

The quality of the coach-athlete relationship predicts objective performance in elite cricket

KIERAN PHILLIPS, SOPHIA JOWETT, ALEKSANDRA KRUKOWSKA-BURKE *and*
DANIEL J. A. RHIND¹

Loughborough University, UK

The purpose of the study was to investigate the links between interpersonal aspects of coach-athlete relationship (CAR) quality and performance in elite cricket. Understanding how objective indicators of performance associate with interpersonal relationship aspects can provide new insights about the role and significance of the coach-athlete relationship. 25 male and 28 elite female cricketers completed questionnaires assessing CAR quality (closeness, commitment and complementarity) along with shot data for 28,215 balls faced across the 2021 county championship and in the Rachel-Heyboe Flint trophy held in United Kingdom. It was found that CAR quality predicted cricket skill execution performance (middle%). This research is the first of its kind in providing an empirical link between CAR quality and on-field performance in an elite environment, suggesting its importance in providing a potential physical competitive edge. This study opens new avenues for future research and should encourage more multidisciplinary research which brings together sport psychology and performance analysis.

KEY WORDS: Coach-athlete relationship, Cricket Performance, Performance Analysis.

Coach-athlete relationships (CAR) can be defined as a dynamic social situation in which coaches' and athletes' cognitions, feelings and behaviours are mutually and causally inter-connected (Jowett & Poczwardowski, 2007). The coach-athlete relationship has been identified as an important factor in promoting happiness and welfare (e.g., Felton & Jowett, 2017; Gosai et al., 2021), as well as providing a source of support during hard times like injury and emotional setbacks often associated with performance slumps (Jowett, 2017). Within elite cricket, Ogden et al. (2022) identified the CAR as significant in influencing athletes' mental health. In their study it was identified that when relationship quality was high, athletes experienced feelings

Correspondence to: concerning this article should be addressed to Kieran Phillips.
(E-mail: K.phillips2@lboro.ac.uk)

of reassurance and trust in which they felt coaches 'had their back'. In contrast, athletes who reported low levels of quality stated that they experienced nervousness and anxiety particularly around team selection, creating detrimental effects to their mental health. Furthermore, The CAR has also been identified as a possible explanation for differences in coaches' perceptions of performance in cricketers, with some identifying issues such as communication affecting overall relationship quality (Khan et al., 2017).

Coach-athlete relationships (CAR) have been described as the essence of coaching (Jowett, 2017). The CAR quality can be conceptualised in terms of closeness, commitment, complementarity and co-orientation between an athlete and their coach, known as the 3+1Cs model (Jowett & Shanmugam, 2016). In brief, closeness refers to a coach and an athletes' affective bond (e.g., mutual trust, respect, appreciation), commitment refers to their intention to maintain the connection over time and complementarity refers to their behavioural interactions capturing the extent to which they are cooperative and collaborative. Last, co-orientation reflects the degree to which a coach and an athlete have similar views and shared understanding. The 3+1C conceptualisation of the CAR has been widely applied in both men's and women's sport, and there is an extensive body of supporting evidence which further demonstrates the importance of high-quality relationships (Foulds et al., 2019). It has been previously shown that the quality of the CAR is critical to athletes' experience within their sport (e.g., Antonini Philippe et al., 2011; Cho & Baek, 2020) as well as impacting athletes' sources of motivation (e.g., Avci et al., 2018; Jowett et al., 2017). While research has examined the links between coach-athlete relationship quality and different facets of performance (e.g., Jowett, 2008, Jowett & Nezelek, 2012; Hampson & Jowett, 2014), performance as a variable has been examined subjectively. Subjective performance using self-reported scales captures perceptions of athletes which can be biased (Filbay et al., 2019). Socially desirable responses fail to capture reality and as performance is a contested yet significant factor in competitive sport, this study aimed to measure athletes' performance using an as objective measure as possible. The benefits of using actual, objective, on-field performance metrics were identified by Lorains, Ball and McMahan (2013) who advocate for a consistent and reliable way to measure performance.

As recommended by Rhind and Jowett (2010), factors relating to and including the CAR along with the model should be examined in relation to outcome variables such as performance. However, research has tended to examine performance satisfaction rather than actual performance using measures such as the Athlete Satisfaction Questionnaire (Riemer & Chelladurai, 1998) as an

indicator of performance. This is evident in Jowett's (2008) study of the impact of coach motivations as well as Kim, Kim and Lee's (2020) study of coach leadership and behaviours, and the subsequent impact on performance satisfaction. Whilst these studies are practical in terms of optimising the CAR and demonstrating the effectiveness of relationship maintenance strategies, they fail to distinguish the impact of CAR on actual physical performance levels.

Using objective measures of performance has been identified as a crucial step for the future of sport psychology research. For example, social-psychological reviews into transformational leadership (Arthur et al., 2017; Clarkson et al., 2019) as well as mindfulness and emotional regulation (Josefsson et al., 2019) have urged researchers to study objective measure of performance in order to strengthen their arguments. Within the context of the coach-athlete relationship, the only research that we are aware of measuring athlete performance using physical measures (and not measures that rely on perceptions) is conducted by Davis and her colleagues (2018). They examined the associations between the quality of CAR and athlete exhaustion on physical and cognitive performance using shuttle and Stroop-type tests. Their results highlighted a negative association between low CAR, and high cortisol responses to performance and exhaustion. Whilst this study is a positive step in understanding the relationship between CAR quality and athlete performance using alternative methods of measuring performance-related outcomes, it still does not explain the impact the CAR quality may have on actual on-field performance. The lack of evidence that exists in this area presents a dual opportunity. First, to design a study that aims to explore the associations between the CAR quality and an objective, actual, and in-field measure of athlete performance. Second, to bring together two distinct disciplines within sport sciences, namely sport psychology with a new sport field in known as performance analysis where its focus is to examine and compare performance levels objectively (James, 2015). The following section describes how we established a performance metric for the purpose of this study.

Establishing a performance metric

Hughes and Bartlett (2002) explained the importance of using performance indicators as an objective way in which to measure performance. A performance indicator can be defined as an action variable aimed at explaining an aspect of athlete/team performance, with these variables falling into outcome (match classification) or process (technical/tactical components of performance; Butterworth et al., 2013). Performance indicators are import-

ant as they allow for the identification of differences between successful and unsuccessful performance as well as offering tactical insight to identify team/individual weaknesses to exploit in training/competition (Bartlett, 2001)

When examining current cricket research, the majority of performance related literature has tended to focus on the shortest format of the game, Men's Twenty20 (T20) cricket (Petersen et al., 2008), with a particular focus on examining the outcome approach to success (winning). Across multiple competitions (Douglas & Tam, 2009; Manage et al., 2013) and in differing countries (Petersen et al., 2008; Scholes & Shafizadeh, 2014), it has been shown that factors such as taking wickets in the first six overs (as Moore et al., 2012) as well as scoring more runs from boundaries had a greater effect on match success (Najdan et al., 2014). Major limitations around this literature centre on its limited scope for development, particularly as the findings are fairly self-explanatory in nature, indicating, if you score more runs and take more wickets, you win. Similarly, it fails to identify the process involved in executing these skills effectively, whilst also failing to include Women's cricket within its sample, presenting an opportunity as it becomes increasingly professionalised (Parry et al., 2021).

The extant literature fails to identify the strategies and/or processes which are involved when explaining successful performance (Lord et al., 2020). In order to further the field of performance analysis, Glazier (2010) suggested the adoption of a constraints-based approach when conducting future research. In essence, to describe the reasons (constraints) for performance. One of the constraints described by Glazier (2010) referred to the "task constraints", relating to the goal of the task and the governing rules. It also includes the implementation of coach tactics and player technique. Glazier's (2010) arguments largely reflect the process variables originally introduced by Hughes and Bartlett (2002), further suggesting the benefits of using process over outcome variables. This was further emphasised by Lemmer (2011) who suggested there is a need to challenge existing methods/measures when evaluating performance as the accepted outcome measures identified previously, fail to consider the multiple factors which can impact a player's performance, such as skill execution, highlighting the need for new methods (Manage & Scariano, 2013). Lemmer (2011) originally concluded that researchers need to challenge authorities on these existing measures, incorporating and designing new ideas as better measures of performance. Glazier (2010) and Lemmer (2011) both suggested that using measures which consider task constraint elements, such as skill or strategy, would not only enhance cricket performance research, but would also allow it to be combined with other scientific fields such as sport psychology.

When determining an appropriate process variable in order to assess the skill within a batter's performance, Stretch et al. (2004) identified the importance of shot connections as a measure of performance. In their study, they identified significant differences in the impact points between different player and level types depending on shots played. However, what was more crucial is they identified how different impact points (connections) across different shots played increases/decreased the likelihood of dismissal, highlighting potential risks of failing to hit close to the middle of the bat. The concept of shot timing has already been applied within a psychological domain evident in Thelwell and Maynard's (2003) study involving a mental skills intervention for cricket performance consistency, as well as VanVelden's (2010) study who assessed the advantages of delivering a perceptual-motor training programme. A major limitation, however, surrounds their use of laboratory settings, which limits the extent to which findings can be transferred to real-life game situations.

Therefore, the potential for further research to address this limitation is warranted by measuring a batsman's real-life performance across a season. Furthermore, whilst the idea of using shot connection as a process measure of cricketing performance is an encouraging one, the methods highlighted previously are considerably dated (Moodley & van der Haar, 2020), and in parts lack real consistency, particularly in being open to biases in terms of observer interpretations of "timing". With this in mind, and with the emergence of performance analysis as a discipline (van den Berg et al., 2020), as well as the growth of sport analytics and data collection within cricket, in-game shot connections can be recorded and coded to provide an objective and reliable measure in which to test against, particularly in relation to the present topic.

The aim of this study was to incorporate performance analysis and data analytics to help understand how the quality of coach-athlete relationships associate with performance (shot connection) in elite cricket. The following hypothesis was proposed: *The Quality of the coach-athlete relationships across all three main subscales (Closeness, Commitment, Complementarity) predicts higher levels of batting performance based on the processes involved (shot connections)*. The capacity to measure performance more objectively would provide evidence of the significant influence of the quality of CARs for coaches, athletes, and sport organisations. The growth of performance analysis, and particularly the data analytics within cricket, offers opportunities for sport psychology research to apply objectivity to its performance observations (James, 2015).

Method

PARTICIPANTS

A total of 53 professional cricketers consisting of 25 males and 28 females from 14 elite counties/regions within the United Kingdom, with a mean age of 25.7 (SD = 3.6) years were involved in the study. All male athletes work with a male coach whilst in the women's game, 12 (43%) athletes work with a female coach and 16 (57%) work with a male coach. Athletes had worked with their coach for an average of 3.1 years (SD = 1.7 years).

PROCEDURE

upon institutional ethical approval, contact was made to male first class counties and professional women's regions through contacting coaches and analysts requesting participation for the study. The inclusion criteria for this study were as follows: must be aged 18 or over, is classed as a specialist Batter, Batting all-rounder/wicketkeeper who was expected to play First-Class County/Women's regional cricket in the 2021 season. Athletes then completed an online questionnaire reporting the quality of their coach-athlete relationship prior to the start of the 2021 season.

Following permission from the English and Wales Cricket Board (ECB), data surrounding runs scored, balls faced, instances where no shot was played as well as shot connections were collected for each of the First-Class County/Rachel Heyhoe Flint Trophy games the 53 athletes participated in. In total, this produced data for 28,215 balls faced across 113 games.

MATERIALS

COACH-ATHLETE RELATIONSHIP QUESTIONNAIRE (CART-Q direct version, Jowett & Ntoumanis, 2004) is an 11 item self-reported measure of the quality of the coach-athlete relationship. Athletes were asked to describe how each statement is relevant to how they interact with their head coach, e.g. *I am close to my coach (Commitment)*, *I like my coach (Closeness)*, *When I am coached by my coach, I am at ease (Complementarity)*. Participants responded to each statement on a 7-point Likert-type scale, from 1 (strongly disagree) to 7 (strongly agree). The CART-Q has high internal validity ($\alpha = .93$, Jowett & Ntoumanis, 2004) and is stable across long periods of time, with a test-retest reliability of $\alpha = .90$ (Gencer, 2020). In the present study,

the questionnaires subscales had reliability of $\alpha = .93$ (closeness), $\alpha = .97$ (commitment), and $\alpha = .96$ (complementarity).

Shot Connections. Data regarding shot connections was selected in accordance with the ECB measured parameters (see table 1 for full list of shot connections and their operational definitions). These shot connections were then grouped (as below) and converted into percentages in relation to the number of balls faced before being collated in Microsoft excel alongside questionnaire responses and were then exported to IBM® SPSS® Statistics software for analysis. Shot Connections were noted through recording each individual ball clip within Play Cricket Scorer Pro (PCS Pro), coding for whether a shot was

TABLE I
Types of Shot Connections recorded and operational definitions.

Shot Connections	Operational Definition (2021)
Good	
Middled (Figure 1)	<i>Regardless of type of shot played, this signifies a good connection made, timed well and hitting the middle of the bat</i>
Poor	
Thick Edge	During a shot played horizontally (Drive), the ball strikes off centre between classed as middled and outside Edge
Outside Edge (Figure 1)	During a shot played horizontally, the ball makes contact on the edge of the bat furthest away from the batter.
Inside Edge (Figure 1)	During a shot played horizontally, the ball makes contact with the edge of the bat closest to the batters' body
Top Edge (Figure 1)	During a shot played horizontally (cut), the ball strikes the section of the bat facing upwards (towards the sky)
Bottom Edge (Figure 1)	During a shot played horizontally (cut), the ball strikes the section of the bat facing downwards (towards the ground)
Leading Edge	The edge of the bat closest to the bowlers end of the pitch as the bat is held with its face turned away from the bowler
Mis-Timed	Where the shot, regardless of connection made is played either too early or late in relation to the ball arrive
Bat Pad	Whereby a horizontal bat shot is played close to the batters' pad, the ball first makes contact with the bat, closely followed by the pad
Gloved	The ball makes connection with a batters' glove whilst held on the handle of the bat
Missed/Fail	
Missed	Whereby a clear shot attempt is made however the batter fails to make contact
Hit Body	Whereby a clear shot attempt is made however the batter fails to make contact with the bat resulting in the ball hitting the body
Hit Pad	Whereby a clear shot attempt is made however the batter fails to make contact with the bat, subsequently resulting in the ball hitting the pad

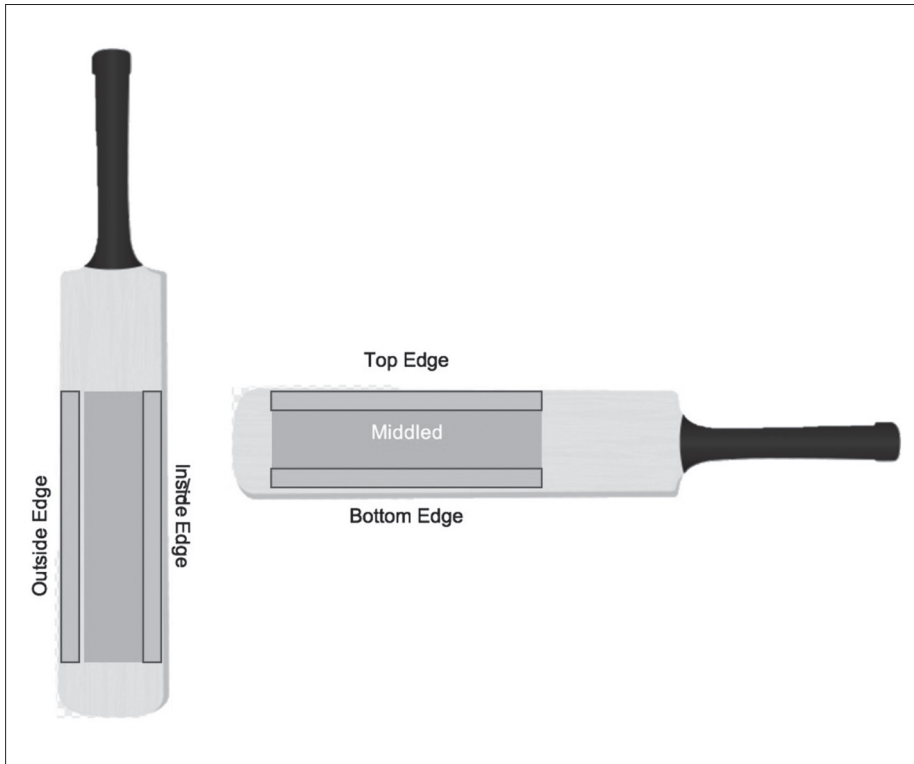


Fig. 1. - Visual representation of types of shot connections made.

played as well as the connection made on the bat, see table 1 for the full list of connections. Inter-rater reliability of the shot connections recorded was tested by randomly selecting 5253 shots across 18 different matches to be reanalysed within a hand-written notational system. The results of the two tests were analysed using a Cohen's Kappa due to its known ability in taking into account the element of chance (Warrens, 2015) when assessing whether data regarding each connection falls within the accepted confidence limit. It was shown in accordance with Warrens (2015), that there was a good agreement between the two shot connection scores, $K = .64$ (95 CI%, .34 to .94), $p < .001$.

Analysis

Data from the cart-q (direct) and the quantity of individual shot connections was collated into microsoft excel before being exported to ibm®

spss® statistics programme for analysis. Following the tests of normality, correlations between EACH OF THE VARIABLES (CAR DIMENSIONS AND SHOT CONNECTIONS) WERE CONDUCTED. Multiple regression analyses were then performed to explain any variance between the dimensions of the CAR and performance.

Results

PRELIMINARY ANALYSIS

Prior to the analysis, accuracy of data entry, missing values, outliers, as well as assumptions of univariate and multivariate analysis (Levene's test of equality of error variances, Kolmogorov-Smirnov's test of normality) were examined. No issues were identified. This section will provide an overview of the results in accordance with the aims and the formulated hypotheses of the study.

REGRESSION AND CORRELATION ANALYSIS

Table II II highlights the mean, standard deviations and the correlations between the key variables within the study. Significant correlations were recorded between all three CAR subscales and performance. A multiple regression analysis was subsequently performed to assess the ability of the three subscales of CAR (closeness, commitment and complementarity) to predict the percentage of balls middled (Middled%). Upon entry of the three subscales, the total variance explained by the model was 36%, $F(3, 49) = 9.13$,

TABLE II
Mean (M), standard deviation (SD), and the correlations between all study variables

Variables	M	SD	2	3	4	5
1. CAR	4.83	1.07				.47**
2. Closeness	5.53	1.07	-	.89**	.84**	.37**
3. Complementarity	4.75	1.08	.89**	-	.83**	.28*
4. Commitment	4.61	1.17	.84**	.83**	-	.53**
5. Performance Middled %	45.53	14.38	.37**	.28*	.53**	-

Note: * $p < .05$, ** $p < .01$, *** $p < .001$

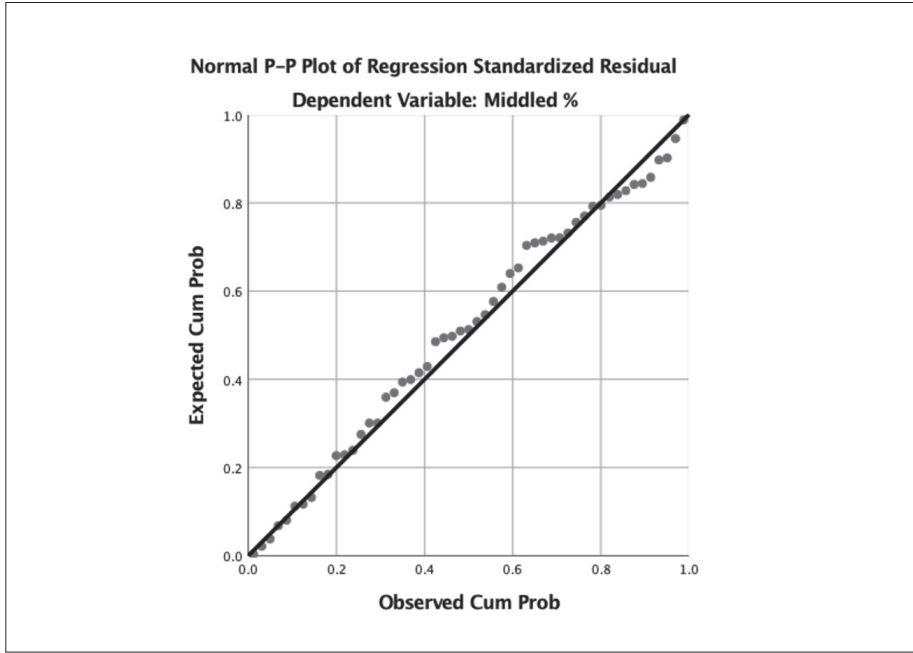


Fig. 2. - Variance of the three facets of CAR on Middled%

$p < .001$. In the final model, two of the control variables were shown to be statistically significant with commitment recording a higher beta value ($beta = .92, p < .001$) than complementarity ($beta = .55, p = .04$); closeness was non-significant ($beta = .08, p = .75$)

Discussion

The aim of this study was to explore the links between the quality of the coach-athlete relationship and batting performance (shot connections) of athletes within elite cricket. The hypothesis formulated was that the quality of the coach-athlete relationships across all subscales would predict higher levels of batting performance (shot connections). The hypothesis was supported as two (commitment and complementarity) of the three subscales of the quality CAR model were shown to significantly predict cricket shot execution performance.

These results suggest that a positive relationship exists between CAR quality and batting skill execution and as the quality of the coach-athlete

relationship increases in terms of commitment and complementarity, athletes are also likely to see increases in their skill replicability.

It was shown that a positive association exists between CAR and batting performance based on percentage of balls middled (skill execution). This result has not only reaffirmed previous findings that have used more psychologically objective (e.g., Davis et al., 2019) and subjective measures of athlete performance (e.g., Jowett, 2009; Jowett & Nezelek, 2012), but it has furthered the understanding of the connection between CAR quality and sport performance by providing the first known link between CAR quality and sporting performance using an actual, physical and on-field measure of performance. Similarly, in addition to the known benefits high CAR can bring, such as promoting athletes (and coaches') well-being (e.g, Gosai et al., 2021) as well as support during difficult times (Jowett, 2017), it can be suggested that high CAR quality can contribute to achieving a higher level of sporting performance. Stretch et al. (2004) initially highlighted the importance of consistently hitting the middle of the bat when making connection with the ball, particularly when reducing the risk of dismissal. This study has begun to suggest the importance of having good CAR quality as this appears to be associated with consistent performance (middled%) and potentially decreasing the likelihood of a dismissal.

The findings of this study are in line with previous research (e.g., Gosai et al., 2021; Jowett, 2009; Jowett & Nezelek, 2012) which has identified similar links between coach-athlete relationship and subjective performance often measured as either athlete satisfaction with training and performance (see Riemer & Chelladurai, 1998) or as physical competence (Marsh et al., 1997). This study has specifically highlighted that commitment and complementarity as opposed to closeness are significant and strong predictors of batting performance. Batting is a technical component that requires a great deal of skill. The margins are small and the consequence of a mistake are significant for a game of cricket. The findings indicate that athletes and coaches invest a great deal of time (commitment, investment, time) and hard work (complementarity, cooperation, collaboration) to perfect the batting technique.

According to the conceptualisation of commitment within the 3+1Cs model, commitment is defined as an athlete's intention to maintain a long connection with their coach. Commitment highlights that athletes are prepared to stay with a coach on the basis of their prior investment and accommodation. In other words, athletes who perceive that their coaches are in full support of them and have shown to them that they are prepared to sacrifice their time, to energise and empower them (Barnwell et al., 2021) by instructing, supporting and helping them over time, are more likely to execute batting more consis-

tently and successfully. Correspondingly and according to the conceptualisation of complementarity within the 3+1Cs model, complementarity is defined as an athlete's capacity to be at ease in the presence of their coach as well as responsive and receptive to their coaches' instructions and efforts to improve their performance. Complementarity in the context of this study suggests that athletes who are comfortable, responsive and receptive to their coaches are more likely to be better batters. Therefore coaches who have the capacity to create an environment within which their athletes (cricketers) think there is commitment and in turn there is future in the coach-athlete relationship, as well as complementarity, a sense that there is cooperation or collaboration, are more likely to have athletes (cricketers) who are willing (motivated) to put the hard craft required over prolonged period of time (Warburton et al., 2020) to be successful in executing a technical skill that can often determine how well a team performs in a game. While closeness did not seem to directly predict performance (shot connections), previous research has shown the important role played by closeness (see e.g., Jowett, 2009). Closeness reflects coaches and athletes' affective bond and it manifests through such relational properties as mutual trust, respect and appreciation (Davis et al., 2019). It is plausible that lack of Closeness may affect inversely the links of Commitment and Complementarity with Performance given the high correlations noted. This conjecture warrants investigation and longitudinal designs.

One of the key advantages of this study centres around expanding understanding of cricket performance metrics, particularly from a batting perspective. Literature has typically adopted an outcome measure approach (Hughes & Bartlett, 2002) with comparisons between successful and unsuccessful performance made based on runs and wickets (Moore et al., 2012; Najdan et al., 2014). As a result, Lemmer (2011) suggested that there was a need to challenge this understanding and a need to develop new performance metrics. This study provided attempts at meeting this and has offered a new repeatable and objective measure in shot connections when assessing cricket performance differences. Similarly, by applying a performance analysis approach to assessing cricket performance, this study has expanded on the works of Thelwell and Maynard (2003) and Vanvelde (2010) by helping to update their initial ideas of shot timings within a real-world scenario. Furthermore, by applying performance analysis to psychological constructs regarding the coach-athlete relationship, this study provides evidence to suggest a performance analysis approach could be implemented within other sports science fields.

There are limitations of the present study which need to be acknowledged. Despite identifying a potential link between CAR and cricket performance, due to the cross-sectional design employed in the current study, it fails to iden-

tify definitive causality when explaining the associations relationship quality influences performance. Therefore, future studies should aim to bridge this gap by employing longitudinal and experimental designs, and by considering additional variables which could help understand the influence of CAR on athletes' performance, such as athletes' motivation as it has been shown to impact performance (Weakley et al., 2020). In the present study the dimensions of the CAR were only measured from the athletes' perspective; CAR is a dyadic phenomenon involving both athletes and coaches, and not including coaches' views meant that the current study could provide only recommendations from the athletes' data. Providing coaches' perspectives and comparing them with the athletes' views could potentially uncover new practical recommendations allowing coaches and athletes to work together in a greater synergy (Mueller et al., 2018), achieving the known benefits, including now on-field performance. Likewise, measurement of the CAR was only conducted at the start of the season, as previously mentioned, the CAR is a dynamic construct (Ogden et al., 2022) with this study it is not possible to capture how a relationship can fluctuate over time as well as how it can influence performance over time. Given the important role of communication in the development and maintenance of good quality CARs (Jowett & Poczwardowski, 2007), research should investigate the role of communication (COMPASS model; Rhind and Jowett, 2010) in the link between CAR quality and performance.

Research into the coach-athlete relationship and its impact on performance has real life sporting implications, particularly from a competitive advantage point of view. Ultimately, elite, competitive sport is largely a results-based business in which jobs, funding and sponsorship is dependent on team and individual success. As a result, it may be recommended to coaches and athletes to broaden their understanding of the factors which may contribute to increasing the quality of their relationship, particularly as this may offer opportunities through providing a performance edge while maintaining high levels of well-being (see e.g., Gosai et al., 2021).

In summary, this study incorporated a performance analysis approach in order to objectify on field performance when explaining the link between CAR and elite cricket performance. The present study constitutes the first of its kind in providing a link between CAR quality and on-field performance in elite sport suggesting the importance of the coach-athlete relationship in producing performance gains. The real-world sporting applications this offers can be used to explain deviations and potentially sudden drops in performance. Likewise, the present study has opened avenues for further research in this area, particularly when identifying causality as this area currently remains severely under-researched in the literature.

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