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Social identity and personal connections on the mat: Social network analysis within Brazilian Jiu-Jitsu

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ABSTRACT

There is growing support for the claim that sport participation is commonly a social experience that is shaped by peer interactions. The current study examined how the structure of peer interactions within a large sport club were associated with social identification within that setting and predicted adherence to club activities. To understand the group's social structure, we used a social network derived from reported peer interactions. We expected that one's position within the network (i.e., structural centrality, derived from peer-reported interactions) would be positively associated with their social identification and would prospectively predict adherence at a follow-up point in time. Participants included 185 practitioners from a large Brazilian Jiu-Jitsu (BJJ) club (M_{age} = 31.91 *SD* = 7.05, 95% male). Participants completed a name generator survey (to construct the social network) alongside items related to social identification, whereas club records were accessed to measure adherence at a 7 month follow-up. Regression analyses indicated that those who were most central within the peer network reported stronger perceptions of one social identity dimension (i.e., ingroup ties) and were more likely to continue involvement in BJJ. These findings demonstrate how structural centrality within a large peer network may relate to beliefs about the group and behavior – with a key implication being the need to strengthen athletes' peer integration within club environments.

1. Introduction

There is growing evidence that social influence is a powerful mechanism for promoting physical activity and sport participation (Grant, Hogg, & Crano, 2015). When describing why social influence is so prevalent in sport, researchers often look toward evidence of the direct influence of personal relationships on health and goal pursuit. Most notably, individuals have a need to belong, which is an innate orientation to form and maintain meaningful interpersonal relationships (Baumeister & Leary, 1995). As they pursue this need, individuals are sensitive to indications of acceptance and engage in goal-directed activities to cultivate or maintain relationships that provide positive feelings and acceptance. This social influence is borne out in research revealing that individuals often prefer (or seek out) social exercise settings (Burke, Carron, Eys, Ntoumanis, & Estabrooks, 2006) and that the mere presence of peers is enough to motivate adolescents to be physically active (Salvy et al., 2008). These social motives explain why people seek out sport contexts that involve other individuals and why their health behaviors are sensitive to others' behaviors and beliefs.

Beyond mere peer influence, *groups* are particularly inherent in physical activity contexts: Ranging from small and close-knit teams to the larger and more diffuse organizations and clubs that surround them. Groups are a unique type of social influence because members must share common goals/benefits and identify as a group while also forming social structures like roles and norms (Carron & Eys, 2012). Group dynamics research often considers whether and how athletes seek out rich group settings. For example, research involving groupness (i.e., degree that athletes perceive that their team features the core characteristics of a 'group'), reveals that athletes report stronger commitment to their group and intentions to return when they report high perceptions of groupness (Spink, Ulvick, McLaren, Crozier, & Fesser, 2015). Interactions with other group members also influence athletes' personal development and long-term sport participation (Weiss & Smith, 2002).

Although much of the existing research focuses on group processes such as group cohesion, the *structure* of sport and exercise groups also

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impacts members' experiences and outcomes. Structure is evident in psychological processes that guide members' interaction and indicate individuals' positions (e.g., roles, norms), as well as groups' physical properties (e.g., group size, interdependencies; Carron & Eys, 2012). As detailed by the moniker 'group structure', these aspects represent a type of scaffolding that shapes emergent group processes (Evans & Eys, 2015). Measuring the emergent group structure holds value because it targets the complexity of groups and unique experiences of each member within them. We argue that researchers have yet to direct attention toward understanding group structures evident in the patterns of interaction among members. As such, we conducted the current study to examine how social structures revealed through peer interaction networks influence sport involvement.

1.1. Social networks and social identity

Although numerous approaches may be used to study emergent group structures, a social network approach is uniquely suited for gathering an understanding of how members orient themselves. Social network analysis involves studying the structure of human interaction as a system, and is applied in large groups like online social networks and workplace organizations as well as small groups like sport teams. Network designs entail studying members who are characterized as 'nodes' in the network and connected through some form of 'tie' or link that forms the structure. Ties are constructed by researchers based on co-occurrences (e.g., co-participation in events), social relations (e.g., those who an individual likes), interactions (e.g., those who someone recently talked to), and flows (e.g., paths that information travels through; Borgatti, Everett, & Johnson, 2013). Once constructed, networks are used to derive many indices that describe the group as a whole. In whole network designs, a core/periphery structure often emerges with a small group of closely connected individuals alongside a large group of sparsely connected individuals. To the extent that a core/periphery structure is detected, the network may gain certain benefits (i.e., efficient communication) along with drawbacks (i.e., status differences; Borgatti et al., 2013).

Applied to health behaviors of individual members within networks, researchers have studied 'contagion' and spread of health behaviors across social relationships (e.g., obesity contagion across close personal ties; Christakis & Fowler, 2007). Social networks are also used to explore how a member's position within the network influences his or her motives and behavior (Robins, 2015). At this level of analysis, member structural centrality often represents the 'importance' of an individual (node) within a network, which is especially the case with the commonly-used indicator of indegree centrality (i.e., number of times an individual is nominated by peers; Hanneman & Riddle, 2005). Of course, what 'importance' represents depends on the types of dyadic phenomena used to form ties between individuals. Within sport and exercise groups, social relations (e.g., liking, leadership, friendship) are common and the interpretation of centrality in such networks is bound to the characteristic being used. Whereas centrality of networks indicating affiliations between members have been used to represent status in sport teams (Ponzi, Zilioli, Mehta, Maslov, & Watson, 2016), indegree centrality in a sport team leadership network has been interpreted as an indicator of power and influence (Fransen et al., 2017). Researchers have even studied different types of leadership networks (i.e., task, social, motivational, external), and interpreted centrality in each network differently (Loughead et al., 2016). Across these examples, centrality has successfully been used to predict individuals' roles within groups as well as other aspects of the group environment (e.g., cohesion; Loughead et al., 2016).

Compared to social and relational ties, networks based on simpler and more overt forms of interaction are less-evident in past sport team research, with the exception of recent research using peer nominations of information exchange as a cue for cohesion (McLaren & Spink, 2018). Nevertheless, interaction networks are often useful for researchers studying larger groups because their validity demands less interpretation by respondents and because they can capture centrality across different types of social relations (Borgatti et al., 2013). However, the meaning of centrality in such networks represents a more general form of connectedness, acceptance, and/or status (Robins, 2015). For instance, an individual whom is central in a network based on interactions may derive affective benefits from being embedded in the group, while their access to more individuals provides opportunities to influence others, gain resources, and gain knowledge (e.g., Mullen, Johnson, & Salas, 1991).

When considering how individuals respond to their structural position within an interaction network, social identity theory is a particularly fruitful theoretical perspective. Social identity theory focuses on how individuals construct and manage social identities in ways that optimize self-evaluations while also optimizing group distinctiveness (Tajfel & Turner, 1979). Social identities are specifically "those aspects of an individual´s self-image that derive from the social categories to which he perceives himself as belonging" (Tajfel & Turner, 1979, p. 40). Social identification is a motivated process focused on categorizing oneself within groups as well as ensuring positive views of those groups are maintained. It is driven by belongingness along with a host of other motives such as esteem enhancement, meaning finding, and distinctiveness (Vignoles, Regalia, Manzi, Golledge, & Scabini, 2006).

Recent investigations of social identity strength are guided by Cameron's (2004) conceptualization, which emerged alongside the validation of a three-factor survey. With this view, *ingroup affect* refers to the positive affective perceptions that individuals hold about their group membership and gain by being a member. *Ingroup ties* refer to individuals' perceptions of connectedness with others within the group. Finally, *cognitive centrality* refers to how salient the group identity is within one's sense of self. Cameron's (2004) survey was validated when measuring identification within organizations (i.e., universities) or social categories (i.e., nationalities). Meanwhile, sport research using this approach has focused on small groups, revealing how identifying strongly with one's team predicts outcomes such as youth development, group cohesion, and prosocial behavior (see Bruner & Benson, 2018).

Considering conceptual links between social identity strength and network centrality, the ingroup ties factor is a reflection of individuals' connectedness with others and is closely theoretically linked to centrality. Conceptual links are also evident with ingroup affect, presuming that centrality may represent acceptance that makes the group appealing. Conceptual links to cognitive centrality are perhaps not as strong, but may exist to the extent that centrality leads group ties to stretch farther into individuals' lives. Although these conceptual links focus on how identities are forged, it is plausible that highly-identifying individuals seek out connections with others. In either case, evidence that central individuals within groups hold stronger social identities would hold theoretical implications for the relevance of structural centrality and for validating dimensions of social identity.

Although there is limited evidence linking social identity and network centrality in sport or exercise, researchers have demonstrated how these constructs independently influence individuals' decisions to commit within groups. Regarding how centrality influences commitment within organizations, employee turnover is greatest among individuals who are less central within their organization (Feeley, Moon, Kozey, & Slowe, 2010). Notably, studies using prospective designs in large-scale organizational networks support theoretical expectations that less-central employees experience reduced motives to retain membership (e.g., more negative affect, fewer pressures from other not to quit, more perceived alternatives; Feeley et al., 2010). Similarly, athletes with strong team social identities are also more committed to their group (e.g., Martin, Balderson, Hawkins, Wilson, & Bruner, 2017). Identifying with sport groups is expected to motivate adherence as a way to sustain positive feelings about the group and align behavior with others (Rees, Haslam, Coffee, & Lavallee, 2015).

1.2. The current study

Although network research is emerging in sport and exercise psychology (e.g., Fransen et al., 2015; 2017), no existing studies have examined how group experiences and adherence are associated with structural centrality. Furthermore, sport network research has generally been conducted within sport teams (i.e., samples derived from multiple small and discrete networks), compared to whole network designs using nominations from other group members in a setting larger than traditional sport teams. Indeed, group dynamics research is commonly conducted with teams where small group processes are particularly potent (Carron & Eys, 2012). Although larger networks feature more diffuse patterns of interaction, the process of social identification applies equally to very large group identities (Cameron, 2004) and social network analyses are particularly relevant in larger whole-network designs where richer information about social structures emerge.

In addition to understanding whether structural centrality motivates adherence in a large network context, social identification holds numerous conceptual links with network centrality and both constructs hold potential to keep exercisers and athletes involved. The current study sought to: (a) describe the nature of an interaction network within a large sport club and, (b) examine associations between individuals' structural centrality, social identification, and adherence within the club. We expected that those with higher structural centrality identify more strongly with their group. Although structural centrality was measured concomitantly with social identity, we employed structural centrality as a predictor of identification based on the observation that structural centrality scores are derived from *other individuals* within the club based on interactions over time, holding temporal precedence. We expected that more central individuals would report stronger ingroup ties and affect; cognitive centrality was not measured. Using a prospective design to examine how structural centrality and social identity strength predicted adherence at a seven-month follow up, we expected that central individuals and individuals reporting strong ingroup ties and affect would maintain group membership.

2. Method

2.1. Context and participants

We conducted the current study within the context of a large Brazilian Jiu-Jitsu (BJJ) club at both competitive and recreational levels. BJJ is a combat sport with growing numbers of participants who seek many different motives in its practice. The social aspect of these club settings feature unique characteristics, as they are comprised of large numbers of practitioners who interact with others (in and out of smaller training groups), and where the combat-focused nature demands connections with others. Status contrasts are also embedded in the activity itself, as proficiency is represented by 6 belt colors ranging from white (i.e., novice) to black (i.e., experienced). BJJ is a particularly popular form of sport and recreation within its 'home country' of Brazil, where surveys have identified more than 350,000 regular practitioners, across 1500 training centers and clubs (Guimarães, 2006). The club studied in the current study was located in a metropolitan area in the south of Brazil and integrated members who train for major international events, alongside recreational BJJ practitioners. At the time of the study, the club hosted 26 training sessions (or classes) every week across 260 practitioners.

Regarding the ways that members were divided into groups within these 26 classes, the 25 weekday classes could be classified into five training groups, whereas the 'weekend class' included one informal and drop-in session during weekends. Weekday training groups hosted training sessions once a day, meeting at a similar time (i.e., two morning groups, three evening groups) and with participants in each group sharing characteristics (i.e., belt status). As such, we were able to classify the club into 5 subgroups. Nevertheless, there was a great deal of overlap between subgroups, especially when the groups trained at the same time; 46% of participants reported belonging to more than one group.

Considering the value of attaining a representation of social structures that accurately portrays the entire group, we sought all BJJ participants within the club along with related coaches and staff. Although nominal researcher-defined boundaries could be used to define network boundaries (i.e., reporting only ties with other subgroup members), we applied a realist boundary-specification approach by allowing participants to freely nominate club members with whom they recently interacted. This approach allowed natural network boundaries to emerge and ensured that important ties were not excluded (Borgatti et al., 2013). The study sample included 185 participants, which represents 71% of all BJJ practitioners of the club. To assess representativeness of respondents (i.e., were highly-engaged members included?), we assessed the number of nominations for those who were not sampled. Out of the 75 individuals identified as 'missing', 57% received only one nomination from other members, 36% received from two to five nominations, and 7% received from five to nine nominations. Although the club was affiliated with a separate general fitness facility with 200 members (e.g., group fitness, cardio machines, free weights), we focused exclusively on BJJ practitioners. Finally, responses from two coaches and two staff members were sought to best represent the network, subsequent analyses to predict identity and adherence were only relevant for those participating as 'members' within the gym (n = 181).

Participants ranged from 16 to 62 years of age (M_{age} = 31.91, SD = 7.05, 95% male), and represented all levels of ability, ranging from white belt (19%), through blue (27%), purple (22%), brown (10%), and black belts (23%). Participants reported attending 4.38 (SD = 2.47) training sessions per week, and 40.9% reported participating in BJJ competitions outside of the immediate gym context. Participants reported an average of 7.18 years of involvement in BJJ (SD = 5.72), ranging from a few months to 42 years. Most participants (68%) reported attaining a college/university degree or higher educational credentials.

2.2. Procedures

Given the need to sample as many highly-engaged members as possible, a meeting was arranged with the gym manager and the coaches to explain the objectives and procedures of the study. The primary investigator recruited participants in a common entryway to the facility before and after all training sessions on several occasions during February and March of 2016. In addition to recruiting participants as they entered or left the facility, we used a snowball sampling approach. A roster of participants was provided by the facility so the study team was able to record the degree that facility members had been reached and as a means of identifying or interpreting names listed by participants. This provided an opportunity to identify and recruit remaining members who were highly nominated (i.e., > 10 nominations) and particularly vital aspects of the group structure.

The survey was completed in two sections. First, participants completed a pen and paper social network name generator survey. Subsequently, they completed an online survey using a tablet provided by the investigator to provide responses on remaining items (i.e., demographics, social identity). For follow-up behavior data on involvement, facility attendance was obtained by the primary investigator seven months after the first data collection. It should also be noted that a pilot study was conducted with 24 members of a neighboring BJJ club, with a focus on ability of members to complete the name generator survey and one questionnaire that was translated from English for this study. Approval was obtained through the lead investigators' institutional review board before conducting the study and all participants completed informed consent before participating.

2.3. Measures

2.3.1. Social network survey

To produce the interaction network, participants responded to the question: '*Please list below the names of BJJ practitioners with whom you typically interact with during training sessions in this club*'. Participants were encouraged to nominate as many other members as they could recall recently interacting with in list form, using blank spaces provided on a sheet of paper. This represents a name generator survey (Marin, 2004). Although providing participants with complete rosters is encouraged, open-name generators (i.e., free recall) are recommended in cases like the current study where roster size is large and when privacy concerns preclude roster use (Marin, 2004).

2.3.2. Demographic items

Participants completed items assessing general demographic characteristics (e.g., gender, age, education) along with items regarding their BJJ involvement. Participants specifically reported their belt color, whether or not they participated in competitions outside of the training facility, the length of time training in BJJ, and the number of training sessions they attended per week.

2.3.3. Social identity

Identification with the BJJ club was measured using the Social Identity Questionnaire for Sport, and we employed the survey used by Bruner, Boardley, and Côté (2014). This questionnaire employs Likert-type responses ranging from 1 (*Strongly disagree*) to 7 (*Strongly agree*). Three subscales include four items assessing ingroup ties (e.g., '*I feel strong ties to other members of this team*'), four items for ingroup affect (e.g., '*Generally, I feel good when I think about myself as a team member*') and four items for cognitive centrality (e.g., '*I often think about the fact that I am a team member*'). This survey is a sport-based adaptation of Cameron's (2004) scale, which was validated when assessing social identity strength within large groups and social categories (i.e., university, nationality, gender). As such, there is evidence for validity for these items when studying large group identities, although the sport-based use of these items typically involves teams. Furthermore, research conducted after the initiation of the current study also provides indications of internal consistency and validity for the Social Identity Questionnaire for Sport with English speaking respondents, using a similar but shortened scale (Bruner & Benson, 2018).

The current study only included eight items reflecting ingroup ties and ingroup affect, and excluded the cognitive centrality subscale because internal consistency of the cognitive centrality items has been variable in past research (Bruner et al., 2014; Obst & White, 2005) and because the core constructs of interest were individuals' perceptions of connections to others and the affect derived from those connections. Also, researchers translated the instrument into Portuguese for this study, and revised this version based on feedback from a researcher with proficiency in both English and Portuguese – focusing on readability and application to participants. Original and translated items are listed in the online supplemental material.

2.3.4. Involvement

To indicate study participants who retained involvement at a later point in time, the facility provided the roster of individuals who had retained their membership over the preceding seven months along with information regarding whether members had participated in a class during the preceding month.

2.4. Analysis

2.4.1. Constructing and evaluating the social network

We formed an adjacency matrix, or sociomatrix, using interaction nominations provided by participants to construct a network that would be used to derive structural centrality indices for each individual. In this kind of matrix, the list of respondents is included along the horizontal and vertical axes so that each row or column represents a single participant. This was a binary network indicating presence (coded as '1') or absence of interaction (coded as '0') between each participant.

Social network analysis was conducted with UCINET6 (Borgatti, Everett, & Freeman, 2002) to calculate whole-network density and structure as well as centrality of each member. Network density provides one of the broadest indicators of the network's interconnectedness using the number of ties in the network proportional to the total number of possible ties (Robins, 2015). We also evaluated the degree that the network represented a core/periphery structure using the UCINET program, which identifies highly interconnected members as the 'core' and uses an unnormalized Pearson coefficient approach. The program estimates the correlation between the existing network and an ideal core/periphery structure where all core members are connected with one another and to others, while no periphery members are tied. Values are interpreted as a correlation coefficient, where a core/periphery structure is denoted by values close to one (strong: $r > 0.5$; Borgatti et al., 2002).

Regarding centrality, although interactions for any given participant could be derived from both outgoing ties (i.e., nominations *of* others) and incoming ties (i.e., nominations *from* others), analyses focused on incoming ties. Similar to past researchers who have integrated more than one centrality indicator (e.g., Kreager, Molloy, Moody, & Feinberg, 2016), we considered indegree centrality (i.e., number of interaction nominations from other club members) as well as *bonacich indegree centrality*. Although both are commonly correlated, the latter was selected as a modified indicator that is derived from the overall number of times an individual was nominated, but where each nomination is weighted by the relative importance of each member (i.e., higher weights assigned to ties from popular participants; Borgatti et al., 2002). Bonacich centrality is valuable because it models centrality relative to the whole network as opposed to only centrality relative to one's proximal peers. As indegree centrality and Bonacich indegree centrality values are often positively skewed, square root transformation was used (see Osgood et al., 2013).

2.4.2. Preliminary analyses

Initial analyses were conducted to evaluate whether the data met assumptions of primary analyses. Regarding data management, it is important to note that belt status was coded into either low status belts (i.e., white or blue; $n = 83$) or high status belts (i.e., purple, brown, black; $n = 98$). Regarding continued membership at 7 months 'out', participants were assigned a binary value regarding whether they had retained their involvement and had attended a session in the preceding month (1) or had not (0; $n = 33$). A confirmatory factor analysis was conducted using items from the Social Identity Questionnaire for Sport, as this was the first case it has been used within the Portuguese language and with a large sport club (as opposed to a small group). Finally, bivariate correlations were used to indicate relationships among key variables.

2.4.3. Regressions

Linear regressions were used to predict ingroup ties and ingroup affect. Using two steps, the initial step used control variables that were related to structural centrality (i.e., belt color, competition status, years involved within sport) to account for the tendency for demographic characteristics to account for some aspects of centrality. The subsequent step(s) included structural centrality. We conducted a logistic regression to predict follow-up involvement again using the same control variables at Step 1, followed by ingroup ties, ingroup affect, and structural centrality. All regressions integrated bootstrapping.

3. Results

3.1. Whole network description

To describe the features of the network from which structural centrality measures were derived, the whole network was examined with a particular focus on density (See online supplemental materials for a network visualization). Density of the whole club network was 8%, which means that there were 34,225 potential ties among all 185 participants in the sample, contrasted against 2859 ties reported by participants. Related to this density, the average number of nominations that members received was 15.53 (SD = 8.47). Because density of a network is inversely related to size (i.e., bigger networks characterized by lower density) and because density is closely tied to how a network is measured, there is limited ability to relate this density score to groups in other contexts. Regarding a core/periphery structure, 42 individuals were identified as members of the core and were nominated at least 20 times by other members. When compared with a core-periphery structure, the current network demonstrated a correlation of $r = 0.45$ ($p < .001$). In other words, ties amongst core and periphery members in the current (real) network was strongly correlated with a 'perfect' hypothetical core-periphery structure (i.e., dense core with many shared ties, frequent incoming ties from the periphery, relatively fewer ties from the core to the periphery, and sparse periphery-to-periphery ties). See the online supplemental materials for a block model that illustrates the density of ties.

A further presumption of analyses at a whole network level, instead of discrete class-level networks, is that ties are not constrained within subgroups alone. To consider the extent that class membership accounted-for interaction ties within a given dyad, we conducted Quadratic Assignment Procedure (QAP) analyses. QAP is a non-parametric technique and was used to examine the correlation between the interaction matrix and a separate matrix, constructed based on shared subgroup membership within the club (i.e., cells included a '1' if participants both reported being in the same club and a '0' if not). Analyses using UCINET software produced a correlation statistic that represents the consistency with which the 34,225 potential ties across the dataset were congruent for both matrices. QAP produced a small but significant correlation, $r = .09$ ($p < .001$). While this reveals that interactions were more likely within subgroups, this weak correlation supports the assumption that individuals frequently reported ties that extended beyond their immediate subgroup.

3.2. Preliminary analyses

To confirm the factor structure of the Social Identity Questionnaire for Sport within the Portuguese language, we tested a confirmatory factor model that included a two-factor structure where the two latent dimensions were allowed to correlate (Bruner & Benson, 2018). The model fit well (χ^2 (27) = 46.95, CFI = 0.97, TLI = 0.96, RMSEA = 0.06, 90% CI [0.03, 0.09], SRMR = 0.05) and the interfactor correlations between the subscales was positive and strong ($r = 0.47$). The standardized factor loadings for items on their respective factors were high and significant. This supports construct validity within this context. Acceptable internal consistency was also evident, including Cronbach´s alphas (α) of 0.77 (affect) and 0.87 (ties) along with composite reliability (CR) of 0.74 (affect) and 0.88 (ties).

Bivariate correlations between key variables of this study are displayed in Table 1. Notably, both indicators of structural centrality shared positive correlations with belt color, participation in competitions, years of involvement, and ingroup ties. Involvement at 7 months' follow-up was positively correlated with participation in competitions and centrality.

3.3. Primary analyses

Initial analyses indicated that the data met assumptions related to regression (e.g., linearity) but uncovered multicollinearity between the two structural centrality measures (i.e., indegree and Bonacich indegree). As such, three regressions were computed using indegree centrality as a predictor, followed-by three regressions with Bonacich indegree centrality as a predictor. In all regressions, descriptive analyses indicated that it was important to control for variables that predicted social identity or continued involvement, at an initial step: belt status (i.e., high or low), years within the club, and competitive status.

3.3.1. Predicting social identity

Linear regressions were used to examine the extent that structural centrality within the peer network predicted strength of social identification. Following Step 1 (control variables), Step 2 added either indegree centrality or Bonacich indegree centrality as a predictor. Coefficients for each predictor are displayed in Table 2.

In regressions using *indegree centrality*, the overall model predicting ingroup ties was significant, $R^2 = 0.17$, F (4, 176) = 10.13, $p < .001$. In particular, the R^2 change attributed to structural centrality was 0.06 ($p < .001$), whereby ingroup ties was highest among those who were more central ($B = .83$) and those participating in competitions ($B = 0.56$). The overall model predicting ingroup affect was also significant, $R^2 = 0.06$, F (4, 176) = 3.03, $p = .005$, however the only significant predictor was competitive status ($B = 0.50$). In regressions using Bonacich indegree centrality, the overall model predicting ingroup ties was also significant, $R^2 = 0.20$, F (4, 176) = 14.02, $p < .001$. The R^2 change attributed to structural centrality was 0.07 ($p < .001$), and centrality was the only significant predictor of ingroup ties ($B = 0.96$). Similar to above, the overall model predicting ingroup affect was significant, $R^2 = 0.08$, F (4, 176) = 4.06, $p = .004$, but the only significant predictor was competitive status ($B = 0.47$). In sum, both indicators of centrality demonstrated similar patterns in regressions – whereby those with higher structural centrality reported stronger ingroup ties.

3.3.2. Predicting involvement

Recall that we expected participants with greater structural centrality (i.e., both forms) and greater social identity (ingroup ties and ingroup affect) would be more likely to continue involvement, using logistic regressions presented in Table 3. In regressions using *indegree centrality*, the overall model was significant, χ^2 (6) = 26.81, $p < .001$, *Nagelkerke* $R^2 = 0.23$ – with a change in the R^2 from the preceding step of .09. The final model correctly classified 83% of the results for involvement, with participants being more likely to retain involved over time when they were central ($B = 2.54$) and when they participated in competitions ($B = 1.23$). In regressions using *Bonacich indegree centrality*, the overall model was also significant, χ^2 (6) = 26.87, $p < .001$, *Nagelkerke* $R^2 = 0.23$ ($\Delta R^2 = 0.09$), and correctly classified 82% of the results for involvement. Centrality was the only significant predictor ($B = 3.01$). As a result, both regressions demonstrated that structural centrality, but not social identity, predicted involvement.

4. Discussion

The complex social structures that are demonstrated in the interpersonal interaction patterns within sport clubs represent novel avenues to examine and promote social influence. In the present study, we aimed to understand the structure of peer interactions within a sport club and examine how that structure influenced how individuals view sport groups and engage in related activities. Building from the network of self-reported peer interactions from most individuals in a BJJ club, members who received more nominations from others in the gym (and especially from others who were central) were more likely to continue their involvement at a follow-up point in time and reported stronger

Table 1
Overall bivariate correlations and descriptive statistics (*M, SD*) of key study variables.

Construct	1	2	3	4	5	6	7	8
1. Indeg centrality	–	–	–	–	–	–	–	–
2. Bonacich indeg centrality	.91**	–	–	–	–	–	–	–
3. Ingroup ties	.37*	.41**	–	–	–	–	–	–
4. Ingroup affect	.13	.18†	.47**	–	–	–	–	–
5. Involvement	.27**	.28**	.15†	.25*	–	–	–	–
6. Belt	.40**	.44**	.21*	.11	.14	–	–	–
7. Competition	.34**	.43**	.33**	.28**	.25*	.21*	–	–
8. Years involved	.37**	.44**	.16†	.08	.17*	.69**	.15†	–
M (SD)	.90 (.41)	.90 (.42)	5.21 (1.25)	6.36 (.91)	–	–	–	7.18 (5.72)

Note. All scale-scored variables measured on items ranging from 1 to 7. Involvement, belt, and competition were all represented using binary coding (i.e., 0/1). Indegree centrality was measured using the number of incoming peer nominations, transformed as described in the text. Bonacich indegree centrality included a further calculation based on the relative number of nominations of those who nominated them, prior to transforming the variable.
**Correlation is significant at the 0.001 level; * Correlation is significant at the 0.01 level;
† Correlation is significant at 0.05 level (2-tailed).

Table 2
Results for linear regressions.

Construct	Analyses with indegree centrality			Analyses with Bonacich indegree centrality		
	B (SE)	P	CI [Lower, Upper]	B (SE)	p	CI [Lower, Upper]
DV: Ingroup ties						
Belt	.15 (.24)	.54	-.33, .62	.14 (.24)	.55	-.33, .61
Competition	**.56 (.18)**	**.003**	**.20, .93**	.47 (.19)	.02	.09, .84
Years involved	-.01 (.02)	.92	-.04, .04	-.01 (.02)	.64	-.05, .03
Centrality	**.83 (.24)**	**.001**	**.37, 1.32**	**.96 (.21)**	**< .001**	**.48, 1.45**
Constant	**4.16 (.24)**	**< .001**	**3.74, 4.57**	**4.14 (.20)**	**< .001**	**3.75, 4.54**
DV: Ingroup affect						
Belt	.01 (.18)	.95	-.36, .38	.02 (.18)	.11	-.34, .38
Competition	**.50 (.14)**	**.001**	**.22, .78**	**.47 (.14)**	**.002**	**.18, .76**
Years involved	-.01 (.01)	.82	-.03, .04	-.01 (.02)	.10	-.03, .03
Centrality	.05 (.18)	.79	-.32, .541	.14 (.19)	.47	-.24, .51
Constant	**6.08 (.16)**	**< .001**	**5.77, 6.40**	**6.04 (.16)**	**.002**	**5.73, 6.34**

Note. Unstandardized coefficients are reported and significant coefficients are bolded.

Table 3
Results for logistic regressions.

Construct	Analyses with indegree centrality			Analyses with Bonacich indegree centrality		
	B (SE)	P	Odds Ratio CI [Lower, Upper]	B (SE)	p	Odds Ratio CI [Lower, Upper]
Belt	.51(.59)	.39	.52, 5.31	.46(.58)	.43	.50, 4.97
Competition	**1.23(.56)**	**.03**	**1.15, 10.18**	−1.04(.55)	.06	.12, 1.05
Years involved	.07(.06)	.22	.96, 1.19	.05(.06)	.34	.95, 1.18
Ingroup ties	-.08(.20)	.68	.63, 1.35	-.08(.20)	.69	.63, 1.36
Ingroup affect	.21(.24)	.38	.77,1.98	.21(.24)	.39	.77,1.96
Centrality	**2.54(.93)**	**.006**	**2.05, 78.58**	**3.01(1.15)**	**.009**	**2.11, 192.98**
Constant	−2.41(1.61)	.14	–	−2.51(1.65)	.13	–

Note. Unstandardized coefficients are reported and significant coefficients are bolded.

perceptions of connectedness to others. This investigation presents a novel step toward applying network methods when predicting sport behaviors within large group settings. Indeed, even though a well-known early example of contemporary social network analysis explored shifts in membership within a Karate club (Zachary, 1977), there are few applications in this context. To promote application of the current findings, it is thus essential to identify links to theory and practice.

Perhaps the most notable findings from this study relate to how structural centrality in the peer network predicted involvement at a follow-up point in time along with social identification. As such, this research demonstrates how our social position within a group's structure, derived from other group members' responses, shape sport experiences. There is an existing empirical foundation demonstrating that individuals are drawn to sport groups with richer social ties (e.g., Spink et al., 2015). In martial arts contexts in particular, affiliation/acceptance and friendship are both important motives that drive continued commitment and training (e.g., Jones, Mackay, & Peters, 2006; Pinheiro, Andrade, Pinheiro, & Noce, 2015). Although we note caution when deriving interpretations about what centrality in an interaction network represents, we expect that structural centrality in this network represents a form of acceptance and embeddedness that makes the social context more attractive for those who are more central. Furthermore, the results were consistent across two indicators of structural centrality (i.e., indegree centrality and Bonacich indegree centrality). Considering that indegree centrality is the simpler indicator, the sheer number of nominations one receives may be most pertinent for this context, even if some additional variance may be explained by the centrality of others who nominate an individuals. Although these findings align with past research, they advance an understanding of how group structures influence behavior regardless of how individuals actually perceive that group.

In addition to the direct role of structural centrality, it is also important to explore why it was a predictor of ingroup ties perceptions but did not predict ingroup affect. At an intuitive level, it is reasonable that ingroup ties would be the dimension of social identification associated with centrality as its items explicitly describe feeling connected with others. Such evaluations are unique from ingroup affect responses, which relate to how those ties make one feel. Indeed, there is emerging

understanding that dimensions of social identity each hold different implications for motivation and behavior (Martin et al., 2017). In the current case, it may seem that quality of interactions (i.e., affect) may be distinct from the quantity of those interactions (i.e., ties). Given the value of ingroup affect, it is nevertheless of interest to examine the potential that strengthening one's evaluations of ingroup ties may influence the positive affect gained through that identity. Regardless of which domain was associated with structural centrality, social identification motivates individuals to value their group and align with their group's norms, values, and ideals (Rees et al., 2015).

Considering that social identity strength did not predict behavior, it is important to consider how social identification with sports groups may influence other outcomes beyond adherence behavior, or may impact adherence indirectly (e.g., well-being; Rees et al., 2015). Social groups are fundamental for physical and social health, and social identities in particular support mental health by providing a sense of community, supporting meaning-making, enhancing access to social support, and because it enhances the power of others' social influence (Cruwys, Haslam, Dingle, Haslam, & Jetten, 2014). The social identification within this type of club environment may, thus, impact health through a more holistic pathway.

Practical implications also emerge when considering findings regarding the core/periphery structure of the current network along with the demographic correlates of structural centrality. Notably, the network featured a dense core, with periphery members being more likely to nominate members of the core as opposed to one another. Furthermore, those who were most central tended to have been involved for a longer period of time, be at a higher belt status, and be involved in competitions outside of the club. When considering tendency for periphery members to nominate the core, for example, it seems that peripheral members were especially aware of interactions with core members (e.g., upward comparisons Mussweiler, Rüter, & Epstude, 2004). These descriptive findings hold relevance for socializing new members and leading within the group. As an example related to the socialization of new members, Veelen, Eisenbeiss, and Otten (2016) revealed how affiliations with others hold a particularly important role for newcomers, who are establishing social identities and are concerned with affiliations that represent their place *within* the group. As such, it may be especially important to help an inexperienced practitioner (i.e., white belt, new to sport) find his or her place within the group at a point in time when structural centrality is important for motivation. In so doing, ensuring diverse social interactions both inside and outside of small group training sessions (e.g., volunteering together, advice giving, mentorship) may especially foster links to newcomers. Similarly, leadership styles of coaches and peer leaders can shape the identities and social ties among members. Social identity leadership is an approach that is used to consider how leaders enrich social identity, based upon the extent that they are perceived: (a) to represent the ingroup prototype, (b) to be acting in the collective's best interest, (c) to promote the value of identifying with the group, and (d) to directly shape the group's identity, such as be defining norms (see Slater, Coffee, Barker, & Evans, 2014). Leaders within clubs like this should find ways to help foster links between members along with fostering social identity.

A further observation related to this sample was that members of the current club were participants in an individual sport. Although at times the dichotomy between team and individual sports has promoted an assumption that individual sport group members rarely need to integrate with others, recent research promotes the potential for interpersonal influence in individual sport settings. Specifically, Evans, Eys, and Bruner (2012) used social interdependence theory to highlight the degree of interpersonal influence in individual sports – focusing on the strands of interdependence that connect members. Focusing on interdependencies among members from the current study also reveals potential ways that social influence may emerge. As one example of interdependence in the current context, being in a combat sport meant that training explicitly demanded interdependence with others – providing a setting for group processes to emerge within. This means that improving individually may also help others develop skills and may provide ways for each teammate to develop roles within the interaction (e.g., mentor-mentee). In sum, although we did not examine interdependence, organizations may seek to foster connections or to increase the relevance of those connections by introducing additional and varied types of interdependence.

Despite the novelty of this study, methodological considerations should be mentioned. One potential area of focus relates to the level at which the network was studied. Traditionally, research involving sport groups is enacted at the small group level – examining the nature of personal relationships in small interdependent groups with clearly defined boundaries. Similarly, most existing uses of social network analysis in sport focus on small networks (i.e., individual teams) and demonstrate the influences of centrality within closeness or leadership networks that are explicitly relational (Fransen et al., 2015; 2017). For example, Fransen et al. (2015) demonstrated that leaders who group members felt more closely connected to were often viewed as more effective. Meanwhile, our sampling approach revealed ties within and across training groups and social identity was measured at the level of the entire club. As such, even though the resulting network did not noticeably reveal factions, one methodological limitation of considering the club as a whole network is that analyses were unable to discern the training subgroups that could represent unique influences. Even when considering the potential to account for subgroup membership in regressions, our sample of participants ($n = 181$) and training subgroups ($k = 5$) did not reach critical thresholds for nesting of individuals within subgroups to disentangle within- and between-group processes. Considering that characteristics of small groups may not be evident within the network, these findings are thus not generalizable to small group processes.

Despite limited generalizability to small groups, we view the whole-network design as novel in the sport and exercise field, and potentially powerful considering that centrality within the whole network was linked to ingroup ties and adherence. The use of a whole network analysis and the measurement of social identity in large groups is also theoretically tenable. For instance, social identification often unfolds in similar ways when identities are constructed around small groups all the way to large organizations or categories (e.g., Cameron, 2004). Whole network designs also hold value because, as groups increase in size, diversity and sheer number of potential ties exponentially increases. Considering the value of whole network processes, we hope that researchers may soon capture large network processes in tandem with small group processes. This may be done by combining assessment methods (i.e., peer nominations within training groups, and a separate nomination outside of training groups) and to integrate both using multilevel analyses.

It is also important to consider measurement-related concerns. Although the open nomination of names was a necessity to reduce participant burden and promote privacy, the absence of a roster as a prompt means that nominations made from each individual may have been influenced by aspects such as recency. We also used a binary measure of continued involvement that resulted in the majority of participants in this research being identified as 'involved' at the follow-up point in time. A more fine-grained measure indicating the frequency of participation may have provided greater variability and increased the potential to identify associations with study variables.

Finally, considering the descriptive analyses along with the simple regressions, this research addresses a first generation question (i.e., descriptive associations) rather than investigating the potential for centrality to influence behavior through social cognitions (see Zanna & Fazio, 1982). Although one underlying presumption for examining social identity was the potential link to behavior, the current study measured structural centrality alongside social cognitions so was not designed to test mediation. The design of the study nevertheless

supported the use of centrality as a predictor because it was derived from the responses of other group members. As such, the structural centrality measure held temporal precedence (i.e., members' interactions took place preceding the survey) and overcomes issues of 'common method variance' when associations among constructs are overestimated because of similar assessment styles (i.e., Likert-style surveys). Nevertheless, the use of longitudinal methods in future research would establish causality and provide the potential to examine individual ties among members as a direct source of influence (Christakis & Fowler, 2007). For instance, 'contagion' of social identity within the group could be identified by examining whether individuals' beliefs are influenced by those to whom they are tied.

5. Conclusion

We explored how the simple presence (or absence) of interactions with others in a large sport club environment influenced experiences and prospectively predicted behavior. Centrality within the peer interaction network was a unique variable that predicted involvement as well as the dimension of social identity derived from feelings of connectedness with others. These findings continue to support the value of privileging athletes' and exercisers' interactions with others to support positive experiences and to promote adherence. This supports the potential of social network approaches, and opens the door for further explorations that examine conditions where these associations are strongest and to identify mediators of these effects.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.psychsport.2018.10.006.

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