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A season-long examination of the intervention tone of coach–athlete interactions and athlete development in youth sport

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A R T I C L E I N F O

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A B S T R A C T

Objectives: Coaches are a primary influence on athletes' development in youth sport (Horn, 2008). However, the intervention tone of coaches' behaviour has not been directly observed. The purpose of this study was to examine associations between the intervention tone exhibited by youth sport coaches and athletes' individual developmental trajectories over the course of a season.
Design: Short-term longitudinal study with behavioural observation.
Method: Fifty-five athletes and their coaches from five youth volleyball teams were observed at three time points, and the intervention tone of interactive behaviour was systematically coded and organized by coach–athlete dyad. Athletes completed measures of the 4C's of athlete development (competence, confidence, connection, character) at each time point, which were used to create individualized developmental trajectories. Person-centred analyses were used to examine associations between athletes' developmental trajectories and their unique interactive experiences with their coach.
Results: Cluster analysis revealed the presence of three distinct clusters based on athletes' developmental trajectories: 1) high and increasing, 2) low and decreasing, and 3) moderate and maintaining, with athletes from each team distributed across clusters. Analysis of dyadic interaction profiles revealed significant differences in interactive behaviour between clusters.
Conclusions: Results suggest that differences in coach–athlete interactive experiences are associated with different developmental trajectories over the course of a season, even for athletes working with the same coach, highlighting the individualized nature of coaches' influence on young athletes. Practical implications for coaches include a critical awareness of their unique interactive relationship with each athlete independently, as well as the importance of fostering these relationships with regard to young people as more than just athletes.

1. Introduction

Coaches are one of the primary influences on athletes' experiences in sport. Within youth sport particularly, the role of coaches in facilitating positive developmental experiences is of utmost importance (Horn, 2008). This study presents a season-long examination of the ways in which youth sport coaches interact with their athletes and how the characteristics of these interactions, individualized to each athlete, influence the course of athlete development.

2. Intervention tone

A significant body of research exists that addresses youth sport coaches' behaviour, particularly with respect to influences on athlete development (Erickson & Gilbert, 2013). However, much of the observational research within this field has targeted the pedagogical or instructional content of coaches' behaviour and a number of authors (Cushion, 2010; Horn, 2008) have suggested that a complete understanding of coaches' influence on athletes will necessarily require additional examination of a broader range of behaviours and behaviour qualities. We suggest that one such behavioural quality is the notion of intervention tone (Erickson & Côté, 2015), intended to capture not simply 'what' coaches say (functional content), but rather 'how' they say it (psychological meaning conveyed by the particular expression of that content). For this purpose, intervention tone is conceptualized as a higher-order

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integration of elements of diverse theoretical approaches that make reference to the qualitative characteristics of (and psychological meaning associated with) coaches' behaviour, beyond the explicit functional content of that behaviour. Rather than an additional competing construct, intervention tone is presented here as a phenomenological frame or umbrella under which to synthesize the various related theoretical constructs already in use in existing literature that address coach behaviour in some way; an integrated way of thinking about and describing coaches' behaviour as a phenomenon experienced by athletes. Thus, the notion of intervention tone is not, in itself, novel; we argue that the novel contribution of this perspective is the provision of an integrative conceptual and phenomenological frame tying together elements of several independent theories.

This notion of intervention tone as an important quality of coaches' behaviour is present in some form in a number of different theoretical approaches (such as the multidimensional model of leadership (Chelladurai & Saleh, 1978); transformational leadership (Arthur, Woodman, Ong, Hardy, & Ntoumanis, 2011; Bass, 1985); implicit theories of ability (Dweck, 2006, 2007); and positive youth development (e.g., Holt, 2008; Weiss, Smith, & Stuntz, 2008)). Within this cluster of tone-related conceptual overlap, the strongest empirical support for the importance of the tone of coaches' behaviour appears to come from two general theories of motivation: self-determination theory (SDT: Ryan & Deci, 2000) and achievement goal theory (AGT: Nicholls, 1984; Roberts, 2012). Within the extensive SDT literature in sport (see review by Ntoumanis, 2012), the degree to which coaches' behaviour provides support for athletes' functioning as autonomous individuals is known to be a key contributor to positive athlete experiences. According to SDT, athletes' perceive coaches' behaviour as autonomy-supportive, or conversely, as controlling (i.e., limiting their personal autonomy and positioning the coach as the final decision-making authority) above and beyond the particular content of the behaviour (e.g., instruction, encouragement, etc.). This differential perception is precisely the type of presentational quality of coach behaviour represented by the notion of intervention tone.

Similarly, decades of AGT research (see review by Roberts, 2012) has highlighted the significant role of coaches in creating the overall motivational climate experienced by athletes. Motivational climate refers to athletes' perceptions of the predominant criteria used to evaluate competence in a given setting. Within AGT, the motivational climate of a given setting can be classified as either mastery- or task-oriented; mastery climates promote evaluation of competence based on effort, learning, and self-referenced improvement while task climates promote evaluation of competence relative to the performance of others. Research in youth sport contexts has demonstrated that more mastery-oriented climates are associated with a number of positive athlete outcomes (e.g., Cumming, Smoll, Smith, & Grossbard, 2007; Miller, Roberts, & Ommundsen, 2004). The accumulated body of literature suggests that athletes' perceptions of the coach-created motivational climate are based on the evaluation-relevant meaning conveyed by the coach's behaviour (i.e., its intervention tone), rather than the specific content or wording.

Further, Erickson and Côté (2015) argued that the combined terminology of autonomy-support from SDT and evaluative (motivational) climate from AGT together capture a parsimonious conceptualization of the intervention tone of coaches' behaviour with commonly used and widely understood language, where the combination can be representative of more than simply the sum of its parts. Most importantly in this line of argument, we posit (see Erickson & Côté, 2015) that this combined conceptualization is parsimonious and meaningful because it is integrative of tone-related elements common across multiple theoretical frameworks such as the multidimensional model of leadership (Chelladurai & Saleh, 1978), transformational leadership (Arthur et al., 2011; Bass, 1985), implicit theories of ability (Dweck, 2006, 2007) and positive youth development (e.g., Holt, 2008; Weiss et al., 2008).

2.1. Methodological considerations

While there appears to be strong support across multiple theories for intervention tone as an influential quality of coaches' behaviour, the vast majority of research has investigated elements of these tone-related characteristics (albeit typically within the scope of a single theoretical lens) with respect to the perceptions of athletes or coaches, primarily with questionnaire or qualitative methods. However, while this previous work has generated a wealth of very useful findings, little research has directly observed the behavioural manifestations of the full range of these interactive qualities, particularly within youth sport settings. The present study attempts to contribute to addressing this gap via utilization of systematic observation methods specifically designed to capture intervention tone.

Further, the influence of the intervention tone of directly observed coach behaviours has received little attention with respect to athletes' unique individualized interaction experiences with a particular coach. Much previous research (including our own – e.g., Erickson, Côté, Hollenstein, & Deakin, 2011) has taken a predominantly coach-centric approach, seeking general behavioural profiles for what a coach typically does, regardless of with whom they are interacting. To better understand the variable, individualized, and interactive nature of coach–athlete relationships and their influence on athlete outcomes, Poczwardowski, Barott, and Jowett (2006) argued for a shift in the unit of analysis in coaching research from the coach in isolation to the coach–athlete dyad. From this perspective, while the coach in team sport settings remains a shared element for all athletes, each specific coach–athlete pairing might thus be considered a unique, though not entirely independent, dyad (such that different athletes on the same team might have different interactive experiences with the same coach). This variability in interactive experience is of key interest in the present study, and is addressed accordingly by situating the coach–athlete dyad as the central unit of behavioural analysis.

2.2. Coaching and athlete development

Several authors (e.g., Côté & Gilbert, 2009; Horn, 2008) have suggested that coaching effectiveness is best understood as the degree to which coaches positively influence athletes' development over the time course of their relationship. Much previous work in sport drawing from the positive youth development literature has promoted an holistic view of athlete development, concerned with aspects of the athlete as a person beyond simply their sport skill and ability. One way in which this holistic view has been operationalized is as the 4C's of athlete development (Côté, Bruner, Erickson, Strachan, & Fraser-Thomas, 2010; Côté & Gilbert, 2009), which are competence, confidence, connection, and character. The 4C's are a sport-specific modification of the 5C's framework used extensively within the more general positive youth development literature (e.g., Lerner et al., 2005). The combination of all 4C's is intended to encompass the full spectrum of positive developmental outcomes associated with sport participation and represent the desired products of holistic athlete development (Vierimaa, Erickson, Côté, & Gilbert, 2012). Further, the 4C's framework is intended to capture development at the individual level, and thus differentiate athletes on different trajectories.

3. Purpose

The present study was an observational exploration of coaching effectiveness in competitive youth sport contexts. In particular, the purpose of this short-term longitudinal study was to examine potential associations between the intervention tone exhibited by competitive youth sport coaches in their individualized interactions with athletes (i.e., as coach–athlete dyads) and athletes' developmental trajectories over the course of a competitive season. While no specific hypotheses were tested, due to the exploratory nature of the present study, it was expected that athletes with different developmental trajectories over the course of the season would experience interactions with their coach characterized by different intervention tones.

4. Methods

4.1. Participants

Participants for the present study were 55 coach–athlete dyads, representing the head coaches ($n = 5$) and all athletes ($n = 55$) from five competitive youth volleyball teams within a single club in a mid-size Canadian city. Participating teams were from the under 15 (U15), U16, U17, and U18 girls and U18 boys age groups and as such, the athletes were predominantly female ($n = 45$, 82%). The mean age of the total sample was 15.89 years (SD = 1.13). Athletes averaged 3.38 years (SD = 2.24) of previous volleyball experience and .25 seasons (SD = .48) with their current head coach prior to the season of data collection. Two coaches were female (U16 and U18 girls) and three were male (U15 and U17 girls, U18 boys). Informed consent was granted in writing by all participants and parents/guardians of athletes under age 18 before the initiation of data collection. All study procedures were approved by the general research ethics review board at the researchers' home university and by the volleyball club's executive committee.

4.2. Procedure

Participating teams were observed during a single training session at each of three time points roughly corresponding to the beginning, middle, and end of their season (the full competitive season ran from November through May). Each observed session was recorded on video with two separate HD camcorders, one focused exclusively on the coach and the other taking a wide-angle perspective to capture the full training context and activities. To record audio of the training session, each head coach wore a wireless lapel microphone linked to the camcorder focused on him/her, while the wide-angle camcorder was linked to a large parabolic microphone to capture verbalizations from all athletes as well. The two video and audio streams were then time synchronized and combined into a single split-screen video file for each practice. At each of the three time points, all athletes and coaches also completed a questionnaire packet measuring the 4C's (competence, confidence, connection, and character).

4.3. Measures

4.3.1. Behavioural observation

Behavioural data for coaches and athletes were collected via systematic observation of the videotapes of recorded training sessions. The observational data coding was conducted in a continuous manner for each participant, such that the activation of a particular code indicated the end of the previous code for that participant, resulting in a continuous stream of time series data. All behavioural coding was conducted with Noldus Observer software (Version 9: Noldus, Trienes, Hendricksen, Jansen, & Jansen, 2000).

Systematic observation of coaching behaviour, the primary target of investigation, was conducted according to the Assessment of Coaching Tone (ACT) observational coding system (Erickson & Côté, 2015). Developed specifically to capture the intervention tone of coaches' behaviour, the ACT has been subject to rigorous reliability testing (including both inter- and intra-rater reliability) and initial validation (addressing comprehensiveness, generalizability, and discriminant validity). Coding was conducted by two independent coders with several months of structured training and supervised experience of systematic observational coding, and not involved in the study design or formulation of hypotheses Both coders for the present study progressed through the standardized training protocol and met both the inter- and intra-rater reliability threshold standards (consistently reached at least 75% agreement with a 'gold standard' coder, with respect to timing, frequency, and duration of behavioural codes requiring multiple coding decisions per behaviour) described for the initial development of the ACT (Erickson & Côté, 2015) prior to coding video for analysis. Further, both coders maintained these standards in subsequent reliability checks during coding of videos for analysis (see Erickson & Côté, 2015; for full details of coder training and reliability testing standards, as well as system validation strategies).

The ACT is comprised of a behaviour content dimension and three intervention tone dimensions. Each coach behaviour is classified by the combination of a content code and one or two corresponding intervention tone modifiers (depending on which content code is selected) and can only be appropriately classified by a single combination (i.e., all codes within a single dimension are mutually exclusive). While a brief description of the dimensions and the behavioural categories contained within each is presented below, full details of the coding system including decision rules and specific examples can be found in the ACT coding manual (available upon request from the corresponding author; see also Erickson & Côté, 2015).

The initial content dimension, while not the central focus of the ACT, does provide a general context upon which to ground the subsequent intervention tone modifiers. The content dimension consists of nine categories: 1) *organization*, 2) *instruction/feedback*, 3) *positive evaluation/encouragement*, 4) *negative evaluation*, 5) *discussion of mental skills*, 6) *discussion of social/moral behaviour*, 7) *non-sport communication*, 8) *observation*, and 9) *not engaged*.

Once the initial content code has been selected, a given behaviour is then coded for its intervention tone – the primary feature of interest. The three intervention tone dimensions are intended to capture the degree of autonomy support, the evaluation climate promoted, and the degree of personal rapport conveyed by any given coach behaviour. The first intervention tone dimension, degree of autonomy support, qualifies any behaviour initially coded as organization, instruction/feedback, positive evaluation/encouragement, negative evaluation, mental skills, or social/moral behaviour content. The degree of autonomy support is classified according to one of three categories: 1) *Autonomy-supportive* – conveys view of athlete(s) as capable decision maker and contributing member of the situation, 2) *Neutral* – absence of autonomy-related tone, or 3) *Controlling* – conveys an autocratic tone, with coach as total decision maker. The second intervention tone dimension, evaluation climate, qualifies any behaviour initially coded as instruction/feedback, positive evaluation/encouragement, negative evaluation, mental skills, or social/moral content. The evaluation climate promoted is also classified according to one of three categories: 1) *Mastery-Oriented* – self-referenced or focused on the process of skill execution, 2) *Neutral* – absence of evaluation climate-related tone, and 3) *Ego-Oriented* -

other (comparative)-referenced or focused on the competitive outcome of skill execution. The third and final intervention tone dimension, degree of personal rapport, applies only to non-sport communication content and is classified according to one of two categories: 1) *Personal* – communication from the coach making direct reference to personal information about the athlete, or 2) *General* – communication from the coach NOT making direct reference to personal information about the athlete.

For athlete behaviour, given the focus on coach–athlete interactions in the present study, only explicitly interactive behaviours directed at the coach were coded. Subject to the same reliability standards as the coding of coach behaviour, athlete behaviours were classified according to a simple five code categorization scheme: 1) *Engaged* – athlete not directly communicating to coach, 2) *Acknowledgement* – simple confirmation of communication from coach, 3) *Coach Talk: Controlled* – communicating with coach where an a priori "correct", coach-decided answer is assumed, 4) *Coach Talk: Input* – communicating with coach where athlete contributes new information, opinions, observations, etc., and 5) *Coach Talk: General* – communicating with coach about non-sport/performance matters.

4.3.2. Athlete outcomes

Athlete outcomes focused on measurement of the 4C's – competence, confidence, connection, and character. The specific battery of measures chosen was based on the extensive review and recommendations of Vierimaa et al. (2012) in their work on measurement of the 4C's in youth sport contexts. For ratings of all C's, athletes were instructed to refer only to their current organized sport context.

Athletes' competence was measured using the Sport Competence Inventory developed by Vierimaa et al. (2012), based on the work of Causgrove, Dunn, and Bayduza (2007). The final competence score for each athlete was calculated as the average of the ratings from the coach, the athlete themselves, and all of their teammates, representing a triangulation of the perceptions of multiple evaluators. Confidence was measured using the self-confidence subscale of the Revised Competitive State Anxiety-2 (CSAI-2R: Cox, Martens, & Russell, 2003). As the original version of the CSAI-2R targeted state confidence, the instructions were modified for the present study in line with the recommendations of Vierimaa et al. (2012) to target trait sport confidence instead (i.e., "indicate how you *generally* feel" rather than "indicate how you feel *right now*"). Connection, operationalized for this study as the quality of the relationship between coach and athlete, was measured by the Coach–Athlete Relationship Questionnaire (CART-Q: Jowett & Ntoumanis, 2004). Character was measured by the Prosocial and Antisocial Behavior in Sport Scale (PABSS: Kavussanu & Boardley, 2009). For the present study, an overall character score was calculated for each athlete as their score on the prosocial dimension minus their score on the antisocial dimension. Conceptually, we felt an overall score may better represent the real-world expression of character (as intended in the C's model) rather than a more theoretically-driven hard distinction between prosocial and antisocial. Practically, collapsing character into a single dimension also allowed us to reduce the number of variables in analyses – of concern given the relatively small sample size in this exploratory study. However, its use will necessarily require further theoretical and psychometric testing and validation. All established questionnaires have previously demonstrated adequate psychometric properties; see Vierimaa et al. (2012) for more extensive discussion of the reliability and validity of each instrument and justification for their selection. For the present sample, internal reliability ranged from acceptable to excellent across the four questionnaires (Cronbach's alphas range = .75–.95).

4.4. Data analysis

The data analysis strategy for this study was based on a person-centred, rather than variable-centred, approach. As such, the central focus was on the experiences of individual athletes and thus on the grouping or differences between cases in their entirety (i.e., on all variables) rather than relationships between scores on variables independent of the person reporting them. In this line, the overall goal of the present analyses was to identify clusters of athletes with similar developmental trajectories over the course of the season and examine for potential differences between cluster groupings in their coach–athlete interactive experiences. All statistical analyses were conducted with SPSS software (version 21).

After initial data screening, analysis of the 4C's questionnaire data consisted of three major stages, targeted at 1) creating, 2) validating, and 3) describing clusters of athletes with similar developmental trajectories over the season. For the first two stages, the measures of each C were standardized to a 5-point scale then combined to form an overall 4C's measure out of 20 for each athlete at each of the three time points. Standardization to a 5-point scale, rather than more typical z-scores, was chosen in an effort to preserve some interpretability of independent and summed C's scores in an absolute sense (e.g., as indicators of high vs. low positive development, independent of total sample characteristics). The first stage was a *K*-means cluster analysis intended to identify natural groupings of cases based on the combined 4C's measure at all three time points (i.e., three data points per case). Thus, athletes were grouped based on similarities in the shape of their holistic longitudinal trajectory over the course of the season. In the second stage, as a validation of the clustering solution, the longitudinal trajectories of the resulting clusters were then compared via profile analysis (also known as the multivariate approach to repeated measures ANOVA) to see if there were statistically significant differences between the groups over time. Finally, as the clusters were created based on the combined 4C's measure, individual ANOVA's were conducted for each C to explore potential differences between the groups for these more specific characteristics.

Once coach and athlete behaviour were coded within the Noldus Observer software, behavioural data were exported to the Gridware program (Version 1.1: Lamey, Hollenstein, Lewis, & Granic, 2004), a free software package designed for state space grid methodology (Hollenstein, 2007; Lewis, Lamey, & Douglas, 1999). State space grids (SSG's) are a dynamic systems-based method for visually representing and quantitatively analysing real time behavioural data for multiple interacting agents (i.e., coach and athlete, in this case) simultaneously. The primary function of the Gridware software in this case was to calculate and analyse behavioural data for each of the 55 coach–athlete dyads separately. The individualized interaction profile for each dyad was calculated with respect to only those coach behaviours directed at that particular athlete or to the team as a whole (including the athlete in question), as well as that athlete's behaviour toward the coach. Thus, the resulting interaction profile captured the unique interactive experience of each athlete with his/her coach over the course of a training session. Dyadic behavioural data was then averaged across observed sessions for each dyad, grouped according to athlete cluster membership, and (as the primary analysis of interest in the present study) compared for possible differences between clusters using univariate ANOVA's.

For the purposes of the present study, two general behavioural characteristics were analysed for the dyads in each cluster: 1) coaches' use of intervention tone, and 2) athlete interactive behaviour directed at the coach. Coaches' use of intervention tone was first examined in terms of each of the tone categories independently, then explored in follow-up comparisons examining use of the tones in combination and with the behavioural content codes through which they were expressed. The relative utilization of intervention tones was assessed with respect to both the mean frequency and mean duration (in seconds) per training session for dyads within each cluster. Athlete interactive behaviour directed at the coach was similarly assessed with respect to both the mean frequency and mean duration (in seconds) per training session.

5. Results

5.1. Analysis of 4C's data

5.1.1. Data screening

Initial screening of the 4C's data at all three time points revealed no significant violations of normality. While no data points fell outside the typical cut-off of 3.29 SDs from the mean (Tabachnick & Fidell, 2007), four extreme values were identified as potential univariate outliers. These potential univariate outliers were dealt with on an analysis-by-analysis basis, depending on the robustness or susceptibility to outliers of each statistical technique. Based on calculation of Mahalanobis distances, no multivariate outliers were identified. There were a number of instances of missing data, primarily for total cases at particular time points which represent an athlete being absent from training the day of data collection. Again, missing data were dealt with on an analysis-by-analysis basis (see specific subsections).

5.1.2. Cluster analysis

A *K*-means cluster analysis was performed using the combined 4C's measure for each athlete at the three time points (i.e., three data points representing each athlete's developmental trajectory), from which a three cluster solution emerged as the most statistically optimal and parsimoniously interpretable grouping (Everitt, Landau, Leese, & Stahl, 2011). While a range of two to six cluster solutions were generated, the three cluster solution was chosen as it maximized the Euclidean distance between cluster centres at each time point (i.e., >3 units between all clusters) while minimizing within-cluster Euclidian distances from the cluster centre at each time point (i.e., <2 units for all cases). The season-long trajectories of the combined 4C's measure for all cases are presented by cluster in Fig. 1. Based on examination of the shape and temporal trend of the trajectories within each cluster, the first cluster ($n = 23$) was labelled "*High and Increasing*" (HI), the second cluster ($n = 13$) was labelled "*Low and Decreasing*" (LD), and the third cluster ($n = 19$) was labelled "*Moderate and Maintaining*" (MM). All three clusters contained at least two athletes from each of the five participating teams, with the exception of the LD cluster which did not contain any athletes from the U15 girls' team. See Table 1 for means and standard deviations for each cluster at the three time points.

Table 1
Descriptive statistics by cluster on combined 4C's measure.

	Time 1	Time 2	Time 3
	M (*SD*)	*M* (*SD*)	*M* (*SD*)
Cluster 1 "high and increasing"	14.39 (1.09)	14.87 (.90)	14.95 (.83)
Cluster 2 "low and decreasing"	11.92 (.79)	10.80 (1.06)	10.63 (.84)
Cluster 3 "moderate and maintaining	13.28 (.62)	12.96 (.65)	13.08 (.90)

All cases were included in the *K*-means cluster analysis, regardless of missing data, as this analysis is robust to missing data and will group cases based on any available data points. Since *K*-means cluster analysis can be susceptible to undue influence from outliers, the analysis was run both with and without the potential univariate outliers. When run with the potential outlier data points removed pair-wise (i.e., the cases in question were retained, minus the extreme data points), the same three cluster solution emerged and only one case was reclassified from the MM cluster to the HI cluster. Examination of the raw data trajectory for the reclassified case supported this new classification.

5.1.3. Profile analysis

As validation of the cluster solution, the resulting three clusters were compared via profile analysis to see if longitudinal trajectories of the combined 4C's measure differed significantly between clusters. All profile analyses and associated follow-up contrasts were conducted using SPSS's GLM program. As profile analysis can be extremely sensitive to outliers, the four potential univariate outlier points were removed from the data set. As profile analysis in SPSS GLM will only analyse complete cases, values for missing data were imputed using the procedure recommended by Tabachnick and Fidell (2007, pg. 345) for repeated measures designs which takes into account the commensurate nature of longitudinal data by incorporating the mean of known values for the specific case, the group mean for the specific time point, and the overall group mean. The analyses were run on both the original data set and the data set with missing values imputed, producing equivalent conclusions and suggesting an absence of meaningful bias in data missingness. As such, only the results of the higher powered analyses with the missing values imputed are presented here.

A significant main effect was found for the levels test ($F(2, 52) = 128.06$, $p < .001$, partial $\eta^2 = .83$), indicating a difference between groups across all time points. Planned pair-wise Tukey HSD contrasts revealed significant differences between the

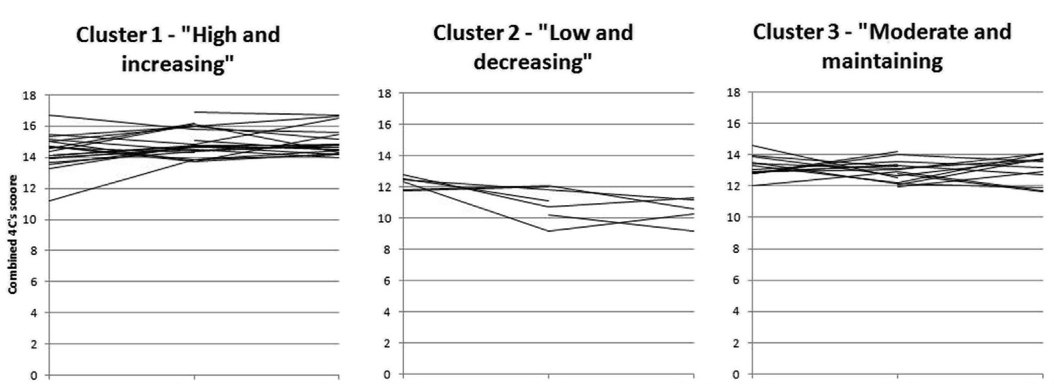

Fig. 1. Season-long trajectories on combined 4C's measure for all cases, grouped by cluster.

estimated marginal means of each cluster for all comparisons (i.e., 1–2, 1–3, 2–3) at $p < .001$ (HI cluster EMM = 14.76, SE = .14; LD cluster EMM = 11.01, SE = .19; MM cluster EMM = 13.12, SE = .16). A significant main effect was also found for parallelism (Wilks' criterion $F(4, 102) = 10.73$, $p < .001$, partial $\eta^2 = .30$), indicating a difference in the shape of the average longitudinal trajectory of the clusters over the course of the season. This deviation from parallelism was explored with post-hoc simple-effects analyses consisting of within-subjects ANOVA's for each cluster separately (testing for differential effects of time, as recommended by Tabachnick & Fidell, 2007), including planned polynomial contrasts. These analyses for the HI cluster revealed a significant main effect for time (Wilks' criterion $F(2, 21) = 4.06$, $p = .032$, partial $\eta^2 = .28$) and a significant linear contrast ($F(1, 22) = 8.47$, $p = .008$, partial $\eta^2 = .28$) while the quadratic contrast was not significant, indicating a significant linear upward trend from the beginning to the end of the season. For the LD cluster, the main effect for time was also significant (Wilks' criterion $F(2, 11) = 45.11$, $p < .001$, partial $\eta^2 = .89$) as was the linear contrast ($F(1, 12) = 10.35$, $p < .001$, partial $\eta^2 = .87$) while the quadratic contrast was again not significant, indicating a significant linear downward trend from the beginning to the end of the season. For the MM cluster, there was no significant effect for time, indicating a flat or unchanging trajectory over the course of the season.

5.1.4. Cluster characteristics

Given that the cluster analysis and profile analysis of the resulting clusters was conducted with the combined 4C's measure, comparisons between clusters on each of the 4C's independently using four separate ANOVA's were conducted to better understand the particular characteristics of each cluster. In particular, we sought to examine whether one or several of the C's were contributing more heavily to the differentiation of the clusters than others. As the levels effects was significant in the preceding profile analysis, these ANOVA's were run on the mean score for each C for each participant (i.e., averaged across the three time points) in order to simplify interpretation.

Even with a Bonferroni-corrected alpha value of .0125, the omnibus ANOVA tests revealed significant differences between the clusters on each of the 4C's (*Competence* – $F(2, 52) = 8.38$, $p = .001$, partial $\eta^2 = .24$; *Confidence* – $F(2, 52) = 16.07$, $p < .001$, partial $\eta^2 = .38$; *Connection* – $F(2, 52) = 36.64$, $p < .001$, partial $\eta^2 = .59$; *Character* - $F(2, 52) = 10.33$, $p < .001$, partial $\eta^2 = .28$). Planned pair-wise Tukey HSD contrasts were then used to compare scores between each cluster. See Fig. 2 for means on each C within each cluster, with significant differences in cluster mean compared to both other clusters (e.g., 1–2 and –3, etc.) highlighted with an asterisk above the particular C score. Additional significant differences between individual clusters are highlighted below. Overall, athletes from the HI cluster reported significantly higher levels of competence, confidence, and character than the athletes of both other clusters and also scored higher than athletes from the LD cluster on connection ($p < .001$). Athletes from the LD cluster reported significantly lower levels of confidence and connection than both other clusters and also scored lower than athletes from the HI cluster on competence ($p = .001$) and character ($p < .001$). Athletes in the MM cluster scored lower than the HI cluster on competence ($p = .025$), confidence, and character ($p = .023$) and also scored higher than the LD cluster on confidence and connection ($p < .001$). The difference between the HI cluster and the MM cluster on connection was not significant, nor was the difference between the LD cluster and the MM cluster on both competence and character.

5.2. Behavioural data

5.2.1. Data screening

Screening of the primary tone dimensions (from which all subsequent component scores were derived) found no significant deviations from normality. Three data points exceeding the typical cut-off of 3.29 standard deviations from the mean (Tabachnick & Fidell, 2007) were classified as outliers and subsequently excluded from analysis. All athletes who had completed the 4C's questionnaire were also observed at that same training session, so all athletes included in the cluster classification had complete behavioural data based on at least one observed training session.

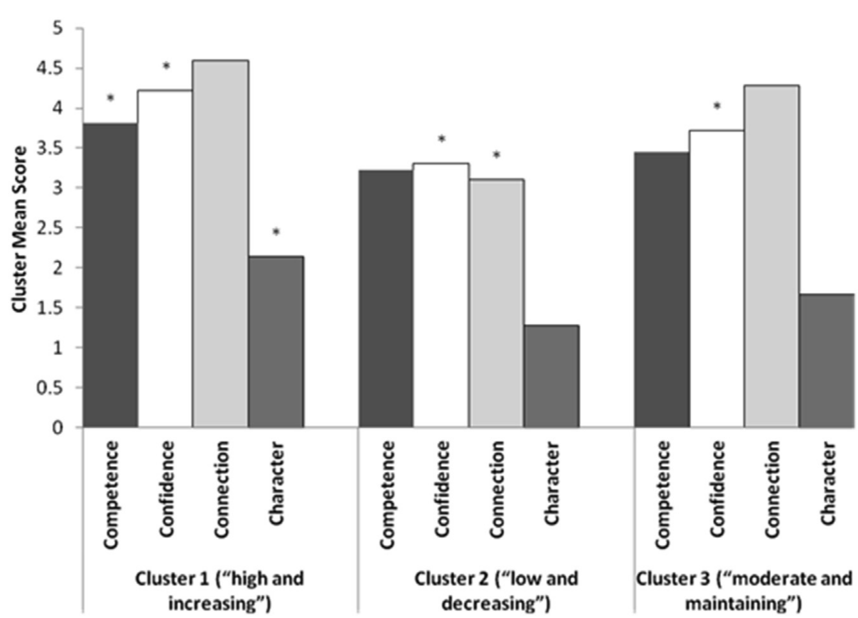

Fig. 2. Cluster means on each C. Asterisks indicate significant differences from both other clusters at $p \leq .0125$.

5.2.2. Coaches' use of intervention tone

With respect to coaches' overall utilization of the different intervention tones, athletes across all clusters experienced more controlling interactions ($M = 187.34$, $SD = 89.96$) than autonomy-supportive ($M = 31.72$, $SD = 8.93$), more mastery-oriented interactions ($M = 90.69$, $SD = 59.55$) than ego-oriented ($M = 9.15$, $SD = 4.33$), and more non-sport interactions characterized by general rapport ($M = 12.63$, $SD = 6.01$) than personal rapport ($M = 1.77$, $SD = 2.18$). In the most general comparison between clusters, there were differences on both the mean duration per training session of overall interaction from the coach, including both individualized and full team-directed interactions ($F(2, 52) = 4.04$, $p = .023$, partial $\eta^2 = .14$), and the mean duration per training session of individualized interaction from the coach directed at the specific athlete ($F(2, 52) = 4.91$, $p = .011$, partial $\eta^2 = .16$). Based on planned pair-wise Tukey HSD post-hoc contrasts, athletes in the LD cluster received significantly more overall coach interaction ($M = 2259.31$ s, SD = 554.14, $p = .025$) than athletes in the HI cluster ($M = 1860.66$ s, SD = 328.72), with a trend toward longer mean duration than the MM cluster ($M = 1893.02$ s, SD = 435.86, $p = .051$). Athletes in the LD cluster also received significantly more individualized coach interaction ($M = 145.87$ s, SD = 100.78, $p = .008$) than athletes in the MM cluster ($M = 74.28$ s, SD = 49.36).

Initial comparison between clusters on the basic intervention tone dimensions independently across all behaviours (with a Bonferroni-corrected alpha value set at .0125) found differences on the mean duration per training session in which athletes experienced controlling interaction ($F(2, 52) = 5.11$, $p = .009$, partial $\eta^2 = .16$) and mastery-oriented interaction ($F(2, 51) = 5.97$, $p = .005$, partial $\eta^2 = .19$) from the coach. Planned pair-wise Tukey HSD post-hoc contrasts revealed that athletes in the LD cluster were the target of significantly more controlling ($M = 1448.74$ s, SD = 571.16, $p = .007$) and mastery-oriented ($M = 665.75$ s, SD = 265.87, $p = .003$) interaction than athletes in the HI cluster (controlling $M = 938.90$ s, SD = 368.41; mastery $M = 424.84$ s, SD = 152.44). A significant difference was also found for the mean duration per training session for general rapport ($F(2, 52) = 7.41$, $p = .001$, partial $\eta^2 = .22$). Athletes in the HI cluster experienced more non-sport communication characterized by general rapport ($M = 110.51$ s, SD = 53.55) than athletes in either the LD cluster ($M = 62.66$ s, SD = 22.68, $p = .004$) or the MM cluster ($M = 71.02$, SD = 32.46, $p = .009$). No significant differences between clusters were found for autonomy-support, either of the two neutral tones, or personal rapport independently.

Based on the significant findings for the duration of controlling and mastery-oriented tone dimensions in the initial comparisons, follow-up comparisons were conducted on the mean duration of all possible two dimensional combinations that included controlling or mastery elements. Significant differences were found for the mastery plus autonomy-supportive combination ($F(2, 51) = 6.24$, $p = .004$, partial $\eta^2 = .20$) as well as a trend towards significance for the mastery plus controlling combination ($F(2, 51) = 4.74$, $p = .016$, partial $\eta^2 = .16$). Planned pair-wise Tukey HSD post-hoc contrasts revealed that athletes in the LD cluster were exposed to longer mean durations of both the mastery plus autonomy-supportive combination ($M = 210.83$ s, SD = 61.15, $p = .004$) and the mastery plus controlling combination ($M = 446.52$ s, SD = 222.83, $p = .010$) than athletes from the HI cluster (mastery plus autonomy-supportive $M = 143.92$ s, SD = 52.83; mastery plus controlling $M = 264.89$ s, SD = 127.86). No significant differences were found for the controlling plus ego-oriented combination.

Finally, as a further follow-up to the initial mastery and controlling tone dimension findings, the clusters were compared with respect to the mean duration of each dimension as expressed through the different possible behaviour content codes. These comparisons found significant differences on positive evaluation/encouragement with a mastery-oriented tone ($F(2, 51) = 5.35$, $p = .008$, partial $\eta^2 = .17$) and discussion of mental skills with a controlling tone ($F(2, 52) = 4.83$, $p = .012$, partial $\eta^2 = .16$). Planned pair-wise Tukey HSD post-hoc contrasts revealed that athletes in the LD cluster were exposed to longer mean durations of both mastery-oriented positive evaluation/encouragement ($M = 87.38$ s, SD = 46.28, $p = .005$) and controlling discussion of mental skills ($M = 19.07$ s, SD = 7.48, $p = .008$) than athletes in the HI cluster (mastery-oriented positive evaluation/encouragement $M = 41.60$ s, SD = 36.95; controlling discussion of mental skills $M = 11.17$ s, SD = 6.82). Additionally, though they did not meet the stringent alpha cut-off set for the present analyses, trends towards differences on discussion of mental skills with mastery-oriented tone ($F(2, 51) = 4.38$, $p = .018$, partial $\eta^2 = .15$) and negative evaluation with a mastery-oriented tone ($F(2, 51) = 3.16$, $p = .051$, partial $\eta^2 = .11$) were also noted. Again, mean scores of athletes in the LD cluster were higher for both mastery-oriented discussion of mental skills ($M = 21.85$ s, SD = 5.76, $p = .014$) and mastery-oriented negative evaluation ($M = 9.15$ s, SD = 6.11, $p = .042$) than those of athletes in the HI cluster (mastery-oriented discussion of mental skills $M = 13.67$ s, SD = 9.17; mastery-oriented negative evaluation $M = 4.93$ s, SD = 3.53). No significant differences were found for any other behaviour content codes with either mastery or controlling tone.

5.2.3. Athlete behaviour

Athletes' utilization of the different coach-directed interaction categories was then compared between clusters. A significant difference was found for the mean duration athletes spent talking with the coach in a controlled manner ($F(2, 52) = 4.49$, $p = .016$, partial $\eta^2 = .15$). Planned pair-wise Tukey HSD post-hoc contrasts revealed that this difference was located between higher mean scores for the LD cluster ($M = 15.13$ s, SD = 18.04, $p = .012$) than the MM cluster ($M = 4.12$ s, SD = 4.91). No significant differences were noted for any of the other athlete behaviour categories or for overall amount of athlete interaction.

6. Discussion

This study sought to examine the influence of coaches' use of different intervention tones in their interactive behaviour on individual athletes' developmental trajectories. Initial descriptive analyses revealed the presence of three distinct clusters of athletes representing different developmental trajectories from the beginning to the end of the season. Highlighting the individualized nature of athlete development, athletes from each team were distributed across clusters. As the primary analyses of interest, behavioural data analysed for each coach–athlete dyad separately showed that athletes in the LD cluster received the highest amount of interaction from the coach, including individualized interaction directed at them specifically. This extra interaction was primarily mastery-oriented and controlling, expressed largely through positive evaluation/encouragement and discussion of mental skills. These athletes also spent more time interacting with the coach in a controlled manner, whereby the "correct" answer is known and held by the coach rather than collectively negotiated within the dyad. In contrast, athletes in the HI cluster experienced significantly more general interaction from the coach related to matters outside of sport. Similar to their 4C's scores, athletes in the MM cluster did not receive uniquely differentiating scores on any behavioural dimension.

Results for the LD cluster suggest that coaches were giving extra attention to these athletes who were rated as the lowest in skill from the beginning of the season. Perhaps surprisingly, given the negative trajectory, this additional interaction often took what might be considered positive or facilitative forms with respect to both tone and content (e.g., individualized mastery-oriented positive evaluation/encouragement and discussion of mental skills; Becker, 2012; Roberts, 2012). These behaviours were also often controlling in tone, but this was not accompanied by any less autonomy-supportive behaviour than received by athletes in the other clusters. The extra attention from the coach, targeted to performance-related matters, may actually have served to reinforce these athletes' perceptions of being less skilled than their teammates and negatively influenced the full breadth of their developmental experience. Despite what may have been the best of helping intentions, these efforts appear to have had a paradoxically strengthening effect on the athletes' negative developmental trajectories over time. This is not to suggest that mastery-oriented interactions are somehow harmful; only that perhaps – given adequate baseline levels – more of a good thing may not always be better. This distinction may be particularly salient in team settings, where dyadic-level analyses in the present study highlighted differences in coach interaction between individuals on the same team that may be readily apparent to athletes. In addition to further exploring this association, future work might also seek to identify the beliefs and cognitions leading coaches to adapt their individualized interaction patterns in this manner. The work of Solomon and colleagues (e.g., Solomon & Buscombe, 2012) on coaches' expectancy effects, whereby coaches' beliefs about an athletes' ability or potential can influence the coaches' behaviour toward that athlete which in turn influences the athletes' experience, may be a fruitful framework to guide future research as well as a potentially explanatory mechanism. Further, future research utilizing the tripartite model of efficacy beliefs forwarded by Lent and Lopez (2002), and in particular the notion of relation-inferred self-efficacy (RISE) may offer additional and complementary insight into this relational process. Referring to an individual's beliefs about how significant others view their ability (i.e., meta-perceptions (e.g., Kenny & DePaulo, 1993); see also Jowett's work (e.g., 2007) on coach–athlete relationships specifically), RISE beliefs in this model also critically highlight the idiosyncratic lens through which coach interactive behaviour is interpreted by the athlete, such that positive coach behaviour is not necessarily congruently interpreted as positive.

Results for athletes in the HI cluster offer indirect support for the significant body of research highlighting the critically important role of positive interpersonal relationships with adults on youth development, both in sport (e.g., Petitpas, Cornelius, & Van Raalte, 2008) and in the general psychology literature (e.g., Lerner, 2002). The significantly higher levels of interaction these athletes received from their coach about matters beyond their immediate sport performance context gives the impression of a more comfortable interactive relationship, where they are treated as more than just an athlete. If accurate, such a conclusion is directly in keeping with current positive youth development in sport literature (e.g., Holt, 2008). Further, such interaction patterns may serve relationship maintenance functions (Rhind & Jowett, 2010) as well, potentially strengthening positive relational effects over the course of the season. Athletes in the MM cluster, on the other hand, while not experiencing the extra mastery-oriented and controlling interaction of the LD cluster, also did not appear to benefit from the extra general non-sport communication afforded to the HI cluster.

Overall, the present study offers several implications for both theory and future research. Foremost, the results provide support for the notion of intervention tone in coaches' interactive behaviour as a differentiating factor in athlete development. Additionally, the person-centred approach employed in the analysis of both 4C's (via cluster analysis) and behavioural data (via dyadic analysis) offers unique benefits to the study of coaching and athlete development by allowing more direct access to the individualized experiences and developmental trajectories of each athlete. More specifically, these findings contribute to two bodies of literature: first, the direct observation of behavioural manifestations of intervention tone may provide additional information beyond general perceptions for integrating existing theoretically-oriented research and second, the addition of intervention tone helps to broaden the scope of coach behaviour research beyond instructional or pedagogical content to encompass more nuanced behavioural quality dimensions. Finally, the distinct clusters with unique interaction profiles offer further validation for the utility of the 4C's framework as representative developmental outcomes in youth sport, capable of capturing and differentiating athlete development over time.

These implications should be considered in light of the limitations inherent to the study. While large with respect to the depth of dyadic analysis of observational data, the sample size was too small to permit more complicated statistical analyses such as hierarchical linear modelling which may have been better able to account for possible group level effects. Longitudinal growth modelling variants which integrate predictors of change (e.g., latent class analysis) were similarly precluded due to sample size constraints. As well, the sample included both male and female participants but was again too small to permit gender comparisons for either coaches or athletes. Finally, there were obviously limitations to the measurement of athlete development as conceptualized by the 4C's. Data collection was largely self-report, and while the measures chosen represent elements of each C, they do not capture the full range of developmental processes inherent to such a comprehensive conceptualization.

In sum, the present study on intervention tone lends insight into "how" coaches interact with their athletes, beyond simply "what" they say. The results of the individualized dyadic interaction analyses suggest that even with typically beneficial intervention tone, the relative amount of interaction in relation to other athletes maybe critical to its effectiveness. Further, this study supports the importance of not limiting coach–athlete interactions to purely sport-related matters and communicating with young people as more than just athletes. It is hoped these findings can be of use to both future research and the real-world promotion of positive athlete development.

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