that may be paramount for the player. Research demonstrates that through informal learning (such as coaching manuals, video footage, science videos), coaches are able to develop strategies to overcome the above practical coaching dilemmas (Gilbert & Trudel, 2001). Therefore, this method of coach learning should not be underestimated.

> *"One must remember that the game has changed drastically over the years and coaching textbooks have not. A coach should endeavour to realise this and continue to develop his coaching structures." – South African Secondary School Cricket Coach (40.4% of coaches shared the similar sentiment).*

According to Parkin (2003), each coaching structure may change over time but it must also have a strong foundation. Some coaches advocate for a Humanistic approach that involves focusing on all aspects of the player, while concentrating on a few key components of technique (Lyle, 2002). From a different perspective, it is perhaps unsurprising that one of the few consistent and global findings in the coaching literature is that coaching knowledge and practices, among both elite and non-elite coaches, are conceptualised from both formal and informal sources (Gilbert & Trudel, 2001; Cushion *et al.,* 2003; Nelson & Cushion, 2006; Lemyre *et al.,* 2007).

Cricket is evolving rapidly and this poses another challenge for coaches. The challenge is that coaches feel that some of the coaching manuals are outdated and not relevant to their current practice of cricket coaching for individual players. It can therefore be argued that these coaches rely on their experiences, which is the most important facet in the development of coaches as noted by Nelson *et al.,* (2006).

> *"I feel that you stick to the textbook as much as possible but adapt to suit each individual. I feel some of the things in the textbook is outdated and therefore I change and adapt certain things so that it works for the individual" – South African Primary School Cricket Coach (31.2% of coaches shared the similar sentiment).*

It was found that cricket coaches in this study consider the importance of individuality with a player, which supports adopting the athlete-centred approach (Weissensteiner *et al.,* 2008). However, a majority of coaches still apply the generic approach to young players and only later adopt a tailored approach to players as they age and develop.

> "*Cricket is a game of technique and each individual will have his own style which will suite his style of play. As coaches we can only teach the basics and enhance each individual in the various styles until he finds one that would suit his game" – South African Secondary School Cricket Coach (18.6% of coaches shared the similar sentiment).*

Similarly, most of the South African cricket coaches in this study indicated that players should apply a textbook cricket approach.

> *"I feel that all batsmen should be taught the textbook style to the extent that they can then decide as to whether or not they feel more comfortable with their own natural techniques" – South African Secondary School Cricket Coach.*

Some cricket coaches even felt that both the individual and textbook cricket approach is advisable which aligns with the global findings noted above.

> "*I feel it's important to both coach each player as an individual and applying a textbook cricket approach. The combination of both is the recipe to success" – Zimbabwe Franchise Cricket Coach (6.2% of coaches shared the similar sentiment).*

In contrast, few of the coaches in other countries such as India, Pakistan and the West Indies feel that coaching methods and approaches towards batting techniques are also slightly different.

> *"Correct batting techniques are created by batsmen on the field and not by the textbooks or coaching laboratories. However, techniques are dynamic in nature, keep analysing it and apply it as per need and acceptability of individual batsmen" – India Franchise Cricket Coach (3.8% of coaches shared the similar sentiment).*

In the game of cricket there is always a chance for players to improve and coaches need to find a way to distinguish between the over and under-utilisation of coaching manuals. Textbooks have limited use once the player advances to higher levels, however the utility of coaching manuals for the basic fundamentals of batting is imperative. The emphasis on enhancing natural ability is also important, especially with regards to the BBT (Weissensteiner *et al.,* 2008). Of note are models of batting that have been proposed such as by Bennie & O' Connor (2011). Weissensteiner *et al.,* (2009) developed a model of expertise in cricket batting in which a favourable socio-developmental environment provides the essential foundation for the development of positive psychological attributes, technical skill mastery and superior visual-perceptual skill. Furthermore, Renshaw *et al.,* (2010) propose a constraint-led approach in conjunction with the athlete-centred approach (individuality noted above) to coaching cricket, which is a suitable theoretical method that coaches and scientists can utilise to underpin learning design. By adopting this approach, coaches understand that performance problems can be solved in a number of ways (such as coaching a batting technique) and therefore there is a rejection of the concept of one optimal movement solution.

Coaching the batting backlift technique

From a coaching and practical perspective, when coaches were asked about what a 'looped' backlift or rotary style of batting is, 68.3% of the cricket coaches were aware of this technique (Figure 5.4). However, most of the cricket coaches in this study taught the backlift of the bat to be directed towards the keeper or towards first or second slip (83%) (Figure 5.8). The key question here is that if most of the coaches are aware of the 'looped' or 'rotary' technique and if the majority of the coaches teach the backlift towards the wicket-keeper or the slips, why are they not coaching the 'looped' backlift?

One explanation is that some coaches perceive the LBBT to be more difficult for batsmen to master than the SBBT. This also makes the technique more challenging to teach.

> "*A coach requires a lot of experience if teaching a backlift beyond first or second slip. It is very clear that a majority of young players attempting the rotary style of batting cannot execute it, hitting across the line" - Australian International Coach (4.1% of coaches shared the similar sentiment).*

“I believe there are some benefits to be gained from using the "rotary" technique particularly with regard to bat speed and hitting power. In my experience however this technique is more difficult to master for some players and is perhaps most suited to batsmen who have a greater natural ability to "time" the ball” – South African Club Cricket Coach (9.4% of coaches shared the similar sentiment).

Although this finding does not provide an indication as to whether the coaches are comfortable to teach the LBBT or not, the path to coaching expertise is indeed not well understood (Grundel *et al.,* 2013; Nelson *et al.,* 2006). Furthermore, the change of thinking (teaching the LBBT) is perhaps one of the greatest challenges for coaches as well (Renshaw *et al.,* 2010). Aside from the relevance of coaching expertise, some of the cricket coaches believed that the coaching of the backlift is not as important as other elements of the batting technique.

"The backlift by itself isn't as important as where the face is pointing at the point of contact. The "traditional" approach is likely to be best for cricketers just learning, as it presents the face forward throughout the stroke, but as long as the batsman is presenting the face of the bat to the ball at contact, how it actually gets there is secondary” - England Club Cricket Coach (6.8% of coaches shared the similar sentiment).

This generalisation may certainly be true, but not all strokes in cricket are played with the full face of the bat unless a batsman is driving a ball straight down the ground (this area in cricket is referred to as the ‘V’) (Woolmer *et al.,* 2010). In essence, it has been shown that batsmen can still play most cricket strokes with the full face of the bat if a LBBT is employed (as outlined in Chapter 3 of the thesis).

A few of the coaches in this study felt that it would be adequate to emphasise the face of the bat being open, semi-open/closed or closed.

> "*The current coaching recommendation of open bat face coming down from first slip is adequate for most purposes" – Australian International Coach (5% of coaches shared the similar sentiment).*

In contrast, few of the coaches in this study felt that it would not be important to emphasise the face of the bat being open, semi-open/closed or closed.

> *"The backlift is in any case a means of generating power, the face of the bat can be unimportant as long as the point of contact is correct" – South African Secondary School Cricket Coach (6.2% of coaches shared the similar sentiment).*

This perception probably supports the traditional approach over the years as to why coaching manuals such as the MCC did not emphasise on the importance of the face of the bat because it is in fact, relatively unimportant which way the bat is angled (The MCC, 1954). In addition, this approach might be adequate for players not struggling, but can pose a challenge for such players who are encountering challenges in their batting earlier on in their careers. Bearing in mind the individuality of coaching players, some of the coaches adopted an approach that works best for the player (athlete-centred approach) (Weissensteiner *et al.,* 2009).

> "*Each player has a unique approach to batting. If the kid is scoring runs and not being dismissed in a "similar" way each game I will leave him/her as is.*

Some batters have a natural loop without me telling them and some use the conventional backlift, I would opt on working with the batters individually instead of dictating how they should go about the backlift" – South African Junior Provincial Cricket Coach (24.8% of coaches shared the similar sentiment).

This notion can be further supported by Beek (2000) in that the natural way of learning movement skills such as batting takes place at a sub-conscious level and cannot be enforced on to players via explicit instructions. However, Lyle (2002) argues that there is little empirical evidence to suggest that one coaching style is more effective than another and that a coaching style still has to have balance and substance. In addition, in cricket, coaches tend to judge the ability of players based on how they perform in the nets or practice without realising the variance of player types (match player, net player or dual players). Coaching that takes place in the nets should only provide an indication to the coach of the players' potential and not his/her skill level, as this can only be accurately determined during matches (Renshaw *et al.,* 2010; Portus & Farrow, 2011).

"A flat backlift with a straight bat will look great in the nets and avoid failure making the coach feel great. This however, makes the player succeed and ingrain a process which does not meet the same requirements as the game" – England International Cricket Coach (3.1% of coaches shared the similar sentiment).

Based on the above insights, one can notice that coaches have been coaching more of the SBBT (83%) as opposed to the LBBT (17%) at various levels. More so, it is noticeable from this study that most coaches towards the higher levels of cricket understand the potential value of the LBBT (bat directed beyond second slip or as a 'looped' technique) but potentially experience difficulty in teaching it.

Recommendations

The recommendation from this study is that coaches should be educated on how to coach the LBBT since variability is a key feature in enhancing performance (Renshaw *et al.,* 2010). Cushion *et al.,* (2003) suggests that collective understandings begin to develop through experiences and as such, the culture of coaching the LBBT can start to take shape. Since a large proportion of literature on coach learning has tended to focus on expert coaching practitioners, there has been little appreciation of the teaching and learning preferences of coaches across developmental spectrums. The development of tools to support and assist coaches is integral so that they can feel more confident and competent to coach the LBBT, especially among the junior levels.

Strengths and Limitations

The first strength of the study was the adequate sample size (n = 161). Another strength of the study was the ability to have a diverse spread of cricket coaches based on their age and the proficiency level at which they are coaching. The coaches' varied ages indicate that they have varying levels of experience, which possibly may affect their teaching approaches to the BBT. A limitation of this study was that majority of the cricket coaches in the study sample were South African and there was a low representation of cricket coaches from the other countries, which makes the findings more representative from a South African perspective.

A further limitation of the study was that most of the questions asked on the survey were closed-ended and not open-ended questions. Having closed-ended questions might have limited the responses from coaches. However, the inclusion of one open-ended question allowed for the capturing of additional insights, comments and suggestions by the cricket coaches. The findings from this study have contributed towards foundational insights from coaches on the teachings of the backlift in cricket. As such, an in-depth qualitative evaluation is therefore required to explore specific insights and perceptions of the overall batting technique in cricket among cricket coaches at various levels.

Further qualitative research

Based on the above findings, further studies should consider investigating the teachings of the BBT by coaches through individual interviews and focus group discussions consisting of open-ended questions. Examples of such questions to be asked are:

- If a young player was struggling with their backlift, what would your coaching approach be and why?
- Seeing that coaching should emphasise more on individual ability, on what basis would you coach a LBBT?

CONCLUSION

This study has shown that a majority of cricket coaches teach what is advocated in cricket coaching manuals. This study also showed that cricket coaches mostly teach the SBBT as opposed to the LBBT at various levels of cricket ability. It has been highlighted that some experience is generally required if coaching a player to lift the bat beyond second slip or as a LBBT. Future research is therefore needed to develop tools and updated coaching recommendations to assist coaches in coaching the backlift at all levels. Further qualitative research is required in order to evaluate the teachings of cricket coaches for other elements of the batting technique (grip, stance, downswing, impact with the ball and follow through). The findings from this research study suggests that all various coaching cricket bodies worldwide should meet in order to link the science and coaching of the BBT. This would allow for coaches to be clear and consistent on the coaching of batting techniques (specifically on the BBT) among cricketers at all levels.

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6

A NOVEL COACHING CRICKET BAT: CAN IT BE USED TO ENHANCE THE BACKLIFT AND PERFORMANCE OF JUNIOR CRICKET BATSMEN? A PILOT STUDY.

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ABSTRACT

Background

In the current literature, it is questionable whether cricket bats in their current form and dimensions allow a young cricketer to hit the ball effectively. The aim of this study was to test the effectiveness of a novel coaching cricket bat among junior cricket batsmen with regards to enhancing performance and the direction of the backlift.

Methodology

A cross-sectional research study with analytical research methods was employed, in which two groups (coached: n = 12 (n = 6: Experimental and n = 6: Control) and un-coached: n = 35) of participants (ages 9 – 13) took part in both a pilot and intervention study. Participants were required to use a novel coaching cricket bat in a coaching game format. Biomechanical and video analysis was conducted in both the frontal and lateral planes. A Student T-test (pilot group) and a Two-Way Analysis of Variance (ANOVA), Chi-squared test and effect sizes (intervention group) were performed. These analyses were performed using R at a significance level of $\alpha = 0.05$.

Results and Discussion

Pilot study results demonstrated that participants scored an additional 100 runs when utilising the coaching cricket bat compared to a conventional cricket bat ($p = 0.003$). Six weeks post intervention (training with the coaching cricket bat), the experimental group displayed improved performance (*ES* = 5.41). Players' backlifts had subsequently become more lateral which may have promoted more effective ball striking as a result of this training effect.

Conclusion

The recommendation from this study is that coaches should encourage young cricketers to use the coaching cricket bat as it is perceived to be a potentially significant training aid for enhancing their performance and the direction of their backlift when they utilise conventional cricket bats in match play.

Key words: Cricket batting, junior cricket, coaching cricket bat, batting backlift techniques, performance, coaching

INTRODUCTION

Technique forms a key component in cricket and enhancing the understanding of cricket batting biomechanics, skill acquisition and assisting cricket coaches to develop efficient batting skill development programmes is imperative (Portus & Farrow, 2011). According to Portus *et al.,* (2011), coaches constantly find difficulty with designing the most effective batting skill practice structures or programmes. In addition, there is limited empirical evidence currently existing to assist coaches to develop an evidence-based approach. However, according to the literature, there are still certain issues where educated guesses are advocated as the best method a sport scientist can offer (Portus & Farrow, 2011).

Addressing the role of variability in sports skills and their implications for coaching is paramount (Barlett, 2000). Increased attention to the normalisaton of performance indicators to aid coaches must be administered. The study by Bartlett (2000) also informs future researchers that further development of coaching tools by performance analysts is a high priority in moving forward to benefit coaches.

In light of the above, and as outlined in Chapter 5, it is particularly challenging for most coaches to coach a backlift in the lateral direction or as a looped technique. To date, there are no studies that evaluate the performance outcomes of different batting backlift technique types among junior cricket batsmen. Furthermore, though the backlift has shown to be a contributing factor to successful batsmanship (the LBBT best perfected by Sir Donald Bradman and other great batsmen from the past), there is currently no evidence showing which backlift technique type promotes better run scoring and performance.

As such, a novel coaching cricket bat was conceptualised that has weight on either sides towards the distal end of the bat which also weighs significantly less than a normal cricket bat for junior cricketers. Although there is a wider surface area, the weight and angular momentum of the bat upon pick up also allows a player to lift the bat in a lateral direction (Stretch *et al.,* 2005). This may assist a young cricketer to lift their bat wider than second slip with an open face of the bat before making impact with the ball. The conceptualisation of the dimensions of the bat originated from combining a cricket bat and tennis racquet into one model (Figure 6.1). The coaching cricket bat has been conceptualised, designed, manufactured and has been patented in South Africa and the United Kingdom (Design Registration number: F2013/01526, updated cricket bat, class 21, part F) (Appendix D).

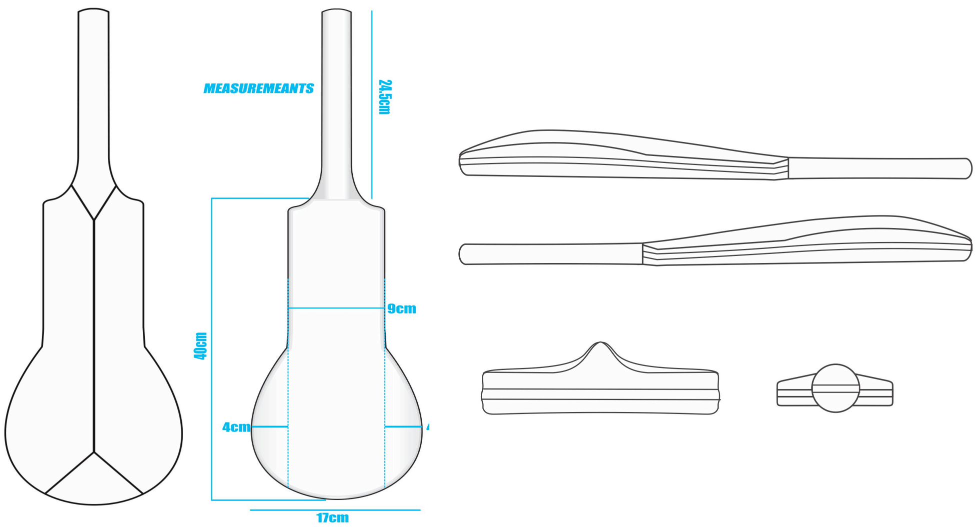


Figure 6.1: The coaching cricket bat in the frontal, rear, side-on and aerial views

Research Aims

There is presently no evidence that a cricket bat in its current form and dimensions allows a young cricketer to train effectively so that he or she can hit the ball with more power and efficient timing in a match situation. There has been limited investigation into improving the performance of batting among junior cricketers in the form of a revised or newly conceptualised coaching cricket bat. Therefore, the purpose of this study was to test the effectiveness of the novel coaching cricket bat among junior cricket batsmen. We wished to test the hypothesis that this novel coaching cricket bat would enhance their performance and influence the direction of the batting backlift technique.

Hypothesis

We hypothesised that there would be alterations in the backlift technique of cricketers who use the novel coaching cricket bat for more than four weeks.

METHODOLOGY

Research Design

A cross-sectional research study was employed where both observational and analytical research methods were utilised. This study contained two components, a pilot study as well as an intervention study.

Participants

The coaching cricket bat was tested among young male and female uncoached participants (n = 35), ages 10 – 13 years old, prior to the intervention in the Western Cape, South Africa. Players who participated in the intervention study were young male junior cricketers (n = 12), ages 9 – 10 years old also from the same study setting.

Defining batsmen in this study (pilot and intervention groups)

All players in this study that were recruited and analysed were defined as batsmen. All players in the intervention group were habituated with their respective bats prior to the start.

Ethical Considerations

Information leaflets were distributed to participants and informed consent forms as well as child assent forms were obtained from the participants and their parents prior to their participation in the study. Ethical approval for the study was granted by the Human Research Ethics Committee of the University of Cape Town (HREC: 586/2014 and HREC: 327/2015). This research study conforms to the World Medical Association Declaration of Helsinki on Ethical Principles for Research Involving Human Subjects.

Study Procedure

The pilot study

The purpose of the pilot study was to validate the use of the coaching cricket bat and to verify the response rate from players while playing with the bat. This was done by comparing it to a conventional (normal) bat as well as to document how players respond to the coaching cricket bat in a match situation. A conventional cricket bat was used first before the coaching cricket bat. Three balls per bat were bowled in order to attenuate the three varied lengths in cricket (short, back of a length and full). As such, six balls were bowled to each player (three balls facing a normal cricket bat and three balls facing the coaching cricket bat with varied lengths of deliveries) facing the same bowler (Figure 6.2). The researchers had considered the use of the bowling machine to ensure standardisation during the study. However, the objective of the study was to mimic a match situation and environment where the same player had bowled to the batsmen. In the event where the ball had not been delivered at the desired length or line, the bowler was asked to re-bowl the ball.

a) Normal Bat **b) Coaching Cricket Bat**

Figure 6.2: Uncoached player using both the normal bat (a) or coaching cricket bat (b)

The normal bat used in the pilot study weighed 900 grams and the coaching cricket bat weighing in at 575 grams. In the intervention group, the coaching cricket bat was the same and weighed 575 grams and the weight range of the conventional bats used by each player was between 850 and 950 grams.

In addition, one ball per length delivery was used in order to measure the instinctive response from the player. Facing a second or third ball of the same length delivery might have allowed the player to get used to the ball thrown, hence six deliveries was deemed to be effective for the pilot study. Deliveries between the coaching and conventional cricket bats were not permutated, allowing for the measures and responses from participants to be consistent and accurate. The pilot study was performed in a day, which took approximately three hours on the field including a warm-up for all of the 35 participants prior to the session.

The pilot study had also shown that the coaching cricket bat was more suited to junior players aged 9 – 11. This subsequently made the researchers choose players within these age groups for the intervention group. Seeing that the pilot study was only done during one match of cricket, the comparison of runs scored between the two bats used by each player is solely an indication of how the bat could possibly work in an intervention scenario over a longer time period (i.e. six weeks).

The intervention study

Seven months after the pilot study, further research was conducted utilising an intervention of six weeks among young players coached the traditional way, whereby they were previously taught to lift their bats in the direction of the wicket-keeper or first slip. Young coached cricket players (n = 12) were recruited, ages 9 – 10 years old. A randomised-controlled study design was administered whereby the groups of cricket players randomly obtained a number from a hat and were subsequently required to train and play within that group, either in the control or experimental group. There was no randomisation in the pilot study and the players from this group belonged to the same cricket club. Randomisation had taken place in the intervention group in which the players had played for the same school but for different teams within the school of the same age group.

Players attended all sessions during the intervention. The experimental group was required to train daily utilising the coaching cricket bats whereas the control group was required to train daily with their normal bats. Players from both groups were asked to hold their respective bat with both hands and hit the ball against the wall continuously with a ‘looped’ technique (Figure 6.3). Tennis players train in a similar fashion hitting the ball against the wall. Donald Bradman used to hit the ball against a circular surface in his back yard with a stump. This was the motivation for allowing players to train in a similar scenario using their respective cricket bats and hitting the ball against a wall.

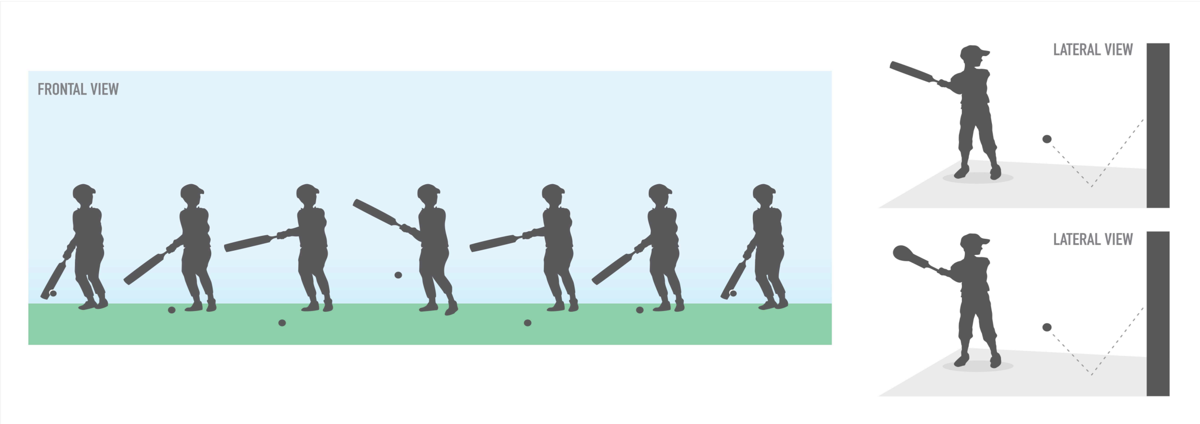


Figure 6.3: Players hitting the ball against the wall continuously with a 'looped' technique

Parents and coaches were asked to assist in reminding the participants to practice with their required bat for the six-week period, whether it was at home or in formal practice structures such as the nets or field. In addition, cricket coaches were assigned three days a week to ensure the training was conducted with the players' required bat during formal practice structures. Upon receiving feedback, parents and coaches had also reassured us that the participants had trained with their required bat on a daily basis. Coaches had conducted warm-up sessions before practices for the six-week intervention. Both static and dynamic stretches were conducted as well as fitness-related warm-up exercises such as interval running and field jogging.

During the pre-match (week 1) and post-match (week 6), the two groups played a mini-cricket game against each other on the cricket grounds in the form of a cricket coaching game at a suitable time for both parents of the participants and the researcher. Each batsman faced six balls each and faced the same bowler at both pre-match and post-match stages. Warm up sessions were provided before both the pre and post-match sessions. Players were encouraged to score as many runs as possible within the six balls and thereafter both team scores were calculated and compared to each other.

We considered blinding players to the bats that they were going to use. However, this was not possible as the players using the coaching bat would have been able to identify the difference from the standard cricket bat. It could be argued that players in the pilot study group may have had an increase in confidence that resulted in better performance. However, in the intervention study, players in the experimental group had used the coaching bat daily for six weeks, which implies that it was not necessarily just an increase in their confidence.

Description of the cricket coaching game

The cricket coaching game has been conceptualised and designed in order to improve the batting performance of young cricketers. Instead of the usual circular boundary in cricket, the game consists of a semi-circle in which players can only score runs in front of the wicket/square. This was to motivate players to hit the ball in front of square (Figure 6.4).

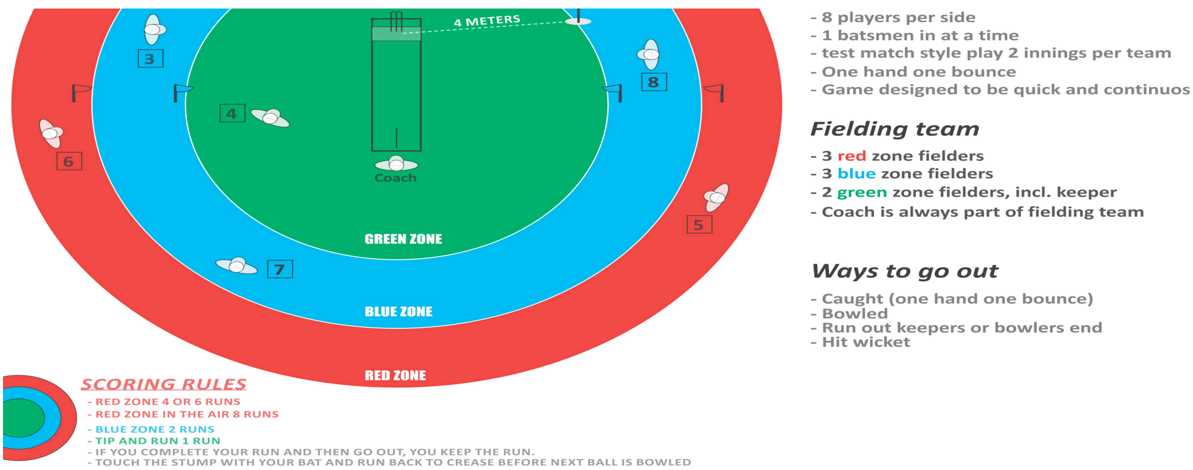


Figure 6.4: A visual description of the cricket coaching game

Biomechanical and Video Analysis

Biomechanical and video analyses were performed on both participant groups. This analysis 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.

Canon LEGRIA HF R506 HD Camcorder™ video cameras was used to capture video footage of the players and attached to a laptop computer. An external hard drive from the video camera was inserted into the laptop for further usage of the software. Conventional cones used for training was set out and placed (at each of the three legs of the tripod stand) to control for accurate camera distances between the camera and participants as well as the angles for video recording. The frontal camera was situated 22 yards in front of the participant (due to pitch length at junior cricket level being roughly 22 yards) and the lateral camera was also situated 22 yards perpendicular to the batsman at a 90° angle to the frontal camera in order to ascertain accurate camera distances. (Figure 6.5).

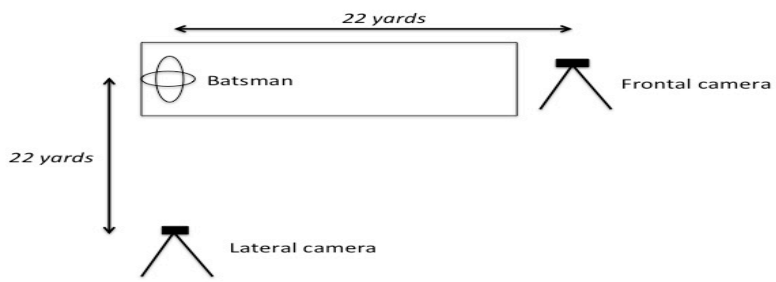


Figure 6.5: Camera setup for the intervention study in frontal and lateral views

The classifiers used and the analysis was performed similarly to other studies (Stuelcken *et al.,* 2005; Noorbhai & Noakes, 2016a) as well as the previous chapters in the thesis.

Quantitative Data Analysis

For the pilot study, a Student's T-test was used to determine whether there was a difference in average runs scored by cricketers in the three age groups when using a normal and the coaching bat. For the intervention study, a Two-Way Analysis of Variance (ANOVA) was used to determine whether the average number of runs scored pre- and post-match differed for control and experimental groups. A Chi-squared test was also performed to determine whether the classifier allocation among the cricketers in the experimental group differed between pre- and post-match samples. These analyses were performed using R (R Core Team, 2014) at a significance level of $\alpha = 0.05$. Cohen's d effect sizes were calculated using STATISTICA 11 (Cohen, 1977) to determine the effectiveness of both groups between the pre and post-match in the intervention group. According to Sullivan & Feinn (2012), medium and large effect sizes are more than 0.5 and 0.8 respectively. As such, the level of significance for medium and large effect sizes for this study was set at $ES > 0.5$ and $ES > 0.8$.

RESULTS

Batting performance

In the pilot study, participants scored 100 runs more with the coaching cricket bat (105 balls, 308,5% strike rate) than with the normal bat (105 balls, 213.3% strike rate) ($p = 0.003$) (Table 6.1). In cricket, a strike rate is defined for a batsman as the average number of runs scored per 100 balls faced. Similar to the findings of Chapter 4, a vast majority of the uncoached cricketers (80%; $n = 28$) in the pilot study were also shown to have a LBBT (Noorbhai & Noakes, 2016b).

Table 6.1: Average (± Std error) runs per cricketer and total runs overall in three groups of uncoached cricketers during the pilot study.

Age group (Gender)	N	Normal bat		Coaching bat	
		Average runs per cricketer (± Std error)	Total runs overall	Average runs per cricketer (± Std error)	Total runs overall
U11 (Boys)	11	6.18 ± 1.39	68	9.09 ± 1.36	100
U12 (Boys)	12	6.67 ± 1.31	80	9.33 ± 1.11	112
U12 – 13 (Girls)	12	6.33 ± 1.43	76	9.33 ± 1.48	112
Total	**35**	**6.39 ± 0.78***	**224**	**9.27 ± 0.75***	**324**

** Statistical significance at α = 0.05*

There was no difference in the total number of runs scored by cricketers across the three age groups (F = 0.036, df = 2, p = 0.97). However, cricketers using the coaching bat scored approximately 1 more run per ball or an average of approximately three more runs in total when using the coaching bat than the normal bat (F = 6.70, df = 1, p = 0.012) (Table 6.1). This effect did not differ across age groups (F = 0.008, df = 2, p = 0.99) (Table 6.1).

In the intervention study, the experimental group scored double the total number of runs (an additional 16 runs) and an average of approximately 3 more runs per player in the post-match than in the pre-match, which showed a large effect (*ES* = 5.41) (t = 3.32, df = 5, p = 0.021) (Table 6.2). In the control group, there was no significant difference in the average number of runs scored per player in the pre- and post-matches (t = 0.35, df = 5, p = 0.74) (Table 6.2).

Table 6.2: Total number of runs and classifier of the backlift scored before and after the 6-week intervention among coached cricketers

Control group				**Experiment group**			
Player	Runs (*Classifier*)		ES	Player	Runs (*Classifier*)		ES
	Pre-match	Post-match			Pre-match	Post-match	
A1	10 (*1*)	10 (*1*)	0	B1	3 (*1*)	8 (*3*)	1,69**
A2	4 (*1*)	5 (*1*)	0,33	B2	0 (*3*)	4 (*3*)	1,35**
A3	1 (*1*)	0 (*1*)	-0,33	B3	4 (*2*)	4 (*3*)	0
A4	0 (*3*)	1 (*3*)	0,33	B4	4 (*2*)	5 (*3*)	0,33
A5	4 (*1*)	4 (*1*)	0	B5	0 (*2*)	2 (*3*)	0,67*
A6	2 (*1*)	0 (*1*)	-0,67	B6	4 (*3*)	8 (*3*)	1,35**
Total	**21**	**20**	-0,33	**Total**	**15**	**31**	5,41**
Average (± Std Err)	**3.50 ± 1.46**	**3.33 ± 1.59**		**Average (± Std Err)**	**2.50 ± 0.81**	**5.17 ± 0.98**	

ES = Effect Size; ES > 0.5 ES > 0.8***

Direction of the backlift

In the intervention study, the participants' backlift in the control group remained fairly straight when comparing pre vs. post-match measures (Appendix E6 Table 6.4). In the transverse plane (Appendix E6 Table 6.6), most of the participants' bat face was closed or in the direction of the wicket-keeper and/or the stumps. Within the experimental group, the participants' backlift had subsequently become more lateral when comparing the pre-match to the post-match (χ^2 = 6.00, df = 2, p = 0.049) (Appendix E6 Tables 6.2 and 6.5). In the transverse plane, most of the participants' face of the bat was open facing towards the off-side (Appendix E6 Table 6.7).

DISCUSSION

The main findings of this study showed that the novel coaching cricket bat might be a promising training aid that can be used to train young cricket batsmen (ages 5 – 11) in order to develop the potential for striking the ball with power and timing. Another finding of this study has also shown that the coaching cricket bat may have a positive effect on the backlift used by young cricketers. In addition, the training drill of hitting the ball against the wall with the coaching cricket bat may also have had a likely positive effect on the backlift of young cricketers.

Since the weight and angular momentum of the bat upon pick up allows a player to lift the bat in a lateral direction, it also assists a young cricketer to lift their bat wider than second slip with an open face of the bat before making impact with the ball. In addition to the physical characteristics of the bat, the grip of the bat also has a wider circumference than normal cricket bats that make it easier for players to place their hands comfortably on the bat and grip the bat. A fundamental question is: what impact would coaching have had during the intervention on batting performance in the experimental group, specifically on the hand position? This would entirely depend if the coach emphasised other elements of the batting technique aside from what the participants were required to execute as described in the methodology section.

There is currently no recommendation on how to technically coach a backlift. Therefore, coaching during the intervention might have hindered the batting performance in the experimental group. It is advised that young players use the coaching cricket bat solely in training to acquaint themselves with the bat. In addition, hitting the ball against a wall with the coaching cricket bat may also assist in habituating players prior to training with the bat.

Despite the fact that the coaching cricket bat can assist in performing a more lateral backlift, the hand position in this study was not measured. However, one could argue that in order to open the face of the bat, the bottom hand grip of the player would be more open which would allow for the player to loop the bat, open the face of the bat and execute a particular batting stroke. Future studies are recommended in this area, specifically on the association of the grip and the batting backlift technique in cricket.

Physical characteristics of the coaching cricket bat and other cricket bats

Another reason for players hitting the ball more effectively could be due to the weight component and dimensions of the coaching cricket bat, which allows for a superior magnitude of displacement and angular velocity upon execution of the shot (Stretch *et al.,* 2005). A common argument for the model of the coaching cricket bat is that it would be easier for a player to hit the ball due to the wider surface area.

Although there is a wider surface area, the weight and angular momentum of the bat upon pick up also allows a player to lift the bat in a lateral direction. This may assist a young cricketer to lift their bat wider than second slip with an open face of the bat before making impact with the ball (Figure 6.1).

In conjunction with the weight component, Stretch *et al.*, (2005) conducted a study to compare the rebound characteristics of wooden and composite cricket bats. The study showed that the rebound characteristics of the composite bats were significantly less than the traditionally designed English willow wooden bats (Stretch *et al.,* 2005). In addition, a composite bat does not enhance performance by allowing the batsman to hit the ball harder, assuming all other factors, such as bat speed, mass distribution and the impact point are equal. Our coaching cricket bat is made from a resin composite material, giving it a lighter weight than the normal bat. Yet junior cricketers were able to score more runs than with the normal bat, and were able to develop a more LBBT after a few weeks. This might suggest that the weight of the coaching cricket bat (and not merely the design) is a key precursor for why young players are able to effectively hit the ball.

With similar dimensions and weight characteristics, aluminium and wooden bats have similar static balance and resistance to rotary motion (Elliot & Ackland, 1982). The fundamental question here is: why would one want to resist the rotary motion of a bat when previous studies have shown that a majority of successful batsmen used a lateral backlift or a 'looped/rotary' motion? (Noorbhai & Noakes, 2016a). Aluminium bats have significantly larger reaction impulses at all impact sites compared to wooden bats. In addition, senior cricketers recorded significantly greater rebound values at three of the four impact locations when using an aluminium bat. Junior wooden bats had superior rebound values to the aluminium bats in two of the four impact sites (Elliot & Ackland, 1982). Therefore, it is evident that the composition, dimensions and weight of cricket bats may have a significant effect on a batsman. Specifically, with young cricket players, the coaching cricket bat may be an effective tool to specifically assist in the backlift and performance.

What are the new findings?

- The coaching cricket bat might be a promising training aid to train young cricket batsmen (ages 5 – 11) for striking the ball with power and timing.
- The coaching cricket bat, together with the training drill of hitting the ball against the wall may have a positive effect on the direction of the backlift of young cricketers and may also serve as a promising training tool if used for a minimum of four weeks.
- Due to its weight component and dimensions, the coaching cricket bat may assist the young cricketer in formulating a lateral backlift, which can potentially enhance batting performance in the long-term.

How might it impact on coaching practice in the near future?

- Batting training against a wall might assist young cricketers to adopt a more looped batting technique whereas the coaching cricket bat may produce potential improvement of batting performance over a longer period.
- Coaches might encourage young cricketers to use the coaching cricket bat as it is perceived to be a potentially significant training aid for enhancing their batting performance and backlift when they utilise conventional cricket bats in matches.
- Since a training effect can only be produced among players over a longer period and also bearing in mind that variances of learning abilities exist between individuals, the

coaching cricket bat might have positive effects among young cricket players in terms of adapting their performance and change in batting technique.

Training effects of the coaching cricket bat

The key questions in which most coaches would be concerned about regarding the coaching cricket bat are:

a) How can you ascertain that the LBBT will work for every player from a young age?
b) How can you ascertain that the coaching cricket bat will provide the desired training effect to the young player for having an open face of the bat and lateral backlift after training for a minimum of four weeks?

One could use an analogy for driving to answer these vital questions: most people would take a driver's test, get their license, but not all drivers will drive the same. Similarly, all players will respond differently to the coaching cricket bat and the training involved. Individuality is essential to effective training (Norris & Smith, 2002) and the coaching cricket bat will possibly reduce the passivity of players and make them more assertive at hitting the ball.

The use of the coaching cricket bat aligned with the LTAD model

There are critical periods during ones life in which the effects of training can be maximised for sports. Long-term training is required for optimal development in order to produce elite athletes (Balyi, 2001). The Long-Term Athlete Development (LTAD) model is one such training guide that facilitates the process of talent identification and development. It can be described as the appropriate training aimed at developing athletes in general rather than identifying talent at an early phase.

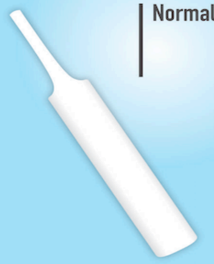
PHASE	AGE (YEARS)	DESCRIPTION	BAT USED
Training to Win	18+	Players should continue using a conventional bat during both training and matches.	 Normal Bat
Training to Compete	15–21	Players should now start using a conventional bat during both training & matches.	
Training to Train	12–15	Training with the coaching cricket bat during training and using a conventional bat during matches.	 Adapted – longer length and less surface area at distal end
Learning to Train	9–12	Learning the batting backlift technique with the coaching cricket bat (longer length and less surface area at the distal end of the bat).	
FUNdamentals	6–9	Fun and participation with the coaching cricket bat. Emphasis should be drawn towards motor control, learning and enjoyment. There is an average length and wider surface area at the distal end of the bat.	 Original Coaching Bat
ACTIVE START	0–6		

Figure 6.6: The use of the coaching cricket bat aligned with the long-term athlete development (LTAD) model

Though it has come under scrutiny (Ford *et al.,* 2001; Greyson *et al.,* 2010), the strength of the model lies in the fact that it takes the whole athlete's life into consideration with specific attention to stages of development (Balyi, 2001). As such, the use of the coaching cricket bat can also be aligned with this LTAD model (Figure 6.6).

Cricket as a team sport is categorised as a late specialisation sport which requires a five-stage model (retirement and retainment omitted from the Figure above) but the model does not take into consideration a developing country context (socio-economic disparities related to physical fitness) such as South Africa (Armstrong *et al.,* 2011). Therefore, several sporting bodies have developed their own sport-specific LTAD models to meet the demands of cricket in their own settings such as Cricket South Africa (CSA, 2011).

What all authors and each model assimilate towards is that the ages of nine to twelve are crucial for motor development in children known as the 'golden age of learning' (Balyi & Hamilton, 1995; Viru *et al.,* 1998). Children are developmentally ready to be introduced to long-term sport-specific technical skills (Sellers, 2014; Balyi, 2001) such as batting. Taliep *et al.,* (2015) further suggests that this early adolescence phase might be an important training window for skill acquisition for batting in cricket. Whilst not all players will become elite batters, at this stage children are encouraged to develop cricket specific skills. Should this not happen then children run the risk of missing out on the window of opportunity and they will never reach their full potential as a successful cricket player (Balyi, 2001).

As a young player goes through the growth and development stages, the coaching cricket bat can be incorporated into the various LTAD stages. The length of the coaching cricket bat and the surface area of the bat towards the distal end can be adapted to facilitate adequate improvements through a long-term process to develop young cricketers.

Future examinations investigating the kinematics of batting against trials of different speeds, different locations of ball-bounce and different lengths of cricket bats may be useful in determining how information can be used by batsmen to initiate bat downswing and ensure effective timing. Furthermore, an examination of the kinematic movements of batsmen in response to alterations in the mass and length of the bat may help to better understand the specific sources of information used to derive time-to-contact information to initiate bat downswing (Sarpeshkar *et al.,* 2011).

Strengths and limitations

The strength of this study was the ability to capture videos for both groups of participants analysing six various ball deliveries for each participant and performing analyses in both the frontal and transverse planes. Another strength of this study was that each group of participants played in the same environment and in the same month, which limited a seasonal effect. Biomechanical and video analysis of the players was also obtained objectively and was not self-reported. The main limitation of this study was the sample number in the intervention study group. Initially, 20 participants had been recruited and closer to the time, eight participants had dropped out. However, the researchers had accounted for recruiting 20 participants in case of such a dropout where more than 10 participants would still have been available for accurate and reliable analyses. In addition, the pilot group (n = 35) supported the sample number of the intervention cohort (n = 12). Another limitation of the study was that the experimental bat (the coaching bat) was used after the conventional bat in both the pilot and intervention studies. Participants may have inferred a learning effect after using the conventional bat first.

CONCLUSION

The coaching cricket bat may be a promising training aid to train young cricket batsmen (ages 5 - 11) in order to develop the potential for striking the ball with power and timing. The coaching cricket bat, together with the training drill of hitting the ball against the wall may have a positive effect on the batting backlift used by young cricketers, particularly if used for a minimum of four weeks. However, further research needs to be conducted with the coaching cricket bat over a long-term period (a cricket season) among young cricket players to contribute towards a conclusive finding.

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7

THE USE OF A MOBILE APPLICATION TO ANALYSE THE BATTING BACKLIFT TECHNIQUE IN CRICKET

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ABSTRACT

Background

The introduction of digital technology has revolutionised sports. This has occurred both in general sports and with high performance sports in which digital technology combined with science and medicine can improve professional sport through the application of performance analysis. No study has yet been conceptualised to design a mobile application to analyse and improve the batting technique of cricket batsmen, especially by analysing the batting backlift technique (BBT) in cricket.

Design and Methods

The Backlift In Cricket Software System (BICSS) was divided into two components: a frontal view interface and a lateral view interface. Android Open Computer Vision (CV) and JavaScript was used for this particular project as they are both well documented and supported by a software development platform called Qt 5.3. A trial was conducted among previously analysed coached cricketers (n = 30) utilising existing video footage and comparing the methods of analysing the cricketers using the Kinovea™ software and the Backlift In Cricket Mobile Application (BICMA). A Pearson's correlation coefficient (r) was performed to measure the strength of the association between two samples. All analyses were conducted using R at a significance level of $\alpha = 0.05$.

Results and Discussion

The results obtained had clearly matched the results form the previous study in terms of the batting backlift technique type (BBTT). The results from the BICMA show that a vast majority of the cohort (73%) employed a straight batting backlift technique (SBBT). This is consistent with the previous study, in which the batsmen were analysed traditionally utilising video cameras and analysis on a laptop computer.

Practical implications

The use of the BICMA can be used to evaluate the backlift type of any batsman. The development of the BICMA is the first mobile application that can record and analyse the backlift of a batsman through a Smartphone without the need for connectivity from parent software on computers.

Key words: Mobile application, performance analysis, batting backlift technique, cricket

INTRODUCTION

According to both the scientific and coaching literature, the backlift is a key element of the overall batting technique, and more emphasis should be placed on the analysis of the backlift of players, especially at the junior levels (Noorbhai & Noakes, 2015; Noorbhai & Noakes, 2016a; Woolmer, Noakes, & Moffett, 2009). One can argue that this fact has been neglected due to the tedious process of accurately analysing certain techniques in sport. The use of digital and mobile technology has therefore filled this void and has been proven to be valuable in assisting scientists and coaches in analysing performances of their players (Soomro, Noorbhai, & Sanders 2015; Xu, Cheng & Zhang, 2009).

The use of digital technology for analysis and improvement in sport

The introduction of technology has revolutionised sports in general and high performance sports which have combined technology with science and medicine and changed professional sport and its analysis (Soomro, Noorbhai, & Sanders 2015). One particular study validated a mobile application for measuring jump performance and found that height can be easily, accurately and reliably evaluated using a specially developed iPhone 5s app. (Balsalobre-Fernández *et al.,* 2015). Advances in computing, networking, information technology and multimedia technologies have led to a dramatic growth of sports video content and has accelerated the need for analysis and understanding of sports video content. The analysis of this content has been a niche research area and a number of potential applications have been identified (Xu, Cheng, & Zhang 2009).

From a motor control theory perspective, it is well documented that when feedback is provided in an appropriate manner, motor skill acquisition improves significantly

(Sullivan, Kantak, & Burtner 2008; Liebermann, Katz, & Hughes 2002). Consequently, feedback is a major factor in the improvement of sport skill performance. Recently, advances in information technology have made it possible to augment and improve the feedback athletes receive during training and competition (Liebermann, Katz, & Hughes 2002).

From a biomechanics perspective, there have been a handful of mobile applications that have been designed to provide feedback, improve performance and analyse a range of variables such as angular momentum, speed, human movement and joint angles (Noraxon, 1991; Quintic, 1996; Dartfish, 1999). Specifically within the sport of cricket, there are also mobile applications that focus increased attention towards injury prevention, predictions of match outcomes, team analysis and logging of training hours (Soomro, Noorbhai, & Sanders 2015; VcamCricket, 2004; Eagle Eye, 2012; Cricket-21, 2011). However, there are limited applications that address the enhancement and improvement of batting in cricket.

The Backlift in Cricket Mobile Application

To our knowledge, no study or platform has yet been conceptualised to specifically design a mobile application in order to analyse and improve the batting technique of cricket and especially the batting backlift technique (BBT). Therefore, the aim of this chapter was to document the rationale and protocol used for the development of a complimentary smartphone based mobile application known as the Backlift in Cricket Mobile Application (BICMA) designed to analyse, monitor and improve the BBT in cricket. The BICMA was also validated by comparing results to conventionally used means to analyse the backlift.

METHODOLOGY

Biomechanical analysis of the backlift in cricket (frontal and lateral view)

Frontal view analysis

For the purpose of the biomechanical analysis of the backlift, the toe of the bat is defined as the vector orthogonal to the toe of the bat being the pointer (Glazier, Davids, & Bartlett, 2003). This strengthens the validity and reliability of the analysis as the backlift can be readily detected and analysed at different positions and time points in the backlift (Hopkins, 2000).

Drawing a vector is a common approach in defining the toe of the bat to define the direction in which the vector points (Kreighbaum & Bartels, 1996). Lines and vectors were drawn 1) vertically from the head to the hands of the batsman (green line), 2) a line drawn horizontally to show where the hands rest (blue line) and 3) a line drawn obliquely to show the direction of the bat during the backlift (red line) (Figure 7.1). The still photo (which was captured from the video footage and the last frame just before the bowler had released the ball) was analysed. This identified the position of the batsman at the instant of delivery. As described in previous chapters, these lines create an angle to show how far away the bat is from the body in the frontal plane and how much rotation has occurred before the ball is struck with the bat (Noorbhai & Noakes, 2016a, 2016b).

Right-hand batsman *Left-hand batsman*

Figure 7.1: Lines and vectors drawn to depict the angle of the backlift

Lateral view analysis

The direction in which the face of the bat points is a key indicator of what the batsman does just before impact with the ball. Previous analysis of batsmen had shown that batsmen either have an open or closed face of the bat during the backlift and at the start of the downswing (Noorbhai & Noakes, 2016a; Chapter 2). Most batsmen who have a LBBT have an open face of the bat during the backlift whereas virtually all batsmen who have a SBBT have a closed face of the bat during the backlift (Noorbhai & Noakes, 2016a).

The critical indicator in this analysis is the amount of the face of the bat the batsman shows during the backlift at the moment the bowler releases the ball. For the lateral view analysis, a rectangle is used to depict how much of the face of the bat is shown from the off-side (or none). If more than 50% of the face of the bat is shown, it is categorised as an open face of the bat whereas if it is less than 50% of the face of the bat shown, it is categorised as a closed face of the bat.

Software system development

The Backlift In Cricket Software System (BICSS) was divided into two components namely a frontal view interface and a lateral view interface. This relies on client-server architecture with two different view interfaces operating as clients.

Mode of availability of software

The client-side has been built in a manner that can simplify importing it to diverse smartphone operating-systems, with the initial release aimed at the larger Android ecosystem (database version of Android). The server-side of the mobile application was implemented to also be compatible with various server operating systems such as the iPhone Operating System (iOS) and Windows, in order to reduce dependability upon a single technology.

Tools and Languages

Client-side software

A software development platform (Qt 5.3), was chosen to programme the functionality of the client-side software because it is a cross-platform framework. This means that even though the initial release is compatible with Android only, the source code can later be imported to 15 other operating systems with relative ease. It also allows developers to programme software using a range of different programming languages. Android (Android, 2007) Open Computer Vision (CV) and JavaScript were used for this project as they are both well documented and supported by Qt 5.3.

The aforementioned platform and languages simplify the construction of custom-user interfaces, and provide the opportunity to augment user-interface components with high-level logic. The Qt Software Development Kit (SDK) was used to develop the client-side software. The architecture of the system is further described in the next section.

Software Architecture

The software architecture chosen to build the project integrated the two components of the system (Figure 7.2):

- Frontal view interface
- Lateral view interface

User Interface Design

The user interface of the BICMA was designed for ease of use. All interfaces are represented as screenshots on a smartphone device (Figure 7.3). When a user selects the <u>frontal view interface</u>, the batsman would be analysed in the frontal view. Before beginning the video capture, the leads (lines drawn on the BICMA) would need to be set as this is crucial part in the analysis to determine the backlift type. There are three leads for the user to illustrate before beginning the analysis:

1. The vertical orthogonal: the tester draws a line with their finger from the head of the batsman to the batsman's gloves.
2. The horizontal line: a horizontal line drawn at the level of the batsman’s hands.
3. The oblique line drawn from the handle/hands to the top of the bat.

The user can then click ‘set’ and once the video of the batsman has been captured, the user can click ‘analyse’. From here on, the mobile application determines the type of backlift as: (a) The Straight batting backlift technique or, (b) The Lateral batting backlift technique. When a user selects the <u>lateral view interface</u>, determines whether the face of the bat is open or closed (Figure 7.2).

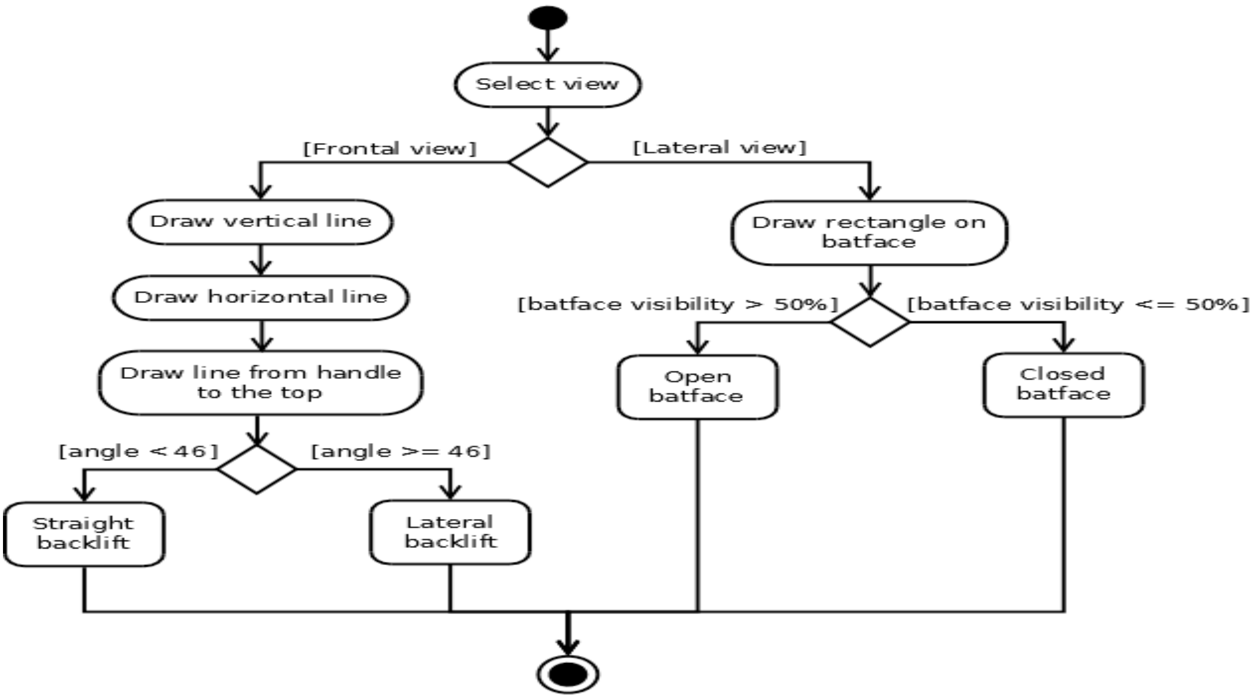

Figure 7.2: A Unified Modelling Language (UML) diagram showing the algorithm that defines the working process of the BICMA

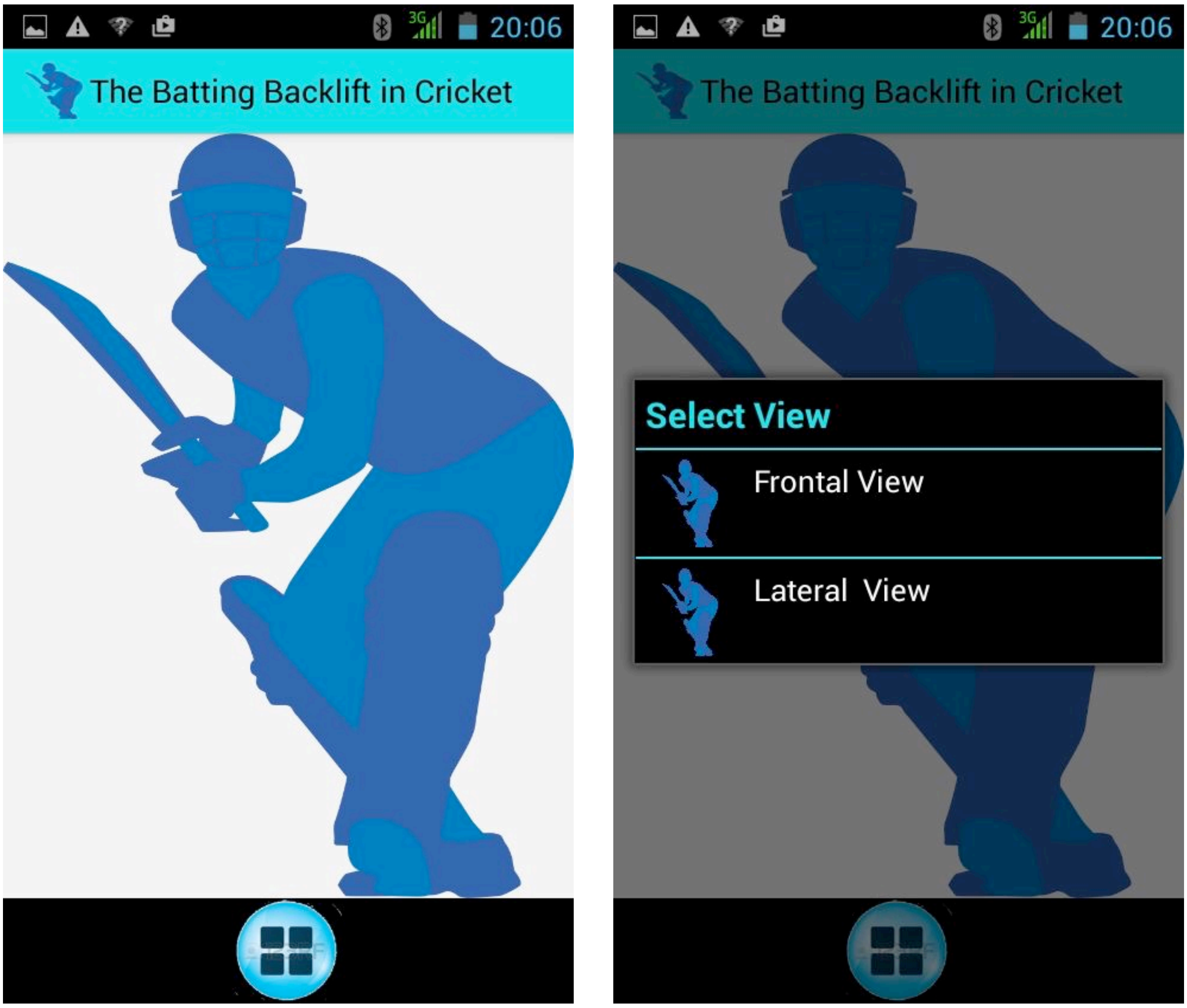

Figure 7.3.1: The home screen of the BICMA

Figure 7.3.1 above displays the 'home screen' of the BICMA. The picture to the right is the first screen that will appear when the users click on the menu button. When users click on the menu button they can either navigate to the frontal or lateral view interfaces.

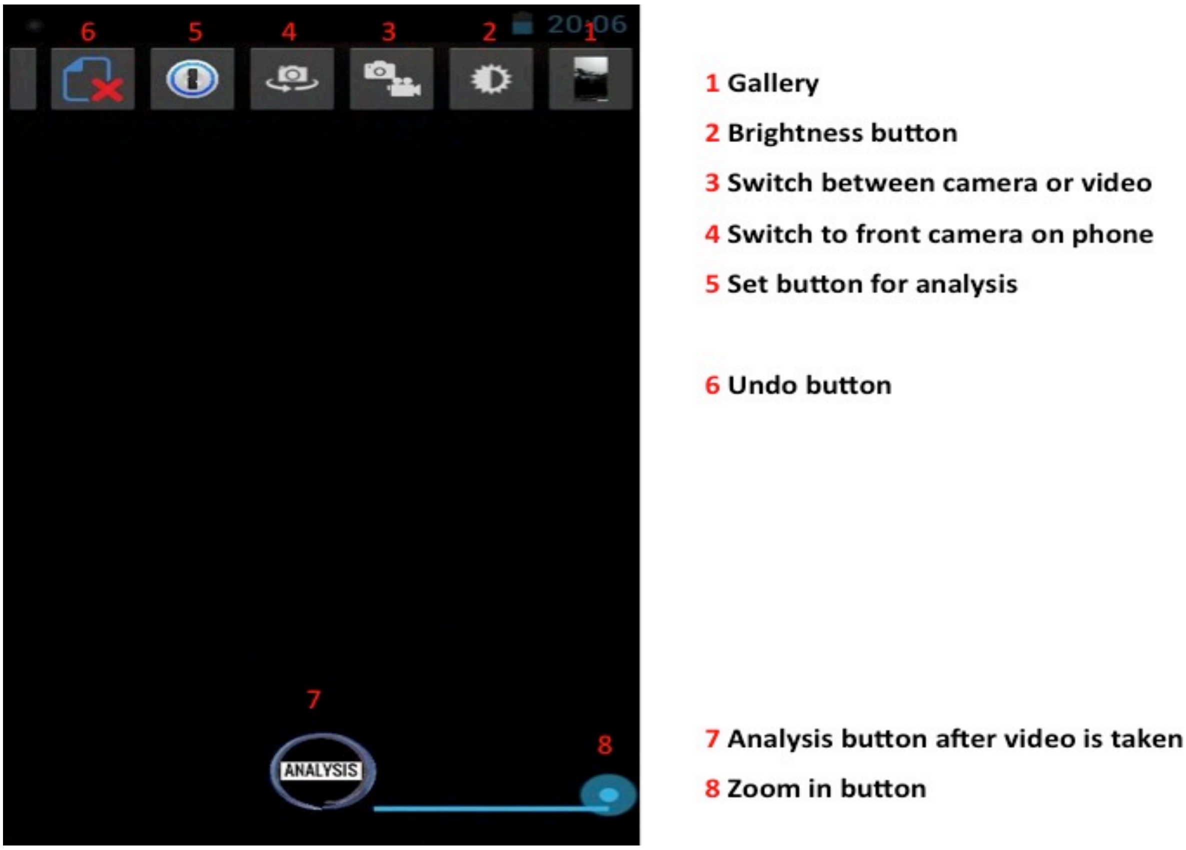

Figure 7.3.2: The Frontal View of the BICMA

Figure 7.3.2 above shows the frontal view screen when users click on the frontal view interface. At the top of the picture, there are six icons (1 = Gallery; 2 = Brightness button; 3 = Switch between camera or video; 4 = Switch to front camera on phone; 5 = Set button for analysis; 6 = Undo button). Users can click on ‘1’ to view their videos or photos taken from the BICMA and store it in their phone’s gallery. Users can also click on buttons (2 - 6) to adjust the brightness, switch between camera or video interfaces, switch to the front or back camera on the phone, set the button for analysis after the leads have been drawn and there is an undo button if the leads have been drawn inaccurately. Icon 7 (allows the user to analyse the backlift after video is taken) and 8 (to adjust the zoom on the video or picture) are situated at the bottom of the picture.

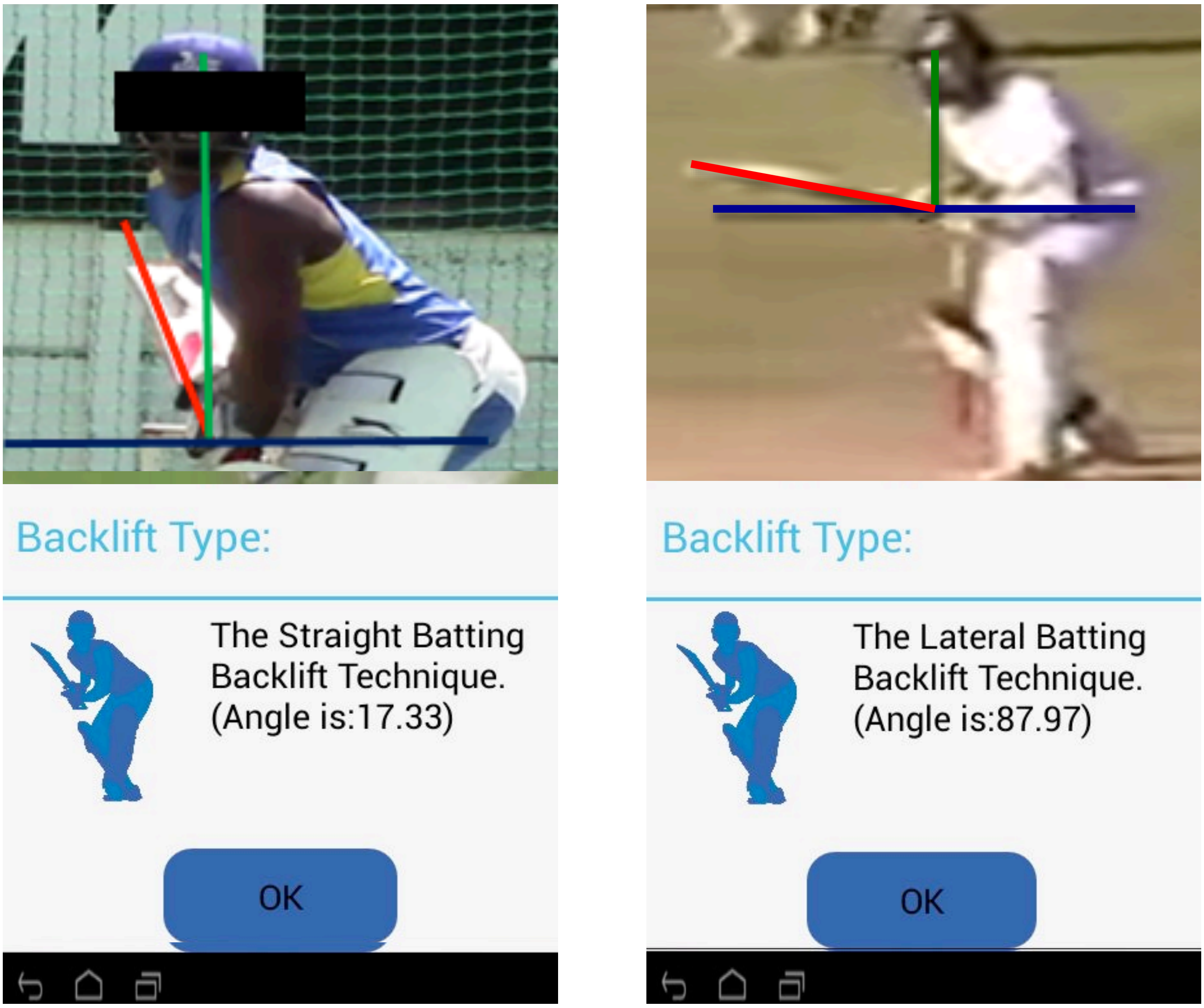

Figure 7.3.3: Analysis in the frontal view

Figure 7.3.3 shows an example of the analysis of the direction of the backlift in the frontal plane. After the user draws the three leads on the batsman and analyses the video footage, the user can then select the 'set' button (analyse button – icon 7 from Figure 7.3.2) and the BICMA will then indicate whether a batsman has a SBBT or LBBT with the exact angle.

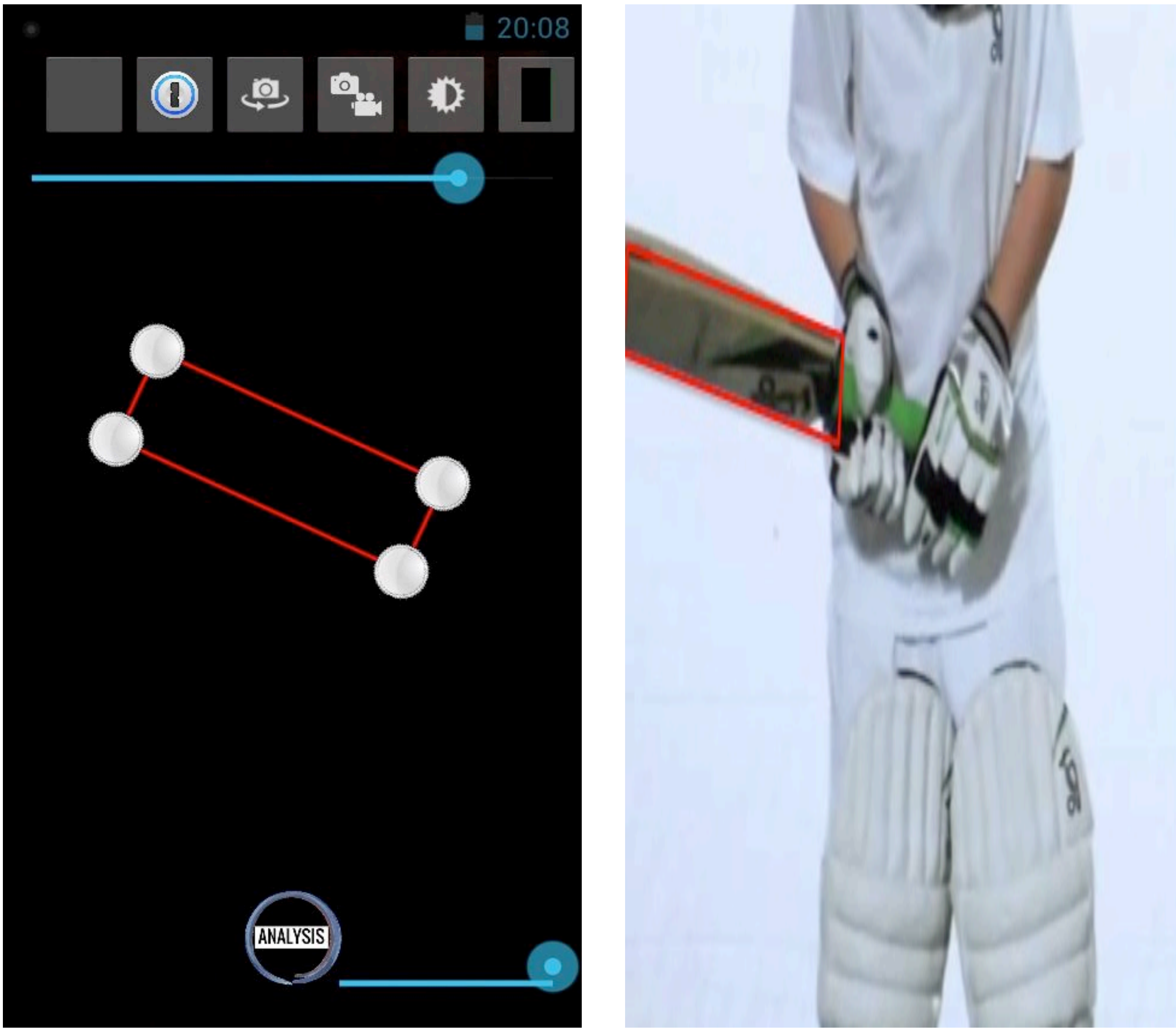

Figure 7.3.4: Analysis in the lateral view

Similarly to Figure 7.3.3, Figure 7.3.4 shows an example of the analysis of the direction of the face of the bat in the lateral/transverse plane. The above picture illustrates the rectangle that the user can draw to fit the face of the batsman after the video is taken.

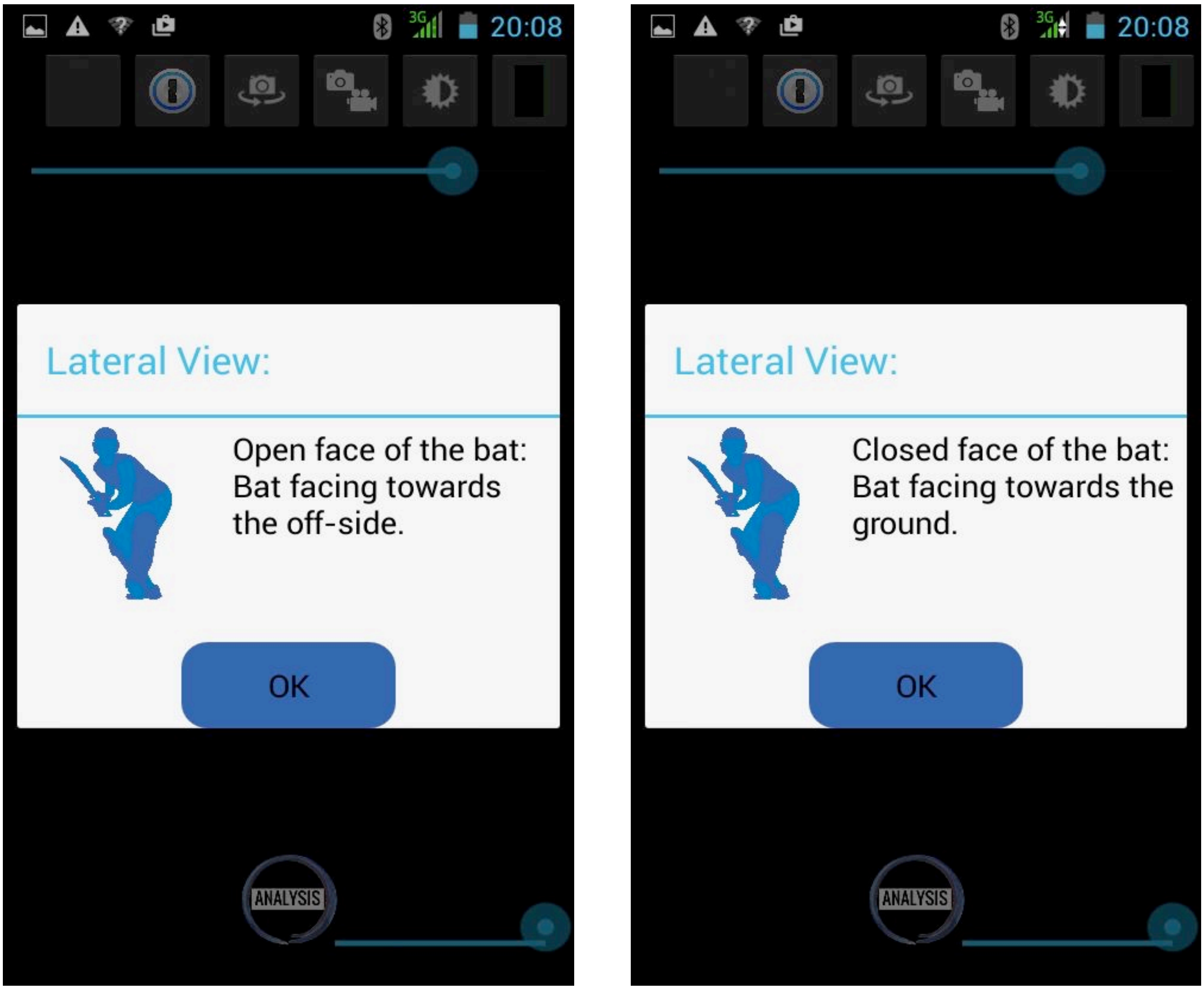

Figure 7.3.5: An illustration of the Lateral view when users click on the set button

After the user analyses the video footage and draws the rectangle on the batsman's bat, the user can then select the 'set' button (analyse button – icon 7 from Figure 7.3.2) and the BICMA will then indicate whether a batsman has an open or closed face of the bat.

Validating the use of the BICMA for analysis

A trial was conducted among previously analysed coached cricketers (n = 30) (Noorbhai & Noakes, 2016b) utilising existing captured video footage. This was done to determine whether the mobile application was able to replicate the accuracy of results from the analysis conducted in the previous study in which only video analysis was performed. In the previous study analysis was conducted traditionally with the use of two high definition Canon LEGRIA HF R506 HD Camcorder™ video cameras in both the frontal and lateral views. The video footage was then transferred to a laptop computer for analysis utilising the Kinovea™ (Version 0.8.15) software package. In this study, a brief comparison was also conducted between the mobile application and Kinovea™ to determine whether the results had matched or not.

As described in previous chapters, classifiers were utilised to identify the type of batting backlift technique employed by all batsmen. These classifiers were coded as 1 (bat face facing straight back and towards the wicket-keeper or the ground), 2 (bat face facing first or second slip), 3 (bat face towards gully or point). If the bat is directed fairly straight back or towards the slips/gully regions but has an open face of the bat, it is classified as classifier 3. Angle ranges were conceptualized to determine these classifiers (1: between $0^{o} – 25^{o}$), (2: between $25^{o} – 45^{o}$), (3: 46^{o} or more and an open face of bat). Seeing that classifiers provide angle ranges only, it was needed to determine whether the BICMA could also replicate the estimated angle of the backlift.

Data analysis

A Paired Two Sample T-test was performed to determine whether the percentage of cricketers assigned to each classifier in Chapter 4 differed from that determined using the BICMA application. The test returned a Pearson's correlation coefficient (r) that measures the strength of the association between the two samples. All analyses were conducted using R (R Core Team, 2014) at a significance level of $\alpha = 0.05$.

RESULTS

Based on the angle of batting identified by the BICMA application, cricketers were mostly assigned to the same batting classifiers reported in Chapter 4 (Table 7.1), with some discrepancy in the Under-19 age group. The percentage of cricketers assigned to each classifier was not significantly different when using the traditional method (using video cameras and analysis with Kinovea^{TM} software on a laptop computer) and the BICMA application ($r = 0.97$, $df = 8$, $p = 0.50$), with 97% of cricketers assigned to the same classifier between methods.

The average batting angle overall for the coached adolescent cricketers was 33º (± 5.19), which falls into classifier 2 and is a characteristic of the straight batting backlift technique (SBBT). Among all cricketers in the group, the application allocated 73.3% to classifiers 1-2, which matches the 73% of cricketers using the SBBT, as identified in Chapter 4.

Table 7.1: Percentage of coached adolescent cricketers using the LBBT or SBBT, assigned to classifiers 1- 3 using the Kinovea™ software and the BICMA application. Mean estimated angles (± Std error) are those for the cricketers in each age group determined using BICMA.

Adolescents age groups	N	Backlift batting technique (%)		Classifier (%)			Angle identified by application (%)			Mean estimated angle (± Std error)
		LBBT	SBBT	1 (0º – 25º)	2 (26º – 45º)	3 (46º <)	(0º – 25º)	(26º – 45º)	(46º <)	
Under-13	10	30	70	50	30	20	50	30	20	31.2º ± 9.81
Under-15	10	30	70	50	20	30	50	20	30	34.7º ± 8.55
Under-19	10	20	80	60	10	30	50	20	30	33.1º ± 9.50
Total (Overall)	**30**	**27**	**73**	**54**	**20**	**26**	**50**	**23.3**	**26.7**	**33º ± 5.19**

DISCUSSION

In sports training and conditioning sciences, images and video recordings represent one of the most important sources of information and are used for a variety of purposes (Wilson, 2008; van Mechelen *et al.,* 2014). Although computing devices (such as high-speed cameras and slow motion videos) (reviewed by Busca *et al.,* 2016) used in everyday life termed 'Ubiquitous Computing' are frequently used to acquire, analyse and present performance data during training and competition (Baca *et al.,* 2009), smartphones have become increasingly used as a multi-functional device in modern times. It has become an ideal platform that is accessible, useable and affordable for everyone to support a variety of applications in daily life including in the sports domain (Kranz *et al.,* 2013; Busca *et al.,* 2016). It has been noted that the integration of the personal device into the real world has the potential to positively impact on people's lives (Kranz *et al.,* 2013).

We report on the BICMA in this study, which has shown to be a reliable and valid application in analysing the BBT of batsmen when compared to conventionally used methods (as in Chapter 4). Biomechanical and video analysis in cricket can be a tedious process that includes the use of high-cost speed camera equipment, third-party software (license-free (Dartfish©, Kinovea™) or licensed such as Quintic™) and analysis tools (Busca *et al.,* 2016). The BICMA provides ease of access and is inexpensive to scientists, players and cricket coaches to analyse the type of backlift and the direction of the face of the bat in cricket by combining a three-step process (video capturing, transfer to software on laptop and analysing the video footage) into one mobile application.

The use of 'apps' is widely used in fitness and health fields (reviewed by Kranz *et al.,* 2013) but a few exist for simple video analysis in sports. Simple functions of these 'apps' include zooming, angle and line drawings, timing and video comparisons. Examples of these smartphone applications include CoachMyVideo, Dartfish Express, Technique, SloPro, Coach Eye, ICoach View or Shot Coach. These apps make use of the camera on the smartphone device, promote video sharing on social media platforms and according to Busca *et al.,* (2016) 'constitute a useful pocket solution for coaches and athletes in the field'.

As such, our mobile application not only uses the phone's built in camera but allows the captured images to be stored on the phone for later analysis by the player or playback analysis by the coach. It does not however have sharing capability like other 'apps' noted above and rather has been designed for the personal use of coaches and cricket players for their own reflection to enhance their performance for competitive/training purposes.

Our validation of the app by comparison with Kinovea™ software analysis aligned with the findings of the BICMA. Other apps (either on Android or AppleStore) validated by comparison to traditional methods have been used in jump assessment (Balsalobre-Fernandez *et al.,* 2015), sprint measurement (Samozino *et al.,* 2016) and ball speed recording (Busca *et al.,* 2012). After a manual search on the Android store (Android, 2007) we found many apps for providing cricket news and information. On the AppleStore (2001) we found apps such as CACricCoachHD (video coaching app for allowing cricket coaches to provide immediate visual feedback in slow motion during training sessions and competition) and XEQT Pro (monitors how accurate bowlers are), whilst My Cricket Coach (provides personable and inspiring cricket coaching videos to both coaches and players) is available on both operating systems. To date, no mobile application has been developed to assist specifically in performance enhancement of the batting backlift in cricket and ours presented a novel ease of access for coaches and players alike.

Strengths and Limitations

The strengths of this mobile application allows a user to instantly record and analyse the backlift of cricket batsmen and provide real-time feedback from the immediate analysis. In addition, from the footage stored, the user will also be able to analyse other pertinent variables of the overall batting technique (stance, feet, head position and follow through) by adjusting the alignment of angles drawn on the BICMA. The limitation however is the fact that the BICMA has only been programmed and designed to analyse the backlift of the batting technique specifically. As such, users will only be able to gauge other variables with the naked eye and without the use of accurate verification as provided by the BICMA for the backlift and face of the bat.

Future plans

The mobile application has been validated but however needs to undergo further rigorous testing to validate its reliability for a full cricket season to gauge the response of usability from the players and the coaches. Furthermore, it needs to be imported to other platforms and operating systems such as iOS and Windows. Connectivity with these platforms such as iOS that has updated their smartphones with high-speed cameras capable of recording up to 120 Hz will contribute towards the assistance of a well-rounded analysis for the batsmen.

CONCLUSION

The use of the BICMA can be used to evaluate the backlift type of a batsman by analysing and tracking the bat position of batsmen during the backlift. The development of the BICMA is the first complimentary mobile application available on Android markets (Android, 2007) that can record and analyse the backlift of a batsman through a Smartphone without the tedious need for connectivity from parent software on computers. The mobile application provides real-time data that can be stored on the user's phone and device for subsequent usage and analysis by both coaches and cricket players. Further testing is required to analyse the reliability of this novel mobile smartphone application in cricket.

Acknowledgements

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8

SUMMARY OF RESULTS AND WAY FORWARD

Brief Background and Rationale

As outlined in Chapter 1, the backlift is an important component of the overall batting technique. Research conducted in Australia by Stuelcken, Portus & Mason (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 thesis aimed to build on what was found from this study and expand on the scientific understanding of the BBT in cricket.

In addition, Sir Donald Bradman is notably the prime example of the 'looped' or lateral backlift. To a large extent, his influence has provided a rationale for this study investigating whether batters who display elements of his looped action had any factors of success in their careers. However, coaching manuals in Bradman's era (aside from his own book in 1958) hardly addressed this issue and therefore it was imperative to document and analyse the BBT of current batsmen across varied levels of cricket ability.

There is the growing realisation by 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, 104 years later, there is still no consensus of how the backlift in cricket batting should be coached (Fry, 1912; Penn & Spratford, 2012). Presently, the debate regarding the BBT in cricket continues (Woolmer, Noakes & Moffet, 2009). It was therefore essential to investigate the BBT of past and present cricketers as well as among cricketers playing in various proficiency levels. In addition, more emphasis needed to be focused on how the BBT can be effectively used in cricket by both coaches and players.

Research Aims and Objectives

To our knowledge, very few studies have attempted to investigate and analyse in-depth information of the batting backlift technique of cricket players at various levels. We therefore considered it feasible to investigate a range of questions regarding:

- The direction of the backlift among elite, professional, semi-professional, adolescent and young cricketers (Chapters 2 – 4).
- The direction in which the face of the bat points upon pick up among elite, professional, semi-professional, adolescent and young cricketers (Chapters 2 – 4).
- The specific emphasis of the lateral batting backlift technique among semi-pro, professional and international cricketers and how it correlates to other components of the batting technique (Chapter 3).
- How the backlift is currently coached by exploring the perceptions, experiences and understanding of cricket coaches of different batting techniques and the batting backlift technique (Chapter 5).
- The use of coaching tools in the form of a) a coaching cricket bat (Chapter 6) and b) a mobile application (Chapter 7) to enhance and improve the batting backlift technique among young cricket players.
- Practical implications and coaching recommendations for batting backlift techniques (Appendix F).

Research Design

Chapters 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 (n = 69), professional (n = 48) and South African International players (n = 12) as well as uncoached and coached cricketers (n = 80). Biomechanical and video analyses were performed on both participant groups.

These 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.

Chapter 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.

Chapter 6 was a cross-sectional research study in which analytical research methods were employed, in which two groups (coached: n = 12 and un-coached: n = 35) of participants (ages 9 – 13) took part in both a pilot and intervention study. Participants were required to use a novel coaching cricket bat in a coaching game format. Biomechanical and video analysis was conducted in both the frontal and lateral planes as the batters 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 $p \leq 0.05$.

Chapter 7 focused on a mobile application in which the backlift in cricket software system was divided into two components: a frontal view interface and a lateral view interface. Android, Open Computer Vision (CV) and JavaScript were used for this particular project as they are both well documented and supported by a software development platform called Qt 5.3.

Research Findings

Chapter 2 showed that more than 70% of the greatest batsmen of all time did not adopt the traditionally taught straight batting backlift technique (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 lateral batting backlift technique (LBBT) is likely a contributing factor to effective batsmanship. The logic is that if the coached technique of the SBBT is superior then all the world's greatest batsmen would use this technique. There would be no need to develop an alternative method.

Chapter 3 showed that a LBBT is more common at the highest levels when comparing batsmen at the various levels of cricket (SP = 37%; CP = 40%; P = 40%; SAI = 75%); $p = 0.001$. In addition, this study also demonstrated that batsmen who have a LBBT were better able to score runs to all parts of the cricket field. Furthermore, 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.

Chapter 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.

The results from Chapter 5 showed that the majority of cricket coaches teach what is advocated in cricket coaching manuals. This study also showed that cricket coaches mostly teach the SBBT as opposed to the LBBT at the various levels of the game.

In Chapter 6, the pilot study demonstrated that participants scored an additional 100 runs when trained with the coaching cricket bat compared to a conventional cricket bat ($p = 0.003$). After six weeks of the intervention, the experimental group (who trained with the coaching cricket bat) displayed improved performance ($ES = 5.41$). Players' backlifts had subsequently become more lateral which may have promoted more effective ball striking.

Chapter 7 showed that the use of the Backlift In Cricket Mobile Application (BICMA) can be used to evaluate the backlift type of a batsman. The development of the BICMA is the first mobile application that can record and analyse the backlift of a batsman through a Smartphone. It brings the value of convenience for coaches, scientists and players where there would be no need for connectivity from parent software on computers or an external video camera.

How has this thesis contributed to the fields of cricket science, biomechanics, motor control and skill acquisition as they relate to cricket coaching?

Much has changed in the last 50 years of the game due to rapid adaptations of the one-day format. Although cricket has only been in existence for less than 230 years (since 1788), there have been considerable fluctuations in coaching and batting methods in the past century, as described in Chapter 1. This thesis 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 is the backlift.

This thesis has outlined the practices of the backlift at the various levels of cricket ability (junior, adolescent, club, semi-professional, professional and international 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 with a batsman as each player will be different.

Stating that the LBBT is a key determinant to success would be a bold statement as there are other key components to also 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. Chapter 9 completed this thesis by providing a novel way forward for coaches and players in a final chapter that combines the science and coaching of the BTT in cricket.

This thesis 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 part of the thesis 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.

Although some coaches may perceive it to be challenging to teach players the LBBT, Chapters 6 and 7 have provided the science behind some coaching tools, drills and skills that both coaches and players can use to inculcate an effective BBT which can positively affect the batting technique. In Chapter 6, we showed that the novel coaching cricket bat is the main coaching tool that can assist in the enhancement and improvement of the backlift and performance of junior cricket batsmen. It is recommended that coaches encourage young cricketers to use the coaching cricket bat solely in training as the perceived benefits may enhance performance by influencing the direction of the backlift among young cricket players even when they use the conventional cricket bat in matches. The mobile application is an additional tool that coaches, players and scientists can use to analyse and provide recommendations for improvements of the BBT among cricket players.

In summary, this thesis has shown 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. Coaching a LBBT to young batsman may be challenging and therefore a coaching cricket bat has been developed and has shown to be a promising training aid for coaching the LBBT to young cricketers. A mobile application together with practical implications has also been documented to assist in the coaching of the BBT in cricket.

Ultimately, this thesis has contributed to the fields of cricket science, biomechanics, motor control and skill acquisition relating to cricket coaching (Figure 8.1). This thesis directs a path in which cricket players' performances can be enhanced and explains how young players can be moulded in becoming successful batsmen. With the current emphasis being focused towards the one-day format of the game, players will benefit from using recommendations and tools from this thesis: a LBBT, the coaching cricket bat and practical recommendations for effectively coaching a BBT in cricket.

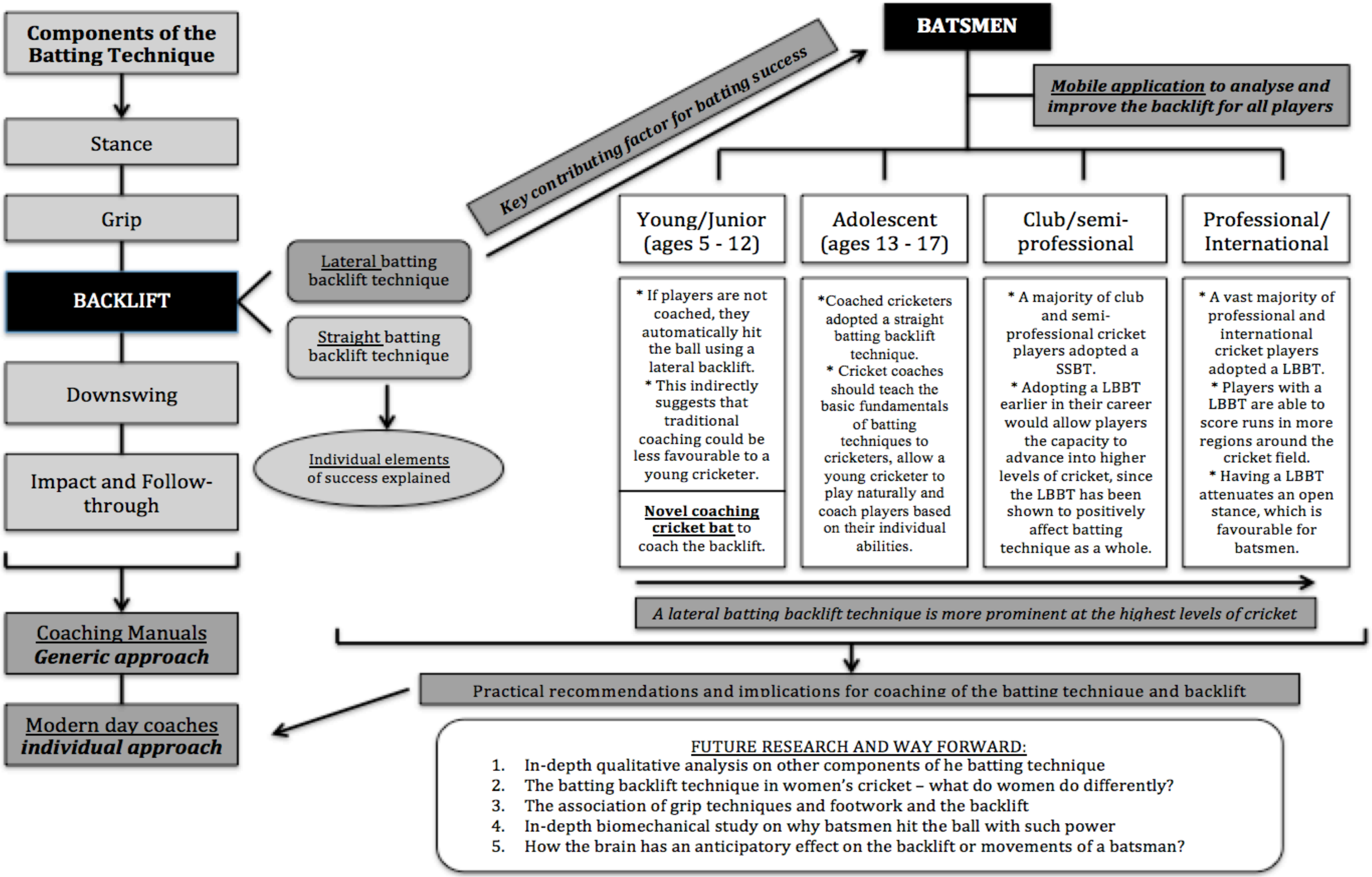

Figure 8.1: A conceptual summary of the thesis

Future research and way forward

This thesis has answered critical questions surrounding foundational and novel questions regarding the BBT in cricket. As such, further in-depth research and questions needs to be answered and investigated in the following areas (Figure 8.1):

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. Another interesting study would be to expose uncoached players to video clips of specific well-known players to see if there is any influence on their backlift.
3. 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.
4. From this thesis, we can understand the backlift to be the "clutch" of a batsman. However, the grip of the "clutch" is key and the association of grip techniques with the BBT is fundamental for in-depth investigation.
5. The foot movements of a batsman are the "gears". The batsman needs to have efficient "clutch control" with particular gear movements. In essence, the association of foot movements with the BBT is paramount for an in-depth analysis of what produces superior batsmanship.
6. There has been much speculation surrounding the stature of a batsman. In particular, it would be important to determine whether batsmen (examples are Bradman, Tendulkar, Lara, Gavaskar, AB de Villiers and Kohli) with a shorter stature are more successful at batting than batsmen with taller stature. The association of stature with a batsman needs to be formulated through a rigorous scientific study.

7. A rigorous and in-depth biomechanical case study among modern successful international cricketers analysing key biomechanical variables from various camera angles is needed to answer critical questions: Why can these batsmen hit the ball with such power and how can they seemingly anticipate the trajectory of the delivery so early in its delivery? Perhaps in some cases even before it is delivered?
8. 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?

The above areas and questions would provide additional insights into the associated movements with the backlift as well as further understanding other movements and components of the batting techniques. In addition, and similar to this thesis, more innovative tools can be designed to assist and enhance the performance of batsmen as well as the 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. Appendix F (Beyond the backlift: Understanding all aspects of cricket batsmanship) therefore aims to assist coaches and players on coaching the backlift in cricket. These recommendations would need to be confirmed with further research on the backlift in cricket.

9

APPENDICES

Appendix A

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Director: Professor T D Noakes
Discovery Health Professor of Exercise and Sports Science

Participant Information Sheet

The batting backlift technique in cricket

Dear prospective participant,

My name is Habib Noorbhai, a Registered Biokineticist and I am currently doing my PhD at the Exercise Science and Sports Medicine Research Unit at the University of Cape Town.

Our research study is aimed at analysing the batting backlift batting techniques of cricket cricket players.

Based on the findings in the study, the researcher hopes to implement better strategies and techniques for batsmen who participate in the study and to analyse their batting techniques respectively. This will help ultimately develop future interventions that will be beneficial to cricketers.

What will happen on the day of analysis

Twelve deliveries (three short deliveries, three good-length deliveries, three full deliveries and three full-toss deliveries, either pitched on middle, leg or outside off-stump) will be analysed in a match situation OR will be bowled to you utilizing a bowling machine during practice. These will take place in indoor nets or on a field, upon which you will be required to bat with your usual batting technique. You will be required to come on one occasion only. Based on the findings gathered from the recordings, there will be a biomechanical and video analysis performed. This analysis will measure a static angle calculation of your technique in the form of a photo sequence that will outline your type of batting backlift technique. Variables of interest will include the direction of your backlift of the bat and where the face of the bat faces to you during your pick up.

Your rights as a research participant

Your confidentiality will be maintained at all times and video footage of your batting will not reach any propriety, media or affiliation. Video footage will be destroyed immediately after the research study has been completed.

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E-mail: timothy.noakes@uct.ac.za
Director: Professor T D Noakes
Discovery Health Professor of Exercise and Sports Science

We understand that your participation in this project is voluntary. You are able to withdraw from this project at any time. If you choose not to be involved in this project, there will be no negative consequences for you. The information that we will get from this study will be very helpful to the study. The potential risks from participating in the study include possible muscle fatigue or injury. Therefore, it is imperative that you come in full protective gear when participating. The assessments that will be conducted involves no invasive procedures. However, the investigators will monitor and ensure that participants are safe throughout the research process. In case of an emergency, participants will be referred to a physician within the premises or taken to a nearest hospital for emergency care. Ultimately, there is no greater risk than when you are playing a game of cricket. The benefits of the study include feedback of all tests conducted, recommendations for the participant after the study has been completed and three guest passes at the Sports Science Institute of South Africa.

This study conforms to the World Medical Association Declaration of Helsinki on Ethical Principles for Medical Research Involving Human Subjects (2013).

If you want any information regarding your rights as a research participant, or complaints regarding this research study, you may contact Professor Marc Blockman at the University of Cape Town Faculty of Health Sciences Human Research Ethics Committee, which is an independent Committee established to help protect the rights of research participants on telephone number 021 4066492.

What if something goes wrong?

The University of Cape Town (UCT) undertakes that in the event of you suffering any significant deterioration in health or well-being, or from any unexpected sensitivity or toxicity, that is caused by your participation in the study (which is highly unlikely), it will provide immediate medical care.

You must notify the investigator immediately of any side effects and/or injuries during the trial, whether they are research-related or other related complications. UCT has appropriate insurance cover to provide prompt payment of compensation for any trial-related injury according to the guidelines outlined by the Association of the British Pharmaceutical Industry, ABPI 1991. Broadly-speaking, the ABPI guidelines recommend that the insured company (UCT), without legal commitment, should compensate you without you having to prove that UCT is at fault. An injury is considered trial-related if, and to the extent that, it is caused by study activities.

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UCT reserves the right not to provide compensation if, and to the extent that, your injury came about because you chose not to follow the instructions that you were given while you were taking part in the study. Your right in law to claim compensation for injury where you prove negligence is not affected. Copies of these guidelines are available on request.

If you have any queries, please don't hesitate to contact the investigators:

Mr. Habib Noorbhai
072 464 5200
habib.noorbhai@yahoo.com

Prof. Timothy Noakes
(021) 650 2459
timothy.noakes@uct.ac.za

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Informed Consent Form (Professional Cricketer / Adult Participant)

The batting backlift technique in cricket

I, ________________________________ hereby acknowledge and understand the conditions for participating in the research study. I am aware of the possible risks and benefits associated with the research study. I understand that the confidentiality will be maintained throughout the research study.

Signature of parent/guardian: ____________________________________

Name of prospective participant: ____________________________________

Date: ____________________________________

Name of investigator: ____________________________________

Signature of investigator: ____________________________________

Date: ____________________________________

Appendix B

Department of Human Biology

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Director: Professor T D Noakes
Discovery Health Professor of Exercise and Sports Science

Child Assent Form

My name is Habib Noorbhai, a Registered Biokineticist and am currently doing my PhD at the Exercise Science and Sports Medicine Research Unit at the University of Cape Town. I am doing a study to determine the batting backlift technique among cricket players at different levels of the game. We are asking you to take part in the research study because this will help the research greatly and will assist in developing projects that will be beneficial to young cricketers, learning how to play the game.

You would be expected to come in at Western Province Cricket Club's indoor nets for up to 60 minutes three times a week for four weeks. You will be asked to join one of two groups before starting the intervention and will be required to either use a normal cricket bat or a coaching cricket bat for training during the four weeks. Both groups will be required to train and practice with their designated bats for a period of four (4) weeks, three days a week for one hour a day. The training will comprise of facing bowlers with their bat in the training nets. You might also be required to take one stump and hit a table tennis ball against the wall for 15 minutes per day. Once the four weeks of training has been completed, you will then play a cricket match in which each player will face not more than 12 deliveries when batting. During the match, video analysis of your batting will be performed. Variables of interest will include the direction of your backlift of the bat, where the face of the bat faces to you during your pick up and from which angle your bat comes down before making contact with the ball. We will keep all your video footage private, and will not show them to your coach, team mates or parent(s)/guardian. Only people from UCT working on the study will see them.

We do not expect that any major problem can happen to you as part of this study, but you might experience muscle fatigue or injury. Therefore, it is important that you come in full protective gear when participating in the study. However, the investigators will monitor and ensure that you are safe throughout the process. In case of an emergency, you will be referred to a physician within the premises or taken to a nearest hospital for emergency care. Ultimately, there is no greater risk when playing a game of cricket. The benefits of the study include feedback of all tests, recommendations after the study has been completed and three guest passes at the Sports Science Institute of South Africa.

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Discovery Health Professor of Exercise and Sports Science

You should know that:

- You do not have to be in this study if you do not want to. You will not be penalized by UCT, your coach, or the club if you say no.
- You may withdraw from the study at any time.
- Your parent(s)/guardian(s) were asked if they would allow you to be in this study. Even if they give their permission, it is still your choice whether or not to take part.
- You can ask any questions you have, now or later. If you think of a question later, you or your parents can contact me at 072 464 5200 or via email (habib.noorbhai@yahoo.com)

Sign this form only if you:

- have understood what you will be doing for this study,
- have had all your questions answered,
- have talked to your parent(s)/legal guardian about this project, and
- agree to take part in this research

Your Signature Printed Name Date

Name of Parent(s) or Legal Guardian(s)

Researcher explaining study Printed Name Date

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Discovery Health Professor of Exercise and Sports Science

Informed Consent Form (Parent/Guardian)

The evolution of batting techniques among past and present world cricket players

I, parent/guardian of ______________________________ hereby acknowledge and understand the conditions for my child participating in the research study. I am aware of the possible risks and benefits associated with the research study. I understand that the confidentiality will be maintained throughout the research study.

If you are under the age of 18 years, your parent or guardian agree for you to participate in the research study. Please could you sign in the space below:

Signature of parent/guardian: ______________________________

Name of prospective participant: ______________________________

Date: ______________________________

Name of investigator: ______________________________

Signature of investigator: ______________________________

Date: ______________________________

Appendix C

A survey on the batting techniques taught by cricket coaches

As cricket coaches you are an integral component to the development of the beautiful game and our cricketers. We are seeking your involvement in a survey designed to learn more about the current teachings of cricket coaches with respect to coaching batting techniques.The aim of this survey is to evaluate the teachings of cricket coaches on the batting techniques among cricketers.

By completing this survey, you understand that your answers will be used for research. However, your name and identity will be coded and kept confidential at all times. Unfortunately there is no incentive for participating in the study. Your input is indeed valued and appreciated.

For any questions or more information on this survey, you may contact Habib Noorbhai or Timothy Noakes via email (habib@habibnoorbhai.com | timothy.noakes@uct.ac.za).

Thank you for your time and contribution!

* Required

Name

Email Address

What is your age? *

- ◯ 16 - 25
- ◯ 26 - 35
- ◯ 36 - 45
- ◯ 46 - 55
- ◯ 56 - 65
- ◯ 66+

Which country do you coach cricket? *

At what level do you currently coach? *

- ◯ Preparatory school (ages 3 - 5)
- ◯ Primary school (ages 6 - 12)
- ◯ Secondary school (ages 13 - 18)
- ◯ Club
- ◯ Junior Provincial
- ◯ Amateur/State B/State Rep
- ◯ Franchise/State/County
- ◯ International

Do you think what is advocated in coaching manuals for batting is what happens in actual play? *

- ◯ Yes
- ◯ No
- ◯ Sometimes

Which backlift do you use to coach cricketers? *

- ◯ Backlift of bat directed straight towards the wicket-keeper
- ◯ Backlift of bat directed towards first or second slip
- ◯ Backlift of bat directed towards gully
- ◯ The looped or rotary backlift

Do you know what a 'looped' backlift or rotary style of batting is? *

- ◯ Yes
- ◯ No
- ◯ I have an idea but not sure

With the backlift, do you think it is necessary to emphasise the importance of the bat face being open or closed? *

- ◯ Yes
- ◯ No
- ◯ Not really

With the backlift, do you advocate that the bat face should be open, closed or semi-open/closed? *

- ◯ Open
- ◯ Closed
- ◯ Semi-open/Semi-closed
- ◯ It doesn't matter

Should the bat face of the bat be directed towards the off-side or towards the wicket-keeper/stumps? *

- ◯ The off-side
- ◯ Wicket-keeper/stumps

Do you think successful batsmen use a particular batting technique or do they have their own natural style? *

- ◯ Particular batting technique
- ◯ Own natural style

Do you think its important to coach each cricket player utilising a generic batting technique? *

- ◯ Yes
- ◯ No

Do you feel its important to coach each cricket player as an individual or applying a textbook cricket approach? *

- ◯ As an individual
- ◯ Applying a textbook cricket approach

Is there anything else that you would like to add, comment on or substantiate?

Submit

100%: You made it.

Never submit passwords through Google Forms.

Appendix D

SERTIFIKAAT VAN REGISTRASIE
REPUBLIEK VAN SUID AFRIKA
Modellekantoor

DEPARTEMENT VAN HANDEL EN NYWERHEID

CERTIFICATE OF REGISTRATION
REPUBLIC OF SOUTH AFRICA
Designs Office

DEPARTMENT OF TRADE AND INDUSTRY

Amptelike model No.: **F2013/01526**
Official design No.:

DIE WET OP MODELLE, 1993
THE DESIGNS ACT, 1993

Volle naam/name van geregistreerde eienaar(s):
Full name/names of registered proprietor(s):
WOOLMER RUSSEL CHRISTOPHER, NOAKES TIMOTHY DAVID

Artikels in verband waarme model toegepas gaan word:
Article to which the design is to be applied:
CRICKET BATS

Soort model: Type of design:	Deel A Part A	☐	Deel F Part F	☒	Klas: Class:	**21**

Datum van indiening: **26/08/2013**
Date of lodgement:

Uitreikingsdatum (waar van toepassing):
Release date (If applicable):

Voorkeurdatum (waar van toepassing):
Priority date (where applicable):

Hierby word gesertifiseer dat-

(i) Die model, waarvan 'n afskrif aangeheg is, geregistreer is ten opsigte van die artikels ingesluit in bogenoemde klas en verband waarmee die model toegepas is, of 'n model toegepas is wat nie wesenlik van die modelverskil nie, ingevolge en behoudens diebepalings van die wet op modelle, 1993; en

(ii) die registrasie geld vanaf die datum van indiening of die voorkeurdatum of die uitreikingsdatum, welke datum ook al die vroegste is en wat hierna die "effektiewe datum" genoem word; en

(iii) die registrasie geldig is vir 'n tydperk van vyftien jaar in die geval van 'n model geregistreer in Deel A en tien jaar in die geval van 'n model geregistreer in Deel F vanaf die effektiewe datum en behoudens hernuwing, wat by verstryking van drie jaar [illegible] effektiewe datum en jaarliks daarna

This is to certify that-

(i) the design, of which a copy is annexed, has been registered in the above class and to which the design or a design not substantially different from the design has been applied, in pursuance of and subject to the provisions of the Design Act, 1993; and

(ii) the registration is effective from the above date of lodgement or priority date or release date, whichever is the earliest and which date is hereinafter referred to as "the effective date"; and

(iii) the registration is effective for a period of fifteen years in the case of a design registered in Part A and ten years in the case of a design registered in Part F from the effective date and subject to payment of renewal fees at the third year from the effective date and annually thereafter.

Signed

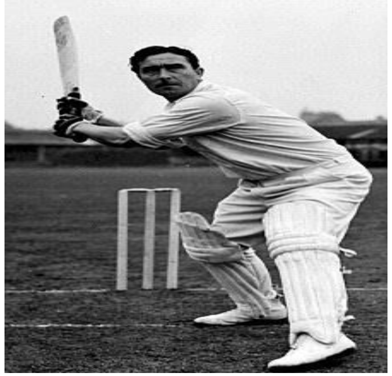
REGISTRAR OF DESIGNS
REGISTRATEUR VAN MODELLE
10.03.2015

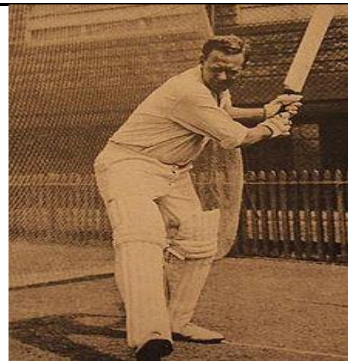
Appendix E: Figures from Chapters

Appendix E1 (Chapter 2 Figures)

Figure 2.4: Images showcasing successful test batsmen's batting backlift technique (n = 35) between 1895 and 2014

			
2.4.1: George Headley	**2.4.2: Donald Bradman**	**2.4.3: Edward Paynter**	**2.4.4: Everton Weekes**
https://www.youtube.com/watch?v=6SzKRrw9KO0	Don Bradman – How to play cricket (1993). https//www.how2dvd.co.uk	https://www.youtube.com/watch?v=20e40_ZV_fk	https://www.youtube.com/watch?v=8xPCrIw1Hp8
			
2.4.5: Walter Hammond	**2.4.6: Jack Hobbs**	**2.4.7: Sir Clyde Walcott**	**2.4.8: Len Hutton**
https://www.youtube.com/watch?v=6vl_IiGivBc	https://www.youtube.com/watch?v=XoORpp1AdSk	https://www.youtube.com/watch?v=8xPCrIw1Hp8	https://www.youtube.com/watch?v=e-RmIPtseJE

		
2.4.9: Dennis Compton	**2.4.10: Frank Worrell**	**2.4.11: Neil Harvey**
http://www.dailymail.co.uk/sport/football/article-1333091/The-Friday-Five-Men-played-cricket-football.html	http://www.youtube.com/watch?v=joScOh-eO6I	https://www.youtube.com/watch?v=s4saUbc_yPE

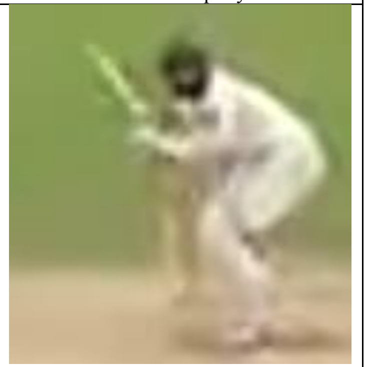
			
2.4.12: Bill Ponsford	**2.4.13 Douglas Jardine**	**2.4.14 Peter May**	**2.4.15 Arthur Morris**
https://www.youtube.com/watch?v=qXLdKAe9wMI	http://www.espncricinfo.com/wcm/content/story/216008.html	http://www.theguardian.com/sport/2010/feb/23/arthur-mcintyr	http://en.wikipedia.org/wiki/Arthur_Morris

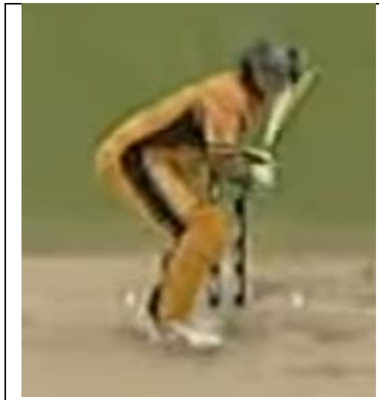
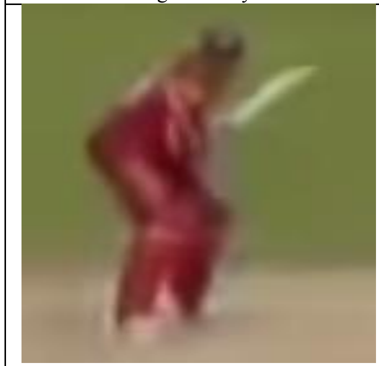
				
2.4.16: Graeme Pollock	**2.4.17: K. Sangakarra**	**2.4.18: Gary Sobers**	**2.4.19: Jacques Kallis**	**2.4.20: Greg Chappell**
https://www.youtube.com/watch?v=RhPnumv9OEM	https://www.youtube.com/watch?v=v66FR-fATUk	https://www.youtube.com/watch?v=JTYhehNbDKo	https://www.youtube.com/watch?v=BTDROEGE0ow	https://www.youtube.com/watch?v=zD9ujsXsDhM

				
2.4.21: Sachin Tendulkar	**2.4.22: Brian Lara**	**2.4.23: Javed Miandad**	**2.4.24: Rahul Dravid**	**2.4.25: M. Yousuf**
https://www.youtube.com/watch?v=qL5FtB2aKIg	https://www.youtube.com/watch?v=qi_hxbOzO_Q	https://www.youtube.com/watch?v=PePZGACmpvE	https://www.youtube.com/watch?v=C4cNkyba_hQ	https://www.youtube.com/watch?v=UkQ_GBhaoKg

				
2.4.26: A.B. de Villiers	**2.4.27: S. Chanderpaul**	**2.4.28: Ricky Ponting**	**2.4.29: Michael Clarke**	**2.4.30: Hashim Amla**
https://www.youtube.com/watch?v=o1fipWfIRyU	https://www.youtube.com/watch?v=7LjSWwHEuAo	https://www.youtube.com/watch?v=nNH8lcDZoJg	https://www.youtube.com/watch?v=7TpN21DgMsE	https://www.youtube.com/watch?v=AgBGu7Cf1Vk
				
2.4.31: Sunil Gavaskar	**2.4.32: Steve Waugh**	**2.4.33: Alan Border**	**2.4.34: Sir V. Richards**	**2.4.35: M. Jayawardene**
https://www.youtube.com/watch?v=pC-bzECLMRs	https://www.youtube.com/watch?v=V55Mg8dn1s4	https://www.youtube.com/watch?v=vGlmr2d5qeQ	https://www.youtube.com/watch?v=4337LFabJEI	https://www.youtube.com/watch?v=0r3RdyNUreo

Figure 2.5: Images showcasing successful ODI batsmen's batting backlift technique (n = 30) between 1974 and 2014

				
2.5.1: Sachin Tendulkar	**2.5.2: Ricky Ponting**	**2.5.3: S. Jayasuriya**	**2.5.4: K. Sangakarra**	**2.4.5: Inzamam Ul-Haq**
https://www.youtube.com/watch?v=qL5FtB2aKIg	https://www.youtube.com/watch?v=nNH8lcDZoJg	https://www.youtube.com/watch?v=ZJs_1PqRck8	https://www.youtube.com/watch?v=v66FR-fATUk	https://www.youtube.com/watch?v=wHMz0qlC-ys
				
2.5.6: Jacques Kallis	**2.5.7: Sourav Ganguly**	**2.5.8: Rahul Dravid**	**2.5.9: Brian Lara**	**2.5.10: M. Yousuf**
https://www.youtube.com/watch?v=BTDROEGE0ow	https://www.youtube.com/watch?v=SRNRdmaPUEg	https://www.youtube.com/watch?v=C4cNkyba_hQ	https://www.youtube.com/watch?v=qi_hxbOzO_Q	https://www.youtube.com/watch?v=UkQ_GBhaoKg

				
2.5.11: Adam Gilchrist	**2.5.12: M. Azharuddin**	**2.5.13: Aravinda de Silva**	**2.5.14: Saeed Anwar**	**2.5.15: S. Chanderpaul**
https://www.youtube.com/watch?v=egxEfBI3hyk	https://www.youtube.com/watch?v=uh714DK4SwQ	https://www.youtube.com/watch?v=RLrT6Muo_rk	https://www.youtube.com/watch?v=t--X5o48jwE	https://www.youtube.com/watch?v=7LjSWwHEuAo
				
2.5.16: Chris Gayle	**2.5.17: Mark Waugh**	**2.5.18: T.M. Dilshan**	**2.5.19: Yuvraj Singh**	**2.5.20: Virender Sehwag**
https://www.youtube.com/watch?v=IHU6Rd4m11c	https://www.youtube.com/watch?v=DuwKVnLDfPk	https://www.youtube.com/watch?v=45kAbnNuhrQ	https://www.youtube.com/watch?v=SNQm4-InMqI	https://www.youtube.com/watch?v=gQKRRZcIXfg

				
2.5.21: Herschelle Gibbs	**2.5.22: M.S. Dhoni**	**2.5.23: Stephen Fleming**	**2.5.24: Shahid Afridi**	**2.5.25: Sir V. Richards**
https://www.youtube.com/watch?v=qfXV7SbStOc	https://www.youtube.com/watch?v=k3OP1lzQbVE	https://www.youtube.com/watch?v=S5S9xZuphlc	https://www.youtube.com/watch?v=AAOIMriulDg	https://www.youtube.com/watch?v=4337LFabJEI
				
2.5.26: A.B. de Villiers	**2.5.27: Shane Watson**	**2.5.28: Andrew Symonds**	**2.5.29: Suresh Raina**	**2.5.30: Hashim Amla**
https://www.youtube.com/watch?v=o1fipWfIRyU	https://www.youtube.com/watch?v=GkudxwdTPuU	https://www.youtube.com/watch?v=B2N89Hv6eiA	https://www.youtube.com/watch?v=SRlL9n-T068	https://www.youtube.com/watch?v=AgBGu7Cf1Vk

Appendix E1 2.3: Successful test batsmen between the years 1895 and 1954 (n = 15)

Player	Time Span	Matches	Innings	Not Outs	Runs	Highest Score	Average	Classifier	BBTT
D.G. Bradman (Aus)	1928-1948	52	80	10	6996	334	99.94	3	Lateral
G.A. Headley (WI)	1930-1954	22	40	4	2190	270*	60.83	3	Lateral
E. Paynter (Eng)	1931-1939	20	31	5	1540	243	59.23	3	Lateral
E.D. Weekes (WI)	1948-1958	48	81	5	4455	207	58.61	3	Lateral
W.R. Hammond (Eng)	1927-1947	85	140	16	7249	336*	58.45	3	Lateral
J.B. Hobbs (Eng)	1908-1930	61	102	7	5410	211	56.94	3	Lateral
C.L. Walcott (WI)	1948-1960	44	74	7	3798	220	56.68	3	Lateral
L. Hutton (Eng)	1937-1955	79	138	15	6971	364	56.67	3	Lateral
D.C.S. Compton (Eng)	1937-1957	78	131	15	5807	278	50.06	3	Lateral
F.M.M. Worrell (WI)	1948-1963	51	87	9	3860	261	49.48	3	Lateral
R.N. Harvey (Aus)	1948-1963	79	137	10	6149	205	48.41	1	Straight
W.H. Ponsford (Aus)	1924-1934	29	48	4	2122	266	48.22	3	Lateral
D.R. Jardine (Eng)	1928-1934	22	33	6	1296	127	48.00	1	Straight
P.B.H. May (Eng)	1951-1961	66	106	9	4537	285*	46.77	3	Lateral
A.R. Morris (Aus)	1946-1955	46	79	3	3533	206	46.48	2	Straight

Player: Aus = Australia; Eng = England; WI = West Indies

Classifier: 1 = bat facing straight back; 2 = bat facing first slip; 3 = bat facing towards gully and/or the face of the bat facing point

BBTT = Batting Backlift Technique Type; Lateral or Straight

**Not out*

Appendix E1 2.4: Successful test batsmen between the years 1955 and 2014 (n = 20)

Player	Time Span	Matches	Innings	Not Outs	Runs	Highest Score	Average	Classifier	BBTT
R.G. Pollock (SA)	1963-1970	23	41	4	2256	274	60.97	3	Lateral
K.C. Sangakkara (SL)	2000-2014	124	213	17	11493	319	58.63	2	Lateral
G.S. Sobers (WI)	1954-1974	93	160	21	8032	365*	57.78	2	Lateral
J.H. Kallis (ICC/SA)	1995-2013	166	280	40	13289	224	55.37	1	Straight
G.S. Chappell (Aus)	1970-1984	87	151	19	7110	247*	53.86	1	Straight
S.R. Tendulkar (Ind)	1989-2013	200	329	33	15921	248*	53.78	3	Lateral
B.C. Lara (ICC/WI)	1990-2006	131	232	6	11953	400*	52.88	2	Lateral
J. Miandad (Pak)	1976-1993	124	189	21	8832	280*	52.57	2	Lateral
R Dravid (ICC/Ind)	1996-2012	164	286	32	13288	270	52.31	3	Lateral
M. Yousuf (Pak)	1998-2010	90	156	12	7530	223	52.29	2	Lateral
A.B. de Villiers (SA)	2004-2014	92	154	16	7168	278*	51.94	3	Lateral
S. Chanderpaul (WI)	1994-2014	156	266	46	11414	203*	51.88	3	Lateral
R.T. Ponting (Aus)	1995-2012	168	287	29	13378	257	51.85	3	Lateral
M.J. Clarke (Aus)	2004-2014	105	180	20	8240	329*	51.50	3	Lateral
H.M. Amla (SA)	2004-2014	76	132	11	6214	311*	51.35	3	Lateral
S.M. Gavaskar (Ind)	1971-1987	125	214	16	10122	236*	51.12	2	Lateral
S.R. Waugh (Aus)	1985-2004	168	260	46	10927	200	51.06	1	Straight
A.R. Border (Aus)	1978-1994	156	265	44	11174	205	50.56	1	Straight
I.V.A. Richards (WI)	1974-1991	121	182	12	8540	291	50.23	2	Lateral
D.P.M.D. Jayawardene (SL)	1997-2014	145	244	15	11493	374	50.18	1	Straight

Player: Aus = Australia; Eng = England; ICC = International cricket council; Ind = India; Pak = Pakistan; SA = South Africa; SL = Srilanka; WI = West Indies
Classifier: 1 = bat facing straight back; 2 = bat facing first slip; 3 = bat facing towards gully and/or the face of the bat facing point
BBTT = Batting Backlift Technique Type; Lateral or Straight
**Not out*

Appendix E1 2.5: Successful one-day international batsmen in the last forty years (1974 – 2014) (n = 30)

Player	Time Span	Matches	Innings	Not Outs	Runs	Highest Score	Average	Strike Rate	Classifier	BBTT
S.R. Tendulkar (Ind)	1989-2012	463	452	41	18426	200*	44.83	86.23	3	Lateral
R.T. Ponting (Aus/ICC)	1995-2012	375	365	39	13704	164	42.03	80.39	3	Lateral
S.T. Jayasuriya (Asia/SL)	1989-2011	445	433	18	13430	189	32.36	91.20	1	Straight
K.C. Sangakkara (Asia/SL)	2000-2014	377	354	37	12806	169	40.39	77.61	2	Lateral
I. Haq (Asia/Pak)	1991-2007	378	350	53	11739	137*	39.52	74.24	3	Lateral
J.H. Kallis (Afr/ICC/SA)	1996-2014	328	314	53	11579	139	44.36	72.89	1	Straight
S.C. Ganguly (Asia/Ind)	1992-2007	311	300	23	11363	183	41.02	73.70	2	Lateral
R. Dravid (Asia/ICC/Ind)	1996-2011	344	318	40	10889	153	39.16	71.24	3	Lateral
B.C. Lara (ICC/WI)	1990-2007	299	289	32	10405	169	40.48	79.51	2	Lateral
M. Yousuf (Pak)	1998-2010	288	273	40	9720	141*	41.71	75.10	2	Lateral
A.C. Gilchrist (Aus/ICC)	1996-2008	287	279	11	9619	172	35.89	96.94	2	Lateral
M. Azharuddin (Ind)	1985-2000	334	308	54	9378	153*	36.92	74.02	2	Lateral
P.A. de Silva (SL)	1984-2003	308	296	30	9284	145	34.90	81.13	3	Lateral
Saeed Anwar (Pak)	1989-2003	247	244	19	8824	194	39.21	80.67	3	Lateral
S Chanderpaul (WI)	1994-2011	268	251	40	8778	150	41.60	70.74	3	Lateral
C.H. Gayle (ICC/WI)	1999-2013	255	250	17	8743	153*	37.52	84.22	3	Lateral
M.E. Waugh (Aus)	1988-2002	244	236	20	8500	173	39.35	76.90	3	Lateral
T.M. Dilshan (SL)	1999-2014	285	260	39	8403	160*	38.02	85.68	2	Lateral
Y. Singh (Asia/Ind)	2000-2013	293	268	39	8329	139	36.37	87.24	3	Lateral

V. Sehwag (Asia/ICC/Ind)	1999-2013	251	245	9	8273	219	35.05	104.33	3	Lateral
H.H. Gibbs (SA)	1996-2010	248	240	16	8094	175	36.13	83.26	3	Lateral
M.S. Dhoni (Asia/Ind)	2004-2014	243	214	63	8046	183*	53.28	89.24	3	Lateral
S.P. Fleming (ICC/NZ)	1994-2007	280	269	21	8037	134*	32.40	71.49	2	Straight
S. Afridi (Asia/Pak)	1996-2014	378	350	25	7619	124	23.44	115.61	3	Lateral
I.V.A. Richards (WI)	1975-1991	187	167	24	6721	189*	47.00	90.20	2	Lateral
A.B. de Villiers (Afr/SA)	2005-2014	162	156	25	6543	146	49.94	94.44	3	Lateral
S.R. Watson (Aus)	2002-2014	173	152	24	5256	185*	41.06	90.20	2	Lateral
A. Symonds (Aus)	1998-2009	198	161	33	5088	156	39.75	92.44	3	Lateral
S.K. Raina (Ind)	2005-2014	192	165	33	4663	116*	35.32	91.61	3	Lateral
H.M. Amla (SA)	2008-2014	88	85	6	4312	150	54.58	90.02	3	Lateral

Player: Afr = Africa; Aus = Australia; Eng = England; ICC = International cricket council; Ind = India; Pak = Pakistan; SA = South Africa; SL = Srilanka; WI = West Indies

Classifier: 1 = bat facing straight back; 2 = bat facing first slip; 3 = bat facing towards gully and/or the face of the bat facing point

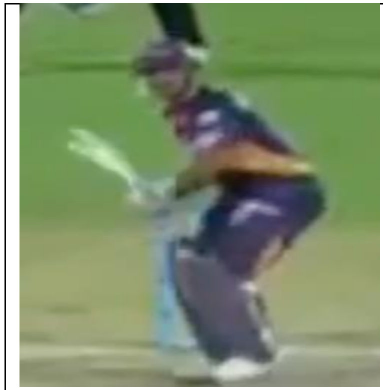
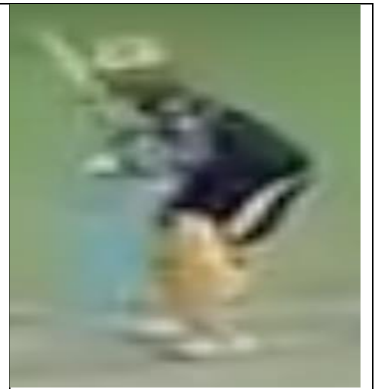
BBTT = Batting Backlift Technique Type; Lateral or Straight

**Not out*

Appendix E1 Figure 2.6: Images showcasing the Top 30 IPL batsmen's batting backlift technique (n = 30) during the 2016 season

				
Virat Kohli	**David Warner (Intl)**	**AB de Villiers (Intl)**	**Shikar Dhawan**	**Gautam Gambhir**
				
Rohit Sharma	**Ajinkya Rahane**	**Murali Vijay**	**Quinton de Kock (Intl)**	**Suresh Raina**

				
Lokesh Rahul	**Robin Uthappa**	**Aaron Finch (Intl)**	**Yusuf Pathan**	**Karun Nair**
				
Brendon McCullum (Intl)	**Dinesh Karthik**	**Ambati Rayudu**	**Dwayne Smith (Intl)**	**Sanju Samson**

				
MS Dhoni	**Wriddhiman Saha**	**Steven Smith (Intl)**	**Jos Butler (Intl)**	**Manish Pandey**
				
Krunal Pandya	**Yuvraj Singh**	**Chris Gayle (Intl)**	**Kieron Pollard (Intl)**	**Faf du Plessis (Intl)**

Appendix E1 Table 2.6: Player statistics of the Top 30 IPL batsmen's batting backlift technique (n = 30) during the 2016 season

Player	Team in 2016	Innings	Runs	Average	Strike Rate	4s	6s	BBT
Virat Kohli	Bangalore	16	973	81.08	152.03	83	38	Lateral
David Warner	Hyderabad	17	848	60.57	151.43	88	31	Lateral
AB de Villiers	Bangalore	16	687	52.85	168.80	57	37	Lateral
Shikhar Dhawan	Hyderabad	17	501	38.54	116.78	51	8	Lateral
Gautam Gambhir	Kolkata	15	501	38.54	121.90	54	6	Lateral
Rohit Sharma	Mumbai	14	489	44.45	132.88	49	16	Lateral
Ajinkya Rahane	Pune	14	480	43.64	126.65	54	9	Lateral
Murali Vijay	Punjab	14	453	34.85	124.45	50	10	Lateral
Quinton de Kock	Delhi	13	445	37.08	136.09	52	13	Lateral
Suresh Raina	Gujarat	15	399	28.50	127.88	39	10	Lateral
Lokesh Rahul	Bangalore	12	397	44.11	146.49	37	16	Lateral
Robin Uthappa	Kolkata	15	394	26.27	136.33	45	8	Lateral
Aaron Finch	Gujarat	12	393	39.30	131.44	45	11	Lateral
Yusuf Pathan	Kolkata	13	361	72.20	145.56	33	13	Lateral
Karun Nair	Delhi	12	357	35.70	120.20	40	6	Straight
Brendon McCullum	Gujarat	16	354	22.12	135.11	38	16	Lateral

Dinesh Karthik	Gujarat	15	335	25.77	125.94	38	3	Lateral
Ambati Rayudu	Mumbai	12	334	30.36	120.14	28	12	Lateral
Dwayne Smith	Gujarat	12	324	29.45	146.61	35	16	Straight
Sanju Samson	Delhi	14	291	26.45	112.36	20	8	Lateral
MS Dhoni	Pune	12	284	40.57	135.24	18	14	Lateral
Wriddhiman Saha	Punjab	12	270	24.55	127.36	29	1	Straight
Steven Smith	Pune	7	270	45.00	153.41	27	8	Lateral
Jos Buttler	Mumbai	14	255	23.18	138.59	23	11	Lateral
Manish Pandey	Kolkata	11	248	31.00	135.52	17	9	Lateral
Krunal Pandya	Mumbai	9	237	39.50	191.13	22	13	Lateral
Yuvraj Singh	Hyderabad	10	236	26.22	131.84	22	13	Lateral
Chris Gayle	Bangalore	10	227	22.70	151.33	17	21	Lateral
Kieron Pollard	Mumbai	12	208	26.00	144.44	11	16	Lateral
Faf du Plessis	Pune	6	206	34.33	127.16	17	9	Lateral

BBT = Batting Backlift Technique

Appendix E2 (Chapter 3 Figures)

Table 3.6: Characteristics and performances of the Free State cricket team (n = 3)

Player	Mat	Inn	NO	Runs	First Class			List A			Classifier	BBTT
					High Score	Average	Strike Rate	High Score	Average	Strike Rate		
T. Ntuli	10	13	6	35	**9**	5.00	31.25	4*	-	77.77	1	Straight
S. Arends	2	3	0	1	**1**	0.33	6.66	-	-	-	1	Straight
J. L. du Plooy	15	24	2	816	**181**	37.09	51.94	85*	154.50	89.04	3	Lateral

*BBTT = Batting Backlift Technique Type; Inn = Innings; Mat = Matches; NO = Not Outs; * = Not out; - = did not play Tests/ODI; Highest scores = BOLD*

Figure 3.3: Batting backlift technique type of Free State cricket players (n = 3)

		
T. Ntuli (S; HS = 9)	S. Arends (S; HS = 1)	J.L. du Plooy (L; HS = 181)

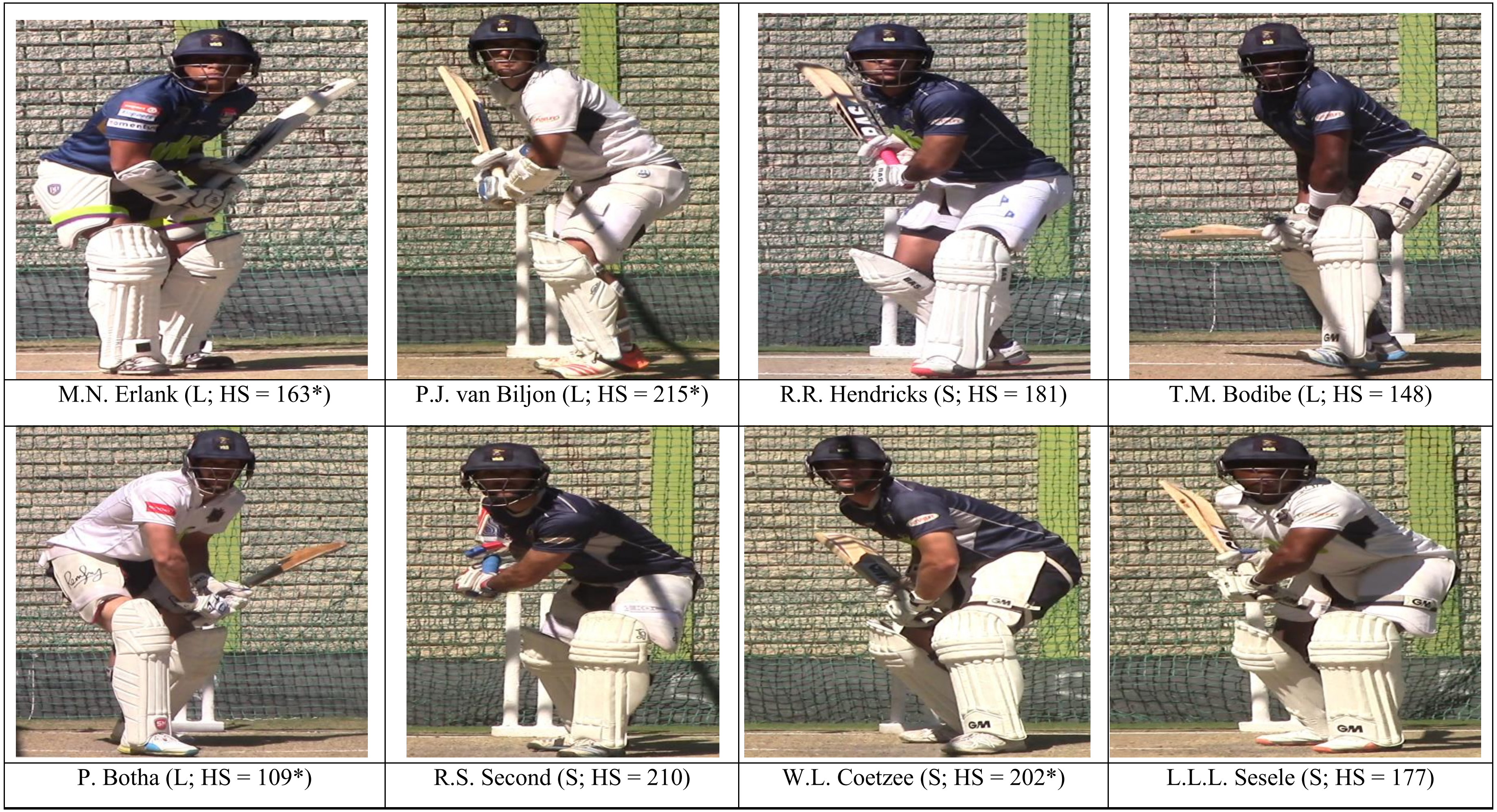
S = SBBT; L = LBBT; HS = Highest Score

Table 3.7: Characteristics and performances of the Knights cricket team (n = 8)

Player	Mat	Inn	NO	Runs	First Class			List A			Classifier	BBTT
					High Score	Average	Strike Rate	High Score	Average	Strike Rate		
M. N. Erlank	88	142	13	3482	**163***	26.99	43.05	72	22.63	73.39	3	Lateral
P. J. van Biljon	72	121	14	4264	**215***	39.85	52.58	134*	32.69	82.47	3	Lateral
R. R. Hendricks	105	185	12	5684	157	32.85	51.65	**181**	36.62	83.42	2	Straight
L. L. L. Sesele	65	116	5	2414	**177**	21.74	49.70	56	17.51	65.54	2	Straight
P. Botha	71	109	17	3359	**109***	36.51	59.72	76	23.30	83.43	3	Lateral
R.S. Second	70	118	9	4224	**210**	38.75	48.47	135*	49.16	74.15	1	Straight
W. L. Coetsee	118	198	23	5598	**202***	31.98	57.98	130*	25.20	88.92	2	Straight
T. M. Bodibe	121	214	16	5074	**148**	25.62	47.64	88	19.47	62.83	3	Lateral

*BBTT = Batting Backlift Technique Type; Inn = Innings; Mat = Matches; NO = Not Outs; * = Not out; Highest scores = BOLD*

Figure 3.4: Batting backlift technique type of the Knights players (n = 8)



M.N. Erlank (L; HS = 163*)	P.J. van Biljon (L; HS = 215*)	R.R. Hendricks (S; HS = 181)	T.M. Bodibe (L; HS = 148)
P. Botha (L; HS = 109*)	R.S. Second (S; HS = 210)	W.L. Coetzee (S; HS = 202*)	L.L.L. Sesele (S; HS = 177)

S = SBBT; L = LBBT; HS = Highest Score

Table 3.8: Characteristics and performances of the Easterns cricket team (n = 10)

Player	Mat	Inn	NO	Runs	First Class			List A			Classifier	BBTT
					High Score	Average	Strike Rate	High Score	Average	Strike Rate		
J. Snyman (L)	14	22	0	605	**150**	27.50	59.37	121*	41.87	74.44	2	Straight
D. Stanley (R)	53	74	31	496	**55**	11.53	39.11	42	21.50	76.78	1	Straight
K. Apea-Adu (R)	7	8	2	51	**31**	8.50	35.66	5*	-	66.66	1	Straight
C.J. Dala (R)	35	39	15	313	**79***	13.04	40.38	20	11.44	77.44	1	Straight
E. H. Kemm (L)	32	55	4	1829	**136**	35.86	37.15	81	32.08	62.09	3	Lateral
W. B. Marshall (R)	17	31	0	860	**103**	27.74	60.60	89	37.50	99.11	1	Straight
T. A. Bula (R)	95	157	23	3909	**106**	29.17	61.73	91	28.00	85.90	3	Lateral
W. Coulentianos (L)	34	57	5	1867	**171**	35.90	53.88	55	43.40	66.36	1	Straight
E. R. Links (R)	50	72	16	1323	**101***	23.62	52.27	42	16.78	64.44	3	Lateral
V. P. Moore (R)	27	37	10	385	**48***	14.25	32.99	18*	13.00	70.27	2	Straight

*BBTT = Batting Backlift Technique Type; Inn = Innings; Mat = Matches; NO = Not Outs; * = Not out; - = did not play Tests/ODI; Highest scores = BOLD*

Figure 3.5: Batting backlift technique type of the Easterns players (n = 10)

Snyman (S; HS = 150)	Stanley (S; HS =55)	Apea-Adu (S; HS = 31)	Dala (S; HS = 79*)	Kemm (L; HS = 136)

Marshall (S; HS = 103)	Bula (L; HS = 106)	Coulentianos (S; HS = 171)	Links (L; HS = 101*)	Moore (S; HS = 48*)

S = SBBT; L = LBBT; HS = Highest Score

Table 3.9: Characteristics and performances of the Gauteng cricket team (n = 10)

Player	Mat	Inn	NO	Runs	First Class			List A			Classifier	BBTT
					High Score	Average	Strike Rate	High Score	Average	Strike Rate		
K. Mogotsi	10	18	2	358	**69**	22.37	47.92	61	21.16	59.90	3	Lateral
Y. Valli	21	36	7	790	**130***	27.24	41.10	31	17.87	54.37	3	Lateral
D. P. Conway	77	121	10	4189	142	37.73	54.90	**152**	44.13	82.77	3	Lateral
S. Pillay	28	45	9	1144	**138***	31.77	44.39	81	30.26	69.95	1	Straight
N.P. Mvelase	8	11	3	90	18	11.25	75.00	**25**	15.00	95.23	2	Straight
B. Dial	8	13	2	306	**94***	27.81	50.24	18	7.00	50.00	2	Straight
S. Jamison	31	33	8	446	**49**	17.84	58.37	15	11.66	62.50	2	Straight
D. Potgieter	4	7	1	99	39	16.50	55.61	**41**	36.50	85.88	2	Straight
G. Roelofsen	1	1	0	4	**-**	-	-	**4**	4.00	100.00	2	Straight
M. K. McGillivray	27	39	8	557	**69**	17.96	50.36	67	29.38	86.62	3	Lateral

*BBTT = Batting Backlift Technique Type; Inn = Innings; Mat = Matches; NO = Not Outs; * = Not out; - = did not play Tests/ODI; Highest scores = BOLD*

Figure 3.6: Batting backlift technique type of the Gauteng players (n = 10)

Mogotsi (L; HS = 69)

Valli (L; HS = 130*)

Conway (L; HS = 152)

Pillay (S; HS = 138*)

Mvelase (S; HS = 25)

Dial (S; HS = 94*)

Jamison (S; HS = 49)

Potgieter (S; HS = 41)

Roelofsen (S; HS = 4)

McGillivray (L; HS = 69)

S = SBBT; L = LBBT; HS = Highest Score

Table 3.10: Characteristics and performances of the North West cricket team (n = 4)

Player	Mat	Inn	NO	Runs	First Class			List A			Classifier	BBTT
					High Score	Average	Strike Rate	High Score	Average	Strike Rate		
K. Rapulana	53	89	5	1930	**112**	22.97	50.40	56	19.16	65.21	1	Straight
M. J. Ackerman	4	7	0	77	31	11.00	48.42	**80**	31.57	86.32	2	Straight
F.J. Lubbe	4	5	1	254	**106**	63.50	51.52	14	7.66	92.00	3	Lateral
W.J. Lubbe	14	23	4	587	**93**	30.89	60.39	78	30.66	72.63	3	Lateral

*BBTT = Batting Backlift Technique Type; Inn = Innings; Mat = Matches; NO = Not Outs; * = Not out; Highest scores = BOLD*

Figure 3.7: Batting backlift technique type of the North West players (n = 4)

K. Rapulana (S: HS = 112)	M.J. Ackerman (S; HS = 80)	F.J. Lubbe (S; HS = 106)	W.J. Lubbe (S; HS = 93)

S = SBBT; L = LBBT; HS = Highest Score

Table 3.11: Characteristics and performances of the Lions cricket players (n = 5)

Player	Mat	Inn	NO	Runs	First Class			List A			Classifier	BBTT
					High Score	Average	Strike Rate	High Score	Average	Strike Rate		
S. C. Cook	171	315	28	11890	**390**	41.42	48.78	127*	38.83	78.09	3	Lateral
H. E. van der Dussen	83	137	14	5046	**166**	41.02	46.26	134*	45.34	73.75	2	Straight
A. N. Petersen	216	371	19	14062	**286**	39.94	51.75	142*	36.29	82.62	1	Straight
T. Bavuma	90	146	21	4900	**162**	39.20	51.26	108*	26.73	80.02	1	Straight
D. Pretorius	32	44	5	1510	**177**	38.71	71.66	77*	41.00	98.49	2	Straight

*BBTT = Batting Backlift Technique Type; Inn = Innings; Mat = Matches; NO = Not Outs; * = Not out; Highest scores = BOLD*

Figure 3.8: Batting backlift technique type of the Lions players (n = 5)

Cook (L; HS = 390)	v.d. Dussen (S; HS = 166)	Petersen (S; HS = 286)	Bavuma (S; HS = 162)	Pretorius (S; HS = 177)

S = SBBT; L = LBBT; HS = Highest Score

Table 3.12: Characteristics and performances of the Northerns cricket team (n = 8)

Player	Mat	Inn	NO	Runs	First Class			List A			Classifier	BBTT
					High Score	Average	Strike Rate	High Score	Average	Strike Rate		
J.J. Pienaar	86	142	13	4008	**185**	31.06	66.35	119	24.98	89.27	1	Straight
V.B. Mahlangu	16	24	1	366	**61**	15.91	46.03	16	10.00	48.78	2	Straight
G. L. van Buuren	54	82	14	3362	**235**	49.44	66.33	119*	31.00	84.80	1	Straight
A.K. Markram	20	32	2	1126	**182**	37.53	59.95	111	35.66	88.06	3	Lateral
S. Naidoo	57	84	7	1893	**119**	24.58	49.01	60	17.40	60.10	3	Lateral
H. Klaasen	42	63	12	2505	**201**	49.11	70.01	70*	22.41	80.54	2	Straight
S. von Berg	75	114	16	2738	**105***	27.93	55.51	47*	14.00	79.83	3	Lateral
S.A. Mothoa	9	17	8	97	**23***	10.77	44.29	-	-	-	2	Straight

*BBTT = Batting Backlift Technique Type; Inn = Innings; Mat = Matches; NO = Not Outs; * = Not out; - = did not play Tests/ODI; Highest scores = BOLD*

Figure 3.9: Batting backlift technique type of the Northerns players (n = 8)

			
J.J. Pienaar (S; HS = 185)	V.B. Mahlangu (S; HS = 61)	G.L. van Buuren (S; HS = 235)	S. von Berg (L; HS =)
			
A.K. Markram (L; HS = 182)	S. Naidoo (L; HS = 119)	H. Klaasen (S; HS = 201)	S.A. Mothoa (S; HS = 23*)

S = SBBT; L = LBBT; HS = Highest Score

Table 3.13: Characteristics and performances of the Titans cricket team (n = 8)

Player	Mat	Inn	NO	Runs	First Class			List A			Classifier	BBTT
					High Score	Average	Strike Rate	High Score	Average	Strike Rate		
H. G. Kuhn	121	211	21	8298	**244***	43.67	-	141*	30.80	85.13	3	Lateral
Q. de Kock	34	57	7	2404	**194**	48.08	81.32	138*	40.01	93.58	3	Lateral
D. Elgar	126	217	21	8751	**268**	44.64	49.99	117	39.51	77.13	1	Straight
T. G. Mokoena	89	150	7	4224	**217**	29.53	62.63	115*	17.44	75.32	2	Straight
T. B. de Bruyn	26	47	4	2009	**202***	46.72	65.91	152*	36.33	81.69	3	Lateral
H. Davids	123	122	10	6658	158	31.40	-	**166**	30.42	33.33	3	Lateral
M.Q. Adams	63	102	8	3773	**167**	40.13	59.88	121*	38.94	95.77	2	Straight
E. L. Hawken	21	23	1	252	**54**	11.45	35.79	18	12.50	69.44	2	Straight

*BBTT = Batting Backlift Technique Type; Inn = Innings; Mat = Matches; NO = Not Outs; * = Not out; - = did not play Tests/ODI; Highest scores = BOLD*

Figure 3.10: Batting backlift technique type of the Titans players (n = 8)

H.G. Kuhn (L; HS = 244*)

D. Elgar (S; HS = 268)

T.G. Mokoena (S; HS = 202*)

T.B. de Bruyn (L; HS = 217)

H. Davids (L; HS = 166)

M.Q. Adams (S; HS = 167)

Q. de Kock (L; HS = 194)

E.L. Hawken (S; HS = 54)

S = SBBT; L = LBBT; HS = Highest Score

Table 3.14: Characteristics and performances of the Kwa-Zulu Natal Inland cricket team (n = 7)

Player	Mat	Inn	NO	Runs	First Class			List A			Classifier	BBTT
					High Score	Average	Strike Rate	High Score	Average	Strike Rate		
D.J. van Wyk	124	212	8	8048	**178**	39.45	53.97	118	34.09	79.59	1	Straight
K. Nipper	77	125	19	3677	**151***	34.68	60.19	100*	27.91	85.67	3	Lateral
R. Pretorius	37	61	6	1319	66*	23.98	58.10	**71**	34.53	93.84	2	Straight
G. Dukes	12	24	3	415	**54**	19.76	58.04	47*	27.00	79.41	3	Lateral
L. Mosena	73	118	4	2612	**105**	22.91	48.22	73	23.39	60.41	3	Lateral
K. R. Kishun	18	23	6	368	**96**	21.64	38.49	37	12.12	59.50	1	Straight
G. Hume	68	89	23	1266	**105**	19.18	45.90	30	17.90	60.47	1	Straight

*BBTT = Batting Backlift Technique Type; Inn = Innings; Mat = Matches; NO = Not Outs; * = Not out; Highest scores = BOLD*

Figure 3.11: Batting backlift technique type of the Kwa-Zulu Natal Inland players (n = 7)

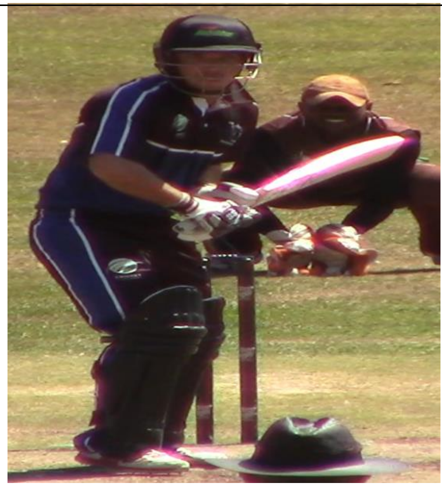
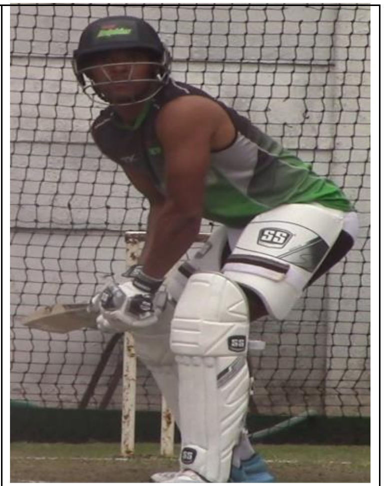
			
D.J. van Wyk (S; HS = 178)	K. Nipper (L; HS = 151*)	R. Pretorius (S; HS = 66*)	K.R. Kishun (S; HS = 96)
			
G. Dukes (L; HS = 54)	G. Hume (S; HS = 105)	L. Mosena (L; HS = 105)	

Table 3.15: Characteristics and performances of the Dolphins cricket team (n = 10)

Player	Mat	Inn	NO	Runs	First Class			List A			Classifier	BBTT
					High Score	Average	Strike Rate	High Score	Average	Strike Rate		
K. Zondo	81	128	3	3503	**175**	28.02	48.07	110	28.66	75.56	1	Straight
V. B. van Jaarsveld	92	152	6	5698	**160**	39.02	63.03	118	37.20	86.62	3	Lateral
J. D. Vandiar	72	118	9	3598	**172***	36.31	59.70	130	31.25	87.33	3	Lateral
D. Smit	116	172	31	5086	**156***	36.07	46.87	109	31.69	76.89	3	Lateral
C. Alexander	90	103	39	802	**54**	12.53	66.00	31*	5.30	63.54	1	Straight
S. Erwee	55	93	10	2958	**200***	35.63	54.07	113	41.04	87.55	1	Straight
M. van Wyk	146	251	37	8318	**200***	38.86	68.88	175*	40.45	143.31	3	Lateral
K.A. Maharaj	74	100	19	1799	**114***	22.20	66.26	43*	13.16	87.17	3	Lateral
M. Shezi	72	86	29	546	**64**	9.57	27.40	16	6.61	43.58	1	Straight
D. M. Dupavillon	40	45	14	392	**44**	12.64	62.02	11	12.0	85.71	1	Straight

*BBTT = Batting Backlift Technique Type; Inn = Innings; Mat = Matches; NO = Not Outs; * = Not out; Highest scores = BOLD*

Figure 3.12: Batting backlift technique type of the Dolphins players (n = 10)

				
K. Zondo (S; HS = 175)	van Jaarsveld (L; HS = 160)	Vandiar (L; HS = 172*)	D. Smit (L; HS = 156*)	C. Alexander (S; HS = 54)
				
S. Erwee (S; HS = 200*)	M. van Wyk (L; HS = 200*)	Maharaj (L; HS = 114*)	M. Shezi (S; HS = 64)	Dupavillon (S; HS = 44)

S = SBBT; L = LBBT; HS = Highest Score

Table 3.16: Characteristics and performances of the Border cricket team (n = 7)

Player	Mat	Inn	NO	Runs	First Class			List A			Classifier	BBTT
					High Score	Average	Strike Rate	High Score	Average	Strike Rate		
G.V.J. Koopman	48	84	4	1981	**108**	24.76	44.00	87*	32.13	69.65	3	Lateral
S. Seyibokwe	50	84	3	2133	**101**	26.33	55.01	33	11.96	67.24	1	Straight
M. Malika	1	1	0	7	-	-	-	7	7.00	87.50	1	Straight
D.L. Brown	97	153	20	3480	**112***	26.16	48.58	76	34.94	90.75	2	Straight
J. Marais	1	2	0	30	**18**	15.00	43.47	9	5.20	47.82	2	Straight
M. Walters	57	96	7	2757	**180***	30.97	48.24	102*	34.93	67.51	3	Lateral
C.G. Bosch	2	3	0	20	13	6.66	28.57	**14**	9.50	52.77	3	Lateral

*BBTT = Batting Backlift Technique Type; Inn = Innings; Mat = Matches; NO = Not Outs; * = Not out; - = did not play Tests/ODI; Highest scores = BOLD*

Figure 3.13: Batting backlift technique type of the Border players (n = 7)

			
G.V.J. Koopman (L; HS = 108)	S. Seyibokwe (S; HS = 101)	M. Malika (S; HS =)	D.L. Brown (S; HS = 112*)
			
J. Marais (S; HS = 18)	M. Walters (L; HS = 180*)	C. G. Bosch (L; HS = 14)	

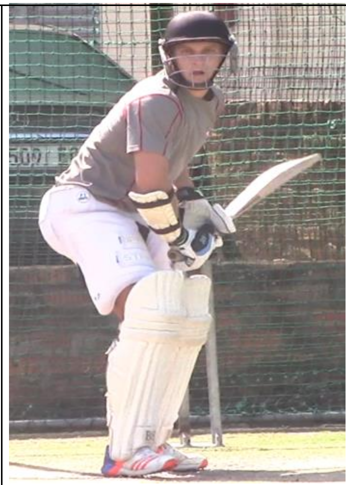
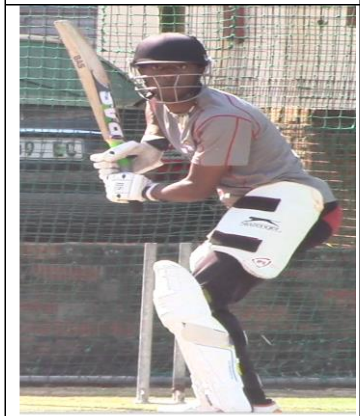
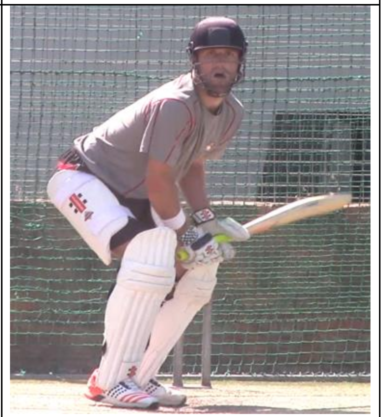
S = SBBT; L = LBBT; HS = Highest Score

Table 3.17: Characteristics and performances of the Eastern Province cricket team (n = 10)

Player	Mat	Inn	NO	Runs	First Class			List A			Classifier	BBTT
					High Score	Average	Strike Rate	High Score	Average	Strike Rate		
D.J. White	70	120	8	3528	**160**	31.50	49.38	94*	29.62	73.67	3	Lateral
E.M. Moore	36	63	8	1936	**144**	35.20	50.82	90	38.06	75.22	3	Lateral
M.C. Christensen	8	9	0	209	**84**	23.22	39.96	27	15.33	112.19	2	Straight
K.R. Smuts	74	123	8	3484	**148**	30.29	55.74	90	21.20	82.73	2	Straight
A.J.N. Price	46	71	5	2235	**167**	33.86	68.20	87	33.60	86.17	3	Lateral
O. Nyaku	12	16	1	342	**93***	22.80	43.18	30	13.50	79.41	3	Lateral
A. Nortje	19	22	8	321	**79***	22.92	55.92	16	10.00	55.55	3	Lateral
T. Bokako	24	31	2	284	**31**	9.79	39.72	28	13.33	56.33	1	Straight
E. O'Reilly	32	34	16	229	**42***	12.72	31.98	6*	4.80	45.28	2	Straight
T. Koekemoer	1	1	0	46	**46**	46	48.93	9	19	86.36	3	Lateral

*BBTT = Batting Backlift Technique Type; Inn = Innings; Mat = Matches; NO = Not Outs; * = Not out; Highest scores = BOLD*

Figure 3.14: Batting backlift technique type of the Eastern Province players (n = 10)

				
White (L; HS = 160)	Moore (L; HS = 144)	Christensen (S; HS = 84)	Smuts (S; HS = 148)	Price (L; HS = 167)
				
Nyaku (L; HS = 93*)	Nortje (L; HS = 79*)	Bokako (S; HS = 31)	O'Reilly (S; HS = 42*)	Koekemoer (L; HS = 46)

S = SBBT; L = LBBT; HS = Highest Score

Table 3.18: Characteristics and performances of the Warriors cricket team (n = 10)

Player	Mat	Inn	NO	Runs	First Class			List A			Classifier	BBTT
					High Score	Average	Strike Rate	High Score	Average	Strike Rate		
C.N. Ackermann	61	107	11	3680	**144**	38.33	46.37	92	32.13	68.07	3	Lateral
G.L. Cloete	80	138	9	3874	**135**	30.03	49.14	85	22.74	65.89	2	Straight
M.L. Price	98	181	9	5366	**181**	31.19	51.99	155	39.77	77.60	2	Straight
J.J.T. Smuts	76	142	8	4386	**150***	32.73	61.29	132	33.89	77.91	3	Lateral
M.Y. Vallie	76	118	13	4211	**167**	40.10	58.94	96	33.00	77.55	1	Straight
M.J. Nqolo	47	72	4	1525	**137**	22.42	53.86	63	23.17	76.14	3	Lateral
C. Fortuin	18	26	2	600	72	25.00	51.06	**80**	15.07	68.28	1	Straight
S.R. Harmer	76	118	25	2450	**100***	26.34	48.75	43*	19.39	101.42	1	Straight
A. Gqamane	46	65	10	1074	86	19.52	77.71	**88***	32.61	112.76	1	Straight
S.S.B. Magala	56	80	18	1053	53	16.98	47.60	**78***	15.36	87.95	3	Lateral

*BBTT = Batting Backlift Technique Type; Inn = Innings; Mat = Matches; NO = Not Outs; * = Not out; Highest scores = BOLD*

Figure 3.15: Batting backlift technique type of the Warriors players (n = 10)

				
Ackermann (L; HS = 144)	Cloete (S; HS = 135)	Price (S; HS = 181)	Fortuin (S; HS = 72)	Harmer (S; HS = 100*)
				
Smuts (L; HS = 150*)	Vallie (S; HS = 167)	Nqolo (L; HS = 137)	Gqamane (S; HS = 86)	Magala (L; HS = 53)

S = SBBT; L = LBBT; HS = Highest Score

Table 3.19: Characteristics and performances of the Cobras cricket team (n = 8)

Player	Mat	Inn	NO	Runs	First Class			List A			Classifier	BBTT
					High Score	Average	Strike Rate	High Score	Average	Strike Rate		
A.G. Puttick	158	274	27	10057	**250***	40.71	-	143	36.39	-	1	Straight
O.A. Ramela	86	150	7	4183	**202***	29.25	42.03	106	28.03	64.63	1	Straight
S. van Zyl	11	15	2	355	101*	27.30	53.95	**114***	37.03	73.96	2	Straight
J.L. Ontong	181	288	22	10901	**166**	40.98	36.77	122	29.43	68.91	2	Straight
D.J. Vilas	88	132	14	4845	**216***	68.69	44.76	120	33.09	95.58	1	Straight
C. Tshiki	27	46	1	928	**175**	20.62	43.42	98	22.80	65.52	2	Straight
W.D. Parnell	56	75	6	1747	111*	25.31	51.54	**129**	24.58	85.48	3	Lateral
V. Philander	123	161	28	3388	**168**	25.47	46.43	79*	23.28	75.22	3	Lateral

*BBTT = Batting Backlift Technique Type; Inn = Innings; Mat = Matches; NO = Not Outs; * = Not out; - = did not play Tests/ODI; Highest scores = BOLD*

Figure 3.16: Batting backlift technique type of the Cobras players (n = 8)

			
A.G. Puttick (S; HS = 250*)	O.A. Ramela (S; HS = 202*)	S. van Zyl (S; HS = 114)	J.L. Ontong (S; HS = 166)
			
C. Tshiki (S; HS = 175)	W.D. Parnell (L; HS = 129)	V. Philander (L; HS = 168)	D.J. Vilas (S; HS = 216*)

S = SBBT; L = LBBT; HS = Highest Score

Table 3.20: Characteristics and performances of the Western Province players (n =10) (Adapted from Chapter 4)

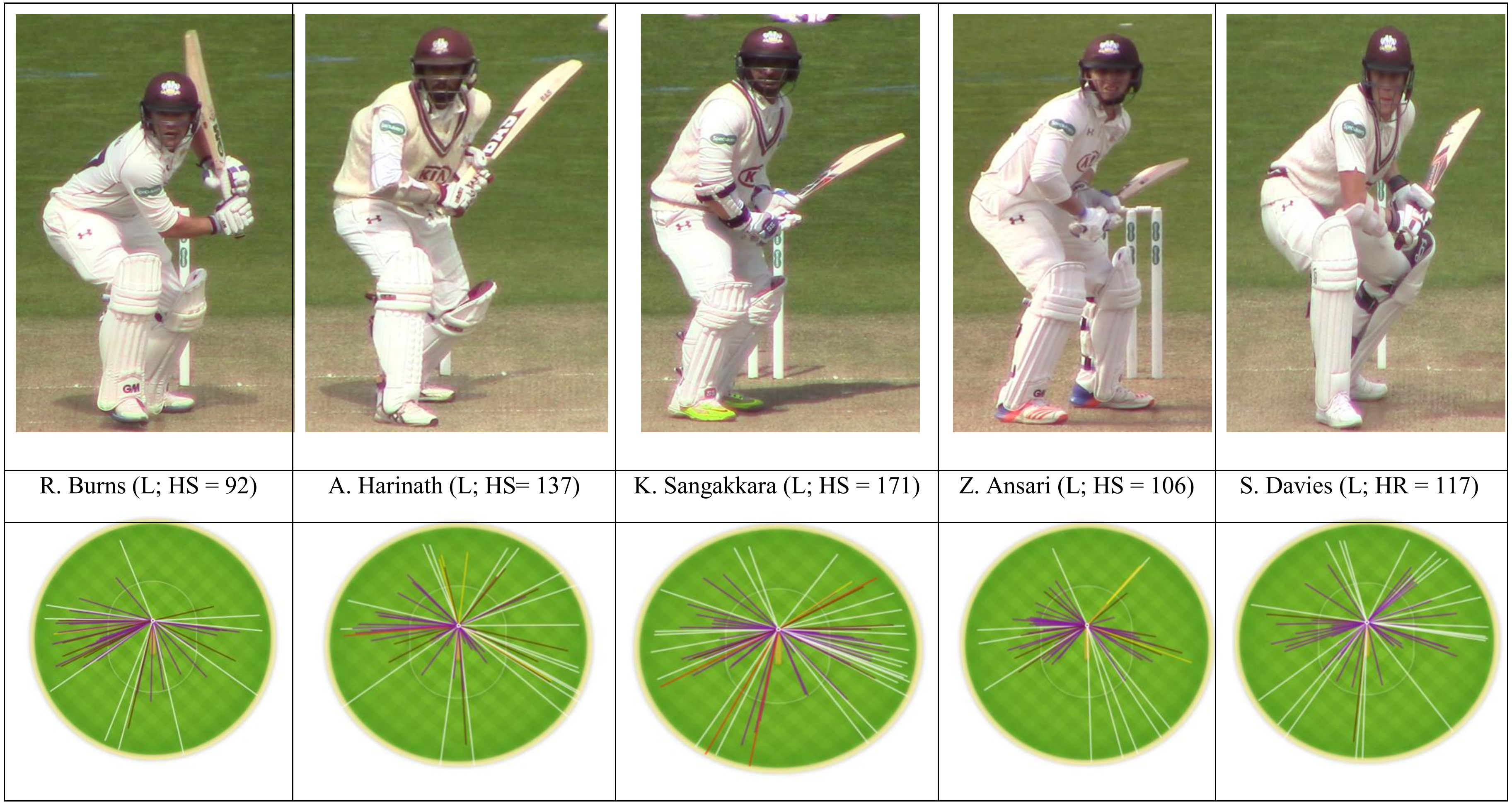
Amateur Players	BBTT	Classifier	First Class		List A	
			Runs	Average	Runs	Average
Player 1	Straight	1	76	7.60	15	15.00
Player 2	**Lateral**	3	5873	**41.35**	2152	**48.90**
Player 3	Straight	2	1927	27.52	487	18.73
Player 4	**Lateral**	3	570	**51.81**	103	**34.33**
Player 5	Straight	2	3000	34.09	376	17.09
Player 6	Straight	1	802	22.91	171	11.40
Player 7	Straight	2	117	23.40	6	3.00
Player 8	Straight	1	73	7.30	46	46.00
Player 9	Straight	2	90	12.85	13	13.00
Player 10	Straight	2	167	12.84	114	16.28

Note: Players from this group provided consent for participation in the study but not for their identity to be disclosed (Figure 3.17).

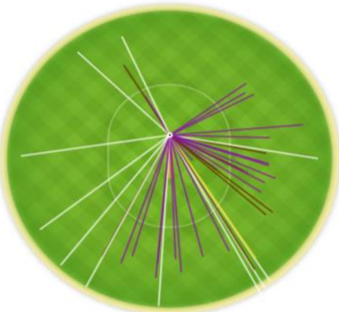
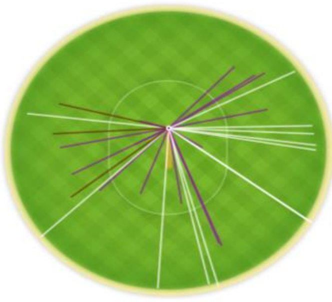
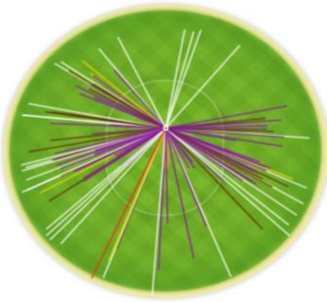
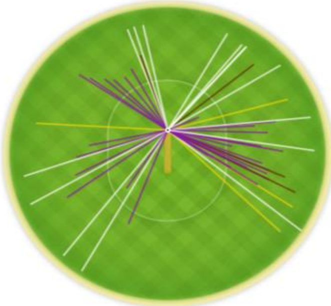
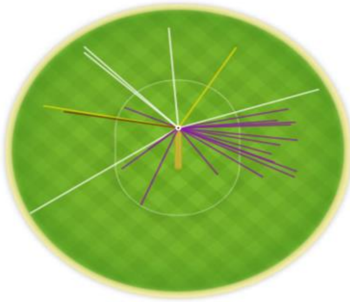
Figure 3.17: Batting backlift technique type of the Western Province players (n = 10) (Adapted from Chapter 4)

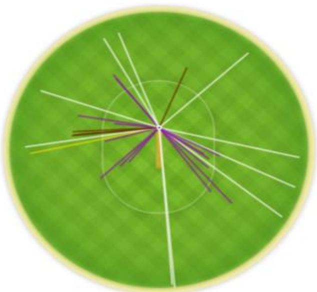
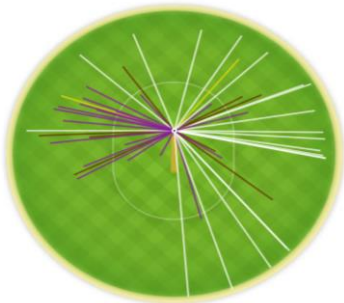
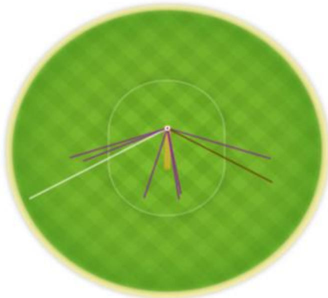
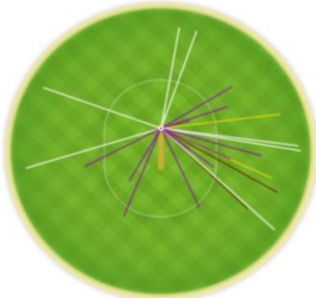
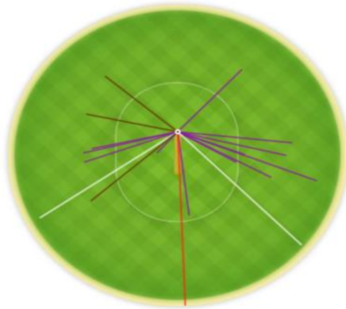
Note: This team provided consent to participate in the study but not for their identity to be disclosed.

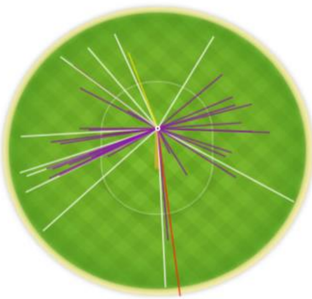
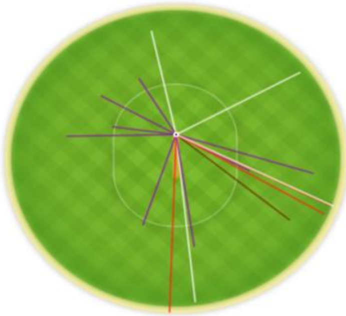
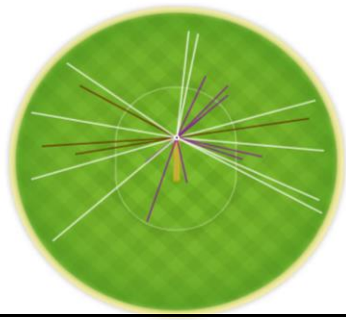
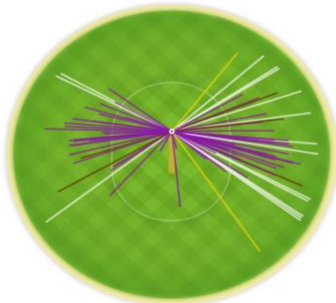
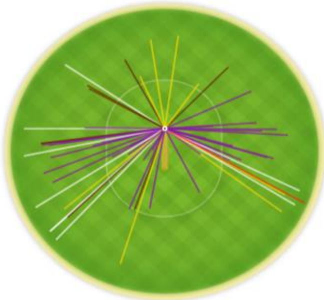
Figure 3.18: Images and wagon wheels of the County Cricket Club batsmen during the 2016 season (n = 25)



HS = Highest Score in the 2016 County season until May 2016; L = Lateral batting backlift technique; S = Straight batting backlift technique

				
J. Roy (S; HS= 85)	B. Foakes (L; HS = 72)	S. Robson (S; HS= 231)	N. Gubbins (S; HS = 109)	N. Compton (S; HS = 44)
				

				
J. Simpson (S; HS = 66)	D. Malan (S; HS= 121)	B. Stokes (L; HS= 12)	A. Voges (S; HS= 50)	J. Franklin (S; HS = 32)
				

				
P. Stirling (S; HS = 85)	T. Roland-Jones (S; HS = 44)	J. Harris (S; HS= 57)	M. Stoneman (L; HS = 141*)	K. Jennings (L; HS = 113)
				

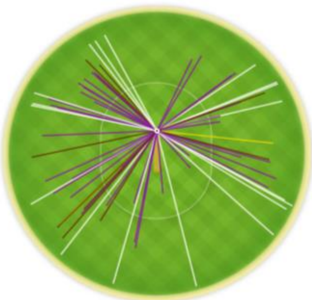
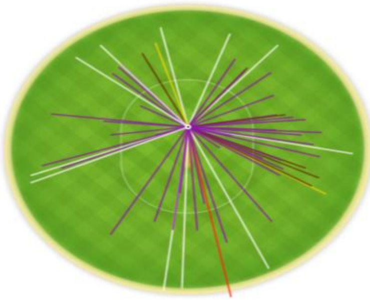
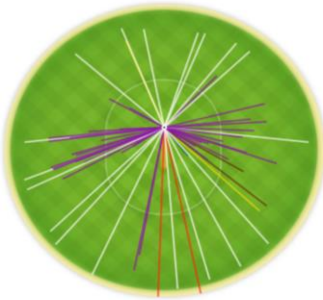
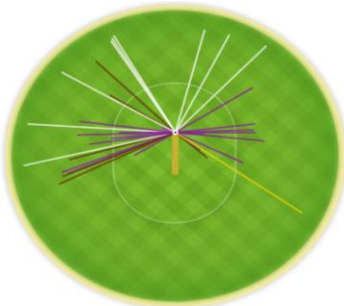
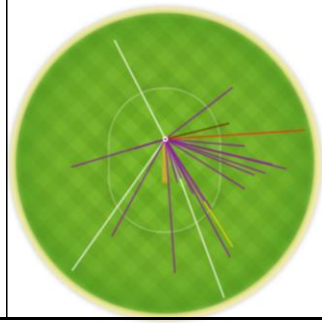
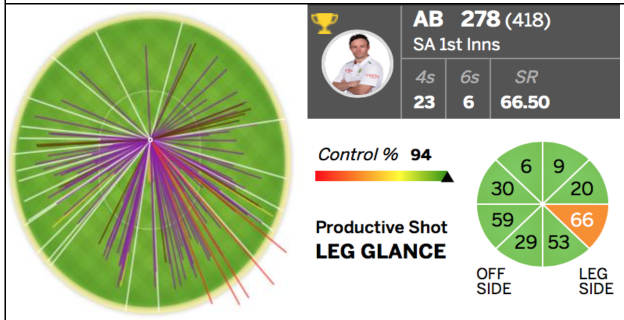
				
S. Borthwick (S; HS = 134)	Collingwood (L; HS = 106)	J. Burnham (S; HS = 135)	M. Richardson (S; HS = 115*)	G. Batty (S; HS = 40)
				

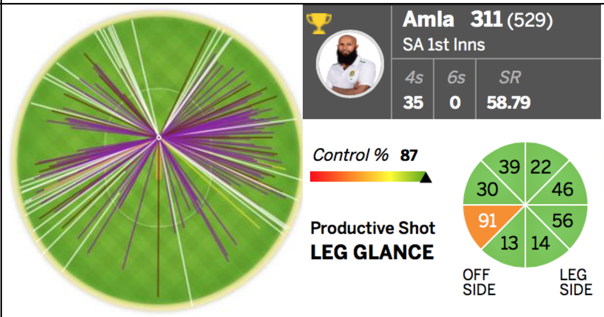
Figure 3.19: South African batsmen's highest score at Test or ODI levels (n = 12)

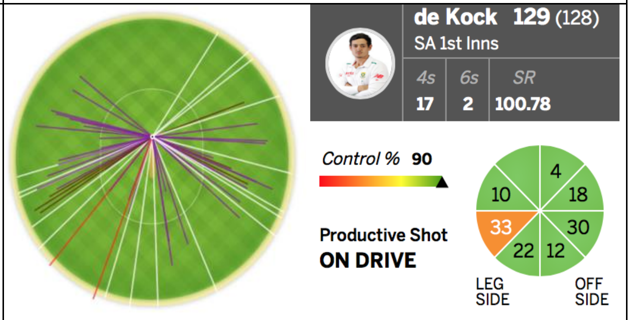
AB de Villiers (L; HS = 278*)

Hashim Amla (L; HS = 311*)

Quinton de Kock (L; HS = 129)

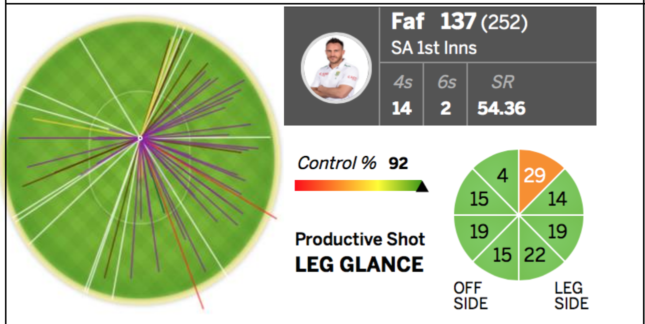


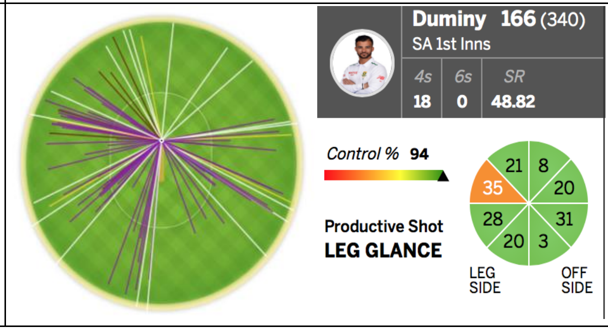


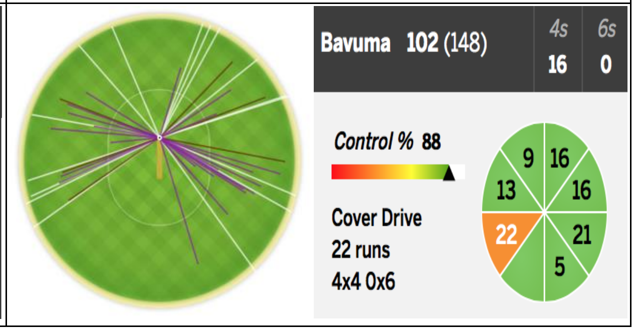


HS = Highest Score in their Test/ODI career; L = Lateral batting backlift technique; S = Straight batting backlift technique

		
Faf du Plessis (L; HS = 137)	JP Duminy (L; HS = 166)	Temba Bavuma (S; HS = 102)







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<tr><td></td><td></td><td></td></tr>
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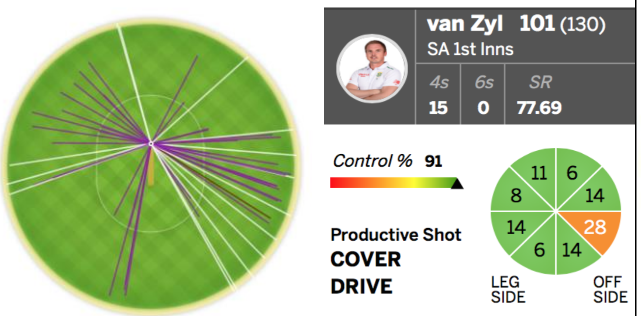
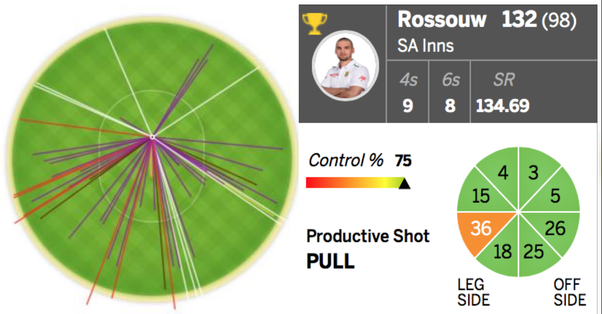
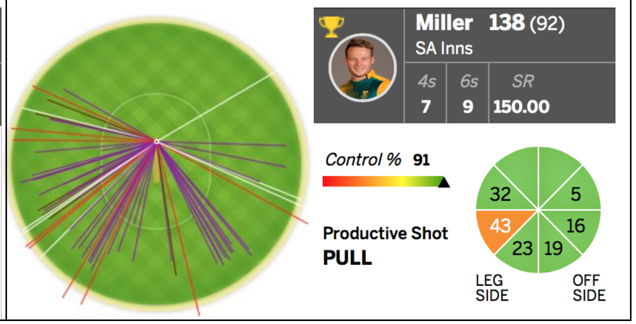
<tr><td>
</td><td>
</td><td>
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<td>Stephen Cook (L; HS = 115)</td>
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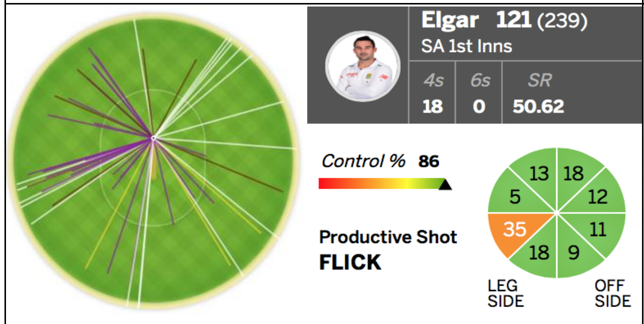
<td>
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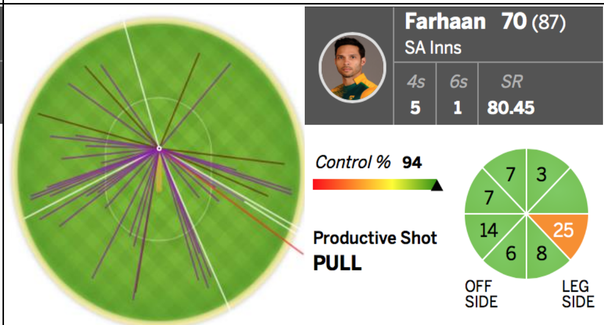
<td>
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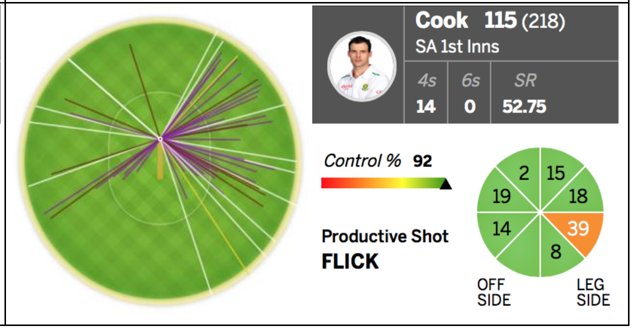
<td>
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Appendix E3 (Chapter 4 Figures)

Figure 4.3: Images of uncoached cricketers (n = 40) playing Calypso (street) cricket

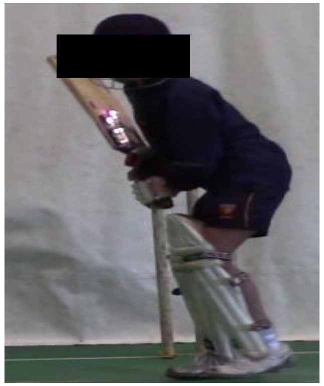
				
4.2.1	**4.2.2**	**4.2.3**	**4.2.4**	**4.2.5**
				
4.2.6	**4.2.7**	**4.2.8**	**4.2.9**	**4.2.10**

				
4.2.11	**4.2.12**	**4.2.13**	**4.2.14**	**4.2.15**
				
4.2.16	**4.2.17**	**4.2.18**	**4.2.19**	**4.2.20**

				
4.2.21	**4.2.22**	**4.2.23**	**4.2.24**	**4.2.25**
				
4.2.26	**4.2.27**	**4.2.28**	**4.2.29**	**4.2.30**

				
4.2.31	**4.2.32**	**4.2.33**	**4.2.34**	**4.2.35**
				
4.2.36	**4.2.37**	**4.2.38**	**4.2.39**	**4.2.40**

Figure 4.4: Images of coached cricketers (n = 30) playing cricket at adolescent level

				
4.3.1	**4.3.2**	**4.3.3**	**4.3.4**	**4.3.5**
				
4.3.6	**4.3.7**	**4.3.8**	**4.3.9**	**4.3.10**

				
4.3.11	**4.3.12**	**4.3.13**	**4.3.14**	**4.3.15**
				
4.3.16	**4.3.17**	**4.3.18**	**4.3.19**	**4.3.20**

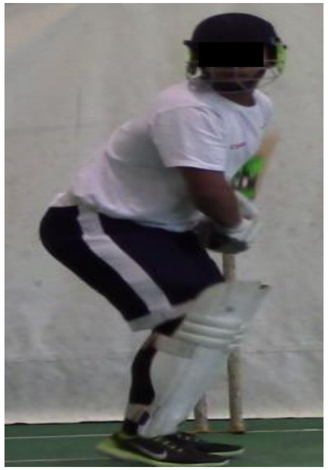
				
4.3.21	**4.3.22**	**4.3.23**	**4.3.24**	**4.3.25**
				
4.3.26	**4.3.27**	**4.3.28**	**4.3.29**	**4.3.30**

Figure 4.5: Images of Coached Cricketers (n = 10) playing cricket at amateur level

				
4.4.1	**4.4.2**	**4.4.3**	**4.4.4**	**4.4.5**
				
4.4.6	**4.4.7**	**4.4.8**	**4.4.9**	**4.4.10**

Appendix E4 (Chapter 6 Figures)

Table 6.4: Images showcasing the batting backlift techniques of the <u>control group</u> (n = 6) over six weeks in the frontal plane

<u>Pre-match (Week 1)</u>					
					
6.3.1 Player A1	**6.3.2 Player A2**	**6.3.3 Player A3**	**6.3.4 Player A4**	**6.3.5 Player A5**	**6.3.6 Player A6**
<u>Post-match (Week 6)</u>					
					
6.3.7 Player A1	**6.3.8 Player A2**	**6.3.9 Player A3**	**6.3.10 Player A4**	**6.3.11 Player A5**	**6.3.12 Player A6**

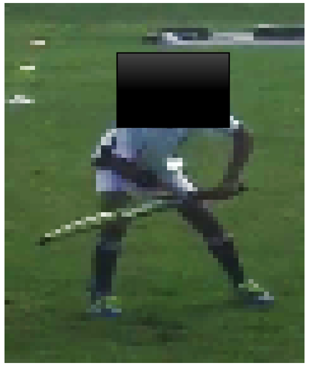
Table 6.5: Images showcasing the batting backlift techniques of the experimental group (n = 6) over six weeks in the frontal plane

Pre-match (Week 1)					
					
6.4.1 Player B1	**6.4.2 Player B2**	**6.4.3 Player B3**	**6.4.4 Player B4**	**6.4.5 Player B5**	**6.4.6 Player B6**
Post-match (Week 6)					
					
6.4.7 Player B1	**6.4.8 Player B2**	**6.4.9 Player B3**	**6.4.10 Player B4**	**6.4.11 Player B5**	**6.4.12 Player B6**

Table 6.6: Images showcasing the batting backlift techniques of the control group (n = 6) over six weeks in the transverse plane

Pre-match (Week 1)					
					
6.5.1 Player A1	**6.5.2 Player A2**	**6.5.3 Player A3**	**6.5.4 Player A4**	**6.5.5 Player A5**	**6.5.6 Player A6**
Post-match (Week 6)					
					
6.5.7 Player A1	**6.5.8 Player A2**	**6.5.9 Player A3**	**6.5.10 Player A4**	**6.5.11 Player A5**	**6.5.12 Player A6**

Table 6.7: Images showcasing the batting backlift techniques of the experimental group (n = 6) over six weeks in the transverse plane

Pre-match (Week 1)					
					
6.6.1 Player B1	**6.6.2 Player B2**	**6.6.3 Player B3**	**6.6.4 Player B4**	**6.6.5 Player B5**	**6.6.6 Player B6**
Post-match (Week 6)					
					
6.6.7 Player B1	**6.6.8 Player B2**	**6.6.9 Player B3**	**6.6.10 Player B4**	**6.6.11 Player B5**	**6.6.12 Player B6**

APPENDIX F:

BEYOND THE BACKLIFT: UNDERSTANDING ALL ASPECTS OF CRICKET BATSMANSHIP

INTRODUCTION

Biomechanical investigations into cricket batting have made some important contributions in establishing benchmarks for the kinematic and kinetic properties for elements of batting across different skill levels. However, in isolation, these studies generally fail to explain why these differences exist. Furthermore, there is little to inform coaches how this information can be used to develop successful programmes to improve performance in different sporting disciplines involving highly skilled actions (Sarpeshkar *et al.,* 2011). As such, there is a clear need for a more multidisciplinary approach to better understand how and why skilled biomechanical movements are produced by the most successful exponents in different sports. In other words, the integration of findings from different scientific fields can provide additional meaning to the biomechanical data to achieve a higher level of understanding through the appreciation of the underlying processes involved in the planning, organisation, and execution of skilled movements in different sports (Sarpeshkar *et al.,* 2011).

Practical implications for coaching the backlift

In light of the above, this research project has shown that the backlift seems to be a key contributing factor to successful batsmanship for batsmen at all levels of cricket ability. In cricket, the objective of batting is to score runs and not to look technical (Noorbhai & Noakes, 2015). As such, there is a distinction of stylists (being technically correct) versus performance (scoring runs) among batsmen. Therefore, additional attention should be focused towards hitting the ball instead of expressing elegance or being overly technical. Coaches need to be aware when to focus on technique and the correct time on emphasising performance. If too much attention is given to the technique, it could be disadvantageous to a cricketer, as outlined in Chapter 4.

Although a few of the recommendations in this chapter may be common knowledge to coaches and scientists, this section attempts to provide implications for coaching the backlift. Firstly, it is important to understand the body segments and movements involved for executing a successful backlift.

A conceptualised body segment model for the batting backlift technique

A conceptualised body segment model for the batting backlift technique (BBT) should be used when coaching batsmen (Figure E1). This will assist in preventing coaches from focusing on just one or two components of the batting technique. Example: players may have a lateral batting backlift technique (LBBT), however what is happening with their head and feet? The below figure illustrates the main body segments that work collaboratively with the backlift. The rest of this chapter will discuss each segment described in the below figure.

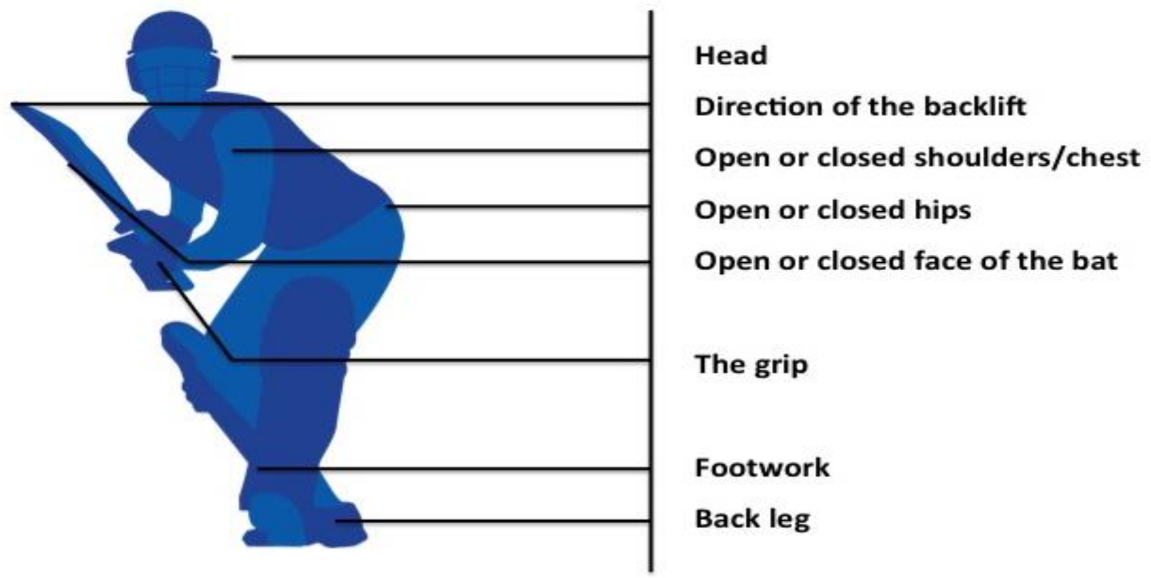


Figure E1: A conceptualised body segment model for the batting backlift technique

Why have some top batsmen been successful with a straight batting backlift technique?

Despite the contributing factor that the LBBT has been for most successful batsmen, an interesting question is: why have some batsmen been successful with a SBBT? Examples of such batsmen are Jacques Kallis, Graeme Smith, and Sanath Jayasuriya. This sub-section aims to discuss the reason as to why each of these players were successful without the use of a LBBT (Figure E2).

Figure E2a: J. Kallis **Figure E2b: G. Smith** **Figure E2c: S. Jayasuriya**

Figure E2: Examples of successful batsmen with a SBBT

Note: In addition to the batsmen's straight batting backlift technique, the toe of the bat for all the above batsmen does not pass their shoulder height. This shows that they do not use a high backlift, nor bat with an open face of the bat. A high backlift, open face of the bat and the direction of the bat towards second slip or beyond are distinguished features of a looped backlift. Other batsmen in Figures 2.6 (Chapter 2) have shown an opposite technique in which the top of their bat passes their shoulder height and is not placed at waist height prior to delivery.

Jacques Kallis (Figure E2a)

Jacques Kallis was one of those batsmen who has been defined as being technically correct in his batting technique (as used in Bob Woolmer's 2009 Art and Science of Cricket). He notably struggled in his early career and towards the middle stages of his career, adopted a trigger movement prior to playing the ball. This shows that batsmen without a LBBT may have to compensate in other areas of their batting technique in order to score runs. This may disadvantage the batsman, but in Kallis's case, he was still able to be successful due to his strong temperament, efficient footwork and balance at the crease. Towards the end of his career, Kallis moved towards using a more open face of the bat due to the advancements of the one-day game and the need to adapt to scoring at rapid rates.

Graeme Smith (Figure E2b)

Graeme Smith was a strong batsman, particularly through the on-side. His factors for success were also his strong eye and balance at the crease. However, a straight batting backlift technique and a wide-closed stance at the crease with a rigid grip made him a likely candidate for an inside-edge dismissal or for leg-before-wicket dismissals. In addition, he struggled with deliveries outside off swinging away from him (just as with most other left-handed batsmen). Furthermore, Smith did not use his height to his advantage like other great batsmen with a tall stature (such as Graeme Pollock and Chris Gayle, who were also left-handed batsmen).

Sanath Jayasuriya (Figure E2c)

On the other hand, Sanath Jayasuriya was one of those batsmen who used his shorter stature to his advantage. Despite his straight batting backlift technique, he was still able to get behind most of the short deliveries and proved to be a prolific player with the pull and cut shots (cross-bat shots). His open stance at the crease also provided him with room to maneuver the ball around the field.

These three world-class players show that each player may have unique reasons explaining why they were successful in batting. However, one might wonder how much more successful these batsmen would have been if they had adopted a LBBT earlier in their careers? In other words, would it have been better if they had not been coached to use the conventional technique? (See Chapter 4).

Elaborating on the use of the SBBT, some players even display two distinct movements prior to making impact with the ball. Figure E3 shows that some batsmen display 'two backlifts' in the time between the release of the ball by the bowler and the ball reaching about mid-way along the pitch. It therefore can be better understood that the backlift is what happens in the batsman's backlift before the ball is released (Figure E3A) and the backswing describes what happens from that moment until the ball is mid-way down the pitch (Figure E3B & E3C). Instead of 'two backlifts', certain batsmen only have 'one backlift', which either means that they are late on the ball or picking up the trajectory of the delivery quicker.

A B C

Figure E3: Differentiating between the backlift and backswing in cricket batting

In order to pick up the trajectory of the ball, some batsmen keep low and kneel while adopting a high backlift just before playing the ball (Figure E4). This has shown to be effective for some of the greatest batsmen (Brian Lara, Chris Gayle, A.B. de Villiers, Yuvraj Singh, Ricky Ponting and Sourav Ganguly) because it would be more challenging for batsmen to pick up the trajectory of the delivery at the same eye-level, especially if bowlers are not too tall (Mann *et al.,* 2016).

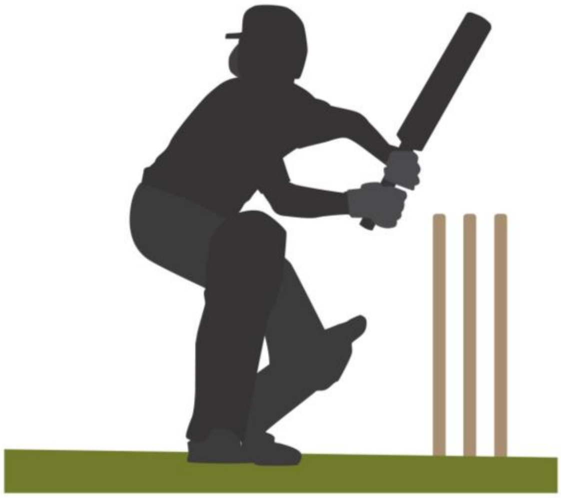


Figure E4: An example of batsmen kneeling down while adopting a high backlift

This poses another interesting question: do batsmen with a LBBT time the ball better and are they able to pick up the trajectory of the ball earlier than those batsmen who adopt the SBBT? If batsmen get into their backlift position already by position Figure E3A or Figure E3B, then they would have adequate time to prepare for the ball, initiate the backswing and play the ball. In the description of Figure E3, this batsman has a SBBT and gets behind the ball by position Figure E3C, which means that he has less time to prepare for the ball which can compromise his shot selection at the respective split second or either be late to hit the ball.

The use of the coaching cricket bat to hit the ball more effectively

As discussed in Chapter 6, another effective way of teaching young cricketers to hit the ball more effectively is to use the coaching cricket bat and hit the ball against a wall repetitively by gripping the bat with both hands (Figure E5). It is advisable for young cricket players to perform this drill at least three times a week for 20 to 30 minutes per day. In addition, if possible, the young cricket player should also use the coaching cricket bat during training or preferably in the nets, experiencing a simulated match situation. In both the frontal and lateral views, Figure E5 shows how a young player can hit the ball repeatedly against a wall with a loop in their backlift. This can be done with a conventional bat or with a coaching cricket bat.

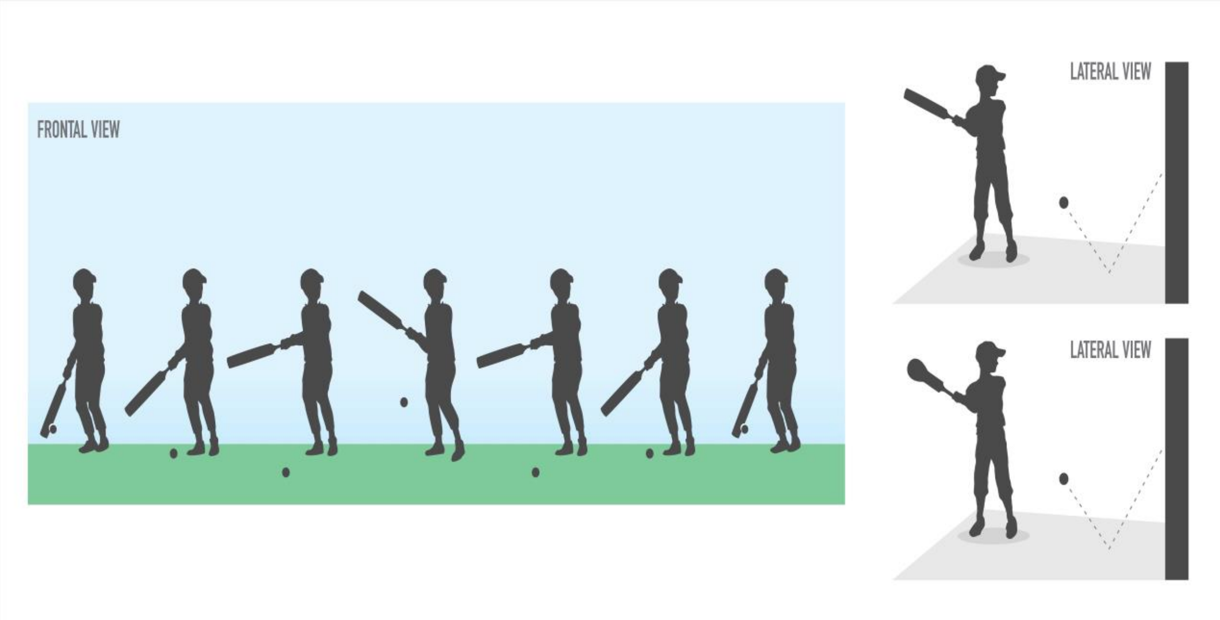


Figure E5: The use of the coaching cricket bat for young cricket players

Throwing the ball against a spherical surface and hitting the ball with a stump

From a motor control and learning perspective, repetitive practice and learning over a period of time can enhance training that subsequently improves performance (as discussed in Chapter 6). Throwing a ball against a circular or spherical surface makes the ball bounce back in an unintended position, which makes a player prepare for the ball in less time that allows adaptation and a quicker response. In addition to enhanced hand-eye-coordination, hitting the ball with a smaller and thinner object with a less surface area (i.e.: a stump) repetitively can assist a player when they use a conventional bat in cricket matches.

In order to eliminate any confusion or contraindications between the use of the coaching cricket bat and the stump, the distinct objectives of these approaches are explained below:

1. As highlighted in Chapter 6, the coaching cricket bat assists young cricket players in the development of a LBBT and to hit the ball more effectively and with power.
2. A stump to hit the ball against a spherical surface helps to assist young cricket players in the development of advanced motor control (hand-eye-coordination, spatial awareness and response time) (Figure E6).

Sir Donald Bradman use to hit a golf ball against a spherical surface in his backyard. This possibly explains why his looped action was so distinctive and why he was so effective when compared to other batsmen. Therefore, the motivation behind this coaching drill comes from the exercise that Bradman had done when he trained.

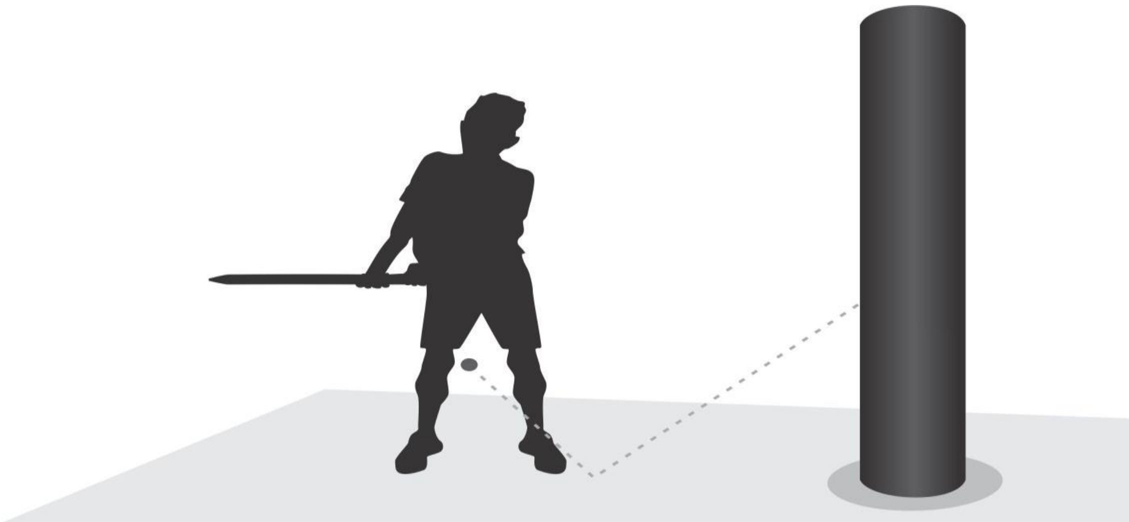


Figure E6: Throwing and hitting a ball against a spherical surface with a stump

Coaching the lateral batting backlift technique to a young cricket player

The following coaching skill description can assist coaches in coaching a LBBT of a young cricket player (Figure E7):

The player bats at the crease/stumps and three cones are set apart on the pitch from the player. Each cone is placed at different lengths of delivery on the pitch. One cone is placed at a back of a length delivery (cone 3), one cone placed at a short length delivery (cone 2) and one cone is placed at half of the pitch. The coach must start with rolling the ball and then proceed to throwing it under arm. When the coach rolls/throws the ball and it passes cone 1, the player must lift the bat in the lateral direction. When the ball passes cone 2, the player must loop the bat and when the ball passes cone 3, the player must be prepared to hit the ball and make impact with the ball after the bat comes down (downswing) followed by a follow-through. This process in coaching is known as chaining where each skill at the cone is broken up and then molded into one complete skill (Baker, 2001).

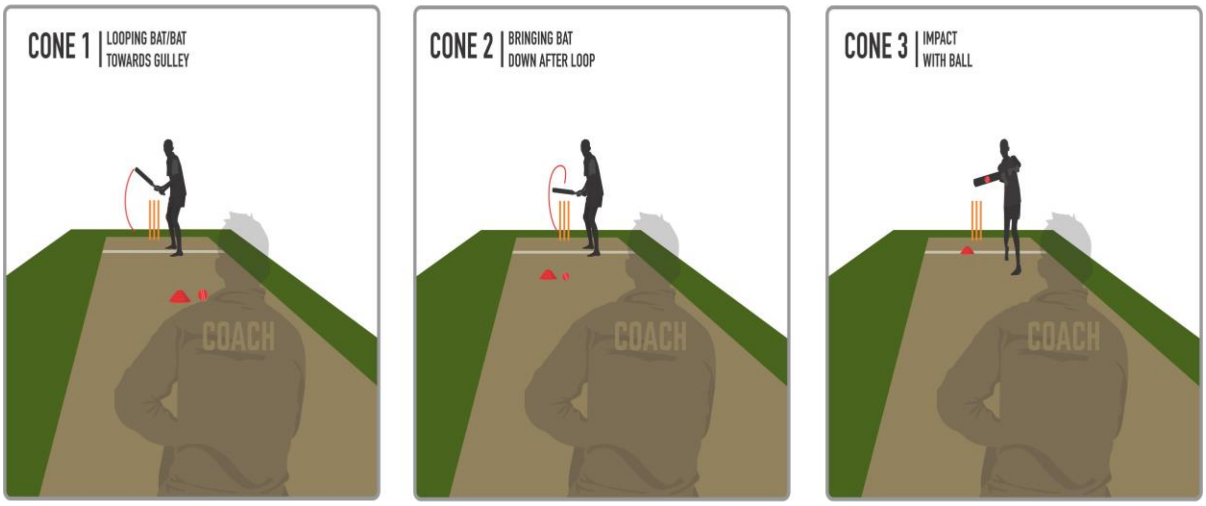


Figure E7: Coaching the lateral batting backlift technique to a young cricket player

Note: When the ball passes cone 1, the player must loop the bat towards gulley. When the ball passes cone 2, the player must bring the bat down after the loop and then make contact with the ball after is passes cone 3.

Bat with an open face of the bat and not closing the face of the bat.

As shown in Chapter 2, an open face of the bat is also categorized as a LBBT, which means that batsmen will be more successful if they use an open face of the bat (as demonstrated in Chapters 2, 3, 4 and 6) (Figure E8).

Figure E8: Coaching the open face of the bat to a young cricket player

Young cricket players should visualise that they are playing 'tennis'

The emphasis of hitting a ball in cricket batting can be compared to other bat sports such as baseball, golf and tennis. Tennis is one of the sports that compliments the loop in the backlift that makes a forehand shot more lateral as opposed to a baseball hit which produces more horizontal displacement. As such, the mindset of a sports player is crucial in assisting them to focus on the task at hand, i.e.: hitting the ball (Figure E9).

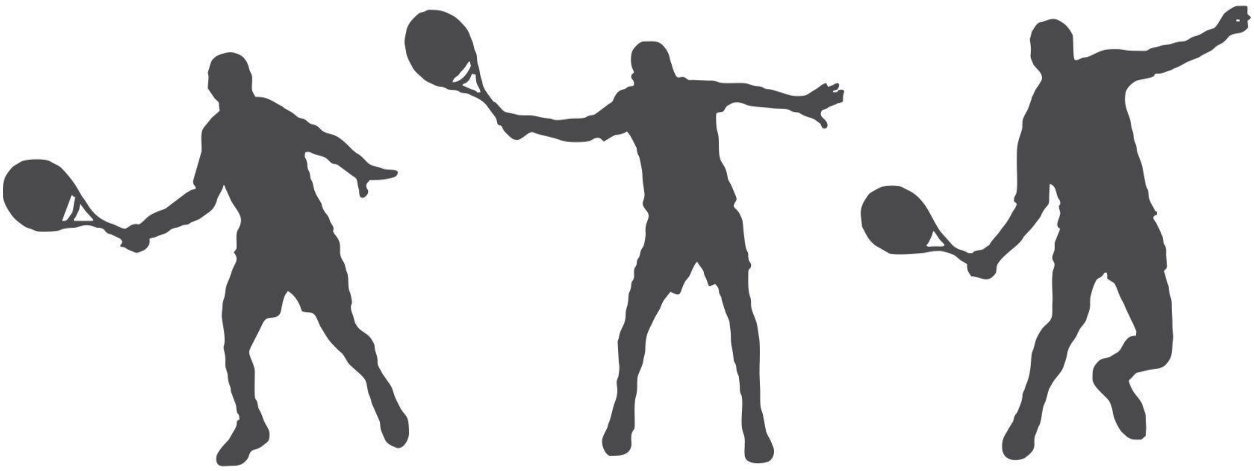


Figure E9: Young cricket players should visualise playing 'tennis'

Similarly in cricket, tennis also requires players to move either on the back or front foot to anticipate and hit the ball depending on the bounce, height and speed of the incoming ball.

Therefore, coaches are advised to encourage young cricket players to not only play tennis but to also allow them to visualise playing tennis in the nets (holding the cricket bat with two hands). The idea of this approach would be to reduce the passivity of the player and encourage the player to hit the ball better instead of leaving the ball or defending it (even though a solid defensive stroke is integral for staying at the crease longer) (Figure E9). In tennis, players tend to approach an incoming ball. Similarly, in cricket, players such as AB de Villiers approach the incoming delivery instead of passively waiting for the ball to arrive.

Footwork and shoulders of a batsman

One needs to also pay attention to the footwork and the positioning of the shoulders (both either being open or closed) of a batsman. Generally, if a batsman has an open stance at the crease with their feet open then it is most likely that their shoulders will also be open. Great batsmen such as Shivnarine Chanderpaul, Kevin Pietersen, Herschelle Gibbs, Gary Kirsten, Younis Khan and Virender Sehwag had an open stance at the crease for most of their careers. Batsmen who have an open stance at the crease will most likely also have a LBBT. One can then draw a straight line from second slip to the batsman's front foot, which means that it would be mechanically impossible for batsmen to still adopt a SBBT by having an open stance at the crease. In order for an open stance to be successful, a batsman would also need to have a stable back leg (the batsman's leg that is closer to the wickets on the inside of the crease) and a minimum shuffle (limited movement of a batsman) across the crease.

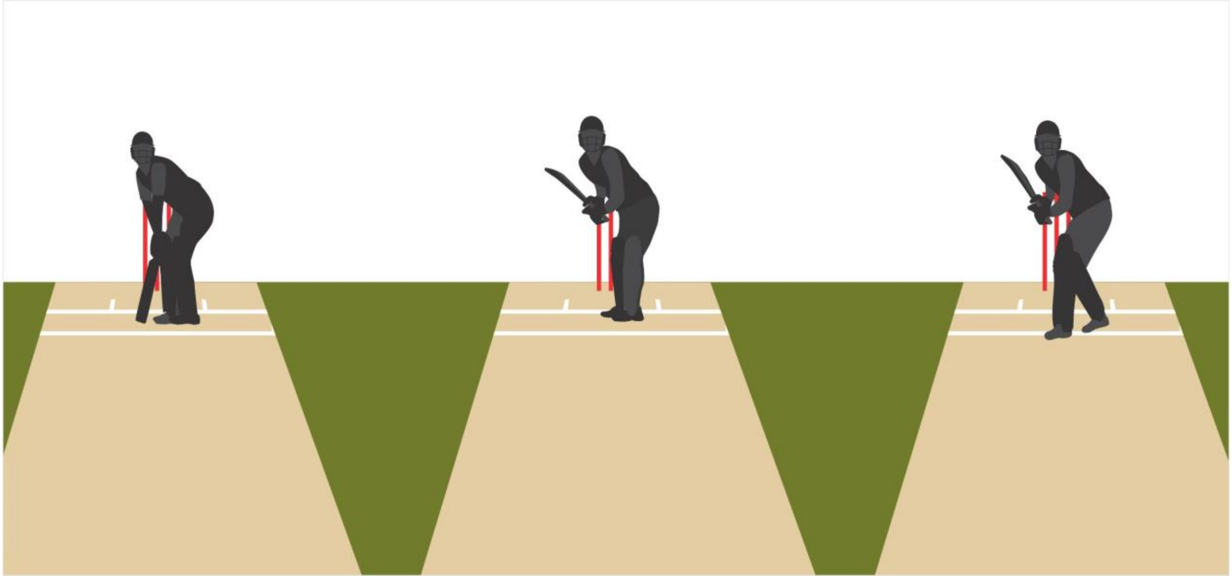


Figure E10: Back leg and shuffling across for a batsman can assist with the LBBT

Back leg and shuffling across

The shuffle allows batsmen to lift their bats more laterally as it would be an uncomfortable position for batsmen to lift their bats in the direction of the stumps or the wicket-keeper while moving (Figure E10). This works in the favour of some unorthodox batsmen such as Shivnarine Chanderpaul as well as technically correct batsmen such as Jacques Kallis when he adapted to limited overs cricket. However, many batsmen shuffle and then freeze at the point of delivery, which causes them to either miss the ball or get out. The recommendation here is that batsmen should follow through with their shuffle (if they intend on shuffling across) and play at the ball. A good example of how a complete shuffle should be executed is Hashim Amla, whereby he did not start his career as a very aggressive batsman. In order for him to score at a rapid rate during one day cricket, there was a time towards the middle stages of his career where he shuffled across and whipped the ball from outside off-stump through the on-side which was his strongest scoring area.

In addition, the back leg at the crease is key and should almost be treated as a 'statue' with fast bowlers. Many batsmen rotate or invert their back leg onto their toes which adversely affects their hips to rotate which makes the batsman compromise the required shot played or execution of shot played. This area of the back leg among batsmen requires further research.

The grip

In addition to the feet, hips and shoulder, there should be a particular emphasis on the grip for batsmen in accordance with the backlift. Minimising the attention towards the grip is similar to the analogy of the motor car of not having clutch control before driving a car. A grip is the clutch of a batsman, the feet are the gears and the bat (backlift, downswing and impact) is the accelerator.

Traditionally, the 'V' grip allows a batsman to lift the bat straight back. However, an adjusted grip in which the 'V' is rotated towards 10:00am on the posterior aspect of the bat, would allow a batsman to lift the bat in a more lateral direction without having to compensate for having an open face of the bat (Figure E11).

Figure E11: A typical open-held grip on a cricket bat

Players such as Eoin Morgan from England have an 'O' grip (fingers completely around the handle) which would make it difficult to hit the ball with power. Once again, and similar to the shuffle across with some batsmen, batsmen would need to compensate with the rest of their body segments if their bottom hand is quite rigid as opposed to the top hand needing to be rigid and the bottom hand to be loose or most of the time being held with two fingers (index finger and thumb) (Figure E11). The grip and hand placements on the bat would also change. In order to train a young player to execute a LBBT, their bottom hand should be more loose and open on the bat. Their top hand should be more rigid in order to provide support and power and as well as to stabilise the bottom hand in order to prevent the batsman from 'scooping' the ball and getting caught.

Summary of practical recommendations and implications for the backlift

The BBT should not be coached or taught in isolation and therefore all accompanying segments outlined above should be adhered to when coaching a player. As such, the conceptualised body segment model for the BBT is a novel approach that coaches, scientists and players can apply in their respective methods.

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