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RESEARCH ARTICLE

Profiles of resilient psychosocial function during three isolated ski expeditions in the High Arctic

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Abstract

To successfully complete a Polar expedition individuals and teams must respond resiliently to the environmental, psychological, and social demands they face. In this study we examined profiles of resilient function in seven people from three expeditions in the High Arctic. Using a structured daily diary, participants reported on experiences of physical health (morning and evening), affect, team cohesion, performance, and potential explanatory factors including sleep, demand appraisals, events, and coping strategies. Notable intra- and inter-individual variability was observed in daily reports and all profiles could be interpreted as representing resilient function. A number of significant relationships were found between markers of resilient physical and psychosocial function and potential explanatory variables. For example, there was much more daily variability in an individual's reporting of positive affect than prior research might imply, and what prior research designs could capture. Further, while negative affect tended to remain low and stable, our findings reveal that even minor and infrequent increases in negative emotions were significantly associated with other variables in the network. Finally, across the expedition period individual coping resources consistently exceeded demands, suggesting that individuals viewed the expedition as a challenge and not a threat. More broadly, these findings inform efforts to monitor, and maintain resilience when operating in Polar and other extreme settings.

KEYWORDS
diary study, expedition, extreme environments, resilience, stress

1 | INTRODUCTION

It is well-documented that demands encountered on Polar expeditions can pose a threat to safety, health, and performance (Leon, Sandal, & Larsen, 2011; Palinkas & Suedfeld, 2008). For instance, extreme cold weather and rugged terrain can result in a range of musculoskeletal injuries (Graham et al., 2021), uncomfortable conditions and prolonged periods of daylight can impair sleep and result in fatigue (Pedlar et al., 2007), and enforced proximity with others can lead to feelings of frustration and disruptive social conflict (Leon & Venables, 2015). Despite these potential environmental and psychosocial difficulties, much of the prior work on Polar expeditions

found that individuals and teams report these extreme experiences to be personally fulfiling (Leon, Sandal, & Larsen, 2011; Suedfeld, 2001). Across expedition periods, Polar expeditioners have consistently reported higher levels of positive rather than negative affect (Leon, Sandal, & Larsen, 2011). They also regularly report positive experiences including enjoying the Polar environment, taking satisfaction from goal progress, and feeling a sense of camaraderie with teammates (Corneliussen et al., 2017; Kjærgaard et al., 2015; Leon, Sandal, Fink, et al., 2011). These findings can be explained by expeditioners generally being highly motivated, well-prepared, and believing that they have the necessary resources to cope (Palinkas & Suedfeld, 2008).

However, while Polar expeditioners may expect an overall positive experience, prior work also documents anecdotal and empirical evidence of significant situational variability in physical, psychological, and social functions. Expeditioners have kept journals since the earliest days of Polar exploration, and in recent years online updates from the field (e.g., blogs) provide near real-time insight into the daily struggles of Polar travellers (Smith et al., 2017; Suedfeld et al., 2017). Journal entries and online updates capture, among other things, the concerns and frustrations associated with difficult weather conditions, nagging injuries, feelings of self-doubt or failure, fluctuations in motivation, and loneliness. These observations suggest that a more nuanced understanding of positive and negative events, and how Polar expeditioners manage them, should take account of these in-expedition experiences rather than rely only on whole-expedition ratings. Recent research adopting systematic intensive sampling approaches offers a growing body of empirical evidence on variations in physical, psychological, and social parameters that have been anecdotally reported in blogs and journals (e.g., daily questionnaires (Anton-Solanas et al., 2016; Blackadder-Weinstein et al., 2019; Pedlar et al., 2007; Smith, 2018; Smith et al., 2021). An important insight from this emerging literature is that an individual's capacity to quickly recover or maintain function across these different parameters when exposed to expedition demands is a critical factor in the successful pursuit of expeditionary goals (Smith et al., 2021).

Quick recovery or maintenance of function in stressful situations is closely aligned with the concept of resilience, a construct from psychology that has received sustained scholarly interest. Although the precise definition of resilience remains the subject of intense debate (Southwick et al., 2014), there is growing consensus among scholars that resilience reflects a person's trajectory of functioning after exposure to adversity (Bonanno & Diminich, 2013; Jones et al., 2022). In a 2017 consensus statement, Kalisch and a large cohort of international researchers suggested that resilience can be defined as the "maintenance or quick recovery of mental health during and after exposure to significant stressors" which "results from a dynamic process of adaptation to the given stressful life circumstances" (Kalisch et al., 2017). Others have explored the role of resilience in high-performing individuals and teams. From this perspective, resilience has been viewed as the capacity to maintain or, in some cases, catalyse improved individual and team performance under conditions of high pressure (Chapman et al., 2020; Fletcher & Sarkar, 2012; Gucciardi et al., 2021; Jones et al., 2022; Sarkar & Fletcher, 2014). Both the mental health and performance-focused literatures emphasise the operationalisation of resilience (or more precisely, resilient function) as something that should be identified *ex post*, and conceptualise resilience as an emergent outcome generated during and/or following an adverse experience or difficult life period (Gucciardi et al., 2021; Kalisch et al., 2017).

Building upon the early work on resilience networks, Kalisch et al. (2019) have proposed that, at the intra-individual level, resilient function is represented by temporal changes in an interconnected symptom network that includes physical, cognitive, emotional, and social nodes. Kalisch et al. (2019) suggest that exposure to stressful demands activates a response in one or more of the nodes (e.g., physical: physiological arousal). Because these symptom nodes are networked, this activation subsequently activates other nodes (e.g., cognitive: worrying thoughts, emotional: feelings of anxiety, and/or social: isolation). Within this framing, when facing stressful situations, resilience is evidenced by a relative limitation of the spread of disruptive node activation, and the network quickly returning to a state of normal function (as opposed to transitioning to a stable, but disrupted, state). In their later work, Gucciardi et al. (2021) proposed that indices of resilient function may be context-dependent, and consequently the representation of specific nodes should be defined based on the nature of the person-environment interaction under investigation. For instance, the node indices that might be relevant to studying office workers during a stressful period might be different to those of interest to a mental health practitioner supporting someone through a period of depression.

The present study leverages the concept of a resilience network, applying this theoretical lens to illuminate what resilient function looks like during Polar expeditions. Consistent with Gucciardi et al. (2021), we adopt a context-dependent view, focusing attention on changes in physical, cognitive, emotional, and social factors that prior work identifies as critical to enabling optimal functioning and the safe and successful achievement of expedition goals (Leon, Sandal, & Larsen, 2011; Palinkas & Suedfeld, 2008, 2021). Markers of resilient functioning used in the present work include physical health, performance, affect, and team cohesion. These markers have previously been implicated in successful individual and team goal pursuit in extreme environments (Driskell, et al., 2018; Leon, Sandal, Fink, et al., 2011, Leon, Sandal, & Larsen, 2011), and thus, we suggest that quickly recovering, maintaining, or improving function in these areas under conditions of stressful demand offers a reasonable proxy for understanding resilient function in demanding Polar expedition settings.

Although prior conceptual work has discussed resilience in the context of extreme expedition activities (e.g., Suedfeld, 2001, 2012), there has been, to date, limited empirical work examining resilience in these settings. Studies that have considered dynamism in variables that are contextually relevant for extreme expeditions (e.g., Smith et al., 2021) are instructive, but this and other work is not grounded within a resilience framework. There has also been very little examination of interrelationships between different markers of

function that Kalisch et al. (2019) and others suggest would function as a dynamic, interconnected, and interdependent resilience network under conditions of stress. From a methodological perspective, prior studies relevant to the present work have typically relied on week-to-week or month-to-month assessment intervals. With the exception of a small number of studies (e.g., Kahn & Leon, 1994; Smith et al., 2021), earlier work may have failed to capture important individual and team variability and, crucial to the study of resilient function, relevant situational changes in network node responses when operating under persistent demand. With the above limitations in mind, scholars lack a complete understanding of intra-(and inter-) individual variations in adaptation, and what a resilient function network might look like in Polar expedition and other extreme environment contexts. The current exploratory study attempts to address these issues by examining both daily temporal variations in factors that might characterise individual and team resilient function in Polar extremes and the interrelations between those variables.

Although the dynamics of resilient function have not received a great deal of attention in extreme environments (e.g., in Polar settings), findings from prior studies provide insight into so-called 'resilience factors' (Bartone et al., 2018; Bögemann et al., 2022). Resilience factors include various dispositional and malleable traits, abilities, and skills that play a protective and, in some cases, enhancing role when individuals are exposed to stressful demands (Fletcher & Sarkar, 2013). Kalisch et al. (2019) propose that resilience factors function as an interconnected network of nodes, working together to protect and promote optimal physical, cognitive, emotional, and social responses to stressors and adversity. Potential resilience factors identified in previous Polar expedition research include, amongst other variables, emotional stability, task ability, and social compatibility (Palinkas, 1991; Palinkas & Suedfeld, 2008).

While the aforementioned variables offer useful baseline information about an individual, they tend to produce small effect sizes and ultimately account for a limited variance in how people actually respond to and operate in extremes (Smith et al., 2018). This has led scholars to suggest that situational resilience factors are likely to be more immediate determinants of a person's function (Palinkas & Suedfeld, 2008; Sandal et al., 2018). In contrast to pre-expedition assessments (like those typically used to assess emotional stability, task ability, and social compatibility), daily reports of situational factors such as rest and sleep, demands encountered, and coping strategies have been demonstrated as moderate-to-strong predictors of performance, health and well-being experiences in expedition settings (Palinkas & Suedfeld, 2008; Smith et al., 2021; Wagstaff & Weston, 2014). Existing resilient performance theories also point towards psychological processes, such as challenge appraisals of stressful demands, as being close antecedents of resilient function (Fletcher & Sarkar, 2014). While there has been some recent progress on the contribution of resilience factors to resilient functioning in intense settings such as military selection (Gucciardi et al., 2021), more research is needed to understand the role and impact of such determinants, especially those that operate situationally, on outcome markers of resilient function in extreme settings.

The present study advances our understanding of the dynamics of resilient function in Polar expedition settings. To our knowledge, this is the first study to apply a coherent theoretical lens (i.e., Kalisch et al., 2017, 2019) to the investigation of resilient function in extreme expedition environments. It is also one of very few attempts to examine the day-to-day profile of and interrelations between physical and psychosocial dynamics in these settings. This intensive sampling approach is necessary to understand variability in how individuals and teams respond to pressing situational demands and how those responses operate across a network of physical, psychological, and social variables. This granular representation is important given that initial studies have suggested that individual function is more variable in these settings than findings from week-to-week, month-to-month, or one-off whole assessments would suggest. Overall, the present research contributes to a prospective evidence-base that can be used to make informed in-the-moment performance and health decisions when individuals and teams are in the field. To summarise, there were two overarching aims to the study:

1. To examine day-to-day fluctuations in and interrelations between markers (i.e., physical health, performance, affect, and team cohesion) that characterise a resilient function network in Polar expedition settings.
2. To examine how situational factors (i.e., daily evaluations of sleep, perceived demands, and coping resources) relate to different outcome markers of resilient function in Polar expedition settings.

2 | METHOD

After receiving institutional ethical approval from the organization of the first author (UREC: 2019-5815-9738), a call for research participants who had upcoming expeditions was sent out online via pre-existing social network websites and directly to mountaineering and expedition clubs. The expeditions needed to be self-supported, lasting at least 10 days and moving between two or more locations. We also stipulated those expeditions could be on-foot or with vehicle support but must have involved sleeping in situ. The recruitment period for this work ran between March 2019 and September 2019.[1] Expeditioners who responded to the call received a participant information briefing sheet to explain the purpose of the study.

2.1 | Participants

Three expeditions met our strict inclusion criteria and were recruited to this study: two teams of two participants and one team of three participants. Of the seven participants, one was female and six were male (M_{age} = 29.43 years, SD = 4.83), and participants were based in the United Kingdom. Further details about the expeditions are

provided below. Some information on locations and routes has been omitted to protect participant anonymity.

2.1.1 | Team A

Team A included two expeditioners skiing above the Arctic circle in northern Norway. The team members covered 250km over 27 days and encountered temperatures between −20°C and +10°C. Each member of the expedition team pulled sleds weighing up to 50kg. Both team members were environmental consultants and had participated in multiple previous expeditions.

2.1.2 | Team B

Team B included two expeditioners walking and kite skiing on the Greenland Ice Sheet. The team members covered 1000km over 19 days and encountered temperatures as low as −34°C with winds up to 110kph. Each member of the expedition team pulled sleds weighing up to 100kg. Initially, the team had intended to cover 1900km. However, on the seventh day, due to injury and poor weather, the team amended their plans and shortened their journey. Both team members had extensive expedition experience.

2.1.3 | Team C

Team C included three expeditioners who completed a glacial traverse in Iceland. The team members skied 200km over 17 days and encountered temperatures between −15°C and +5°C. Each member of the expedition pulled sleds weighing up to 70kg. At the end of day 4, the team adapted their plans due to deteriorating weather conditions. One team member had been on multiple expeditions. The other two members had both been on one short expedition prior to this journey.

2.2 | Measures

During each day of the expedition, participants completed a rating form that captured individual perceptions of various physical, psychological, and social factors associated with long-duration expeditions in extreme settings. One portion of the rating form was completed by the individual at the beginning of the day, and the second portion completed by the individual at the end of the day. The rating form used in this study was an adapted version of a rating form used in prior work in other expedition settings (e.g., Atlis et al., 2004; Blackadder-Weinstein et al., 2019; Kjærgaard et al., 2015; Smith et al., 2021). Specific adaptations to the rating form for this study included adjusting terminology consistent with a daily measurement cadence, separating morning and evening ratings where appropriate, and adding items related to team cohesion and demand and coping resources evaluations. The adapted rating form captured seven categories of items:

2.2.1 | Physical health

Participants rated their physical health on a single item indicator twice daily. In the morning, they ranked their current physical health and sleep quality on a 7-point Likert scale from 1 (very bad) to 7 (very good). In the evening, participants assessed their current physical health and their assessment of their performance on that day using the same 7-point scale.

2.2.2 | Affect

We used the Positive and Negative Affect Schedule (PANAS) (Watson et al., 1988) to assess the emotional state of the expeditioners on a daily basis. The PANAS comprises two 10-item subscales to assess Positive Affect (PA: e.g., enthusiastic, inspired) and Negative Affect (NA: e.g., distressed, hostile). At the end of each day, each participant indicated the emotions they felt during that day using a 5-point Likert scale ranging from 1 (very slightly or not at all) to 5 (extremely). Subscale scores were computed by averaging responses to each of the PA and NA adjective items respectively. The PANAS has been well-used in extreme environment studies (Palinkas & Suedfeld, 2008; Smith et al., 2018).

2.2.3 | Team cohesion

We used four items from the Group Environment Scale (GES; Carron et al., 1985) to assess task and social cohesion. There were two items focused on task cohesion (e.g., "as a team we are working towards the same goals") and two items to assess social cohesion (e.g., "I have friends on this team"). We selected items from the GES based on their relevance to the present context and subscale factor loadings that have been reported in previous studies (Eys et al., 2008; Whitton & Fletcher, 2014). To measure cohesion, participants responded to a 9-point Likert scale ranging from 1 (strongly disagree) to 9 (strongly agree). Subscale scores were computed by averaging responses to each of the two task cohesion and social cohesion items respectively.

2.2.4 | Performance

Participants rated their daily performance using a single-item indicator. Participants rated their daily performance on a 7-point Likert scale from 1 (very bad) to 7 (very good). A similar measure has been used in other studies in isolated, confined, and extreme environments (Goemaere et al., 2019).

2.2.5 | Sleep

Sleep quality was rated using a single-item indicator. At the start of the day, participants rated their previous night's sleep quality on a 7-point Likert scale from 1 (very bad) to 7 (very good). A similar measure has been used in other expedition studies (Anton-Solanas et al., 2016).

2.2.6 | Demand prediction and coping

We evaluated participants' demand and coping resources using the cognitive appraisal ratio (Tomaka et al., 1993). The scale included two self-report items: an evaluation of expected demands (e.g., "how demanding do you expect the rest of the expedition to be?") and an evaluation of expectations about coping resources (e.g., "how able are you to cope with the demands?"). The participants gave their responses using a 6-point Likert scale ranging from 1 (not at all) to 6 (extremely). This scale has previously been used to evaluate performance in demanding settings (Moore et al., 2012).

2.2.7 | Daily events and coping strategies

Participants recorded daily events and coping strategies using checklists in which they ticked the corresponding box to highlight the appropriate item. These were coded as 0 (did not occur/did not use) and 1 (did occur/did use). The daily events checklist was adapted from one developed by military personnel based on Army training strategies (Ben-Porath et al., 1991) and has since been used in numerous Polar expedition studies (Atlis et al., 2004; Blackadder-Weinstein et al., 2019; Leon, Sandal, Fink, et al., 2011; Smith et al., 2021).

2.3 | Procedure

Consent to take part in the research was confirmed by expedition team members completing and returning a pre-expedition demographic survey. After receiving a completed pre-expedition survey, a copy of the rating form described in the prior section was sent to participants by post. An example of how to complete the rating form was included in the mail. Daily rating forms were printed on double-sided A4 paper, with each side encompassing one daily data log. During the expeditions, participants spent approximately 5 minutes at the start of the day and 5 minutes at the end of the day completing the relevant section of the rating form. Overall, the daily response rate from participants during the expeditions was 93% (missing days = 10). The most days of reporting missed by a single participant across the expedition period was 4 (21% of their total potential reports).

2.4 | Data analysis

After creating subscale scores, descriptive data for continuous variables was produced and presented in a table as averages split according to team and individual team member. For checklist reports (i.e., events and coping strategies) frequency scores were also computed and presented in a table. Resilient function marker variables (i.e., physical health, affect, cohesion and performance) were plotted on a series of line charts. Charts were stratified by team with individual-level data for each team member reported on separate lines. A mean trendline within teams for each of the variables was also added to the line charts. Data was analysed using visual inspection techniques applied in single subject design studies (McDonald et al., 2020).

To examine relationships between marker variables and potential influencing factors, a series of nested mixed effects models were computed. When more than 5% of the data can be attributed to nesting of responses within individuals, a mixed modelling approach is appropriate (Hox, 2010). To test the network hypothesis proposed by Kalisch et al. (2019), we iteratively added each of the resilient functioning marker variables as an outcome into an empty (null) model. We used the empty model to partition the nested variance. This step confirmed that more than 5% of variance in resilient function outcomes was nested within individuals. After building the empty model, we iteratively added other marker variables as predictors, thus building up a network of functioning. The same process was followed to examine the impact of situational-contextual factors (sleep quality (morning), physical health (morning), demand prediction, and coping resources upon the physical and psychosocial markers of resilient functioning selected in the present work.

The data that support the findings of this study are available on request from the corresponding author, NS. The data are not publicly available due to the small participant sample and the inclusion of information that may compromise the privacy of research participants.

3 | RESULTS

Mean and range scores for all study variables are presented in Table 1. Expeditioners rated their physical health, both in the morning and evening, as good throughout the expeditions. There was little change in morning-to-evening ratings of physical health (M = 5.44 vs. M = 5.46; scale 1–7). Expeditioners also typically evaluated their performance as good (M = 5.63; scale 1–7). Participants rated their PA scores as moderate, while they scored NA as low (M = 3.30 vs. M = 1.44; scale 1–5) across expedition periods. In general, expeditioners rated their task and social cohesion highly (M Task = 8.49; M Social = 8.68; scale 1–9). They reported moderate-to-good quality sleep during the expeditions (M = 4.99; scale 1–7). Overall, participants evaluated their journeys as demanding (M = 4.58; scale 1–6).

TABLE 1 Descriptive statistics for all study variables.

Team	Team a				Team b				Team c						
Participant	1		2		3		4		5		6		7		
Variable	M	R	M	R	M	R	M	R	M	R	M	R	M	R	Overall mean
Physical health (E)	4.44	3.00	5.67	2.00	4.74	2.00	4.67	4.00	6.59	4.00	6.31	1.00	6.39	2.00	5.46
Positive affect	2.81	2.20	3.21	2.30	3.61	2.80	2.76	1.90	4.26	0.80	3.99	1.60	2.83	3.30	3.30
Negative affect	1.27	0.50	1.65	2.00	1.74	2.20	1.57	2.00	1.20	0.90	1.39	1.20	1.20	1.40	1.44
Task cohesion	8.72	1.00	7.92	2.50	9.00	0.00	7.93	1.50	8.97	0.50	7.77	1.00	9.00	0.00	8.49
Social cohesion	8.96	0.50	8.04	2.00	9.00	0.00	8.73	1.00	9.00	0.00	7.96	2.00	9.00	0.00	8.68
Performance	4.74	3.00	5.74	3.00	5.05	5.00	5.07	4.00	6.94	1.00	6.23	3.00	6.22	3.00	5.63
Sleep quality	4.30	4.00	5.19	3.00	3.53	4.00	4.53	5.00	5.59	4.00	6.14	3.00	6.24	3.00	4.99
Physical health (M)	4.44	3.00	5.41	3.00	4.74	2.00	4.93	4.00	6.35	4.00	6.57	1.00	6.47	2.00	5.44
Demand prediction	4.26	3.00	4.30	4.00	5.32	2.00	4.73	2.00	4.29	5.00	4.46	4.00	4.94	3.00	4.58
Coping resources	4.48	2.00	4.85	4.00	5.47	1.00	5.00	2.00	5.65	1.00	5.08	1.00	5.53	1.00	5.09

Abbreviations: (E), evening; (M), morning; *M*, Mean; *R*, Range.

Participants' checklist responses suggest that the most encountered demands were worries about upcoming weather, bad current weather conditions, and problems with their equipment (see Supplementary Table S1). Despite encountering difficulties, all expeditioners' ratings of having resources to cope with demands exceeded their ratings of the demands themselves ($M = 5.09$; scale 1–6). Participants regularly documented positive experiences during the expedition. Ratings suggest that making progress, enjoying the environment, and feeling able to cope were regularly experienced (see Supplementary Table S1). Responses to the coping strategy checklist suggest that expeditioners most used humour, keeping the goal in sight, and trying to have pleasant thoughts (thinking about good things to come) to deal with demands. Expeditioners often reported using more than one coping method on any given day and across expeditions relied on a relatively wide repertoire of coping methods, indicated by the total number of discrete techniques used across expedition periods (see Supplementary Table S2).

The range of scores reported in Table 1 suggests variability in several aspects of expeditioner experiences across the expedition periods, particularly scores for physical health, PA, performance, sleep quality, demands, and coping resources. Expeditioners' scores for NA, task cohesion, and social cohesion had a smaller range of scores. Day-to-day temporal changes in markers of resilient psychosocial function (physical health, affect, cohesion, and performance) for individuals within each of the teams are presented in Figures 1–3. Notably, these results reveal considerable variation in both individuals' and teams' day-to-day reports of psychosocial function on the different expeditions. A closer examination of individual and team-averaged profiles suggests a rebound patterning response, where decreases in the measured psychosocial variables tended to be quickly followed by a return to or above preceding levels.

Beta coefficients, confidence intervals and significance indicators from multi-level analyses examining relationships between the different physical and psychosocial markers of resilient function are reported in Table 2. Much of the variance in the specified dependent variables was nested at the individual level. When entering predictor (independent) variables, all the models demonstrated an improvement in model fit, as evidenced by changes in the -2Log score. Evening ratings of physical health were positively associated with PA scores. In turn, PA scores were associated positively with task cohesion, social cohesion, and performance. Conversely, NA was negatively associated with task cohesion, social cohesion, and performance. Neither task nor social cohesion was associated with individual ratings of performance.

Findings (beta coefficients, confidence intervals and significance indicators) from the multi-level analysis examining relationships between situational antecedent factors and physical and psychosocial markers of resilient function are reported in Table 3. Similar to the prior analysis, much of the variance in scores was at the individual level, and all models were significantly improved when adding predictor variables. After accounting for data nesting, individuals that reported higher sleep quality in their morning assessment were associated with lower NA scores in their evening assessment. Individual ratings of demand predictions were positively associated with both PA and NA. Ratings for coping resources were inversely associated with NA and positively associated with both task and social cohesion. There was a notable positive association between coping resources and evening ratings of physical health, though the confidence interval included 0. Physical health in the morning was positively associated with physical health in the evening and both positive and NA. There was a positive relationship between physical health in the morning and social cohesion rated in the evening, though again, the confidence interval included 0.

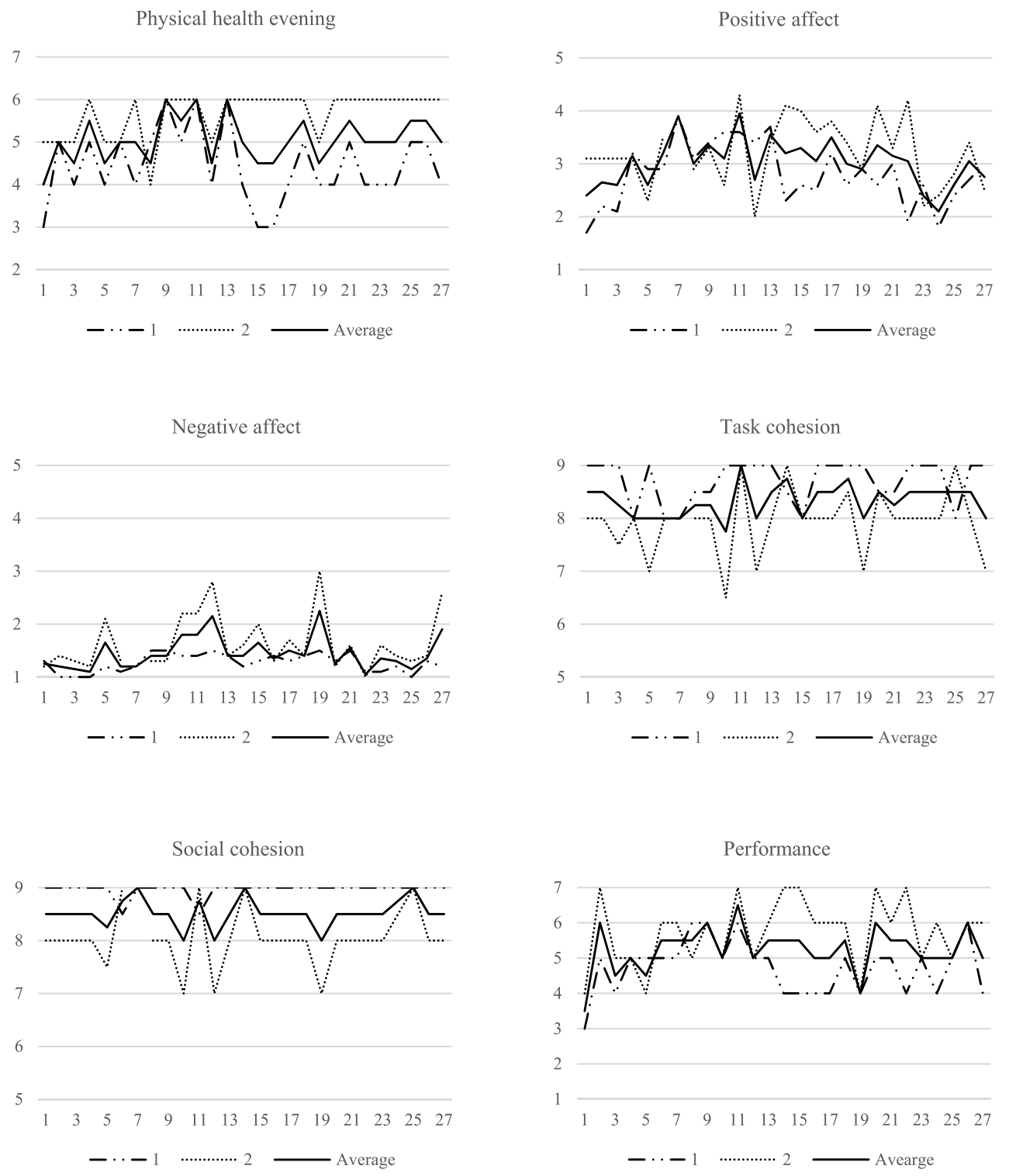

FIGURE 1 Daily changes in markers of psychosocial function for team a (individuals 1 and 2).

4 | DISCUSSION

This study examined resilient psychosocial function in three ski expeditions in the High Arctic. In general, and consistent with prior research in expedition settings, the expeditioners in our study reported that they had a largely positive experience (Nicolas, et al., 2022; Nicoll, et al., 2023). Crucially, however, our results show significant intra-individual and intra-team variations in markers of physical and psychosocial function (i.e., physical health, affect, cohesion and performance) across the sampling period for all teams; and

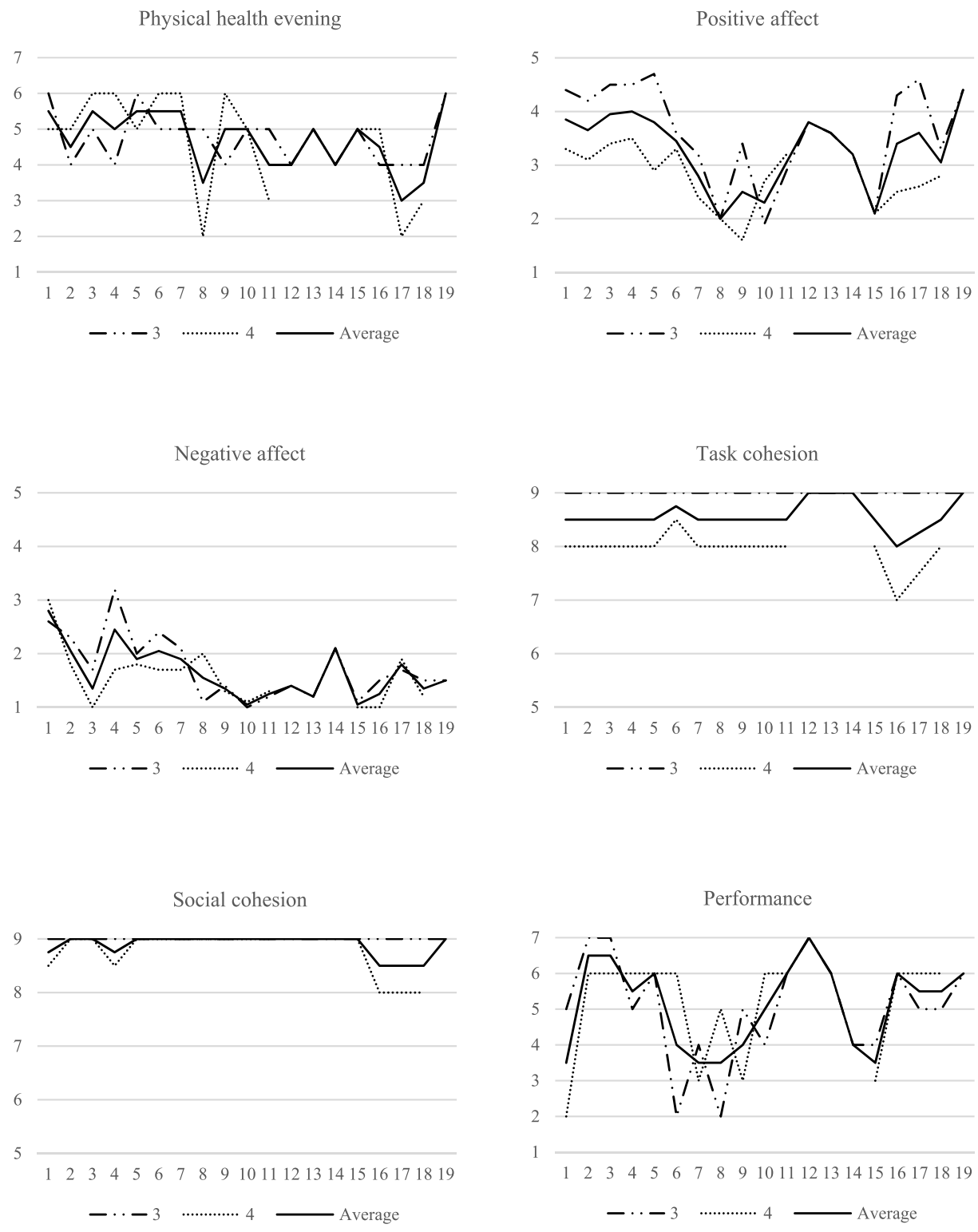

FIGURE 2 Daily changes in markers of psychosocial function for team b (individuals 3 and 4).

these variations were related to outcomes. In addition, notable relationships between markers of resilient functioning and key antecedent situational factors were observed. Our findings offer unique prospective insight into temporal dynamics of resilient functioning. We assessed resilient function *in situ*, identifying factors that might shape the responses of individuals and teams operating under conditions of combined acute and chronic demand. Overall, results underscore the importance of considering the specific situational

FIGURE 3 Daily changes in markers of psychosocial function for team c (individuals 5, 6 and 7).

experiences that shape the resilient responses of individuals and teams in extreme settings.

Given the many studies attesting to the salutary aspects of Polar expeditions, it is not surprising that the expeditioners participating in our study reported similarly positive experiences (Leon, Sandal, & Larsen, 2011). Our findings also demonstrate significant day-to-day variation across several physical, psychological, and social challenges commonly encountered by individuals and teams in expedition

TABLE 2 Multi-level models testing relationship between markers of resilient psychosocial function.

	Positive affect	Negative affect	Task cohesion	Social cohesion	Performance
Physical health (evening)	0.16 (0.03/.28)*	−0.03 (−0.11/.05)	0.02 (−0.05/.10)	0.02 (−0.04/.09)	0.10 (−0.08/.27)
Positive affect	-	-	0.14 (0.04/.24)**	0.10 (0.01/.18)*	0.84 (0.61/1.08)**
Negative affect	-	-	−0.20 (−0.35/−0.05)*	−0.21 (−0.34/−0.08)**	−0.58 (−0.95/−0.21)**
Task cohesion	-	-	-	-	0.07 (−0.43/.58)
Social cohesion	-	-	-	-	−0.22 (−0.81/.38)
Nested variance	48%	21%	70%	68%	38%

Note: +$p < 0.10$; *$p < 0.05$; **$p < 0.01$; values in parentheses 95% confidence intervals (Lower bound/Upper bound).

TABLE 3 Multi-level models with proposed antecedents predicting outcomes related to resilient psychosocial function.

	Physical health (evening)	Positive affect	Negative affect	Task cohesion	Social cohesion	Performance
Sleep quality (morning)	−0.01 (−0.15/.14)	−0.05 (−0.16/.06)	−0.09 (−0.16/−0.02)*	0.06 (−0.01/.12)	−0.04 (−0.09/.02)	0.04 (−0.14/.22)
Physical health (morning)	0.36 (0.17/.55)**	0.17 (0.02/.31)*	0.13 (0.04/.22)**	−0.01 (−0.10/.07)	0.07 (−0.00/.14)+	0.16 (−0.08/.39)
Demand prediction	−0.07 (−0.20/.07)	0.15 (0.04/.25)**	0.07 (0.01/.14)*	0.02 (−0.04/.08)	−0.00 (−0.05/.05)	0.01 (−0.17/.18)
Coping resources	0.19 (−0.05/.42)	0.09 (−0.09/.27)	−0.15 (−0.26/−0.04)*	0.16 (0.06/.27)**	0.15 (0.06/.24)**	0.17 (−0.12/.47)
Nested variance	54%	48%	21%	70%	68%	38%

Note: +$p < 0.10$; *$p < 0.05$; **$p < 0.01$; values in parentheses 95% confidence intervals (Lower bound/Upper bound).

settings. In particular, our findings reveal evidence supporting both maintenance and rebound response patterns. This indicates either a stable functioning or a swift return to or above previous levels following observed declines in function. For example, when an individual experienced a decrease in PA or an increase in NA on a particular day, their scores promptly returned to at least a baseline level (inferred from their reported levels at the beginning of the expedition) in the following days. These results align with recent theories on the nature of resilient function (Kalisch et al., 2017, 2019) and empirical studies (Gucciardi et al., 2021), providing a unique naturalistic, field-based examination of resilient function dynamics under conditions of extreme stress.

The significant variation observed in the affective experiences of expeditioners is particularly interesting when considered in light of much of the prior work on Polar expeditions. In the existing literature, PA and NA are regularly used to assess an individual's emotional response to extreme environments (Leon, Sandal, & Larsen, 2011; Palinkas & Suedfeld, 2008). Our findings are consistent with this work, showing that PA tends to be scored higher and NA lower across expedition periods (Leon, Sandal, & Larsen, 2011). However, our results also suggest that there is much more daily variability in an individual's reporting of PA than prior work might imply and what prior research designs could capture, while NA tended to remain low and stable. In a high-performance environment, like a Polar ski expedition, there are potentially greater costs to negatively valanced emotions than there are equivalent positive benefits to positively valanced emotions. In general, negative emotions are stronger and more important than positive emotions and have greater impact on cognitive processing and behaviour (Baumeister et al., 2001). As such, it would make sense that expeditioners try to minimise and keep negative emotions stable when it is possible to do so. Our results show that even minor and infrequent increases in negative emotions were significantly associated with other variables in the network, and likely exert an effect on behaviour and performance that is disproportionate to the more frequent changes in positive emotions (Wagstaff & Weston, 2014). The coping and emotion regulation strategies used by expeditioners in this study lend support for this interpretation (see Supplementary Table S2). Individuals tended to focus on both minimising and keeping NA at bay while also maximising positive emotional experiences.

Kalisch et al. (2019) theorise that resilient function is networked (i.e., it includes physical, emotional, social, and cognitive nodes), and node areas interact dynamically to determine the impact of stressful demands upon a person's health and performance. In the present work, physical health, affect, cohesion and performance were selected to represent nodes within a resilient function network. Present results suggest that affective experiences play a central role in the network, influencing other variables. However, in contrast to Kalisch and colleagues' interactive network hypothesis, we found no significant relationships between reports of physical health, cohesion, and performance. It is plausible that affect may occupy a connecting role within this type of resilient function network and mediate variables that are more distal from one another. For instance, physical health might only impact cohesion through how it shapes one's affect. This would be somewhat consistent with broaden-and-build theories that have shown the wide-ranging resilience-enhancing effects of stimulating positive emotions (Fredrickson, 2001). That said, considering prior evidence, for example, meta-analytic studies that

have shown a cohesion-performance link (Carron et al., 2002) we would have expected relationships between other nodes within the resilient function network (e.g., relations between physical health and performance and cohesion and performance). An alternative or at least supplementary explanation for our findings is that these relationships might be time lagged (impact is delayed), operate across multiple-levels (individual or team) and/or are moderated by other factors. Our findings emphasise the complexity of studying issues of individual and team resilience (Hartwig et al., 2020). The issue of how nodes within a resilient function network interact during and following demanding periods requires more attention, especially if the idea of a resilient function network is to be accepted as a foundational theoretical construct.

In addition to understanding the dynamics in markers of resilient function, we were also interested in situational resilience factors that might influence those variations. Physical health assessed in the morning were positively associated with assessments of physical health in the evening—and, interestingly, both positive and NA. Although the relationship with NA may be surprising, this finding makes sense in the context of physical endurance events such as a Polar ski expedition. Individuals who perceive themselves as having higher levels of physical fitness at the start of the day may work harder, ultimately leaving that individual more depleted at the end of the day (Smith et al., 2021). Morning assessments of sleep quality of the previous night was associated with lower NA at the end of the day, indicating a potential protective function. These findings are consistent with the overwhelming body of literature that demonstrates the beneficial effects of sleep (Gucciardi et al., 2021; Pilcher & Huffcutt, 1996).

Consistent with the extreme setting, all expeditioners reported the experience as demanding, but also reported they had the resources to cope with those demands. Across the expedition period, individual coping resources consistently exceeded demand scores. This interaction between resources and demands would suggest that individuals viewed the expedition as a challenge rather than a threat. This interpretation aligns with the daily event logs in which individuals consistently reported that they were able to cope with demands. Empirical work has previously linked challenge appraisals and perceptions of control to adaptive stress responses (Carenzo et al., 2020; Fletcher & Sarkar, 2012; Tomaka et al., 1993) and may explain the resilient function profiles observed in the present work. Interestingly, perceived daily demands were positively associated with both PA and NA. The link to PA may be explained similarly to the surprising association between fitness and NA. Given the expeditioners chose to go to these Polar environments, the opportunity to be exposed to demands was likely exciting and viewed as a challenging opportunity rather than a threat (Meijen et al., 2020). It may be that only extremely high levels of demand (not experienced in the present work) will generate adverse responses in populations, like expeditioners, that choose to enter and perform in extremes.

As expected, and in line with major stress-coping theories, coping resources had a buffering effect and were associated with lower NA scores and closely related to both task and social cohesion. Social demands in extreme environments have regularly been documented as some of the most challenging aspects of an expedition (Wagstaff & Weston, 2014). In particular, coping resources that enable expeditioners to manage social dynamics such that they can avoid and resolve conflict and maintain cohesion, would be expected to play a crucial role in the resilient function of individuals and teams in these settings (Corneliussen et al., 2017). This view is consistent with the findings of several prior Polar expedition studies (Smith et al., 2017).

4.1 | Limitations

As with any study, there are limitations to this work. First is the small sample size, a common and difficult problem to overcome when collecting data from individuals engaged in unusual activities. Unlike earlier studies, though, we have combined data from multiple expedition teams undertaking similar journeys. While this still resulted in a limited sample size at level 2 (7), the high data density at level 1 (171 daily reports) did allow us to apply statistical techniques to test the associations between measured variables. While offering novel insights, results should be considered in context. At this point, it would be premature to generalise to other populations, especially those that have not chosen to expose themselves to extremely stressful environments.

A second limitation is related to the methodological approach. We relied on self-reported data collected from individuals. Although we observed variability in participants' responses, which seemed meaningful based on the associations found, there is always the chance that results might be affected by presentation bias. Indeed, this may have accounted for the overall positive impression of the expedition experiences. Further, several of the scales used to capture psychosocial content were single item indicators. Clearly, there is a trade-off between using extensive psychometric questionnaires and ensuring participant compliance. Our approach was, where possible, to draw upon measures that had been used previously and shown good predictive properties but required limited time of the expeditioners. This resulted in excellent compliance. However, we appreciate that in some circumstances the data might be limited. For example, a single item performance measure does not provide discrete information on relevant sub-components of performance (e.g., errors, decision making, goal achievement).

4.2 | Future directions

Extreme environments, such as Polar settings with their combination of acute and chronic demand, provide valuable naturalistic contexts to study and understand issues related to resilient function. Building on the present research, additional studies capturing day-to-day variation in demands and responses could shed further light on what resilient functioning looks like in stressful environments and how and why some individuals and teams breakdown while others are able to rally and rebound. Of particular interest in this regard

would be a closer examination of self-regulation processes (what individuals do to manage themselves and their team), perhaps through qualitative approaches in expedition (e.g., diaries), through post-expedition interviews, and/or other biopsychosocial factors (e.g., physiological biomarkers) that might influence outcomes indicative of resilient functioning. Applying innovative analytical techniques, such as dynamic and lagged modelling, to intensive data collected from expedition samples would help unpack some of the idiosyncrasies of resilient function and provide insight into both the concurrent and delayed effects of certain experiences. Understanding these dynamics is particularly important if resilience is treated as an emergent phenomenon (Gucciardi et al., 2021).

5 | CONCLUSION

The present work offers a unique, prospective, empirical contribution to the literature on resilience by exploring the dynamic profile of markers of resilient function and factors that shape that function in extremely demanding Polar environments. Findings emphasise potentially important contributors to operating effectively under stress, how variability in different markers might be used to understand resilient functioning and reinforce why adopting individualised methods to study resilience is likely to be necessary. In combination with other related research, the present findings can be used to inform the study, assessment, and enhancement of resilient function, both in and beyond environmental extremes.

CONFLICT OF INTEREST STATEMENT

The authors report there are no competing interests to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to the small participant sample and the inclusion of information that compromise the privacy of research participants.

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ENDNOTE

[1] This work was conducted as part of the fulfilment of a Masters of Research degree being undertaken by one of the study authors. As such, there was a finite period for recruitment.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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