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Colin D. McLaren and Kevin S. Spink
University of Saskatchewan

It has been reported in past research that information exchange at the individual and team level (i.e., communication network structure) is associated with higher perceived task cohesion and team performance. The current study extended these findings to intact sport teams and tested these relationships across time. Competitive basketball athletes (N = 133, k = 15; M_{age} = 27.4, SD = 7.5 years) completed measures of information exchange with teammates during a game (peer nominations using social network analysis) and task cohesion. Performance was collected using objective winning percentage. A prospective design across the first half of a competitive season was used. Controlling for early season perceptions of task cohesion, interacting with a higher number of teammates, and higher collective information exchange at the team level at early season significantly predicted later task cohesion perceptions (n = 70; pseudo R^2 = .49). Using a multilevel model, the overall variance accounted for was captured at both the individual (42%) and team (7%) level. In a second analysis, a hierarchical regression controlling for early season team performance found that information exchange of the team as a whole at early season significantly predicted team performance (n = 109; R^2_{adj} = .48, $p < .001$). These results highlight a pattern of relationships between information exchange and both task cohesion and team performance consistent with past theorizing. In terms of uniqueness, specific aspects of information exchange (i.e., individual vs. team level network structure) differed for each dependent variable.

Keywords: information exchange, social network analysis, centrality, density, group dynamics

Although support for the usefulness of cohesion in sport is well established (e.g., Carron & Eys, 2012; Spink, 2016), the processes by which individual members come to draw cohesion perceptions receives less attention (McLaren & Spink, 2018b; Spink, McLaren, & Ulvick, 2018). If the long-term practical goal of practitioners is to impact important individual and team outcomes by altering group cohesion perceptions, understanding the possible sources of information that athletes use to form these perceptions would be instructive. In the context of sport, the accepted definition of group cohesion is " . . . a dynamic process which is reflected in the tendency for a group to stick together and remain united in pursuit of its instrumental objectives and/or for the satisfaction of member affective needs" (Carron, Brawley, & Widmeyer, 1998, p. 213). Further, as this definition is based on the assumption that cohesion " . . . develops as a function of the socialization and interaction processes that occur within groups" (Carron & Brawley, 2000, p. 102), one variable that could serve as a potential source of information for perceived cohesion is team member communication.

Colin D. McLaren and Kevin S. Spink, College of Kinesiology, University of Saskatchewan.

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Correspondence concerning this article should be addressed to Colin D. McLaren, College of Kinesiology, University of Saskatchewan, 87 Campus Drive, Saskatoon SK S7N 5B2, Canada. E-mail: colin.mclaren@usask.ca

In terms of nuance around communication, it also has been noted that the sources of information from which members of a sport team draw their cohesion perceptions could span personal experiences within the group as well as the integration of information about the team as a whole (Carron & Brawley, 2000; Carron, Brawley, & Widmeyer, 2002), Together, these individual and team aspects are selectively filtered and interpreted in a way that informs the athlete's perception as to the unity of the team in its pursuit of different team goals and objectives (i.e., cohesion). This dual source informing cohesion maps well with team member communication as athletes have unique experiences communicating with teammates (individual level) and share in the collective communication that exists between all team members (team level). As such, examining member communication from these two different perspectives would be of value to those interested in understanding how perceptions of cohesion emerge in the sport setting.

Acknowledging the importance of team member communication as a structural component of the team (i.e., individual and team level) as it relates to group cohesion is not a new idea (e.g., Leavitt, 1951; McGrath, 1984; Shaw, 1964). In a review of the group dynamics literature, Cartwright (1968) described group interactions as one incentive property that members consider in determining the attractiveness of a group. First, Cartwright notes that at the team level, individuals are more satisfied with their membership in high task complexity groups like sport teams (and hence more likely to remain) when the structure of communication does not rely on a small number of team members. At the individual level, members are more satisfied when they possess the capacity to be involved in the various interactions of the team (i.e., communicate with many others; see also Shaw, 1964).

In the context of organizational psychology, Balkundi and Harrison (2006) conducted a meta-analysis to synthesize the communication structure/attraction to the team (operationalized as team viability) relationship in a sample of over 3,000 intact organizational groups. Overall, the results supported the theorizing of early group dynamics researchers that higher member communication composed of task-related (i.e., instrumental) interactions between all members of a group (who themselves also are well-connected) was positively associated with team viability (which included measures of team cohesiveness). It was argued that teams with more instrumental connections would be those who communicate often, which could serve to reduce the likelihood of fragmentation and increase cohesiveness (Balkundi & Harrison, 2006).

As a multidimensional construct (Carron, Widmeyer, & Brawley, 1985), cohesion can be differentiated into four different subscales that differ along two general dimensions: (a) personal motives/attractions (ATG) versus the group as a totality (group integration [GI]), and (b) task versus social orientations. Groups form for different reasons and have different goals/objectives (Carron & Brawley, 2000), so it is important to recognize that information exchange will not serve to inform all dimensions equally. Assessing team cohesion through a social lens (i.e., social cohesion) should be informed by interpersonal or affective experiences with other members (e.g., friendship; Herbison, Benson, & Martin, 2017), whereas either task or social cohesion along the individual attraction dimension (ATG) should be related to features of the group that a member finds personally attractive (e.g., status rank; Shanthi Jacob & Carron, 1998). Information exchange, however, relates more to the way a team comes to function as an integrated unit around the task, which clearly aligns it with the cohesion subscale of Group Integration-Task (GI-Task; Carron et al., 1985), which is the focus of this study.

Preliminary empirical research in sport has supported this speculation to the extent that athletes who reported that they communicated with a higher number of team members also reported higher task cohesion perceptions in terms of the group as a totality (GI-Task; McLaren & Spink, 2018a, 2019, Study 1). Considering the individual athlete and the sport team together, research with hypothetical sport teams (McLaren & Spink, 2019, Study 2) found that when members personally engaged in higher information exchange, and the team as a whole engaged in more information exchange, perceived task cohesiveness was higher. These findings are consistent with the idea that engaging in information exchange with teammates should provide an athlete with a perceived window into how united the team is in pursuit of its task goals and objectives (i.e., GI-Task). When individuals exchange information with a higher number of their teammates and the remaining members of the team also exchange information with most members, one plausible interpretation by the individual is that teammates are "in it together" in pursuing task goals (i.e., higher in task cohesion; McLaren & Spink, 2019).

One other conclusion drawn in early group dynamics research (e.g., Leavitt, 1951), and confirmed with meta-analytic findings (Balkundi & Harrison, 2006), is the importance of the communication network for team performance. Consistent with research from organizational group dynamics (e.g., Balkundi & Harrison, 2006; DeChurch & Mesmer-Magnus, 2010), groups in which there was more information exchange between more members had greater team performance. Results from a meta-analysis by Balkundi and Harrison (2006) found that higher information exchange at the individual and team level together would positively predict team performance metrics for different work teams. This has been extended to the context of sport where it has been reported that a more successful team (compared with the less successful one in a head-to-head competition) engaged in a greater amount of information exchange during the game (McLaren & Spink, 2017). One potential interpretation is that when more members are exchanging information with teammates during a game, it is more likely that the appropriate information is communicated at the correct time. In this way, the likelihood of possible process losses stemming from lack of information would decrease, and inter alia, team effectiveness would increase (e.g., Steiner, 1972).

Based on the preceding discussion, two important considerations are worth highlighting with respect to the relations between information exchange and both task cohesion and team performance. First, member information exchange can be parceled into individual and team structural components. A team is composed of a number of different individuals, all of whom may engage in information exchange to a different degree. While overlap exists, the number of members who a specific individual exchanges information with does not necessarily reflect the degree to which the remainder of the team exchanges information. This has not received consideration in the extant sport literature, suggesting that key information may be lost.

Consider a hypothetical team member who has less involvement in the information exchange patterns of the group. This member experiences the social situation of the group in a unique manner vis-à-vis a member who is very central to information exchanges (i.e., exchanges with many others). In accordance with this higher information exchange involvement, this member also would perceive the team as more cohesive. Support can be found in a recent sport study where athletes who exchanged information with more of their teammates held higher perceptions of task cohesion compared with those who exchanged information with fewer teammates (McLaren & Spink, 2019, Study 1). These results, however, are based on concurrent data collection making it difficult to discern the flow of causality (e.g., does higher information exchange lead to higher cohesion, or vice versa?).

In addition, evidence for this relationship has tested information exchange at the individual level and ignored the collective information exchange of an entire team as a construct (e.g., Cranmer & Myers, 2015; McLaren & Spink, 2018a, 2018b). In one experimental study, the information exchange patterns of an entire team were matched with the individual exchange behaviors using hypothetical vignettes (McLaren & Spink, 2019). Higher exchange patterns were associated with higher anticipated task cohesion. Bringing together the extant literature, it follows that a positive relationship would exist between information exchange at the individual and team level and both perceived task cohesion and objective team performance.

Reflecting on the direction of this relationship, research in the organizational domain supports information exchange leading to perceived task cohesion. For instance, past experimental research in other group contexts (e.g., organizational and military psychology) supports the claim that under temporal urgency, groups exposed to a high task cohesion manipulation communicated more task-relevant information during a performance task than those exposed to a low task cohesion manipulation (Zaccaro, Gualtieri, & Minionis, 1995). However, sport teams are unique from business, work, or student groups (Weinberg

& McDermott, 2002) in that members of a sport team must execute their specific role responsibilities against an opponent in real time. This makes coordinating efforts more critical and places a premium on communication. As team performance in sport is not simply the sum of individual achievements, it is possible that the individual level of information exchange will be less of a factor in predicting unique variance compared to other organizational settings (where tasks may be more divisible and differ in interdependence structures; Steiner, 1972). To date, individual and team components of member interactions have not been examined in intact teams.

In addition to this individual/team interface, the second consideration is that these relationships have not been tested across time in the sport context. The research in sport to date is based on cross-sectional field (e.g., Cranmer & Myers, 2015; McLaren & Spink, 2018b) and hypothetical vignette data (e.g., McLaren & Spink, 2019, Study 2). Gathering concurrent data might mask how the variables are associated with each other at different points in the development of a group (Cronin, Weingart, & Todorova, 2011). Further, a reliance on concurrent data to inform research and practice has the potential to overlook the role of method variance in these relationships (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003), and undermine any chance of creating a future case for causality. The use of a prospective design is one way to begin to address these potential limitations.

The purpose of the current study was to constructively replicate (Hüffmeier, Mazei, & Schultze, 2016) the relationship between communication as information exchange and the outcomes of task cohesion and team performance in intact sport teams. A constructive replication differs from exact replications in that it seeks not only to add evidence for a relationship, but also refines or extends what is already known. To date, preliminary research has been based on individual perceptions of typical team communication patterns (McLaren & Spink, 2018b) and consideration of communication structure from only the individual or from combined individual and team communication using hypothetical vignettes (McLaren & Spink, 2019). Collectively, these results suggested that information exchange carried out between a higher number of members (individual and team levels) was associated with higher perceptions of task cohesion and overall team performance. However, a next step in testing information exchange as a potential cue for sport group cohesiveness and an indicator of team performance is needed. This involves using a design in which the communication measure precedes the assessment of cohesion and performance in intact teams.

Given the first-generation nature of the research question (Zanna & Fazio, 1982), it was deemed important to test these relationships during an appropriate stage of group development. According to past meta-analytic research, communication is most predictive of cohesion and performance when it is examined earlier in the life span of a group (Balkundi & Harrison, 2006). As such, these relationships were tested in this study across the first half of the competitive season of intact sport teams. Further, it was important to adopt a methodology that allowed for the individual/team interface to be appropriately captured.

Social Network Analysis

This study used social network analysis (SNA), which uses individual nominations of teammates to model the social connections between members of a group in the form of a network (a set of actors and the social relations between these actors; Borgatti, Everett, & Johnson, 2013; Katz, Lazer, Arrow, & Contractor, 2004; Wäsche, Dickson, Woll, & Brandes, 2017). In this study, the exchange of information between two athletes represents the social connection. Portions of the network can be isolated to examine an individual and his or her connectedness, or all connections can be considered simultaneously as a team-level characteristic.

At the level of the individual athlete, an appropriate metric that can be derived from the network is individual centrality (Borgatti et al., 2013). Typically used as an indicator of prestige, importance, or social capital (Katz et al., 2004), centrality can be further divided based on the direction of a social connection: outdegree centrality is the number of group members with whom a given individual reports having a connection, and indegree centrality is the number of group members that report having ties with a given individual. At the team level, network density represents all of the connections between all of the team members (Borgatti et al., 2013). In terms of this study, density would generate an estimate of collective information exchange by the team as a whole.

It is worth noting that there is likely some conceptual overlap between network density and cohesion. For instance, one of the items used to assess task cohesion reflects an assessment of communication network density. Further, network density also has been called network cohesion on occasion (e.g., Wise, 2014). In the current study, we differentiate between cohesion as a structural component of a network (a term to describe density; Wise, 2014) and our focus on task cohesion as a psychological construct that encompasses perceptions of group-level functioning.

Taken together, two hypotheses were posited for the current study. In terms of cohesion, it was hypothesized that an athlete who (a) reported exchanging information with a higher number of teammates, and (b) is a member of a team that engaged in higher collective information exchange at an early season measurement point would be positively associated with later perceptions of task cohesion with respect to overall team functioning (GI-Task). Aligning this hypothesis with specific SNA metrics, it was predicted that athletes with higher outdegree centrality scores at early season would report higher task cohesion (GI-Task) assessed later in the season. In contrast, indegree centrality would not significantly predict later task cohesion perceptions. The rationale for this follows. Returning to the formation of cohesion perceptions (e.g., Carron & Brawley, 2000), individual athletes are likely to recall who they exchanged information with as part of their own personal experiences. In contrast, the experiences of other athletes identifying those with whom they exchange information should not directly serve to inform member perceptions in the same way, as the member is not privy to the fact that others have identified them as sharing information. A null result between indegree centrality and cohesion would offer validity to the conceptualization of cohesion insofar as the formation of cohesion perceptions. At the team level, the second hypothesis would indicate that higher network density (from the SNA perspective) early in the season would positively predict task cohesiveness later in the season (GI-Task).

Second, team performance represents a team-level variable that is likely influenced by the overall ability of the team to integrate its component parts. Therefore, the information exchange behaviors of each member on his or her own (both personal experiences and other teammate reports) is less likely to predict overall team effectiveness. Rather, the more likely outcome is that team outcome would be associated with the information exchange of all members together. As such, it was hypothesized that the team-level aspect of information exchange at an early season measurement period would positively predict later team performance, while early season individual-level information exchange would not be associated with team performance.

Method

Participants

A total of 133 adult basketball athletes who were members of competitive teams in two adult sport leagues participated in this study. Specifically, 109 athletes completed the study in the early season and 102 athletes completed the study during the later season measurement periods (78 participants completed both early and later season measures). Male athletes were recruited from teams in the top two divisions of a six-division league ($k = 11$) and female athletes were recruited from teams in the top division of a four-division league ($k = 4$). Participants had an average age of 27.4 ($SD = 7.5$ years, range 18–53), and an average of 17.4 and 4.4 years of experience competing in basketball, and on their current team, respectively. With respect to player status within the team, 95 athletes (71%) self-identified as a starter.

Specific to the basketball leagues involved, teams were required to have a team member as a representative for administration purposes. There were no coaches or official captains. As such, decisions such as starting lineups, substitutions, play calling, and weekly attendance were at the discretion of the athletes. Players put together a team, and then submitted the team to the league. The submitted teams were placed into specific competitive levels based upon past season success (in order to achieve competitive balance). Given the past histories of the teams in this study, it was important to control for perceived cohesion and team performance at early season to control for any possible preexisting differences between teams.

Procedure

Following university research ethics approval, team representatives listed on the league websites were contacted by the lead author with an explanation of the research project. At this time, permission also was requested from the team representatives to recruit the remaining members of the team at a weekly game early in the competitive season. After providing informed consent to participate in the research, participants completed two separate questionnaires—the first on either the third or fourth game of the season and the second on the seventh or eighth game of the season (just before the December break when the league shut down for the holidays). All teams were scheduled to compete in 15 regular season games.

At each measurement point, participants independently completed a paper-and-pencil questionnaire package under the supervision of the lead researcher. All participants present agreed to participate. The questionnaire was completed immediately following the game, typically in the team bench area. All participants were informed that they could ask questions in the event that clarification was required, and withdrawal from the study was possible at any time. Survey completion lasted approximately 10 min at each measurement point. Finally, participants could enter a draw each time they completed a questionnaire for a gift card to a local restaurant as potential compensation for their participation.

Measures

Information exchange. To measure the exchange of information between athletes, participants were asked to list those teammates who were in attendance for the particular game examined. This was done on a sheet of paper that included spaces for names to be inserted. Participants were asked to consider the members with whom they exchanged information during the game that just ended. To capture this, participants were presented with the item "I openly exchanged information with these team members during the game," and asked to place a checkmark next to the name of each player that applied to the statement. The item used was adapted from Lee (1997), and has been used in existing studies testing the association between communication and group cohesion (e.g., McLaren & Spink, 2019).

Participant responses were translated into an $n \times n$ adjacency matrix (where n was the number of team members present at that game) using a binary 0 (*did not exchange information*) or 1 (*did exchange information*). Rows (i) represented the members a specific individual nominated as someone with whom they exchanged information during the game, while columns (j) represented those from whom an individual received nominations for exchanging information during the game. Given that it was possible to either be the sender or receiver of information (without a need for reciprocity), the network was directed rather than symmetrical (cell ij may not be the same as cell ji). Diagonal cells were left as missing values given that athletes could not exchange information with themselves. On average, 92.6% of eligible group members were present at the early season measurement period to complete the network measure. The lowest total was 77.8% (7 of 9 members) with 8 of 15 teams having all members present.

Using social network analysis (Borgatti et al., 2013), it was possible to compute network metrics that directly corresponded to information exchange at the individual level. Individual degree centrality is the degree to which a specific individual in the network is connected to others, and can be divided into two separate metrics. First, outdegree centrality is the number of teammates with whom an individual reported exchanging information during the game (correspond to the rows in the matrix). Indegree centrality, on the contrary, is the number of teammates who reported exchanging information with a given member during the game (correspond to the columns in the matrix). Both values were normalized as a proportion score to control for minor differences in team size. Based on the conceptualization of cohesion (Carron et al., 1985), it is outdegree centrality that would best capture personal experiences in the team, whereas indegree centrality would reflect the personal experiences of others. At the team level of the information exchange network structure, a metric of network density can be calculated to estimate the number of exchanges that took place between all members of the team as a whole (Borgatti et al., 2013).

Task cohesion. Perceptions of task cohesion were measured with the positive wording version (Eys, Carron, Bray, & Brawley, 2007) of the Group Environment Questionnaire (GEQ; Carron et al., 1985). The GEQ is an 18-item inventory that captures perceptions of cohesion across two broad conceptual dimensions: (a) task and social needs, and (b) personal attractions to the group and how the group functions as a total unit. Given that the exchange of information is situated at a group level, five items that measured task cohesion perceptions of the group as a totality were assessed (GI-Task; e.g., "Our team is united in trying to reach its goals for performance"). Items were rated on a Likert-type scale anchored at 1 (*strongly disagree*) and 9 (*strongly agree*) with greater scores reflecting greater task cohesion perceptions. Reliability and validity for the original (Carron et al., 1985) and positively worded (Eys et al., 2007) versions of the GEQ have been demonstrated in the context of sport. At both measurement points, one item ("If members of our team have problems in practice, everyone wants to help them so we can get back together again") was removed for contextual reasons (i.e., most teams did not have separate practices). Internal consistency after removing this item was found to be acceptable at both time points ($\alpha_{\text{early season}} = .83$, $\alpha_{\text{later season}} = .85$).

Team performance. An objective indicator of a team's overall performance was derived from the winning percentage of a team. This score was calculated based on the number of games won as a proportion of the total number of games played at the early and later season measurement points. For example, a team with three wins in four total games would have a score of .750, where higher scores (ranging from 0 to 1) reflected higher objective team performance. This measure was similar to that used in other sport team performance research (e.g., Becker & Solomon, 2005; Benson, Siska, Eys, Priklerova, & Slepicka, 2016).

Data Analysis

Prior to the main analysis, data were screened for normality and multicollinearity. Using a prospective design, the two study hypotheses were tested in different ways. To test the communication network/task cohesion relationship, multilevel modeling using hierarchical linear modeling (HLM Version 7.03; Raudenbush, Bryk, & Congdon, 2011) was used. This was possible because later season task cohesion was measured at the individual level (a requirement of HLM), which allowed for variance to be partitioned into individual (Level 1) and team levels (Level 2; Raudenbush & Bryk, 2002). The deviance statistics were compared across two nested models to determine if adding network metrics in the full model predicted unique variance in later season task cohesion beyond that accounted for by early season task cohesion perceptions alone (which was tested separately as the lone predictor in a smaller, control Model 1; see Raudenbush & Bryk, 2002). For the full model (Model 2), early season task cohesion and early season indegree and outdegree centrality as Level 1 predictors and early season network density as a Level 2 predictor were included as factors informing later season task cohesion.[1]

To test the communication network/team performance relationship, a hierarchical multiple regression was used because team performance was measured at the group level (i.e., Level 2) and multilevel modeling requires a Level 1 outcome measure. At Step 1 of the regression predicting later season team performance, early season team performance was added as a control variable, while early season network density and both indegree and outdegree centrality were added at Step 2. To determine the degree to which the communication network structure contributed to later season team performance, the change in variance accounted for as well as the semipartial (*sr*) correlations were examined in the final model.

[1] All data were collected following a weekly game. As such, the current game outcome at the early season measurement period also was entered as a control variable in predicting later season task cohesion and team performance. In both cases, the results were the same with the variables entered or not entered. To maximize power, the game outcome at early season was not entered as a second control variable.

Results

Preliminary Analyses

Testing for the assumptions of multilevel and hierarchical multiple regression analyses revealed that multicollinearity between study variables was not a concern. In terms of normality, GI-T perceptions both at early and later season demonstrated a negative skew. Subsequent analyses revealed that the study results were the same for raw and transformed (reflected and base-10 logarithm; Tabachnick & Fidell, 2013) values. Thus, the raw scores were retained for ease of interpretation. Eligible participants in each analysis are described below. Given that participants could participate at either or both of the two measurement periods, the number of participants potentially eligible for the main analysis is included for each analysis.

In terms of descriptive statistics, participants nominated (and were nominated by) approximately 85% of teammates for information exchange during the early season game. That is, athletes exchanged information with roughly seven of eight teammates during the game. Also, participants reported moderate-high perceptions of task cohesion at both early and later season measurement periods, and objective winning percentage was close to 50% across all teams (Table 1).

Network metrics predicting task cohesion. To check for the interdependence of responses within teams, an intraclass correlation (ICC) value was computed for later season task cohesion (dependent variable). A null model (no predictors) was tested to partition the variance across Levels 1 and 2 (Raudenbush & Bryk, 2002). The resulting ICC for task cohesion (i.e., GI-Task) was 0.23. This suggests that a meaningful amount of variance is housed at the team level (23%). According to Schoemann, Rhemtulla, and Little (2014), ICC values above .05 may indicate that individuals' responses are likely to be more similar to others on their team than that of athletes on another team, and a multilevel model is appropriate. Models were estimated using full maximum likelihood and slopes were fixed. Level 1 predictor variables were group-mean centered (Enders & Tofighi, 2007).

At the time of study, team representatives reported an average team size of 7.7 members (range = 7–9, median = 7). In terms of eligible participants for this analysis, it was necessary for participants to be present at both time points to provide individual cohesion perceptions via self-report. Two of the Level 2 units (teams) had minimal participation at the later season measure (2 and 3 participants, respectively), so the HLM software only computed the analysis with 13 of 15 teams. Two participants were removed due to response bias at later season[2] and one participant was removed as a univariate outlier. In the end, 70 participants were eligible for the analysis.

In Model 1, early season task cohesion (b = .59, $p < .001$) significantly predicted later season task cohesion. A comparison of the deviance statistic between the restricted null model and the unrestricted Model 1 revealed a significant increase in model fit, $\chi^2(1) = 27.36$, $p < .001$, as it pertains to variance accounted for in the dependent variable. In the full model (Model 2), the addition of early season indegree and outdegree centrality at Level 1 and early season network density at Level 2 significantly improved the model fit in predicting later season task cohesion, $\chi^2(3) = 25.09$, $p < .001$. An overview of both models can be found in Table 2.

Overall, a pseudo-R^2 calculation (Kreft & De Leeuw, 1998) revealed that 49% of the variance was accounted for in later season task cohesion. In terms of Level 1 and Level 2 variance components, 42% of the variance could be attributed to the individual level and 7% to the team level. An examination of the specific predictors in Model 2 revealed that early season outdegree centrality ($b = 2.17$, $p = .001$) and early season task cohesion ($b = .41$, $p < .001$) were significant indicators of later season task cohesion at Level 1, and early season network density (b = 4.89, $p = .01$) was a significant predictor at Level 2. Early season indegree centrality (b = $-.21$, $p = .74$) was not significantly related to later season task cohesion perceptions.

[2] These two participants completed the later season questionnaire together and submitted the same responses. They were removed from the main analysis.

Table 1
Descriptive Statistics for Study Variables

Study variables	Mean (*SD*)	1	2	3	4	5	6	7
1. ES indegree centrality	.84 (.15)		.39***	.59***	.23*	.10	.25*	.23*
2. ES outdegree centrality	.85 (.22)			.40***	.44***	.06	.66***	.15
3. ES network density	.84 (.09)				.32**	.14	.47***	.38***
4. ES task cohesion	7.74 (1.21)					.12	.71***	.09
5. ES team performance	.52 (.32)						.11	.70***
6. LS task cohesion	7.83 (1.20)							.21*
7. LS team performance	.56 (.21)							

Note. ES = early season measures; LS = later season measures.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Network metrics predicting team performance. Since team performance was collected objectively, all participants present at early season were eligible for this analysis (n = 109). Given that team performance is a Level 2 (group) variable as noted previously, the second hypothesis was tested using hierarchical multiple regression. At Step 1, early season team performance (sr = .69) significantly predicted later season team performance, accounting for 42% of the variance. The inclusion of early season indegree and outdegree centrality and early season network density at Step 2 significantly increased the variance accounted for in later season team performance, $R^2_{\text{change}} = .06$, $p = .001$. Standardized estimates revealed that early season network density (sr = .23) and early season team performance (sr = .65) were significant predictors of later season team performance (ps < .01), while indegree (sr = .00) and outdegree centrality (sr = .00) were not (ps > .95). In the final model, the variance accounted for was 48%. A full overview of the regression analysis can be found in Table 3.

Discussion

The importance of perceived group cohesion in sport is evidenced by reported positive links to key individual- (e.g., adherence; Spink, Wilson, & Odnokon, 2010) and team-level outcomes (e.g., team performance; Carron, Colman, Wheeler, & Stevens, 2002). Further, it has been argued recently that the sport group dy-

Table 2
Fixed Effects Estimates (Top) and Model Specification (Bottom) for Model Predicting Later Season Task Cohesion

Parameter	Null model	Model 1	Model 2
Fixed effects			
Intercept	7.92 (.18)***	7.92 (.18)***	7.92 (.14)***
Level 1			
ES task cohesion		.59 (.08)***	.41 (.10)***
ES indegree centrality			−.21 (.61)
ES outdegree centrality			2.17 (.63)***
Level 2			
ES network density			4.89 (1.65)*
Model specification			
Deviance statistic	212.35	184.99	159.90
Parameters	3	4	7
Chi-square	34.42***	54.19***	44.23***

Note. $N = 70$. Model 1 is the smaller, control model with early season task cohesion as the lone predictor of later season task cohesion. Model 2 is the full model with early season task cohesion and early season network metrics as predictors of later season task cohesion. ES = early season measure.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 3
Early Season Communication Network Structure Predicting Later Season Team Performance

Variable	$R^2_{adjusted}$	*F* (degrees of freedom)	β	*sr*	*t*
DV: LS team performance					
Step 1	.42	98.59*** (1, 107)			
ES team performance			.69	.69	9.93***
Step 2	.48	33.04*** (4, 104)			
ES team performance			.65	.65	9.93***
ES indegree centrality			−.01	−.00	−.06
ES outdegree centrality			.00	.00	−.04
ES network density			.29	.23	3.46**

Note. $N = 109$. DV = dependent variable; ES = early season measures; LS = later season measures; *sr* = semipartial correlation.
** $p < .01$. *** $p < .001$.

namics knowledge base would benefit from a better understanding of the sources of information (i.e., cues) that athletes use to draw these cohesion perceptions (e.g., McLaren & Spink, 2019; Spink et al., 2018). A basic component of a group that could serve as one of these potential cues is the structure of member communication (e.g., Cartwright, 1968; McGrath, 1984).

The purpose of the current study was to constructively replicate (Hüffmeier et al., 2016) the relationship between member communication and task cohesion as well as test the relationship between information exchange and performance in sport teams. Based on preliminary research in this area (McLaren & Spink, 2017, 2019), the constructive aspect of this replication involved using a prospective field design with intact sport teams. Further, generating whole team communication networks allowed for an examination of the specific exchanges between members, and how these exchanges existed within the context of a team (i.e., communication at the individual and team level as sources of information for perceived task cohesion). Also, perceived task cohesion is an individual-level variable that reflects a personal belief about the degree to which the team is united around task goals and objectives (Carron et al., 1985). As cohesion perceptions are drawn in part by combining personal experiences within the group and the reality of the group as a whole (Carron & Brawley, 2000), it was hypothesized that outdegree centrality and network density early in the season would predict later season task cohesion perceptions based in overall team unit functioning (i.e., GI-Task).

Support for the first hypothesis was found. Specifically, athletes who reported personally exchanging information with a higher number of their teammates early in the season (i.e., higher individual outdegree centrality) reported higher task cohesion later in the season. In addition, the collective information exchange of an athlete's team early in the season also was a significant predictor of later task cohesion perceptions. As expected, indegree centrality, which is the number of teammates who reported exchanging information with that same individual, was not a significant predictor of task cohesion.

The finding that both individual outdegree centrality and network density predicted task cohesion across time appears to be in line with research from organizational psychology (e.g., Balkundi & Harrison, 2006). In spite of the contextual differences between an organization and the sport group setting, the pattern of results that emerge in terms of predicting cohesiveness are similar. Being a member who is highly involved with information exchange and being on a team that engages in a higher degree of information exchange, collectively, appears to predict task cohesion over and above earlier task cohesion perceptions in the sport setting.

In support of the second hypothesis, the results of the current study revealed that information exchange network density significantly predicted later season team performance while indegree and outdegree centrality did not. The findings revealed that higher objective team performance scores (i.e., winning percentage) were associated with teams where members collectively engaged in a higher degree of information exchange (i.e., higher network density). One potential interpretation of this finding could reflect the fact that when the communication network is higher in density (e.g., more overall members exchanging information), the potential effectiveness of the team is less likely to be dampened by process losses (Steiner, 1972). This assumes, of course, that athletes are exchanging and processing the appropriate types of information at the appropriate times (e.g., Hinsz, Tindale, & Vollrath, 1997). As this was not examined in the current study, validation of this assumption warrants future consideration.

Having just a few members who are not well connected in a team sport such as basketball (as used in this study) may be the difference between higher and lower team success because the maximum number of possible connections already are lower (compared with a soccer team with a higher number of possible connections). A potential explanation of these findings from a methodological perspective is the operational congruence between the predictor and outcome variables (e.g., Cronin et al., 2011; McGrath, Arrow, & Berdahl, 2000). In the same way that sport team performance is not simply determined by one member, it may follow that a team level of communication network structure predicted objective team performance, which is captured at the team level.

The current study had strengths worth recognizing. First, the consideration of the individual and team levels of the communication network structure allowed for greater specificity insofar as the structural properties differentially predicted task cohesion and team performance. In past research, metrics of individual degree centrality and network density have been considered together through the use of hypothetical vignettes (McLaren & Spink, 2019). In the current study examining all the variables together, individual outdegree centrality and team network density were associated with the individual-level outcome of perceived task cohesion, while only whole team network density was associated with the team-level outcome of objective team performance in intact sport teams.

From a measurement perspective, two strengths emerge. First, the use of a prospective design increased confidence in the directionality proposed in past research (e.g., McLaren & Spink, 2018a, 2019). It has been argued that member communication may be one potential cue for estimating perceptions of cohesion in sport (McLaren & Spink, 2018a, 2018b); however, this research is based on concurrent research designs. Although an experimental design is needed to verify this claim, consistently replicating the relationship between greater information exchange among a higher number of team members and higher task cohesion and team performance offers credibility for this relationship (Klein, Shepperd, Suls, Rothman, & Croyle, 2015). Further, these results appear to exist above and beyond the early season measures of each outcome variable that were controlled in the analyses.

Second, although some past research sampled athletes from intact sport teams, the goal was not to compile whole network structures (McLaren & Spink, 2019, Study 1) nor were multilevel effects the focus. In the prediction of later season task cohesion perceptions, the current study captured and entered the network structure metrics at the respective level, and also captured the overall variance accounted for by the individual and group. In line with initial theorizing by Carron and colleagues (1998), it appeared that later season task cohesion perceptions were significantly related to both personal experiences of exchanging information with other members early in the season and the collective exchange behaviors of the team. From a measurement perspective, the variance accounted for in task cohesion also was associated with both individual- and team-level effects. As such, the nesting of athletes within intact teams should be considered given that a portion of the variance accounted for in task cohesion came from the team level. As such, future research designs using intact sport teams would be remiss to measure communication as information exchange only at the individual level or aggregated at the team level.

Despite these strengths, it also is important to recognize the study's limitations. First, the item used to capture information exchange network structure asked individual members to identify those they exchanged information with during the game. This captures a quantity-based metric to identify how many teammates an athlete communicated with as opposed to a more sensitive measure of how the two athletes communicated or the quality of these interactions. While this was intentional in order to replicate past findings, future research may expand on this in different ways. For instance, the measure could be expanded to include different types of information that can be exchanged (e.g., Hinsz et al., 1997). The notion of type of information exchanged may be important, as what constitutes an important exchange in basketball (e.g., a point guard signifying a set play while dribbling the ball up court) may differ from that of another sport (e.g., soccer—a goalkeeper directing a defensive player to open space to receive the ball). Further, the item could be adapted to include a scaled response as opposed to a binary response (i.e., increase sensitivity), include other types of communication mediums (e.g., verbal vs. nonverbal), or to generate evidence of the quality of member interactions (i.e., communication efficiency; Wittenbaum, Hollingshead, & Botero, 2004). These considerations would add value by establishing possible boundary conditions (e.g., moderators) for the relationships among communication, cohesion, and team performance.

From a time perspective, it is possible that exchanging information during a practice or after a game, for instance, offers unique capacities for comprehension (e.g., time, absence of a competitor, access to video). Additions to future study designs such as this will aid in understanding more specifically the relationship between information exchange and the outcomes of cohesion and team performance.

A final limitation pertains to sample size. While multilevel modeling is considered to be a larger sample technique (e.g., Maas & Hox, 2005), the current study sampled teams that were, by nature, (a) smaller in size, and (b) open to fluctuations in member attendance over time. Therefore, the overall sample size at Level 1 (athletes) and Level 2 (teams) was smaller than typically suggested for a multilevel analysis but representative of the reality of the groups under study. A shortcoming of a smaller sample is the reduction in power, which leads to the potential for unstable estimates and associated standard errors within the specified hierarchical model. As a result, this increases the chances of rejecting a true null hypothesis (i.e., Type I error; Maas & Hox, 2005). Further to this point, estimates of within- and between-groups reliability using a multilevel confirmatory factor analysis are not possible with a smaller sample as the number of parameters exceed the number of clusters at Level 2 (i.e., teams), which leads to nonidentification of the model (Geldhof, Preacher, & Zyphur, 2014; see Whitton & Fletcher, 2014 for an overview of group-level reliability estimates for the GEQ). As such, it is important for future research to increase the number of teams when studying groups that, by nature, may be smaller in size.

Overall, the current study makes a contribution to the sport communication research base by constructively replicating (Hüffmeier et al., 2016) the relationship between information exchange and the outcomes of task cohesion and team performance using a field design with a nested sample of athletes on intact teams (Klein et al., 2015). The validity of these findings are strengthened when coupled with similar results reported across other studies employing different samples and study designs (McLaren & Spink, 2017, 2018a, 2019). The finding that communication network structure was associated differentially with task cohesion and team performance is a novel finding in sport, and deserves further attention in future research. Also, preliminary evidence now exists for suggesting a potential indirect link (i.e., mediation) between communication network structure and objective team performance through task cohesion. Whereas the team as a whole engaging in higher information exchange is more directly associated with team performance, the exchange behaviors of individual members may inform a higher perception of task cohesiveness, which has been linked to elevated performance in past research (e.g., Benson et al., 2016; Carron, Colman, et al., 2002). This suggests a possible indirect link and awaits future research.

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