

Monitoring changes in cohesion over time in expedition teams; the role of daily events and team composition

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ABSTRACT

Cohesion is an important part of effective team performance. Previous research has focussed on cross-sectional self-report measures in business settings. However, in extreme environments where contextual factors (e.g., weather conditions) can vary considerably from day to day, micro-variations in cohesion could influence daily performance. In small teams under pressure, such variations may be moderated by personality traits. The current study presents a diary methodology to explore variation in cohesion in five expedition teams – tracking temporal changes in cohesion and daily events over twenty days. Pre-expedition personality measures were used to explore the impact of team composition on variations in cohesion. Findings demonstrated that events significantly predicted fluctuations in cohesion across teams. Having more extraverted team members had a negative impact on cohesion. These results offer valuable insight to how this method can track changes in cohesion over time and subsequently enhance understanding of how to mitigate cohesion breakdowns.

KEYWORDS

Teamwork; cohesion; performance; daily diaries.

INTRODUCTION

Expeditions teams operate in extreme, high stakes, pressured environments in which effective teamwork is vital to success (Militello, Sushereba, Branlat, Bean & Finmore, 2015; Driskell, Salas, Driskell, 2017). Research on how teams work effectively in extremes is an important, emerging area of research (Salas, Tannenbaum, Kozlowski, Miller, Mathieu & Vessey, 2015). It is not yet known if the known facets of teamwork will operate in extremes in the same way they do in other environments (Vessey & Landon, 2017). Despite this, there are only a small number of studies that have empirically tested teamwork in extremes and even fewer with a longitudinal design, accounting for the dynamic nature of team interactions. The primary purpose of this research was to trial a method for monitoring team cohesion over time in expedition teams and assess if changes in cohesion could be explained by daily experiences. In contrast to previous research, which has tended to collect data from a single expedition team (e.g., Allison, Duda & Beuter, 1991), we collected data from five teams, travelling to three different locations. This allowed a comparison of how team composition affected the development of cohesion in each team. The majority of participants were high school students, taking part in expeditions lasting 20 days, travelling to three different countries; Mongolia, Kyrgyzstan and Greenland.

Expeditions are defined as journeys, taken with purpose for reasons of adventure, exploration and scientific discovery (Johnson, Anderson, Dallimore, Winser, & Warrell, 2008). Generally, when on expedition, teams tend to be socially isolated and physically confined, in environments characterised by dangerous and difficult conditions (Palinkas & Seudfeld, 2008). This isolation, in combination with the arduous physical demands associated with expeditions, makes establishing and maintaining effective teamwork difficult, increasing the likelihood of social conflicts and exaggerating individual differences (Palinkas & Seudfeld, 2008; Stuster, 2011). Monotonous daily tasks (e.g., setting up and taking down camp) are also typical of an expedition environment (Leon, Kanfer, Hoffman & Dupre, 1994), increasing the likelihood of conflict as individuals contend with feelings of boredom. Despite the challenges to maintaining teamwork on expedition, it is a vital component to success. Failing to work effectively will lead to suboptimal decision-making with consequences for the safety and performance of the team (Driskell, Driskell & Salas, 2017). Teams must be able to coordinate, communicate and cooperate effectively, relying on each other to cope with the challenges of the environment (Bishop, Morphew & Kring, 2000). On reflection of a crossing of the Arctic one member noted: “If you don’t have the team you have nothing. Have team members who have social intelligence... anyone can learn tasks” (Leon, Sandal, Fink & Ciofani, 2011, p.14).

To examine teamwork in expedition teams, we adopted the Input Mediator Output Input (IMO-I) model of teamwork (Ilgen, Hollenbeck, Johnson & Jundt, 2005). This model accounts for the dynamic nature of team interactions, acknowledging that teams exist within the wider environment, changing over time (Kozlowski & Ilgen, 2006). According to this model, the relationships between Inputs (e.g, team size, team composition) and

Outputs (e.g., performance measures) occur in a cyclical process, influenced by Mediators (e.g., processes and emergent states). Team processes are defined as team interactions that are directed towards task accomplishment (Mathieu, Maynard, Rapp & Gilson, 2008) and emergent states are defined as the dynamic properties of the team representing attitudes values and cognition (Marks, Mathieu & Zaccaro, 2001). To study teamwork in expedition teams, we focused on team composition (an input) and team cohesion (an emergent state). Both have previously been identified as important aspects of performance in extremes (Bell & Outland, 2017; Vessey & Landon, 2017).

Cohesion is defined as the shared tendency for the team to remain united in achieving a common goal (Casey-Campbell & Martens, 2009). McClurg, Chen, Petruzelli and Thayer (2017) formulate it more simply as the commitment of a team to working on a task constructively, whilst maintaining social relationships. It tends to be viewed according to its task and social components (Caron & Widmeyer, 1998). Task cohesion is defined as the shared commitment to the task, and social cohesion is defined as the interpersonal bonds that exist between team members (Mikalachki, 1969). In conventional teams, cohesion has been consistently associated with high performance (Beal et al., 2003) and been found to facilitate team decision-making under pressure (Zaccaro, Gualtieri & Minnionis, 1995). Despite this, little research has explicitly measured cohesion in expedition teams, and most existing studies have only used a single item to measure it. Data from a team of 12 members, completing a 61-day trek through parts of Alaska, identified a positive association between cohesion and communication, perception of fairness in task assignments and in the perceived quality of decision making by the team leader (Leon, Kanfer, Hoffman & Dupre, 1994). A further study of an all-female climbing group found that cohesion increased during the early part of the expedition, peaking on the day when the group engaged in their most difficult task, before then tailing off towards the end (Allison et al., 1991). Our research built on the methodology used by Allison et al., (1991), however it utilised a validated measure of cohesion, collected at daily intervals, rather than at six pre-defined intervals.

Team composition is defined as the attributes of team members, including skills, experiences and personality characteristics (Guzzo & Dickinson, 1996). Composition is an input factor, relating to the extent that attributes of team members affect emergent states, processes and outcomes of teams (Mathieu et al., 2008). Specifically, for expedition teams, composition has been identified as an important way of screening those most suited to survival in harsh environments and to support the achievement of team goals (Palinkas & Suedfeld 2008). Previous research has identified traits of openness to new experiences, agreeableness and conscientiousness in expeditioners (Suedfeld & Steel, 2000; Steel, Suedfeld, Peri & Palinkas, 1997). Palinkas, Gunderson, Holland, Miller and Johnson (2000) sought to explore predictors of performance in extremes by identifying the traits of 657 men overwintering in Antarctica. The results of their study posited that low levels of extraversion would be beneficial in an extreme environment. The authors suggest that this may be due to the restrictive social environment of isolated contexts being more suited to less extraverted individuals. Despite identifying common and beneficial traits in expedition teams, studies have not yet compared the composition of several teams and how this composition might interact with other aspects of teamwork (i.e., cohesion). Of the limited research that has been conducted, in conventional teams an association has been reported between emotional stability and cohesion (Barrick, Stewart, Neubert & Mount, 1998) and agreeableness and cohesion (Bradley, Baur, Banford & Postlethwaite, 2013).

The primary purpose of this research was to pilot a diary methodology for monitoring team cohesion over time in expedition teams and assess if changes in cohesion could be explained by daily experiences. We expected that in small teams, changes in cohesion might be moderated by the personality traits of team members. Thus, the second aim of our research was to compare the composition of each of the expedition teams and explore if the team composition affected change in team cohesion.

METHOD

Participants

A total of 71 participants (43 of whom were female) were recruited from a school in the south of England. Participants formed five teams of varying size, travelling to three locations; Greenland, Mongolia and Kyrgyzstan. Each expedition lasted 20 days. The teams included staff members ($n=9$) and students ($n=62$). The average age of the student participants was 15.22 years ($S.D = .35$). For the pre-expedition questionnaire there was 68 participants, 42 participants completed the diary and 50 completed the post-expedition questionnaire.

Procedure

Following ethical approval, contact was initiated with the school several months before the expedition teams were due to depart. Once a formal agreement was made between the researchers and the school, a letter of consent was sent out to the parents of the students taking part in the expedition. Once consent was obtained, participants were briefed on how to complete the daily diary. Each participant was asked to complete a pre-expedition questionnaire and given a daily diary to complete on each day of the expedition. On return, participants were asked to complete a post-expedition questionnaire.

Materials

The pre-expedition questionnaire included questions about demographics (age, gender), a personality measure and a team cohesion measure. Personality was measured with the Ten Item Personality Measure (TIPI) (Gosling, Rentfrow & Swann, 2003), a short measure designed for instances when time is limited. Cohesion was measured using a 6-item scale (Mathieu, 1991). This scale has been used to assess the impact of shared leadership and team members competence on team cohesion and performance over time (Mathieu et al., 2015). The daily diary was designed to mirror those used in previous research (Smith, Barrett & Sandal, 2018). It included 27 diary items (see table 2), with 18 negative items (e.g., “*delay due to weather conditions*”) and 9 positive items (e.g., “*enjoyment of the environment*”). Participants were instructed to place a tick next to each event they experienced that day. The diary also included the same cohesion measure (Mathieu, 1991) as the pre-expedition questionnaire and a single item measuring perceptions of team performance. In the post-expedition questionnaire, participants were asked again to complete the cohesion scale.

Data Analysis

Differences in personality traits across the teams was explored using a MANOVA. A mixed ANOVA and Bayesian statistics were used to examine if cohesion increased following the expedition and if this varied according to group. A linear regression was conducted to explore the extent to which change in cohesion could be explained by the personality composition of the team. To analyse the diaries, R (R Core Team 2012) and lme4 (Bates, Maechler & Bolker, 2012) were used to perform a linear mixed effects analyses to explore which variables significantly predicted changes in cohesion. A major challenge to researching teams in extremes is that sample sizes tend to be small (Bell et al., 2018). However linear mixed model analysis is able to produce reliable results with relatively small samples (Bell, Morgan, Schoenberger, Kromrey & Ferron, 2014). As fixed effects, the 27 diary items were included along with the participant’s team (e.g., Greenland) and the day of the expedition the diary was completed (day 1-20). As random effects, an intercept was added for participants. Intercepts did not vary according to the team participants were in, thus team was included only as a fixed effect. A visual inspection of residual plots confirmed there was no major deviations from homoscedasticity or normality. P-values were obtained by likelihood ratio tests of the full model with the effect in question against the model without the effect in question.

RESULTS

Questionnaire: Personality composition

The mean personality profiles for each team were calculated by aggregating the individual personality data collected in the pre-expedition questionnaire. This is common practice in team research (Mathieu, Gallagher, Domingo & Klock, 2019). A MANOVA was conducted to compare the personality profiles in each team, no significant differences were identified. The most frequent trait found in the sample was openness to new experiences, followed by conscientiousness and agreeableness. The lowest scoring traits were emotional stability and extraversion (See Table 1)

Table 1. Personality profiles of each team

Team	Extraversion	Agreeableness	Conscientiousness	Emotional stability	Openness to new experience
Mongolia 1	4.87	5.10	4.88	5.72	5.31
Mongolia 2	4.96	4.90	5.54	4.75	5.18
Kyrgyzstan 1	4.08	4.80	5.41	5.08	5.62
Kyrgyzstan 2	4.73	5.11	5.38	4.92	5.73
Greenland	4.08	5.20	5.31	4.88	5.70
Total	4.74	5.022	5.29	4.86	5.50

Questionnaire: Personality composition and change in cohesion

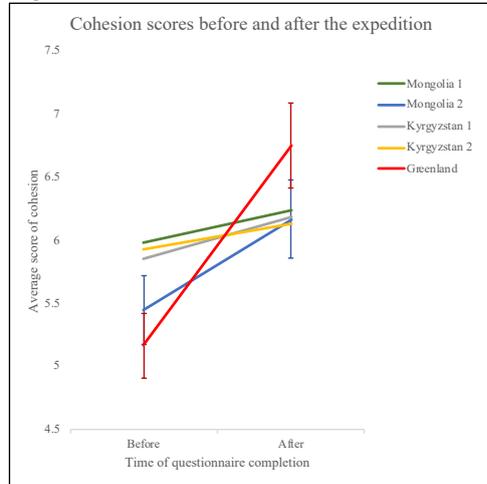
Aggregated personality profiles for each team were assigned to participants. A linear regression was conducted to explore if the change in an individuals’ perception of cohesion could be explained by the mean personality of team. The overall model was significant ($F(4,43) = 4.316, p = .005$), $R^2_{adjusted}$ of .22, indicating 22% of the variance in cohesion change could be explained by the personality composition of the teams. However, of each personality traits, only extraversion significantly predicted a change in cohesion ($\beta = -.53, p = .002$).

Questionnaire: Cohesion scores before and after the expedition

There were no significant differences between social and task cohesion scores in the pre- and post-expedition questionnaires. Due to this, analysis was only conducted to compare the total cohesion scores before and after the expedition. A two-way mixed ANOVA was conducted to explore differences in team cohesion across the five teams and before and after an expedition. Results indicated a significant main effect of time, $F(1,86) = 21.25$,

$\eta p^2 = .20$, $p = <.001$, $B_{H(0, 2559.31)} = 0.55^1$. with overall cohesion significantly higher after the expedition ($M=6.30$, $S.D = .67$) than before ($M = 5.70.14$, $S.D = 6.7$). There was no significant difference in cohesion across the groups. There was however a statistically significant interaction between the increase in cohesion and the expedition team $F(4,86) = 3.75$, $\eta p^2 = .15$, $p = .007$. A simple main effects analysis found that cohesion increased significantly over time for Mongolia team 2 ($p=.019$, $B_{H(0, 5.37)} = 0.55$) and the Greenland team ($p = <.001$, $B_{H(0, 36.75)} = 0.55$), but not for the other three remaining teams (see Figure 1. Error bars included for Greenland and Mongolia 2)

Figure 1. Team Cohesion over time



Diary

The most frequently reported diary item was “*Enjoyment of Environment*” ($n = 608$) and the least frequent item was “*Dispute with the leader*” ($n = 54$). The findings were consistent across the teams. Despite there being twice as many negative items in the diary ($n = 18$) as positive items ($n = 9$), positive items were reported much more frequently (59.4% of all responses). Despite differences between teams in perceptions of cohesion in the pre-expedition and post-expedition questionnaires, there was no significant effect of team in predicting scores of cohesion *during* the expedition, $\chi^2(1) = 1.74$, $p = .19$. The diary data was therefore collated to identify if day of completion or content of the diary could predict changes in cohesion (See Table 2). Perceptions of cohesion significantly correlated with perceptions of performance $r(808) = .81$, $p = <.001$ and had an unacceptable level of collinearity to be included in the mixed model analysis. The linear mixed model analysis demonstrated that the day that the diary was completed had a significant effect on cohesion, $\chi^2(1) = 4.59$, $p = .03$, indicating that as the number of days increased, cohesion increased by $.06 \pm 0.056$. The results of the linear mixed model analysis with regards to the utility of the diary items in predicting changes in cohesion are presented in Table 2. Interestingly “*Satisfaction in making good progress today*” and “*Satisfied that I am able to cope with the challenges of the expedition*” were significantly associated with increases in cohesion. In contrast “*Problem with digestion*” was associated with decreases in cohesion. Perhaps not surprisingly “*Feeling of camaraderie/closeness with team mates*”, “*My team mates approached the expedition today with a good attitude*”, “*Feeling I could rely on my team mates to work effectively*” were all associated with increases in cohesion, whereas “*Concern about how effectively my team and I are working together*”, “*Feeling down/low because my team mate is/are feeling that way*” and “*Tension or argument with team mate(s)*” were all significantly associated with decreased cohesion.

Table 2. Utility of daily events in predicting changes in cohesion

Daily event	Frequency of item	Significance	Change in cohesion
Problems with gear and equipment e.g., clothing, tools, navigation equipment etc.	164	ns	
A delay in progress due to weather conditions	129	ns	
Worried about encountering bad weather	216	ns	
Enjoyment of the environment	608	ns	
Satisfaction that equipment is working properly	423	ns	
Satisfaction in making good progress today	427	.032	+ .15
Satisfaction that I am able to cope with challenges	440	.039	+ .11
Concerns about the effectiveness or safety of the decisions I made today	86	ns	
Concern about the well-being of my team mates	251	ns	

¹ The alternative hypothesis was set by the mean difference reported by Chang and Bordia (2001).

Tension or argument with my team mate(s)	191	.027	-.13
Discussed a problem with a team mate and felt listened to	269	ns	
Feeling of camaraderie/closeness with team mates	529	.013	+.14
Feeling down/low stressed out because my team mates is/are feeling that way	91	.02	-.19
Feeling I could rely on my team mates to work effectively	423	<.001	+.25
Concern about how effectively my team mates and I are working together	89	<.001	-.43
My team mates approached the expedition today with a good attitude	574	<.001	+.25
Satisfaction with the leadership	447	ns	
A problem/dispute with the leader	54	ns	
Problem with digestion	65	.016	-.20
Headache	87	ns	
Lack of sleep	318	ns	
Muscle or joint pain	206	ns	
Personal hygiene (wanting to be cleaner)	278	ns	
Lack of privacy/personal time	163	ns	
Fear of being injured	119	ns	
Loneliness, homesickness	175	ns	
Worried about family/friends	110	ns	

DISCUSSION

The overall purpose of the present study was to trial the use of a diary methodology to examine teamwork in five teams, undertaking expeditions in three locations. We wanted to understand if the composition of the team and the daily experiences of individuals in each team could predict changes in cohesion. Despite no significant differences in personality composition across the teams, the highest scoring traits (openness to new experiences, conscientiousness and agreeableness) were consistent with traits that have previously been identified in expeditioners (Suedfeld & Steel, 2000; Smith, Kinnafick, Cooley & Sandal, 2017), adding to the existing evidence that these personality traits are most suited to expedition environments (Palinkas & Suedfeld, 2008).

In comparing the pre and post-expedition questionnaires an overall increase in cohesion was found. Post-hoc tests indicated that cohesion only significantly increased for two of the teams. This finding supports the view that cohesion emerges and changes over time depending on the dynamics in the environment and the team (Mathieu et al., 2001). By demonstrating differences in the emergence of cohesion across several teams, one theoretical contribution of this research is to support the notion of context being vital in shaping team-based constructs (Ilgen, 1999). If cohesion were to increase organically in teams regardless of context, we would expect to see a similar change across each of the teams, however in our findings an increase was only found in two of the teams. To further explore this, we assigned the aggregated team personality profile to each individual, to see if personality composition could explain the changes in cohesion scores before and after the expedition. The results indicated that the personality profile accounted for a fifth of the variance in scores of cohesion. Further analyses demonstrated that extraversion was the only trait to have a significant effect, leading to a reduction in cohesion. Findings demonstrated that having extraverted team members had a negative impact on the development of cohesion. This provides a possible explanation for why previous research identified low levels of extraversion as beneficial in an extreme environment (Palinkas et al., 2000). Overall the results from the questionnaire support previous suggestions that certain traits may be more beneficial for performance in extreme and challenging environments. By identifying extraversion as an important variable in the emergence of cohesion, the findings support the other research suggesting that deep-level composition, such as personality, can affect team processes and emergent states (Bell & Outland, 2017).

Whilst on expedition, participants completed a diary, monitoring their experiences of daily events and perceptions of team cohesion and performance. Participants consistently reported more positive diary items than negative, and the most frequently reported item across each of the teams was “*Enjoyment of the environment*”. This finding supports existing evidence that extreme environment activities can be promotive of health (Suedfeld, 2000) and a positive experience for those taking part (Smith et al., 2018). Consistent with findings in the literature we found a significant positive relationship between cohesion and performance. This is the first study of its kind to test the relationship between cohesion and performance in an expedition setting and it is promising to see evidence for the importance of cohesion in this context. In addition, consistent with the results of the questionnaires, we found a significant relationship between the day the diary was completed and perceptions of cohesion. As the number of days increased, so did scores of cohesion. Whilst there are very few studies that have studied cohesion over time in expedition teams, this finding is inconsistent with one example of an all-female climbing group, in which

cohesion was found to decline towards the end of the expedition (Allison et al., 1991). The authors suggested that the decline in cohesion may have been because the team had already achieved their main goal, leading to attention shifting from the team towards matters at home. As the participants did not know each other before the expedition, this then led to personal investment in the team waning. In our study, the participants had trained together for two years prior, which might explain why increases in cohesion sustained throughout.

The diary method allowed us to test the validity of monitoring daily events to predict fluctuations in cohesion. Similar methods were used by Smith et al., (2018), to predict fluctuations in positive and negative affect by monitoring daily events and coping strategies. Some associations between the team-focused events and cohesion were expected: for example, “*camaraderie with team mates*” led to an increase in perceived cohesion and “*feeling concerned about the effectiveness of the team*” led to a significant decrease in perceived cohesion. This validates the cohesion measure as reflective of changing perceptions of teamwork across the expedition. Other associations that were made between the daily events and perceptions of cohesion were less obvious and may be of particular value in indicating how to mitigate breakdowns in cohesion. Reporting “*feeling satisfied to cope with the challenges of expedition*” and “*feeling satisfied with the progress of the expedition*” both led to increases in cohesion. These results suggest that experiencing a sense of achievement (satisfaction of coping with challenges) and achieving shared goals (such as progressing in the expedition) are important aspects in the maintenance of team cohesion. Previous work has theorised how this process occurs by suggesting that superordinate team goals encourage social identity, which is an important component in the development of cohesion (Salas & Cannon-Bowers, 2001). Only one diary item that was not explicitly related to teamwork significantly contributed to a reduction in cohesion and this was reporting a problem with digestion. Problems with digestion and diet have previously been identified as major stressors, leading to increased tension amongst crew mates during a 105-day space simulation (Sandal, Bye, Van de Vijver, 2011). Overall the results from the diary data are promising, demonstrating the benefit of the diary methodology to track cohesion over time and assess the utility of daily events to predict changes in cohesion. This was an exploratory study; further research should explore if the relationships between variables identified in this study are consistent for teams operating in other contexts. This could facilitate the development of a mobile monitoring system, allowing team leaders to monitor fluctuations in cohesion in real time and therefore mitigate breakdowns in effective teamworking.

CONCLUSION

Despite being an exploratory study, the findings are promising and identify the need to conduct further research in this context. Our research directly answers the call to conduct more empirical research on teams in extreme environments. We successfully piloted a daily diary method to understand how cohesion is established and maintained in difficult conditions, allowing us to monitor changes in cohesion across the entirety of the expedition, assessing to what extent these changes could be explained by daily events and team composition. These findings offer valuable information to expeditioners and other teams operating in analogous settings (e.g., aid workers, special forces personnel) on factors that might influence cohesion, as well as contributing to the theoretical understanding of how cohesion emerges in different contexts.

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