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The role of coach-athlete relationship quality in team sport athletes' psychophysiological exhaustion: implications for physical and cognitive performance.

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Abstract

The present study aimed to examine associations between the quality of the coach-athlete relationship and athlete exhaustion by assessing physiological and cognitive consequences. Male and female athletes (N= 82) representing seven teams across four different sports, participated in a quasi-experimental study measuring physical performance on a 5-meter multiple shuttle test, followed by a Stroop test to assess cognitive performance. Participants provided saliva samples measuring cortisol as a biomarker of acute stress response and completed questionnaires measuring exhaustion, and coach-athlete relationship quality. Structural equation modelling revealed a positive relationship between the quality of the coach-athlete relationship and Stroop performance, and negative relationships between the quality of the coach-athlete relationship and cortisol responses to high-intensity exercise, cognitive testing, and exhaustion. The study supports previous research on socio-cognitive correlates of athlete exhaustion by highlighting associations with the quality of the coach-athlete relationship.

Key words: coach-athlete relationship, exhaustion, team sports, teammate, performance

The role of coach-athlete relationship quality in team sport athletes' psychophysiological exhaustion: implications for physical and cognitive performance.

Participation in sports encompasses a number of cognitive-affective experiences with implications for athletes' well-being and psychological health (Gustafsson, DeFreese, & Madigan, 2017). Athletes' perceptions of their social environment can manifest psychophysiological implications (Barcza-Renner, Eklund, Morin, & Habeeb, 2016); specifically, coaches are key components of the social environment that may potentially influence stress and the development of exhaustion (Arnold, Fletcher, & Daniels, 2013; DeFreese & Smith, 2014; Fletcher, Hanton, & Mellalieu, 2006; Isoard-Gautheur, Trouilloud, Gustafsson, & Guillet-Descas, 2016). In terms of a positive influence, supportive social interactions within the athletes' environment has the potential to enhance their performance and development (Bianco & Eklund, 2001). On the contrary, unwanted, rejecting or neglecting behaviours that typify negative social interactions (with coaches) can hinder progress and result in a deleterious athlete experience (Newsom, Rook, Nishishiba, Sorkin, & Mahan, 2005).

Recent research has attempted to examine the athletes' social environment from the perspective of the quality of the coach-athlete relationship (Jowett, 2007; Davis, Jowett, & Lafrenière 2013). The coach-athlete relationship has been identified as being a central feature of an athlete's sport experience (Bartholomew, Ntoumanis, & Thøgersen-Ntoumani, 2009). Jowett (2007) defines the coach-athlete relationship as a unique interpersonal relationship in which athletes' and coaches' feelings, thoughts, and behaviours are mutually and causally interconnected. These feelings, thoughts, and behaviours have been reflected in Jowett's (2007) 3 + 1Cs framework. Specifically, according to this framework *Closeness* reflects the affective bond that develops between the coach and athlete and manifests in "feelings" of liking one another, mutual trust, respect, and appreciation. *Commitment* is characterised by the athlete's and/or coach's "thoughts" of maintaining a close-tied athletic relationship over a long period of time. *Complementarity* reflects athletes' and coaches' "behaviours" that are both complementary and cooperative, and determine the efficient conduct of interactions. Finally, the +1C *co-orientation* represents the inter-connected aspect of the coach-athlete relationship and refers to coaches' and athletes' interpersonal perceptions regarding the quality of the coach-athlete relationship. Within the construct of co-orientation, Jowett (2007) has explained the importance of considering two distinct perceptual platforms from which coaches and athletes are likely to view, consider, and assess the quality of the relationship. These perceptual platforms include: the direct perspective (e.g., I like my coach) and the meta-perspective (e.g., my coach likes me). In essence, both the direct and meta-perspectives of the 3Cs, are essential indicators that shape the quality of the coach-athlete relationship.

Previous research has investigated the influence of the quality of the coach-athlete relationship on both interpersonal and intrapersonal outcomes including the athlete's physical and psychosocial development (Davis & Jowett, 2014), satisfaction (Jowett & Ntoumanis, 2004), motivation (Isoard-Gautheur et al., 2016), collective efficacy (Hampson & Jowett, 2014), and one's subjective evaluation of performance (Rhind & Jowett, 2010). However, seldom does sport research link the quality of the coach-athlete relationship to an athlete's actual physical and cognitive performance. This shortcoming may be due to the consideration that subjective evaluations of performance are less intrusive to the athlete and potentially offer greater generalizability across sports (Biddle, Hanrahan, & Sellars, 2001) in comparison to objective physical performance measures where it is crucial to consider the ecological validity of research. Therefore, it is warranted that research incorporates alternative objective measures to more accurately assess athletes' performance with greater applicability to their applied environment. Gillet, Vallerand, Amoura, and Baldes (2010) propose "tournament placing" as an objective measure of performance; however, it is difficult to generalize "tournament placing" to other performance contexts due to many unique variables across specific performance settings (e.g., level of competition; Gillet et al, 2010).

In proposing an alternative method of objectively measuring sport performance, assessing outcomes on a running task may offer increased generalizability across a greater number of sports. This would permit more extensive comparisons when examining the impact of the coach-athlete relationship across a wider range of performance contexts. Further, research examining the potential impact of the quality of the coach-athlete relationship on performance would also be well served by differentiating aspects of performance into subcomponents of performance including physical and cognitive functioning. Cognitive performance in the areas of attention, working memory, and executive function are crucial to athletic proficiency (MacDonald & Minahan, 2016). Despite the importance of decision making in competitive sport (Light, Harvey, & Mouchet, 2014), limited research has investigated the impact of the quality of the coach-athlete relationship on cognitive functioning.

Cognitive and physical subcomponents of sport performance are both notably influenced by athletes' emotions (Vallarand & Bouchard, 2000; Woodman, Davis, Hardy et al., 2009). In particular, the impact of anxiety and stress upon performance has been the focus of extensive research (Hanton, Neil, & Mellalieu, 2008), with athletes reporting a variety of stressors associated with competitive sport (e.g., performance errors, interpersonal relationships; Nicholls, Jones, Polman, & Borkoles, 2009; Sarkar & Fletcher, 2014). The traditional reliance upon self-report measures in the study of stress in sport has been a shortcoming in research design; however, advances in research methods now offer the supplemental use of psychophysiological measures as biomarkers of stress (Hellhammer, Wüst, & Kudielka, 2009). In particular, salivary cortisol, the main end product of hypothalamic-pituitary-adrenal (HPA) axis has emerged as an important biomarker of the psychophysiological stress responses (Hough, Corney, Kouris, & Gleeson, 2013) and provides an indication of the physiological stress response of athletes to a bout of high-intensity exercise (Kerdijk, Kamp, & Polman, 2016; Leite et al., 2011).

Research examining psychosocial stressors (e.g., coaches; Hogue, Fry, Fry, & Pressman, 2013) highlights the significance of examining the cortisol response of individuals (Wegner, Schüler, Schulz Scheuermann, Machado, & Budde, 2015). In particular, the coach-athlete relationship can influence athletes' appraisals of demands on their resources and influence perceptions of stress (Nicholls et al., 2016). However, limited research has examined psychophysiological indices of the outcomes associated with the relationship quality between the coach and athlete. When the relationship quality between the coach and athlete is deemed to be poor, it can potentially contribute to athletes' perceived stress through a coach's use of controlling behaviours that have been associated with maligned motivational regulation and the development of athlete burnout (Barcza-Renner et al., 2016; Cresswell & Eklund, 2007; Gustafsson, Hassmén, Kenttä, & Johansson, 2008; Isoard-Gautheur, Trouilloud, Gustafsson, & Guillet-Descas, 2016). Specifically, poor quality coach athlete relationships (i.e., characterised by a lack of closeness, commitment, and complementarity) have been linked with athlete burnout (i.e., exhaustion, sport devaluation, reduced accomplishment), whilst athletes reporting a high quality relationship with their coach indicate lower levels of burnout (Isoard-Gautheur et al., 2016).

Burnout has been extensively studied in the domain of sport over the past three decades and has been linked with athletes' negative health outcomes (Gustafsson, DeFreese, & Madigan, 2017). In particular, athletes suffering from burnout report greater depression, mood disturbance, and general feelings of frustration (Eklund & Cresswell, 2007; Eklund & DeFreese, 2015). Despite it being the focus of comprehensive study, the understanding of burnout is limited by a lack of agreement regarding the definition of the construct and has been the subject of ongoing debate in the research literature (Kristensen, Borritz, Villadsen, & Christensen, 2005; Lundkvist, Gustafsson, & Davis, 2016). Further, the relationships between the proposed sub-dimensions (i.e., exhaustion, reduced accomplishment, and sport devaluation) are unclear (Lundkvist, Gustafsson, Davis, et al., 2017). That said, there is consensus among researchers that exhaustion is the core dimension of burnout (Gustafsson, Kenttä, & Hassmén, 2011; Maslach, Schaufeli, & Leiter, 2001) and may be used as an indicator of the psychological health of athletes (Gustafsson et al., 2016).

In consideration of the conceptualisation and developmental issues surrounding burnout research, the current study focuses on the core dimension of exhaustion. Further, in light of the observed associations between exhaustion, stress, and cognitive and physical performance, the present study aims to extend previous research examining the influence of the quality of the coach-athlete relationship. Therefore, this study examines the role of coach-athlete relationship quality in team sport athletes' psychophysiological exhaustion with a particular focus upon the implications for physical and cognitive performance.

In review of previous research, three hypotheses were proposed. First, in light of the proposed effects of the coach-athlete relationships on sport performance (Gillet et al, 2010) high quality coach-athlete relationships we expected to be positively related to cognitive and physical performance. Second, considering high quality coach-athlete relationships are associated with lower levels of perceived stress (Nicholls et al., 2016), we expected coach-athlete relationship quality would be negatively related to acute changes in cortisol resulting from the objective measurement of physical and cognitive performance. Finally, in review of research examining coach-athlete relationship quality and burnout (Isoard-Gautheur et al., 2016), the third hypothesis was that a high quality coach-athlete relationship would predict lower levels of the core dimension of burnout represented by athletes' reported exhaustion.

Method

Participants

A total of 82 athletes, including 55 males (67.1%) and 27 females (32.9%), participated in the study. The participants' age ranged from 18 to 31, with a mean age of 19.87 years (SD = 2.94). All of the athletes were actively competing in team sports at a university level; the sample was comprised of four different sports: rugby union (n = 50, 61%), rugby league (n = 19, 23.2%), volleyball (n = 6, 7.3%), and netball (n = 7, 8.5%). The participants trained on average for 9.14 hours per week (SD = 3.55), and attended training sessions with their teammates and coach on a regular basis (range: 3-5 times per week). Participants had on average played their sport for 9.27 years (SD = 5.14) and had been competing with their current team and coach for 1.20 years (SD = 1.80).

Measures

Demographic and Background Inventory. Participants provided a variety of demographic information including: age, gender, years of competitive experience, years played with current team, and level of sport competition. Additionally, the demographic questionnaire examined the number of hours an athlete trained per week (e.g., "On average, how many hours do you train per week?") in a manner similar to previous sport research (Cresswell & Eklund, 2006; Smith et al., 2010).

Coach-Athlete Relationship. The 11-item Coach-Athlete Relationship Questionnaire (CART-Q; Jowett, & Ntoumanis, 2004) was used to measure athletes' direct perception of the quality of the coach-athlete relationship (Jowett, 2008). The 11-item direct perspective has four items assessing closeness (e.g., "I like my coach"), three items assessing commitment (e.g., "I am committed to my coach") and four items assessing complementarity (e.g., "When I am coached by my coach, I am ready to do my best"). All CART-Q items were measured on a scale ranging from 1 (*"Strongly Disagree*") to 7 (*"Strongly Agree")*. Previous research (Jowett & Ntoumanis; Davis & Jowett, 2013) have presented sound psychometric properties of validity and reliability.

Physical Performance. A high-intensity bout of exercise comprised of a 5-meter multiple shuttle test (Boddington et al., 2001) was used to measure participants' physical performance. Participants were instructed to stand in line with the first of six cones that were placed five meters apart in a straight line on a running track (the total distance from the first to sixth cone was twenty-five meters). An auditory signal indicated the beginning of the test; upon this signal participants sprinted five meters to the second cone and touched the ground in line with the cone using their hands before sprinting back to the first cone; without hesitation participants then sprinted ten meters to the third cone and then back to the starting cone. Participants continued to run in this pattern to the subsequent fourth and fifth cone (each time returning to the starting cone) until 30 seconds elapsed and a signal to stop was provided. The distance covered by the participants was recorded to the nearest two and a half meters during each 30 second shuttle. Participants completed six 30 second shuttle tests with 35 seconds of recovery time provided between each shuttle. Participants were instructed to run maximally (i.e. maximal effort) throughout the test and the total cumulative distance covered across the six trials was recorded as the physical performance marker (i.e., total running distance).

Cognitive Performance. Participants' scores on a Stroop task were used as a measure of cognitive performance. The application was downloaded from the Apple app store (EncephalApp Stroop; Bajaj et al., 2015; Bajaj et al., 2013) and was used in testing on Apple iPads (Apple, China). The app allows two components to be set (i.e., the "off" and "on" state), depending on the discordance or concordance of the stimuli. The participants were only exposed to the "on" state, which is the more cognitively challenging of the two states as incongruent stimuli are presented in nine of the ten stimuli. Participants were instructed to indicate the correct response by touching a section at the bottom of the screen which corresponded with the color being displayed; for example, in the discordant coloring trials that participants completed, if the word "GREEN" was displayed in the color red, the correct response is red and incorrect response would be green). If the participant was to make a mistake (i.e., select the incorrect color), the trial would stop and the program would restart at the beginning. Participants were required to correctly answer ten stimuli in a row to complete a trial. Participants were allowed one practice attempt at completing a trial prior to undertaking the two test trials. The mean time (Stroop score) for completion of two successful trials was calculated and used in the further analysis.

Biomarker of Stress. Salivary cortisol was measured as a biomarker of athletes' stress response. Saliva samples were collected in Salimetric collection tubes (Greinerbio-one, Frickenhausen, Germany) using a passive drool technique to gain 1.0 g/mL of saliva. The collection tubes containing the samples were retained by the researcher immediately after collection and frozen at -20C within an hour from the time of collection. Samples were defrosted and centrifuged at 3,000 rpm for 15 minutes prior to analysis. Salivary cortisol was quantified for each sample by enzyme immunoassay (Salimetrics Europe, Newmarket, United Kingdom) in accordance with the manufacturer's instructions. Intra-assay coefficients of variation were less than 10%.

Athlete Exhaustion. Each athlete's level of exhaustion was assessed using items from the Athlete Burnout Questionnaire (ABQ; Raedeke & Smith, 2001). Only the five items referring to the athlete's physical and emotional exhaustion were used for the present study (e.g., "I feel overly tired from my sport participation"). The stem for each item was "How often do you feel this way?" to which participants responded on a five-point scale, ranging from 1 (*"Almost Never")* to 5 (*"Almost Always")*. Previous research has provided sound psychometric properties across all three dimensions of the ABQ (Raedeke & Smith, 2001; Smith, Gustafson, Hassmén, 2010).

Procedure

Ethical approval was granted by the second author's university prior to collecting the data. Initially, the head of the university strength and conditioning department and head coaches of the university sports teams were approached to obtain permission to conduct the study with their respective athletes. On approval, and before a prearranged training session, potential athletes were informed of the nature of the research and invited to take part in the study. Those who provided informed consent were scheduled to attend a testing session. Subjects were asked to abstain from consuming alcohol for 24h before testing and to be well hydrated at the time of testing. Athletes who agreed to take part in the study did so as part of their normal strength and conditioning program. Therefore, the time of day the testing was conducted was dependent on the sports team (i.e., early morning 7-9am, mid-morning 10-11am, afternoon 1-3pm, and evening 6-8pm) but was in keeping with usual training patterns. Under normal conditions, the highest level of cortisol production occurs in the second half of the night peaking in the early hours of the morning (Fries, Dettenborn, & Kirschbaum, 2009). Thereafter, the level of cortisol steadily declines during the day with the lowest level of cortisol in the first half of the night (Tsigos & Chrousos, 2002). However, in the current study there was no significant difference when comparing the time of day testing took place (i.e., early morning, mid-morning, afternoon, and evening) and changes in cortisol levels (i.e., baseline to post-task) across the testing sessions, $F(3,81) = 1.401$, $p = .249$.

Experimental protocol

Following the provision of informed consent, participants produced their first 1.0 g/mL saliva sample. On completion of saliva collection, participants were asked to warm up and then undertake a submaximal attempt of the shuttle test to familiarize themselves with the test protocol. The submaximal attempt of the shuttle test was comprised of a single 30 second trial at a lower intensity following the procedure previously outlined. The athletes then performed the 5-metre multiple shuttle test comprised of six trials and had their maximal distance recorded; immediately upon completion of the physical task they undertook the two Stroop trials and had their cognitive performance recorded. Following the completion of the physical and cognitive testing, participants provided a second 1.0 g/mL saliva sample. Participants then remained trackside and were monitored as they completed the multi-section questionnaire. Participants provided a third and final saliva sample 20 minutes following the completion of the physical and cognitive testing.

Data analysis

The statistical analyses were performed with the IBM SPSS and AMOS programs (IBM SPSS Inc., 2011). Firstly, descriptive statistics and bivariate correlations were performed. For the purpose of the present study, the quality of the coach-athlete relationship was represented by a global score in which all three dimensions of the 3Cs were subsumed. This was due to the strong correlations (ranging from r = .627 to r = .711) observed across commitment, closeness, and complementarity. This approach has been used and supported in previous research (Adie & Jowett, 2010; Davis, et al., 2013; Isoard-Gautheur et al., 2016). A one-way repeated measures ANOVA was used to investigate changes in saliva cortisol across the baseline, post-test, and 20 minutes post-testing.

Structural Equation Modelling (SEM) was then used to test the three hypotheses. The hypothesized model included direct paths between the quality of the coach-athlete relationship and maximum distance covered on the shuttle task (physical performance), Stroop scores (cognitive performance), transient change in cortisol, and athlete exhaustion. All of the factors were allowed to correlate. In Figure 1, the hypothesized associations are illustrated. A collection of goodness of fit indices was employed to assess whether the hypothesized model fit the datawere chosen to assess the model. Following the suggestion made by several researchers (Hu & Bentler, 1999; MacCallum & Austin, 2000), the following indices were employedthe Comparative Fit Index (CFI), the Root Mean Square Error of Approximation (RMSEA), and the Tucker Lewis Index (TLI). According to Hu and Bentler (1999) and MacCallum and

Austin, (2000) values that are equal to or above 0.9 for the CFI and TLI indicate a satisfactory fit to the data, whereas values of 0.95 and higher indicate an excellent fit to the data. Similarly, RMSEA values of less than 0.08 represent a satisfactory fit, whilst values of less than 0.05 provide an excellent fit to the data. .

<insert figure 1 here>

Results

Descriptive statistics

Preliminary analyses showed that none of the participants were considered to be outliers across the variables used in the study (Tabachnick & Fidell, 2007). Descriptive statistics and bivariate correlations amongst variables are presented in Table 1. The ABQ exhaustion scores in the study were low to moderate, indicating that many of the participants were experiencing a low or moderate level of athlete exhaustion; this is consistent with finding commonly reported in related studies (Gustafsson, Davis, Skoog, Kenttä, & Haberl, 2015; Raedeke & Smith, 2009). Athletes reported to experience relatively moderate to high levels of perceived coach-athlete relationship quality.

<Insert table 1.>

Cortisol

A single-factor repeated-measures ANOVA was conducted to investigate changes in participants' cortisol concentration across the three measurement time points. The results suggest that there was a significant difference across the cortisol measurements $F(2,162) = 5.395$, p = .009, $\eta^2 = .062$.

<Insert table 2.>

Bonferroni post hoc comparisons identified that post-test cortisol concentration (*M* = 9.83) was significantly higher than baseline cortisol concentration *p* = .049. Cortisol concentration measured 20 minutes following completion of the 5-meter multiple shuttle test and Stroop test (*M* = 10.32) was significantly higher than baseline cortisol concentration *p* = .029. No other significant differences were found, as shown in table 2.

<*Insert Figure 2,*>

Structural Equation Modelling

Structural equation modelling presented in figure 3, revealed relatively good fit to the data (*df* = 6, χ^2 = 8.394, RMSEA = .070, TLI = .924, CFI = .943). Coach-athlete relationship quality was negatively related to Stroop scores (β = -.228, *p* =.033), indicating that high quality coach-athlete relationships predicted better cognitive performance (i.e., a lower mean time taken by the athlete to complete the two Stroop trials represents better performance). Coach-athlete relationship quality did not predict participants' performance on the physical task (i.e., total distance accrued on the shuttle test, β = .019, *p* = .861). The coach-athlete relationship was negatively related to changes in salivary cortisol from pre to immediate post testing (β = -.240, *p* =.024), suggesting higher quality of coach-athlete relationship was related to less acute stress (i.e., less change in cortisol levels from pre to post-test). Finally, the quality of coach-athlete relationship was negatively associated with athlete exhaustion (β = -344, *p* = .004), suggesting a high quality coach-athlete relationship is associated with low levels of exhaustion.

<Insert Figure 3.>

Discussion

The aim of the present study was to examine potential associations between the quality of the coach-athlete relationship, cognitive and physical performance, as well as athlete exhaustion; based upon previous research three hypothesis were tested. In relation to the first hypothesis, the findings arising from the SEM analysis suggest that the quality of the coach-athlete relationship was associated with better cognitive performance on the Stroop test; however, relationship quality was unrelated to physical performance on the running task. The partial support of the hypothesis suggests further investigation of the associations between the quality of the coach-athlete relationship and athletes' performance outcomes is warranted. In particular, cognitive performance may be closer linked with the attributions underpinning subjective self-ratings of performance (Biddle et al., 2001), and could relate with previous research observing associations between coach-athlete relationship quality and subjective performance (Rhind & Jowett, 2010).

The findings of the present study highlight that coach-athlete relationship quality may have a greater impact on cognitive sub-components of sport performance, and the appraisal of potentially stressful demands, rather than impact directly upon physical aspects of sport. Previous research examining the anxiety-performance relationship highlights that anxiety can be associated with diminished concentration and impaired decision making (Allen, Jones, McCarthy, Sheehan-Mansfield, & Sheffield, 2013). Further, in testing the second hypothesis the findings of the present study suggest that an athlete's anxiety response to performance demands may be influenced by relationship quality with his/her coach. More specifically, the pattern of responses observed in the measurement of biomarkers of stress (i.e., changes in salivary cortisol concentration) may suggest that athletes reporting a positive perception of their coach-athlete relationship perceived the physical and cognitive tests as being less stressful. Research examining coach-athlete emotion congruence suggests that athletes' perceptions of optimal performance are associated with emotional states that align with desired emotional states often derived from interactions with coaches (Friesen, Lane, Galloway, et al., 2017); coach-athlete relationship quality can be enhanced by a coach's use of effective interpersonal emotion regulation strategies (Davis & Davis, 2016).

In relation to the third and final hypothesis, the findings indicate that the quality of the coach-athlete relationship was negatively related to athlete exhaustion. This study supports previous research suggesting that coach-athlete relationship quality can be associated with athlete exhaustion (Isoard-Gautheur et al., 2016) and highlights the importance of the social environment in athletes' sport experiences (Arnold, Fletcher, & Daniels, 2016; DeFreese & Smith, 2014; Fletcher et al., 2006). Relationships characterized as being close, complementary, and committed, have been associated with athletes' reporting less exhaustion. Future research may extend the present study to investigate how perceptions of exhaustion relate with objective and subjective evaluations of cognitive and/or physical performance. The reduced sense of accomplishment dimension of the ABQ (Raedeke, 2001) attempts to elucidate athletes' perceptions of performance associated with burnout, however it relies upon self-reports and may be biased by related factors identified within the experience of burnout (e.g., emotional exhaustion, sport devaluation).

The present study offers new insight into the relationship between the quality of the coach-athlete relationship and cognitive and physical performance, however it has a number of limitations. First, the study is quasi-experimental and therefore does not allow for the examination of causal relations within or between the variables being observed. Research designs that provide the opportunity to investigate temporal changes between the quality of the coach-athlete relationship, physical and cognitive performance, as well as athlete exhaustion over a season would be an important avenue for future research (Lundkvist, et al., 2017). Recent research has highlighted that throughout a season athletes' perceptions of their relationship with their coach may fluctuate both in intensity and direction (Felton & Jowett, 2017). Second, it may be possible athletes' physical performance tested within the present study was not influenced by coach-athlete relationship quality because the test was not directly related to the athletes' actual sports performance or perceived to be important within the coach-athlete relationship. Although the physical test was presented as being a component of the athlete's strength and conditioning program, the absence of the coach during testing may have diminished the salience of the coach-athlete relationship and associated performance outcomes. Future studies may consider replicating the present research design whilst attempting to manipulate the test conditions to increase athletes' perceptions of their coaches' involvement.

The present study highlights a number of applied implications for coaches and athletes. Although the association between coach-athlete relationship quality and cognitive performance observed in the present study occurred within a training session, the extension of the findings to competition is merited with some caution. Evidence forwarded across multiple studies suggests that coaches who invest in the development of high quality relationships with their athletes can optimize an athletes' sport experience, performance, and wellbeing (Davis, Jowett & Lafrenière, 2013; Felton & Jowett, 2014). In the present study high quality coach-athlete relationships were seen to minimize athletes' indices of stress responses observed in cortisol reactivity derived from demanding test conditions (i.e., physical and cognitive performance tests). High quality coach-athlete relationships may afford increased training demands and protect against the development of athlete exhaustion; future research using longitudinal research designs in collaboration with objective psychophysiological measures of training load may shed light on the complex relationship between optimal and dysfunctional training and recovery. Coaches are often responsible for determining the parameters of their athletes' training sessions throughout the season considering training intensity, session length, and the specific drills athletes are instructed to complete (Renshaw, Oldham, Davids, & Golds, 2007); appropriate knowledge of the psychosocial factors influencing exhaustion may also be central to coach education. In collaboration with technology utilizing Global Positioning System data for training and games (Coutts & Duffield, 2010) and session-rating of perceived exertion (RPE; Foster et al., 1995), coaches may seek to enhance relationship quality via the use of emotion regulation strategies (Davis & Davis, 2016; Hill & Davis, 2014) and increasing the positive motivational climate (Olympiou, Jowett, & Duda, 2008).

In summary, the present study extends previous research by highlighting the effect of coach-athlete relationship quality on athletes' physical and cognitive performance, as well as athlete exhaustion. Specifically, coach-athlete relationship quality may enhance cognitive functioning as well as reduce levels of acute stress responses and exhaustion. Subsequently, sport scientists and coaches may promote athletes' optimal performance and wellness through the consideration and development of high quality coach-athlete relationships.

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Table 1. Descriptive statistics, standard deviations, alpha reliability and correlations for all main variables in the study.

	M	SD	α	1	2	3	4	5	6	7	8
Quality relationship	5.04	0.97	0.91	1							
Commitment	4.39	1.14	0.77	.861**	1						
Closeness	5.44	1.12	0.88	.889**	.627**	1					
Complementary	5.29	1.01	0.86	.883**	.629**	.711**	1				
Stroop score	11.97	2.1		-.221*	-.249*	-0.153	-0.178	1			
Exhaustion	2.61	0.67	0.86	-.325**	-.264**	-.367**	-.220*	0.202	1		
Total Distance	697.63	47.22		0.054	.250*	-0.115	0.002	0.097	0.213	1	
Change Saliva	1.9	7.01		-.254*	-0.213	-0.159	-.300**	0.104	0.096	-0.112	1

Note: **. Correlation is significant at the 0.01 level (2-tailed), *. Correlation is significant at the 0.05 level (2-tailed).

Table 2. Representing descriptive and multiple comparisons to summarize Bonferroni test for saliva at baseline, post testing and 20 minutes post testing.

Time		BL	Post	20
	Means (SD)	7.93 (8.00)	9.83 (10.51)	10.32 (10.11)
BL	7.93 (8.00)	1		
Post	9.83 (10.51)	-1.91, p =.049	1	
20	10.32 (10.11)	-2.43, p = .029	-0.52[NS]	1

Note: BL = baseline saliva concentration; Post = immediately post testing saliva concentration; 20 = 20 minutes post testing saliva concentration

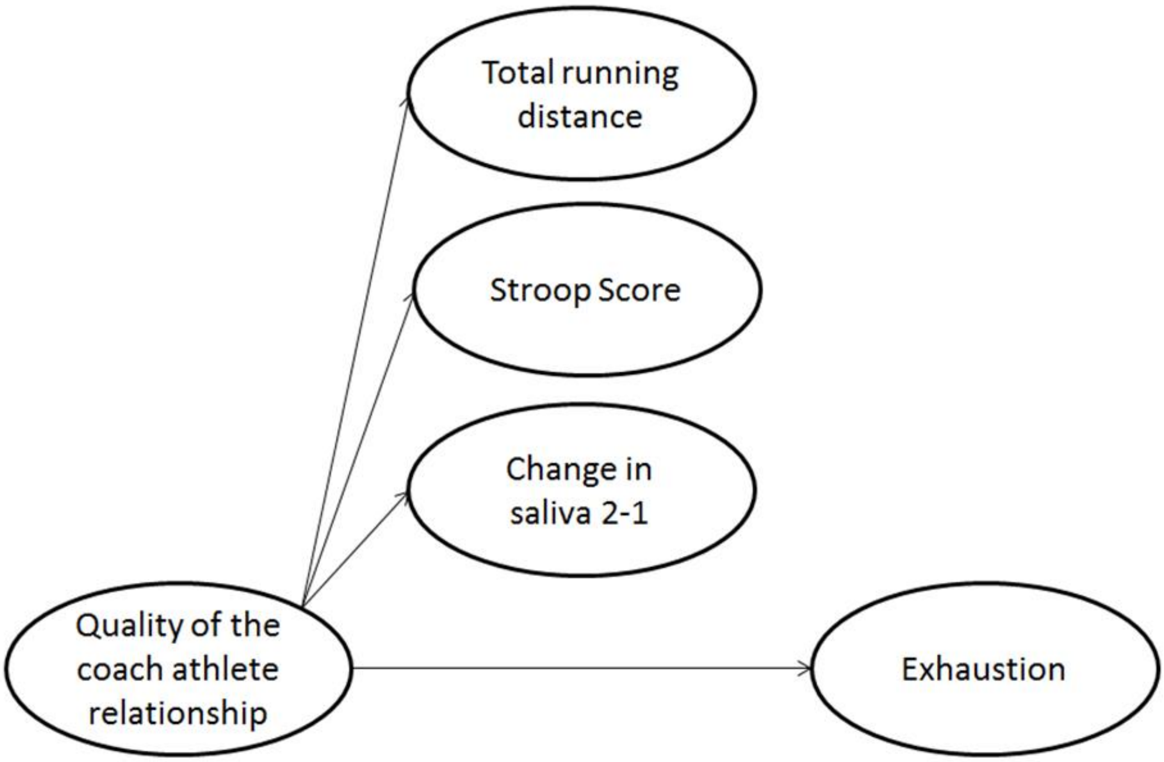
Total running distance
Stroop Score
Change in saliva 2-1
Quality of the coach athlete relationship
Exhaustion

Figure 1. Theoretical model to assess the cognitive and psychophysiological consequences of the quality of the coach-athlete relationship in sports teams athletes.

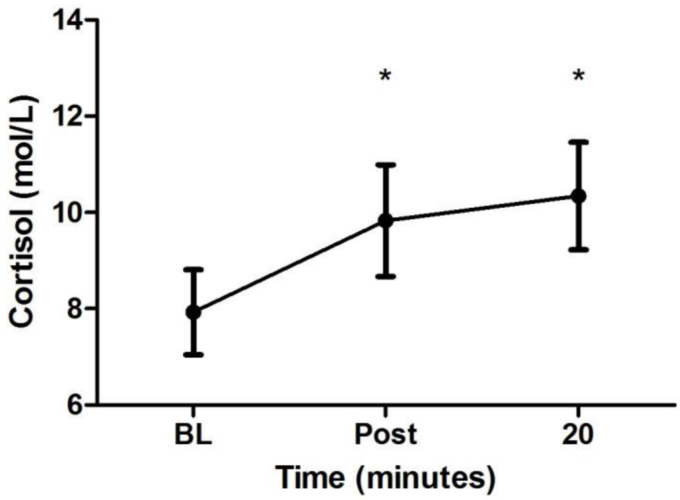

Figure 2. Salivary cortisol (mol/L) response to 5-meter shuttle test and Stroop test represented by means (+/- SEM). BL representing baseline. Post immediately following shuttle and Stroop test. * Significantly different to baseline.

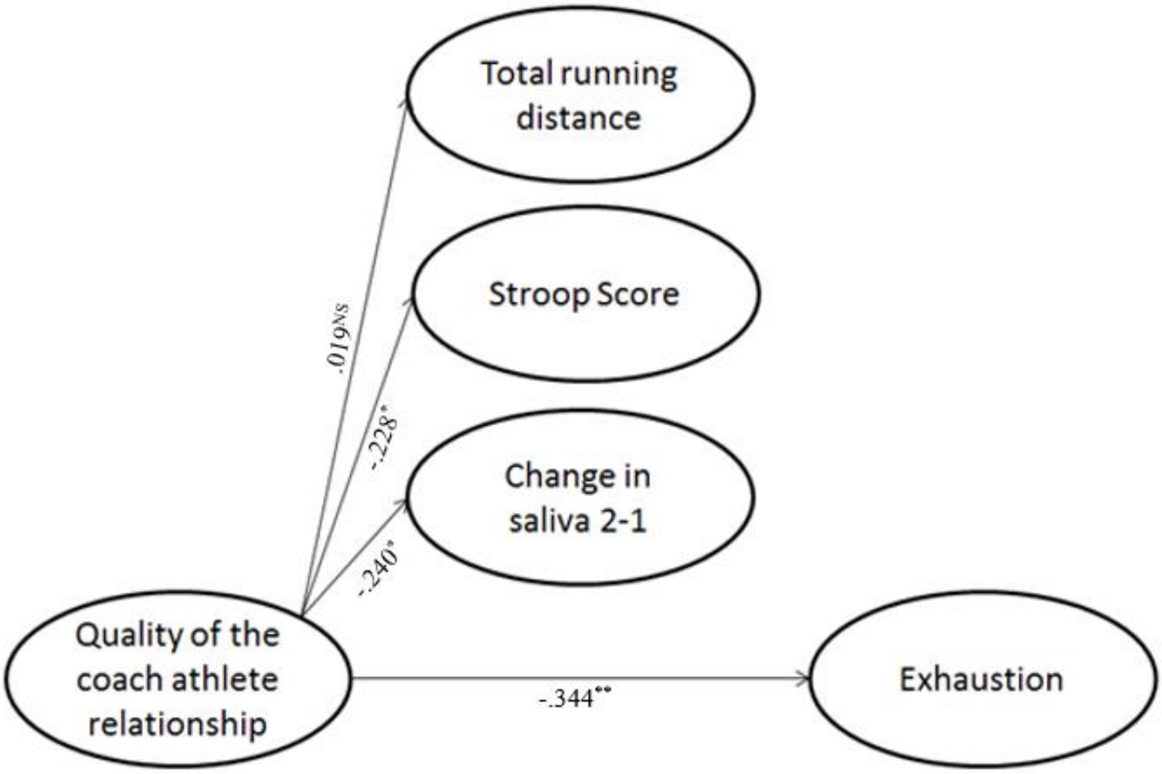

Figure 3. Structural equation modelling of the relationships between the quality of the coach-athlete relationship and exhaustion (5 items of the ABQ), and various

psycho-physiology outcomes relating to sports performance. Dotted lines represent non-significant paths; ***P significant at 0.001; **P significant at 0.01; *P significant at 0.05.