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ORIGINAL ARTICLE

Coupling tendencies during exploratory behaviours of competing players in rugby union dyads

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Abstract
This study investigated interpersonal coordination tendencies in 1vs.1 dyads in rugby union, here expressed by participants' movement velocity towards or away from the sideline as they competed to score or prevent a try. We examined whether coupling tendencies of members of each dyad shaped key performance outcomes (try or successful tackle). Data on movement displacement trajectories of eight male rugby union players (aged 11–12 years) were analysed during performance in 47 trials. To assess coordination tendencies during exploratory behaviours in the dyads, analyses of performance time series data were undertaken using variable time graphs, running correlations and cross-correlations. Results revealed distinct coupling patterns characterised by shifts between synchronous coordination and asynchronous coordination tendencies and uncoordinated actions. Observed behaviours were interpreted as attempts of competing participants to create and perceive possibilities for action while seeking to achieve specific performance goals. Findings also revealed that a variety of patterned relations between participants resulted in different performance outcomes.

Keywords: *Interpersonal coordination tendencies, exploratory behaviours, dyadic sub-systems, pattern formation, team sports*

In recent years, team sports have been studied as social collective systems entailing high levels of competition and cooperation between agents during performance (e.g., Duarte, Araújo, Freire, et al., 2012; Kelso & Engstrøm, 2006; Passos et al., 2009; see also Lebed & Bar-Eli, 2013). Empirical work suggests that sports teams may be analysed as dynamical social systems, implying that interpersonal coordination tendencies of players emerging from 1vs.1 interactions are context dependent and based on mutual information exchange (e.g., Davids, Araújo, & Shuttleworth, 2005; McGarry, Anderson, Wallace, Hughes, & Franks, 2002). Laboratory studies at both behavioural and neural levels lend support to the foregoing notion (Oullier, de Guzman, Jantzen, Lagarde, & Kelso, 2008; Schmidt & Richardson, 2008; Tognoli, Lagarde, de Guzman, & Kelso, 2007). The present approach to analysing interpersonal interactions in team games focuses on the ecological dynamics of decision-making behaviours of system agents as they attempt to achieve specific performance goals related to their roles as attackers and defenders (Araújo, Davids, & Hristovski, 2006).

Previous work has examined interpersonal interactions underlying goal-directed behaviours in 1vs.1 sub-phases in a range of team sports (e.g., basketball: Araújo, Davids, Bennett, Button, & Chapman, 2004; rugby: Passos, Araújo, Davids, Gouveia, & Serpa, 2006; soccer: Duarte, Araújo, Travassos, et al., 2012). Interpersonal coordination tendencies in 1vs.1 dyads, elucidated in attacker–defender displacement trajectories, vary over time, expressing participants' decisions that lead to successful or unsuccessful performance outcomes (e.g., Passos et al., 2008, 2009). Passos et al. (2008, 2009) and Araújo, Diniz, Passos, and Davids (2014) identified several distinct behavioural patterns between

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attackers and defenders in 1vs.1 sub-phases of rugby union, including those leading to different performance outcomes (i.e., clean try, partial or effective tackle). These works also identified key dyadic system parameters such as interpersonal distance and relative velocity of participants, which influenced the patterns that emerged from interpersonal interactions. Correia et al. (2012) manipulated the starting position of defending players in 1vs.2 sub-phases of rugby union showing how the initial conditions of the task influenced the achievement of performance outcomes (try or tackle). They reported key variables that characterised the participants' actions (including the average speed of the players involved and the time elapsing between a tackle or a crossover of one of the defenders and a try). Of note in that study is that a higher frequency of successful tackles emerged between 4 m and 6 m from the initial starting value of interpersonal distance between participants. In this ongoing programme of work, the influence of playing field boundaries on exploratory behaviours of participants in dyadic systems has yet to be considered.

Boundary constraints are important to study since they influence performance of participants by providing formalised limits to displacement trajectories and set the stage for action (see Kelso, 1995, pp. 66–67 for the conceptual scheme). For example, in rugby union the distance to the sideline of an attacker and defender might constrain the vertical alignment on field of both players in a dyad, relative to critical regions of the playing area such as scoring zones. When the vertical alignment between participants in a dyadic system is broken, it may be hypothesised that players might be coordinating with each other in an *asynchronous* manner (Passos et al., 2008, 2009). In contrast, defenders typically attempt to maintain dyadic sub-system stability by counterbalancing an attacker's actions, changing position on field. Here, system stability is maintained by the vertical alignment of the defender with the attacker, restricting space for the attacker to run through and increasing the likelihood of a tackle emerging. When dyadic system stability is maintained, the coordination tendencies of the players can be characterised by a *synchronous* relationship.

In the analysis conducted here, the first step was to calculate the velocity of each player towards a sideline, considered as a formalised informational constraint for participants in a dyadic system (quantified operationally as VelSideline). The second step was to examine whether the velocities of each dyad participant towards the sideline were related. As in previous research, correlation techniques were used to reveal coupling tendencies between participants (Corbetta & Thelen, 1996; Kelso, Holt, Rubin, & Kugler, 1981; Meador, Ray, Echauz, Loring, & Vachtsevanos, 2002) and particularly in sport tasks (Araújo et al., 2006; Duarte, Araújo, Freire, et al., 2012). Based on these analyses, our expectation was that velocity towards or away from the sideline by each dyadic system participant should index, and hence elucidate, the coupling tendencies during exploratory behaviours of these youthful performers.

Method

Participants

Participants were eight male rugby union players aged 11 and 12 years who had on average 4.0 years of playing experience (SD = 0.5 years). Participants played in the U12 National Portuguese Championship. Although they were considered as skilled for their age group, we sought to study a sample of relatively inexperienced individuals in order to avoid the potential performance idiosyncrasies of a more expert group. A local university ethics committee approved the experiment and each participant's parent or legal guardian gave written informed consent prior to the experiment.

Task design and procedures

An experimental field (5 m width × 10 m depth) was used to observe participants' performance in a 1vs.1 sub-phase task in rugby union. In this task, participants started facing each other 10 m apart and while the attacker (ball carrier) sought to score a try, the defender aimed to prevent the attacker from scoring, within the laws of the game, by means of a tackle (for further task details, see previous work by Passos et al., 2006, 2008, 2009). From the body of performance data observed, we selected 20 trials that resulted in a try being scored and 27 trials resulting in a successful tackle being made. This selection process was designed to allow us to compare displacement trajectory characteristics of both the participants in a dyad when different performance outcomes were achieved.

Data from participant movement displacement trajectories over time were captured by two digital video cameras and digitised with dedicated software TACTO 7.0 (25 Hz). The digitisation procedures involved playing the video recordings of performance outcomes at reduced velocity on a computer and following with the mouse cursor in the middle point between the feet of each participant (regarded as a projection of the individual's centre of gravity on the ground, see Duarte, Araújo, Freire, et al., 2010). These procedures allowed us to obtain participants' "virtual bi-dimensional coordinates" (i.e., not corresponding to the real-pitch coordinates) in each frame of a video stream (Duarte, Araújo, Freire, et al., 2010).

To transform these data into real-world three-dimensional coordinates, we used the two sets of bi-dimensional coordinates (one for each video stream) to feed a previously trained artificial neural network (ANN). Reliability was tested as a tool to convert virtual coordinates to real-world coordinates and accuracy was assessed by comparing the predicted coordinates with known ones (with a pooled SD the obtained value was 0.03 which corresponds to the 0.3% of the playing field; cf. reported in Passos et al., 2006). The main reason for using an ANN was the small error value that was achieved when converting virtual coordinates to real-world coordinates. This was verified by calculating the average root mean square error (which reflects the level of system inaccuracy) over 110 data points not used in the training procedure. We obtained a value of 1.3 cm with this measure, which is acceptable for the present study of macroscopic movements of participants on field during performance (Passos et al., 2006). The ANN consisted of four input "neurons", corresponding to the four coordinates of stereo images for each participant (i.e., x and y coordinates were captured from the movements of each participant by both cameras); six neurons in a hidden layer; and three output neurons, corresponding to the real coordinates (x, y, and z; Passos et al., 2006, 2008; Memon & Khan, 2001).

Data analysis

To counterbalance an attacker's movements, a defender will typically aim to intercept his/her trajectory towards the goal line. These counterbalancing movements can be measured by recording the VelSideline of each participant. This measure was obtained for each participant through calculating the first derivative of the distance of each participant to one of the sidelines taken as reference. For the purpose of the present study, data were analysed only until a critical performance moment was reached, i.e., when the attacker ran past the defender (try or ineffective tackle situation) or the defender performed a successful tackle.

When the VelSideline variable displays negative values, the data indicate that participants are running towards the sideline. In contrast, when the VelSideline variable displays positive values, participants are moving away from that sideline, towards the other sideline. Whenever the value of the VelSideline variable is close to zero, the data suggest that participants are running in a straight line, parallel to the sideline.

According to Corbetta and Thelen (1996), continuous correlation analysis methods, such as running correlations, can assist in identification of coordination tendencies including a (i) *synchronous coordination tendency* (ii) *reversed* (*or asynchronous*) *coordination tendency* and a tendency for (iii) *uncoordinated actions* (see also Kelso et al., 1981). Following procedures of Corbetta and Thelen (1996) and also those of Araújo et al. (2006) and Meador et al. (2002), running correlations were calculated on the data for velocity towards the sideline of both participants in the dyads. A 0.4-s window size (i.e., 9 data-point window) was shifted frame by frame (i.e., every 0.04 s) and, at each shift, a correlation value was calculated. In this way, we obtained a continuous correlation function that described the dyadic system's coordination tendencies over time (Meador et al., 2002).

Cross-correlation analysis was also applied to data on the participants' velocity towards the sideline. In attacker–defender dyads, a cross-correlogram may indicate the degree and the lag to which the movement behaviours of one dyad participant are coordinated with the movement behaviours of the other. The shifts in time used in this analysis comprised 10 lags ranging in both negative and positive directions: $t - k$ and $t + k$, $k_{\text{lag}} = 0.08$ s (Amblard, Assaiante, Lekhel, & Marchand, 1994; Derrick & Thomas, 2004; Mullineaux, Bartlett, & Bennett, 2001).

Here we report inferential statistical analyses of the entire data set using correlation methods. We also undertook a qualitative description of the dynamics of the values of each participant's distance to the sideline by plotting variable time graphs and correlation analyses (running and cross-correlations), categorised by different performance outcomes in each trial: i.e., when a try and a successful tackle occurred.

Results

Interpersonal coupling tendencies of participants' velocity towards the sideline

Running correlations were calculated between the VelSideline time series data of each participant (i.e., attacker and defender) in both try and tackle situations. A roughly symmetric shape was observed for both frequency histograms, with a slight (although not statistically significant) skewness to the left. On the other hand, a roughly mesokurtic shape was observed for both frequency histograms, with a slight (but not statistically significant) platykurtic tendency. A chi-square test of homogeneity was performed to examine the relation between the frequency distributions of running correlations for both performance outcomes. The difference between these frequency distributions was not significant [$\chi^2(18, N = 47) = 0.649, p = 1.00$]. For the entire data set (Figure 1), the undifferentiated histograms suggested the lack of a clear coordination tendency between individuals. However, in either trials where

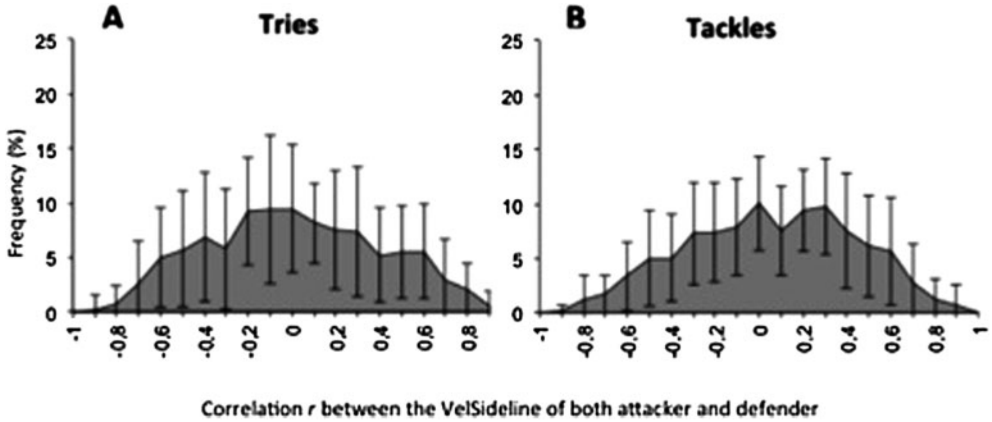

Figure 1. Frequency histogram (*M* and SD for each bin) of lateral displacement pattern coordination tendency: for the entire data set of tries (A) and for the entire data set of tackles (B).

a try was scored (Figure 1A) or a successful tackle occurred (Figure 1B), participants showed a more unrelated coordination tendency (high frequency of *r* running correlation values were around 0). Although some variability was observed between and within trials (considering the coefficient of variation CV of the VelSideline for each trial), these differences were not statistically significant. A Levene's test suggested similar CV variances between tries and tackles [$F(1, 45) = 3.882$, $p = 0.055$]. A subsequent *t*-test also revealed no significant differences between tries and tackles CV means [$t(45) = -0.130$, $p = 0.897$]. Overall, these results suggested the exploratory behaviours of both participants in 1vs.1 dyads in probing lateral space on field to seek a performance advantage.

Interpersonal coupling tendencies in illustrative try situations. Data from three exemplar try situations are shown in Figure 2A. It can be observed that the defenders began to move away from the sideline followed by the attackers' movement displacements in the same lateral direction (i.e., also increasing the velocity at which they moved away from the sideline; Figure 2A grey lines). Although initially some delays appeared in the VelSideline curves, at some point participant trajectories intersected, and attackers and defenders appeared to be concurrently displacing laterally (about 0.2 s, 0.4 s and 0.8 s, for the first, second and third examples, respectively). Yet the curves corresponding to each participant's VelSideline value were mismatched. For instance, it can be observed before the end of the trials, the attackers increased velocity away from the sideline while the defenders increased velocity towards the same line (most noticeable in the first and second examples, approximately between 1.3 s and 1.5 s, 1.3 s and 1.6 s, respectively). This manoeuver from the attackers created a "gap" in the coordination tendencies of participants, destabilising the dyadic system. Although the defenders also began increasing velocity away from the sideline, that preceding "gap" may have allowed the attackers to exploit the space and score a try.

The running correlograms (Figure 2A black bold line) of the illustrative try situations revealed three main stages of coordination: a mostly positive relationship followed by a period where the correlation values are mostly negative, and finishing with a revisit to positive values. This finding is consistent with participants' initially increasing and decreasing velocity almost simultaneously away from the sideline. After that, participants assumed divergent lateral running line patterns consistent with momentarily reversed interpersonal coordination tendencies. In other words, when one participant increased velocity, the other, almost simultaneously, decreased velocity towards the sideline. Towards the end of the trial, the correlations revisited positive values. This finding echoes the re-matching of the VelSideline curves and reveals a synchronous coordination tendency emerging in the dyad. The final close to null correlation values showed that, while the defender was decreasing velocity away from the sideline, the attacker was increasing velocity away from it, suggesting a gap was opened up with the defender.

Interpersonal coupling tendencies in illustrative tackle situations. From the three illustrative tackle situations shown in Figure 2B, it can be seen that both the attackers (Figure 2B dark grey line) and the defenders (Figure 2B light grey line) switched between running towards and away from the sideline. However, VelSideline curves for these illustrative tackle situations were not as closely matched as in the previous try examples. "Gaps" between participants' VelSideline values (i.e., both players were moving towards the sideline, yet the defender was displacing with higher velocity towards it) can be observed by the end of the trials. However, shortly after, the defenders were able to approach the

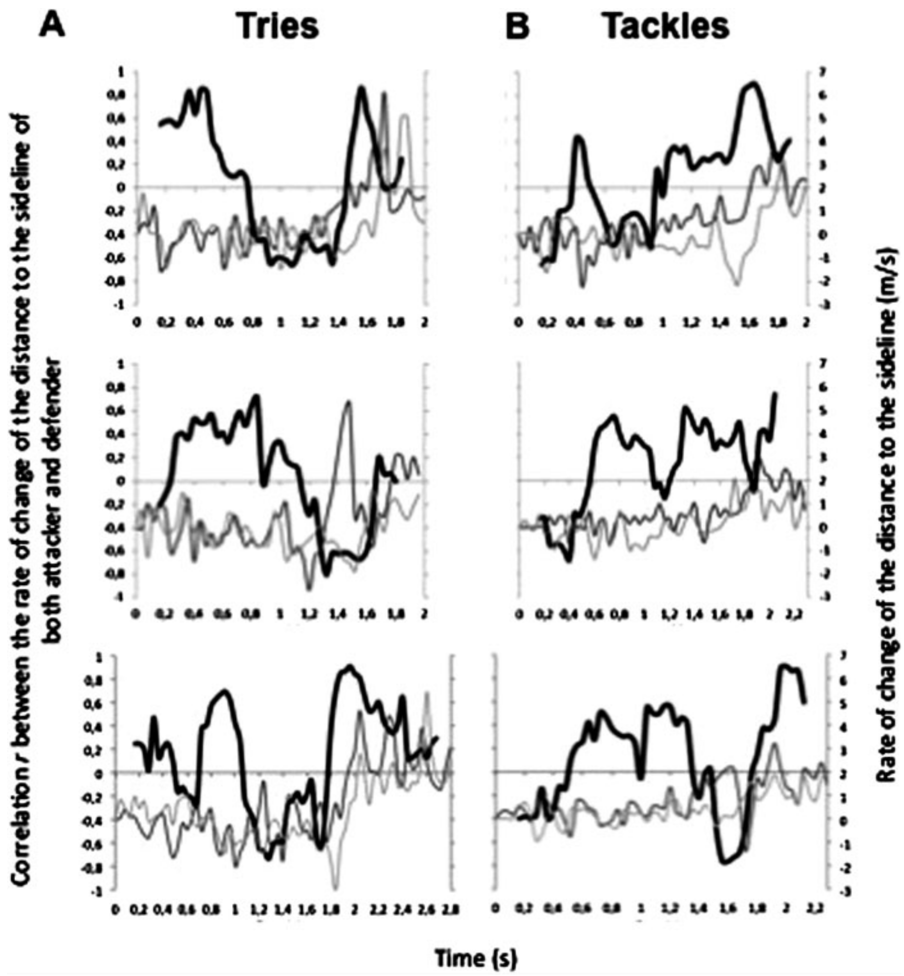

Figure 2. Grey lines: velocity towards the sideline (VelSideline) for both attacker (dark grey) and defender (light grey) over time for six illustrative trials: when three tries are scored (A) and when three tackles occur (B). Black bold lines: running correlations between the velocity towards the sideline (i.e., VelSideline) of both attacker and defender of six illustrative trials: when three tries are scored (A) and when three tackles occur (B).

attackers' VelSideline absolute values, maintaining stability in the dyadic system (captured by a parallel change in both curves). Contrary to the illustrative try situations, the observed parallel behaviour of VelSideline is consistent with an attacker–defender balance that creates the opportunity for a tackle to emerge (Figure 2B grey lines).

In the running correlograms of the illustrative tackle trials (Figure 2B black bold line), negative correlation values revealed that participants' displacement trajectories with respect to the sideline displayed opposing behavioural tendencies. Curves on the time evolution of each participant's VelSideline values in these situations (as displayed by the grey lines) did not match up as in the try examples. In this way a reversed coordination tendency (captured by negative correlation values) was initially observed. Yet, this relation between participants transited to a more synchronous coordination tendency (captured by positive correlation values), and then back to a reversed tendency (revisiting negative correlation values). The running trajectories fluctuated between reversed and synchronous coordination tendencies. In other words, participants' lateral movements, captured by changes in their velocity towards the sideline, were characterised either by being concurrent in contrasting ways (e.g., one was increasing velocity while the other was decreasing velocity in the same direction) or by being concurrent in analogous ways (e.g., both were increasing velocity in the same direction).

Interpersonal coupling latency of velocity towards the sideline

Cross-correlations were calculated for the entire data set and pooled for overall try and tackle trials (Figure 3). Participants' movements were more positively correlated in tackle situations (even when the time lag is included) than in try situations. Positive cross-correlation coefficients suggest that the participants moved with moderate synchronous

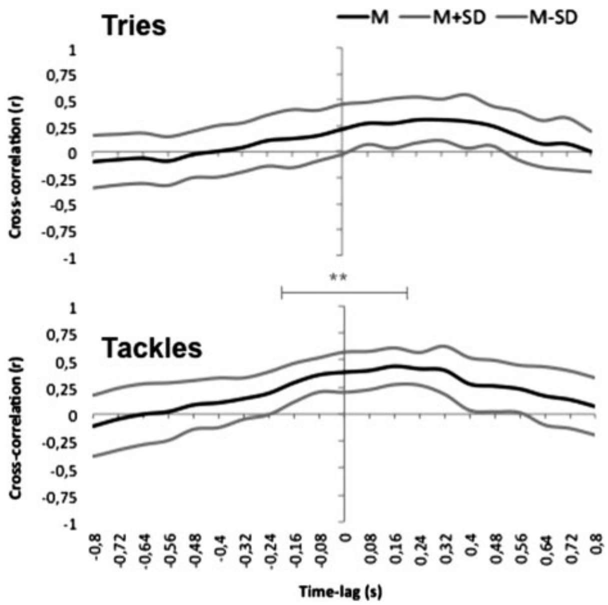

Figure 3. Point-by-point cross-correlation coefficient average band ($M \pm$ SD) of attacker and defender participants' velocities towards the sideline for the entire trials analysed (N tries = 20, N tackles = 27) over the different time lags.

tendencies throughout the whole time series. Data used in this cross-correlation coefficient band were subjected to a mixed model analysis of variance (ANOVA) with lag (21 lags ranging from −0.8 s to 0.8 s) as the within-participant factor and trial outcome (try or tackle) as the between-participant factor. Data were previously tested for normality and for sphericity using Shapiro–Wilk's and Mauchly's tests and, when necessary, the Greenhouse-Geisser correction adjusted the degrees of freedom for the error variance term of the ANOVA. ANOVA yielded main effects for trial outcome [$F(1, 45) = 6.817$, $p = 0.012$, $\eta_p^2 = 0.132$] and for lag [$F(4.099, 184.461) = 23.849$, $p < 0.001$, $\eta_p^2 = 0.346$]. No interaction effects were found ($p > 0.05$). Bonferroni post hoc analyses revealed that correlations were higher for tackle than for try trial outcomes for the overall lags, particularly for lags between lag −0.2 s and lag 0.2 s ($p = 0.012$). As for the lag main effect, post hoc tests showed significant differences for all lag pair comparisons, except essentially amongst the positive lags ($p > 0.05$).

Interpersonal coupling latency for illustrative try and tackle situations. A cross-correlation function was also computed on the same data as the illustrative try and tackle trials outlined before (Figure 2). Correlation values outside the statistical threshold levels, defined by the grey lines (i.e., $r < -2 \times$ SE or $r > 2 \times$ SE, as recommended by Box, Jenkins, & Reinsel, 1994), can be assumed to be statistically significant. For both try (Figure 4A) and tackle (Figure 4B) trials, participants' velocities towards and away from the sideline appeared to be correlated across the entire data set, and the relationship between these time series when in temporal similarity (lag 0), ranged from almost null to positively correlated. Such positive values of the cross-correlation coefficient captured how the participants were moving in moderate synchrony throughout the time series. With the various positive temporal shifts ($t + k$, lags $k > 0$), the correlation values maintained or increased in magnitude for the first lag increments, meaning that they were more related with some temporal delays. This observation implies that, throughout the trial, the defender's VelSideline values followed the attacker's, but the time course of relationship includes a time delay. Conversely, with systematically negative temporal shifts, decreasing weaker correlations were displayed. Such a decrease in association led to correlation values nearing zero by the end of the cross-correlogram. Findings showed that participants were, as expected, more coordinated when the defender moved later than the attacker.

Discussion

Boundary constraints act as clear sources of information, which can formalise the context for the functioning of complex biological systems and can take many forms in sport. For example, they may include the specific rules of a game and field markings, which formally define the space within which a team game is played. The present study investigated the coordination tendencies between attackers and defenders in competing dyads, when exploring lateral space on field, using running and cross-correlations of participants' velocity values towards or away from the sideline in the team sport of rugby union as a measure. Results indicated similar patterns emerging in values of VelSideline for attacking and defending participants, revealing how participants were exploring lateral space on field and the possible existence of dynamic coupling tendencies in 1vs.1 dyadic systems. Depiction of values of VelSideline over time suggested that opposing participant displacement trajectories became coordinated at specific stages of interpersonal interaction. One participant was increasing velocity or decreasing velocity, leading or following the other participant. Such observed changes in velocity towards the sideline might have been due to deceptive movements undertaken by players as they approached each other.

Running correlation values suggested that velocity towards or away from the sideline helped quantify how exploratory actions of both participants in a dyad were coordinated. In the entire data corpus

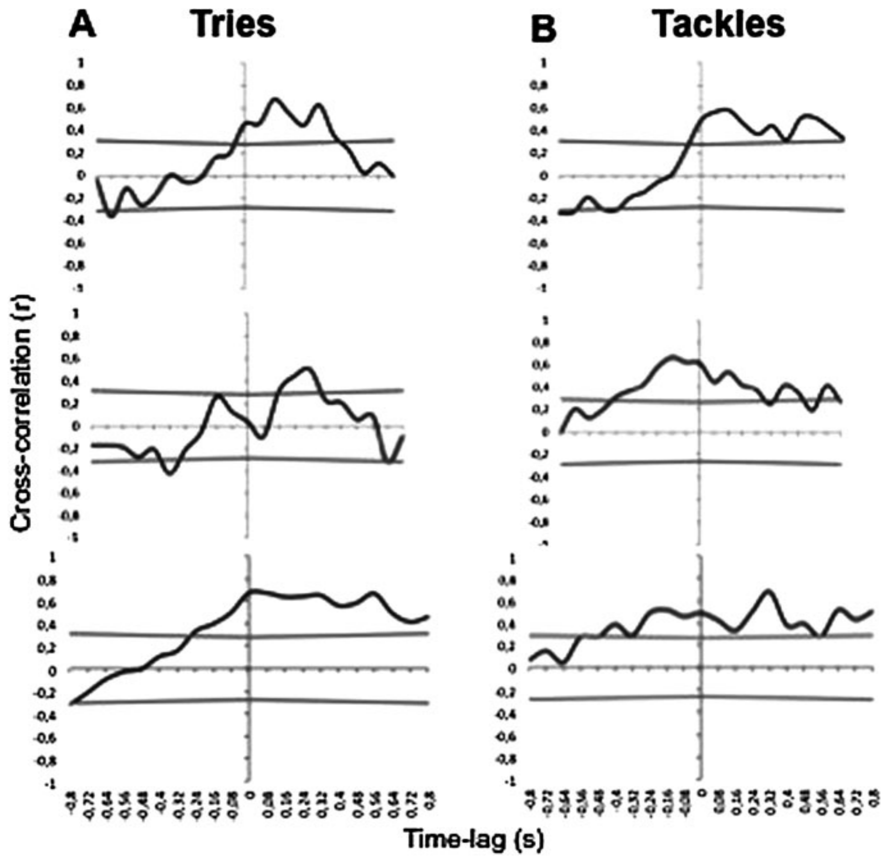

Figure 4. Cross-correlograms for illustrative tries (A) and tackles (B). These plots show the relationship between the series of VelSideline of both participants' (attacker and defender) with temporal shifts of the series, i.e., 10 time lags $t - k$ and $t + k$, $k = 0.08$ s (black solid line). Statistical threshold levels, i.e., $-2 \times$ SE and $2 \times$ SE (lower and upper grey solid lines).

analysed, exploratory behaviours of participants were illustrated in the intervals of synchronous coordination, reversed coordination and uncoordinated action tendencies between participants, expressed through the variable: VelSideline. A *synchronous coordination tendency* corresponded to stages where both participants sought to increase velocity or decrease velocity in the same direction almost simultaneously (resulting in correlation functions with positive values). Such synchronous coordination tendencies imply that the defender's counterbalancing movements were covering an attacker's path towards the goal line. A so-called *reversed coordination tendency* emerged, for instance, whenever one participant increased velocity (or decreased velocity) towards the sideline, while the other decreased velocity (or increased velocity) almost simultaneously in the same direction, or when both increased velocity (or decreased velocity) in opposing directions (displaying correlation functions with negative values). Such reversed coordination tendencies may provide insights on a defender's difficulty in covering the attacker's path to the goal line. Finally, *uncoordinated action tendencies* revealed the existence of apparently independent movements of both participants. This tendency was, however, transient as the zero correlation values were verified by transitions from negative to positive correlations.

Synchronous values might indicate a higher dependency on a defender's lateral displacement trajectories relative to an attacker's. Such dependency may be intentionally created and explored by the attacker. Holding a patterned relation with a defender (where a kind of lateral displacement tracking behaviour is maintained) may be assumed advantageous to an attacker, allowing him/her to avoid interception and a collision while running to the try line. Conversely, if *synchronous coordination tendencies* were to be maintained for a long time, it is likely to increase the probability of the attacker being tackled. The data suggest that relational tendencies of attackers and defenders become coupled at critical moments of performance when the attacker either outruns or is tackled by the defender. This finding concurs with data reported in previous studies of 1vs.1 sub-phases in rugby union (Passos et al., 2009), and in other team sports such as soccer (Duarte, Araújo, Travassos, et al., 2010) and basketball (Esteves, de Oliveira, & Araújo, 2011). They demonstrated that physical variables specifying the relationship between opposing players, such as their relative velocity and interpersonal distance, yield critical values beyond which transitions in players' actions tend to occur. The undifferentiated shape of the frequency distribution observed for the try and tackle data set revealed that this 1vs.1 dyad interaction displayed no predominant form, as lateral coordination tendencies emerged. This feature might be a demonstration of coexisting tendencies to cooperate and compete in a social system formed by opposing team game players (Kelso, 2009).

Cross-correlations were also used to assess interpersonal coupling tendencies, given that changes in participants' distances to the sideline may not have been precisely synchronised suggesting the possibility of time lags during performance interactions. Such lags may be indicative of who was leading whom in the dyads, an issue that needs to be tested in future research. Concerning the entire data set, cross-correlation results showed that changes in the distance of each opposing participant towards the sideline were more synchronised when a tackle occurred, than when a try was scored, especially when the defender moved after the attacker. Such positive lags suggest that a defender's delayed matching of his/her relative position to the sideline set an attacker's opportunities for action.

Previous studies, focused likewise on the dynamics of players' interactions, have also addressed the lead lag relation using the relative-phase method. Pioneered in the sport of tennis (Palut & Zanone, 2005), the use of this method to assess interpersonal coordination has been used in a number of studies in team sports, such as basketball (Bourbousson, Sève, & McGarry, 2010), football (Duarte, Araújo, Travassos, et al., 2012) and futsal (Travassos, Araújo, Duarte, & McGarry, 2012; Travassos, Araújo, Vilar, & McGarry, 2011; Vilar, Araújo, Davids, & Travassos, 2011). Although this method is well known for identifying tendencies for synchronised displacements of players and teams in both lateral and longitudinal directions, other measures, such as running and cross-correlations used in the present study can also provide relevant insights on exploratory behaviours of team games players. In this regard, our observations provide new insights to interpret the spatial exploration behaviours of opposing players trying to create and perceive action possibilities in the pursuit of specific performance goals.

To further describe and explain how boundary constraints influence dynamical processes such as the spatial exploration behaviours of these players, future work could include an experimental task design of subtly and systematically altering distances between the sidelines, inwards and outwards, in order to examine putative effects on dynamical exploratory interactions in dyadic systems in team sports. Further research is also needed to investigate the relation between participants' lateral displacement trajectories towards the sideline and their frontal (i.e., longitudinal) displacement trajectories. Additionally, research could study participant displacement trajectories when influenced by movements of other interacting players, and of course (since the present participants are very young) how such quantities may change with skill development and experience.

This study also has implications for practice as it emphasised the importance of designing practice tasks that offer players the opportunity to constrain the opponents in lateral directions. Coaches could, for instance, make use of the aforementioned manipulation of the distance between the sidelines (inwards and outwards) to provide players with opportunities to explore interpersonal interactions, in either dyadic or other team sub-systems, and to enhance the functional behaviours required in competitive performance contexts.

In sum, in 1vs.1 rugby union dyads there are distinct coupling patterns that result in different performance outcomes, adding evidence for how players create and perceive possibilities for action while seeking to attain specific performance goals.

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