



# Monitoring daily events, coping strategies, and emotion during a desert expedition in the Middle East

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1 **Monitoring daily events, coping strategies and emotion during a desert expedition in the Middle**  
2 **East**

3 **Abstract**

4 Personnel operating in extreme environmental conditions are exposed to a variety of stressors.  
5 Whether a person adjusts to the conditions and is able to cope has implications for their psychological  
6 health. In previous extreme environment work, temporal changes in stress, coping and emotion have  
7 been reported. Building on previous studies, we used a diary methodology to explore temporal  
8 changes in and associations between daily events, coping strategies and affect during a unique hyper-  
9 arid desert expedition. Four participants undertaking a crossing of the Empty Quarter desert were  
10 recruited to the study. Participants completed pre-, post- and 4-month follow-up questionnaires. A  
11 daily self-report diary was used to collect situational data. Time-based changes were analysed before  
12 testing predictive models linking events and coping strategies with affective responses. Findings  
13 suggest that participants had an overall positive experience. There were changes in both the events  
14 experienced and coping strategies used during the expedition. Variation in events and coping  
15 strategies significantly predicted fluctuations in positive and negative affect. Results offer valuable  
16 mechanistic information that could inform monitoring systems aimed at tracking psychological  
17 variables during operations in extreme environments. Results are discussed in relation to the novel  
18 context, diary methodology, and implications for those operating in extremes.

19 ***Keywords***

20 Desert Expedition; Diary Study; Stress; Coping; Emotion; Extreme Environment

21

**Introduction**

22           Individuals and groups operating in extreme environmental conditions can be exposed to a  
23 variety of stressors. Traditionally, extreme environments were defined as “settings that possess  
24 extraordinary physical, psychological, and interpersonal demands that require significant human  
25 adaptation for survival and performance” (Manzey & Lorenz, 1998). There are a variety of  
26 professions and activities that require individuals and groups to expose themselves to such extreme  
27 conditions; including Antarctic scientists (Palinkas & Houseal, 2000), submarine operators (Sandal,  
28 Endresen, Vaernes, & Ursin, 1999), astronauts (Kanas et al., 2007), military and defence personnel  
29 (Miller, 2006; Vos, Parmak & Kral, 2012), humanitarian aid workers (Connorton, Perry, Hemenway,  
30 & Miller, 2012), and expeditioners (Atlis, Leon, Sandal, & Infante, 2004; Leon, Sandal., & Ciofani,  
31 2011a), amongst others. Despite the longstanding history of studying people in extreme locale, there  
32 remains a relative dearth of information regarding the situational experience and individual-  
33 functioning of people in these challenging settings, as well as the specific methods used to counteract  
34 and manage stress (Smith, Kinnafick & Saunders, 2017). This is surprising, especially given the  
35 acknowledgement that what happens at the situational level is likely to be a more proximal  
36 determinant of psychological health than more distal pre-screening or baseline assessments of  
37 individual differences, such as personality (Palinkas & Suedfeld, 2008).

38           Within the present study, we aimed to address a number of limitations associated with  
39 previous extreme environment work by monitoring the day-to-day experience of a small  
40 interdependent expedition group. Specifically, we examined the events experienced, coping strategies  
41 used, and emotional response of individuals completing a crossing of the Empty Quarter desert. In  
42 contrast to previous studies focused on the Polar Regions (Leon, Sandal & Larsen, 2011b), the present  
43 research centred on a team completing a physical and scientific expedition in the Middle East, starting  
44 in Salalah (Oman) and finishing in Doha (Qatar). Specific to this expedition, we anticipated that key  
45 situational stressors would include interpersonal demands associated with being with the same group  
46 for a prolonged period of time, challenges related to travelling through a monotonous environment,  
47 extreme fluctuations in temperature, the role split between the lead and support group, and potential

48 issues due to maintaining equipment in the desert environment. As we were interested in examining  
49 the temporal changes during the expedition, the transition in and out of the expedition period was also  
50 pertinent to the current work. To our knowledge, this is the first psychological study on a group  
51 operating in a hyper-arid desert environment. We believe findings will contribute to theoretical and  
52 applied understanding of how to maintain psychological health throughout endeavours in similarly  
53 demanding environmental conditions.

### 54 **Psychological functioning in extreme environments**

55         A commonly studied indicator of health in extreme settings is an individual's affect, which  
56 represents their emotions, feelings and mood. In previous expedition studies, weekly and monthly  
57 reports of positive affect were found to be rated as considerably higher than corresponding reports of  
58 negative affect (Leon et al., 2011b). This finding is consistent with a salutogenic reaction  
59 (Antonovsky, 1979) suggesting that for some individuals, stressful environmental conditions may be  
60 promotive of health and manifest in positive psychological responses including a sense of enjoyment,  
61 satisfaction, and perceptions of personal growth (Palinkas & Suedfeld, 2008; Suedfeld, 2001).  
62 Although positive expedition accounts tend to be more frequently endorsed (Wood, Hysong, Lugg, &  
63 Harm, 2000), and take precedence over more negative experiences (Kjaergaard, Leon, & Fink., 2015;  
64 Leon et al., 2011a), a diverse range of negative emotions, and associated events, have been linked to  
65 reductions in team cohesion, well-being, and performance in extremes and therefore remain worthy of  
66 investigation (Wagstaff & Weston, 2014). Additionally, a body of evidence suggests there are likely  
67 to be time-based changes in psychological functioning when individuals are exposed to extreme  
68 settings (Nicolas, Sandal, Weiss, & Yusupova, 2013; Sandal, Leon, & Palinkas., 2006).

69         Whilst remaining a controversial issue, findings from several extreme environment studies  
70 support the existence of a third-quarter effect. The third-quarter model posits that emotional and  
71 psychological difficulties should be expected beyond the midpoint and into the third phase of an  
72 expedition (Bechtel & Berning, 1991). For example, a study on Antarctic over-winterers  
73 demonstrated increased work-related and interpersonal stress during the third quarter of their

74 expedition endeavours (Sandal, 2000). Similar findings were observed by Kahn and Leon (2000) who  
75 noted an increase in physical and interpersonal stress towards the mid and latter-parts of a 67-day  
76 Antarctic expedition. Additional studies on groups operating in analogous environments have  
77 highlighted the potential for irritability, tension and reduction in mood, well-being, and motivation to  
78 occur during later phases of the mission (e.g., Steel, 2001; Sandal, Bye, & van de Vijver, 2011).  
79 Together, these findings point towards a reduction in stress-resilience and increased likelihood of  
80 difficulties occurring during mid-to-latter stages of expedition activities. Whilst findings from prior  
81 research suggest that groups operating in extreme settings may be vulnerable to psychological  
82 disruption, certain studies offer a contrasting view and negate the suggestion of a decline in  
83 functioning in challenging environments (c.f. Ritsher, Kanas, Ihle, & Saylor, 2007). Given the  
84 equivocal nature of the findings to date, further research is needed to elucidate when challenging  
85 events may occur, and the subsequent changes (in the present case, changes in affect) that individuals  
86 experience when completing activities in extreme environments. In order to better represent patterns  
87 of functioning, and understand the situational experience, assessments should be secured at more  
88 regular intervals (i.e., daily as opposed to weekly or monthly). Ultimately, findings from this more  
89 intensive sampling process could inform the precise allocation of resources (e.g., when support from  
90 ground/mission control is needed) and how to effectively prepare people for changes that might occur  
91 prior to them entering extreme settings.

### 92 **Coping strategies in extreme environments**

93 The extent to which a person retains a sense of control and reports a positive experience in  
94 extreme environmental situations is linked to their ability to cope (Sandal et al., 2006). Coping has  
95 been defined in a variety of ways, but essentially refers to the capacity for a person to withstand and  
96 counteract physiological and psychological stress (Suedfeld, Brcic, & Legkaia, 2009). In the current  
97 study, we focus on the specific approaches individuals use to manage stress also known as coping  
98 strategies. Our conceptualisations are based on broad problem- and emotion-focused coping  
99 techniques, consistent with the definitions put forth by Lazarus and Folkman (1984). Problem-focused  
100 coping efforts (e.g., problem-solving) are aimed at managing the environment in order to minimize

101 the impact of stress. Emotion-oriented approaches aim to make the environment more tolerable by  
102 managing one's emotional reaction to it, perhaps by using distraction or reframing the situation.

103 Past research on the coping strategies used by personnel in extreme settings has included  
104 studying polar expedition teams (Leon et al., 2011b), submarine personnel (Sandal et al., 1999),  
105 astronauts (Suedfeld et al., 2009), and military recruits (Sandal et al., 1998; Vickers, Ross, Kolar &  
106 Hervig, 1989), amongst others. In prior studies, researchers have found that individuals report a  
107 tendency to use a combination of emotion-focused and problem-focused techniques, with few  
108 depressive reactions and avoidance methods (Atlis et al., 2004; Leon et al., 2011a). Two broad  
109 patterns of findings have been reported in relation to coping strategies in extreme environments.  
110 Results from a collection of studies suggest an increase in the use of coping strategies when operating  
111 under extreme conditions, indicating that more resources have been activated to deal with the situation  
112 (Kahn & Leon, 2000; Sandal et al., 1998). In contrast, other researchers have reported a decrease in  
113 coping strategy use that corresponds with a reduction in mood and could be representative of an  
114 apathetic state (Sandal, van der Vijver, Smith, & Pallesen, 2016). At present, changes in coping  
115 strategy use and the clustering of coping approaches in extreme settings remains poorly understood.  
116 Moreover, although coping strategies have often been assessed during extreme environment activities,  
117 assessments have tended to reflect weekly or monthly timeframes. As such, we still have relatively  
118 limited information on the daily methods that individuals use to regulate their experience.

119 Only a handful of extreme environment studies have directly examined how coping strategies  
120 impact upon other indicators of the psychological experience at the situational level (c.f., Kahn &  
121 Leon, 2000; Nicolas et al., 2013; Wagstaff & Weston, 2014). The lack of research on the day-to-day  
122 experience of individuals functioning in challenging environments may be in part due to limitations in  
123 current measurement approaches and particularly the reliance on overly burdensome self-report  
124 questionnaires. Developing systems that allow us to validly and reliably monitor the psychological  
125 experience of individuals and groups operating in challenging environments (such as those in the  
126 polar regions, on military deployments, and in space) is critical if we are to effectively track, support,  
127 and maintain crew performance and health. In order for monitoring systems to be effective, they must

128 be sensitive to changes in the psychological experience, explain variability in outcome measures, and  
129 not be overly burdensome for individuals to complete. In the present work, we build on the efforts of  
130 other researchers (Kjaergaard et al., 2013; Leon et al., 2011a; Wagstaff & Weston, 2014) to test a  
131 brief and easy-to-complete daily diary that allows individuals to capture key daily events, coping  
132 strategy use, and their affective experience whilst living and working in an extreme setting.

### 133 **The present study**

134         The first aim of the study was to examine the personal characteristics of the expedition team  
135 members, including typical approaches used to manage stress. Scores from baseline were contrasted  
136 with 1-month and 4-month follow-up assessments. It was anticipated that expedition team members  
137 would report a tendency to use problem-focused and emotion-focused strategies and utilise less  
138 depressive or avoidance approaches. Secondly, we used a short daily diary to examine temporal  
139 changes in the events experienced, coping strategies used, and affective responses of team members  
140 participating in this unique desert expedition. The daily diary included items that reflected coping  
141 strategies and affective states examined in the pre-expedition and follow-up surveys. However, this  
142 was condensed to a short form that was quick to complete. We did not hypothesise a specific pattern  
143 of temporal changes, however were interested in the expedition entry and exit periods (weeks 1 and 7)  
144 and the mid-point (weeks 3 and 4) of the crossing. Thirdly, we tested the predictive utility of the daily  
145 diary by assessing the relationship between daily events and coping strategies with positive and  
146 negative affect.

## 147 **Method**

### 148 **Expedition context**

149         Four male participants were recruited to the present study (ages = 67 years; 26 years; 54  
150 years; 32 years). Two of the team members came from the United Kingdom, one from Oman, and one  
151 from New Zealand. The expedition team departed from Oman (Salalah) on the 10<sup>th</sup> of December and  
152 arrived in Qatar (Doha) on the 26<sup>th</sup> of January 2016 (48 days) covering over 1300km and in the  
153 process crossing the Empty Quarter desert, the largest sand desert in the world. There were scientific,

154 physical and educational aims for the expedition. During the crossing, the group photographed and  
155 collected archaeological artefacts as part of a project on the history of Arabia. Physically, the team  
156 were attempting to retrace the first documented crossing of the Empty Quarter completed by Bertram  
157 Thomas in 1930. Finally, the crew also uploaded regular blog posts and interacted with the public via  
158 social media in order to educate and inspire people about the Empty Quarter and desert landscape.

159           During the expedition, two of the team completed the challenge on foot with the support of  
160 camels, which were used to carry their water and supplies. The team who were on foot, aimed to  
161 retrace the steps taken by British explorer Bertram Thomas and relied on historic text and maps to  
162 plan their route. One of the on-foot team was very experienced and had completed over twenty  
163 expeditions in extreme settings, including operating in polar, desert and mountain environments. The  
164 other team member was relatively less experienced and had completed only one prior expedition in a  
165 desert context. The support crew followed in 4x4 vehicles and were responsible for ensuring the  
166 safety of the on-foot team members, as well as coordinating social media activities and photography.  
167 Both support crew were experienced in operating in a variety of extreme and unusual environments,  
168 understood how to navigate vehicles through desert terrain, and had completed numerous expeditions  
169 in the past<sup>1</sup>. At the end of each day on the expedition, the team camped together and prepared for the  
170 following day's march. Although reserve water was carried in the vehicle, this was supplemented by  
171 natural wells in the desert and this partly dictated the route. During the expedition, the temperatures  
172 changed considerably and ranged from 9 degrees Celsius in the evening to 35 degrees Celsius in the  
173 daytime. The team had an on-call remote medical team who could provide support via telepresence in  
174 the case on an emergency. Towards the middle of the journey, the team were several hundred  
175 kilometres from the nearest medical facility and in the event of a medical situation evacuation would  
176 have been particularly challenging.

### 177 **Procedure**

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<sup>1</sup> We have purposely not reported specific differences between the expedition subgroups and not provided identifier codes in order to maintain anonymity for the participants.



178           After receiving ethical approval from the university of the lead author, participants were sent  
179 information of the study and asked to sign a consent form. Following informed consent, participants  
180 completed a pre-expedition questionnaire. Whilst on the expedition, a daily-rating form (a short,  
181 structured diary questionnaire) was completed by the team members at the end of each day. Upon  
182 completion of the expedition, the participants completed a follow-up questionnaire at 1-month and 4-  
183 months after finishing the journey. The first language of one of the team-members was Arabic. As  
184 such, all of the measures were translated into Gulf Arabic using standardised back-translation  
185 procedures. Although completing the pre-expedition survey in Arabic, the individual team-member  
186 completed the remaining survey materials (diary and follow-up) in English.

### 187 **Measures**

188 ***Coping.*** The Utrecht Coping List (UCL; Schreurs, Tellegen, Van der Willige & Brosshot, 1988) was  
189 used to assess typical ways of coping with problems. The UCL is a 47-item measure which consists of  
190 7 subscales tapping into different types of coping strategy. There are 7 items focused on Active  
191 Problem-Solving (e.g., *Making a direct intervention when problems occur*), 8 items on Palliative  
192 Reactions (e.g., *Trying to relax*), 8 items on Avoidance (e.g., *Giving-in in order to avoid difficult*  
193 *situations*), 6 on Seeking Social Support (e.g., *Sharing one's worries with someone*), 7 related to  
194 Depressive Reaction Patterns (e.g., *Isolating oneself totally from other people*), 3 linked to Disclosure  
195 of Emotions (e.g., *Showing one's annoyance*) and 5 associated with Comforting Cognitions (e.g.,  
196 *Telling oneself that things could be worth*). When responding to the questionnaire items individuals  
197 were asked to think about how they react when confronted with a problem. After reading each item,  
198 participants responded using a 4-point Likert scale ranging from 1 (seldom or never) to 4 (very often).  
199 There is good evidence for the validity and reliability of the UCL and it has been well-used in  
200 previous extreme environment research (Sandal et al. 1999, Leon et al., 2011a).

201 ***Positive and negative affect.*** To examine affect, the Positive and Negative Affect Schedule (PANAS;  
202 Watson, Clark & Tellegen, 1988) was used. The 20-item PANAS includes two 10-item subscales one  
203 tapping positive emotions (e.g., *interested, enthusiastic*) and the other tapping negative emotions (e.g.,

204 *upset, scared*). When completing the pre-expedition questionnaire, participants were provided with  
205 the stem, “During the past month I have felt...” and asked to respond using a 5-point Likert scale  
206 ranging from 1 (very slightly or not at all) to 5 (extremely). During the expedition at the end of each  
207 day participants responded to the PANAS using the stem “Today, I have felt...” using the same scale.  
208 The PANAS has been demonstrated as a valid and reliable measure of emotions in many studies  
209 (Crawford & Henry, 2004) and has been well used in extreme environment settings (Palinkas &  
210 Suedfeld, 2008).

211 **Depression.** The Centre for Epidemiologic Studies Depression Scale-Revised (CESD-R; Eaton et al.,  
212 2004) was used to assess mood prior to the expedition. The 20-item revised CESD-R provides a score  
213 for 9 different depression symptom groups (e.g., Concentrating – “*I had trouble keeping my mind on*  
214 *what I was doing*”; Sadness – “*I felt depressed*”). The overall CESD-R score is used as a clinical  
215 assessment and categorises depression according to varying degrees of severity. When completing the  
216 scale, participants responded to the stem “During the past month...” and based their answers on a 4-  
217 point Likert scale ranging from 1 (Rarely or none of the time – less than 1 day) to 4 (Most or all of the  
218 time – 5 – 7 days). Scores below 16 indicate no clinical significance. Values above 16 can be  
219 interpreted in a variety of ways depending on the combination of scores. The CESD-R has been  
220 demonstrated as a valid and reliable measurement instrument (Van Dam & Earleywine, 2011) and has  
221 previously been used to assess those undertaking long stays in extreme environmental conditions  
222 (Grant et al., 2007).

223 **Daily ratings form.** We used a modified version of the rating form employed by Leon and colleagues  
224 in previous expedition projects (Atlis et al., 2004; Leon et al., 2011). The daily rating form was  
225 refined and reformatted prior to being used in the present investigation. The form included items  
226 related to affect (PANAS discussed above), perceived stress (based on a Borg scale; Borg, 1981),  
227 daily events experienced, and coping strategies used (single items that align with subscales included  
228 in the UCL). Within the daily rating form, stress was reported using a 10-point scale ranging from 1  
229 (not at all) to 10 (very much so). Events experienced and coping strategies used were designated with

230 a yes/no response and coded as 0 (did not happen/did not use) and 1 (did happen/did use). The rating  
231 form took approximately 5 minutes to complete each day.

### 232 **Data analysis**

233         Given the small number of study participants, we adopted analytical approaches consistent n-  
234 of-1 clinical trials (Lille et al., 2011). Initially we computed descriptive statistics for all of the  
235 assessed variables. Changes in daily events and coping strategies were then examined according to  
236 weeks of the expedition. Mixed effects analyses of variance were computed including expedition  
237 week as the explanatory variable and the different events and coping strategies as outcomes. A  
238 Bonferroni correction was applied for post-hoc testing and more conservative p-value used to interpret  
239 findings ( $0.05/21 = 0.002$ ). For variables where significant weekly time-based changes were  
240 identified, these were plotted on a graph and individual differences represented. We also plotted  
241 weekly affect scores across the expedition period, including pre-expedition scores and 1-month and 4-  
242 month post follow-ups.

243         To address the second aim of the study and examine the link between events, coping  
244 strategies, and affect we again tested a series of multi-level models. A two-level fixed effects model  
245 was specified where responses (level 1) were nested within participants (level 2). This approach is  
246 appropriate when dealing with nested data and has demonstrated reliability with small sample sizes  
247 (Bell, Ferron, & Kromrey, 2008). When running the MLM models, initial empty models were  
248 computed in order to partition the variance linked to the nesting of responses within participants  
249 (Model 0). Predictor variables (events and coping strategies) were included in Model 1 to explain  
250 variability in the respective outcome variable (positive and negative affect).

### 251 **Results**

252         Prior to the expedition, participants reported a tendency to use active problem-solving  
253 approaches ( $M = 3.21$ ) and comforting cognitions ( $M = 2.85$ ) when dealing with challenging  
254 situations. Depressive reactions tended to be scored low ( $M = 1.57$ ). All team members reported  
255 moderate to high ratings for positive affect ( $M = 3.80$ ) and generally negative affect was reported to

256 be low ( $M = 1.10$ ). However, one individual (A) did report considerably higher pre-expedition  
257 negative affect scores than the other team members. On average, pre-expedition scores for depression  
258 were below the clinical threshold of 16 ( $M = 10.50$ ), but again the value for participant A was 19 and  
259 aligned with their negative affectivity. At 1-month post expedition, there was a reduction in all of the  
260 coping strategies assessed in the UCL, followed by a recovery back to pre-expedition levels at the 4-  
261 month follow up. Positive affect scores were consistent with pre-expedition values when assessed at  
262 the 1-month follow-up ( $M = 3.80$ ) and showed a marked increase at the 4-month assessment ( $M =$   
263  $4.43$ ). Both negative affect and depression scores declined from the pre-expedition into the 1-month  
264 and 4-month follow up phases. See Table 1 for further details on pre-expedition values and individual  
265 team member values.

266 -----INSERT TABLE 1 HERE-----

267 The most frequently reported event on the expedition was satisfaction in making progress ( $N$   
268  $= 104$ ). The most frequently reported coping strategy was thinking of something pleasant ( $N = 96$ ). A  
269 full list of the events experienced and coping strategies used is provided in Tables 2 and 3. A number  
270 of significant findings emerged when examining temporal differences in the events experienced and  
271 coping strategies endorsed during the expedition. Temporal findings related to events are presented in  
272 Table 2 and findings related to temporal changes in coping strategies are presented in Table 3.  
273 Significant time-based effects are presented in plots in Figures 1 (1a - 1d) and 2 (2a - 2c).

274 -----INSERT TABLES 2 & 3 HERE-----

275 In Figure 3, temporal scores for positive and negative affect are presented. Overall, scores for  
276 positive affect were moderate and values for negative affect remained relatively low. Both positive  
277 and negative affect decreased between pre-expedition ratings and week one ratings. A further  
278 decrease in positive affect and slight increase in negative affect emerged at week 5 of the expedition,  
279 although the changes were not significant. In the follow-up phases negative affect remained low,  
280 however positive affect increased beyond pre-expedition scores.

281 -----INSERT FIGURE 1 HERE-----

282 Findings from MLM analyses linking daily events to positive and negative affect are  
283 presented in Table 4. Feelings of satisfaction in making good progress and being able to cope were  
284 associated with higher levels of daily positive affect. Muscle and joint pain was associated with lower  
285 daily positive affect scores. Problems with gear, fear of injury, concerns about decisions, worries  
286 about family, and concerns about team working all predicted higher daily negative affect scores.

287 Findings related to the MLM model linking coping strategies and daily affect are presented in  
288 Table 5. Thinking of something pleasant, seeing the situation in a positive way, and efforts to relax  
289 were associated with higher daily positive affect scores. Negative feelings about a teammate and  
290 discussing personal concerns were linked to lower positive affect scores. Discussing task concerns,  
291 keeping feelings to self, having negative feelings about a teammate and discussing personal concerns  
292 were associated with increased negative affect scores. Thinking of something pleasant and keeping  
293 the goal in sight were linked to lower daily negative affect.

294 -----INSERT TABLES 4 & 5 HERE-----

295 **Discussion**

296 The overall purpose of the present study was to examine the psychological experience of a  
297 group undertaking an expedition in a unique desert context. We were interested in the profile of the  
298 expedition group, temporal changes that occur during and post expedition, and understanding the  
299 situational experience of the team. Using a diary-study method we assessed day-to-day changes in  
300 factors (events & coping strategies) related to psychological health (i.e., affect). Notably, findings  
301 highlighted specific events and coping strategies associated with changes in daily positive and  
302 negative affect. To our knowledge this is also the first psychological study published in the context of  
303 a hyper-arid desert expedition. Given the novel location, route, and format of the expedition, findings  
304 offer valuable insight into understanding the experience of other individuals and groups, such as  
305 expeditioners, aid workers and, defence and security personnel operating in comparable settings.

306 At the pre-expedition phase, participants reported a tendency to use more active-problem  
307 solving and comforting cognitions when dealing with stress, and limited reliance on avoidance

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308 strategies. These tendencies have previously characterised other individuals and groups operating in  
309 extreme settings and are suggestive of a well-adapted group (Kjaergaard et al., 2015; Leon et al.,  
310 2011a). During the expedition, daily positive affect remained at a moderate level. Daily negative  
311 affect tended to be scored low. Scores for affective states are similar in magnitude to those reported  
312 throughout other expedition studies (Leon et al., 2011b). There were no significant temporal changes  
313 in positive and negative affect during the expedition, although there was an observable decline in  
314 positive affect during week 5 of the expedition. In the 1-month post and 4-month follow-up, there was  
315 a trend for positive affect to be elevated compared to pre- and in-expedition levels. Satisfaction can be  
316 derived from overcoming the challenges faced on the expedition, which is likely to manifest in  
317 positive feelings and emotions as evidence by the elevated positive affect score in the present work  
318 (Suedfeld, 2001). Negative affect scores remained low through the post-expedition assessments and  
319 depression scores were reduced compared to pre-expedition values. One individual (A) reported  
320 depression scores beyond the value of 16 used in clinical screening assessments. On further inspection  
321 of his responses, it was evident that this individual had experienced disturbed sleep on the run up to  
322 the expedition. Overall, the descriptive accounts from the pre- and follow-up phases generally point  
323 towards a group who derived benefits from the expedition and coped well with the transition out of  
324 expedition life.

325         During the expedition, the team frequently reported having a positive experience, consonant  
326 with the view that extreme environment activities may be promotive of health (Suedfeld, 2001).  
327 Despite the relatively positive account, a number of significant temporal changes in logged variables  
328 were noted. In the present study, observed changes did not fit a distinctive pattern such as the third-  
329 quarter (Bechtel & Berning, 1991) and were not specific to either of the two sub-teams. During the  
330 expedition, there was a significant decrease in concerns about teammate wellbeing. At the individual  
331 level, all team members reported a gradual decline in concern for teammate wellbeing throughout the  
332 expedition. Team member B did report an increase in concern at week 5, which may coincide with a  
333 particular experience at that point in time (see Figures 1a-1d). These types of change may be  
334 indicative of individuals becoming less benevolent towards each other, which has been found in

335 previous extreme environment research (e.g., Palinkas, 2003; Sandal et al., 1998; Sandal et al., 2011;  
336 Wagstaff & Weston, 2014). Such an interpretation is supported by the descriptive changes and  
337 reductions in reports of camaraderie by all team members throughout the expedition.

338         Remaining changes may reflect the environment becoming normalised. For instance,  
339 reductions in satisfaction that equipment is working, worries about friends and family and enjoyment  
340 of the environment are likely to indicate a levelling of the psychological experience (Steine, Steine,  
341 Sandbaek, & Roseth, 2003). Upon entering the expedition, some individuals may worry about leaving  
342 family behind and be concerned about whether equipment is going to work. After spending a short  
343 period of time adjusting and successfully dealing with initial difficulties, reduction in these types of  
344 report would be expected. Conversely, after the initial excitement of starting the expedition and being  
345 in a new environment, enjoyment of the conditions is likely to wane. This represents the monotony of  
346 seeing the same type of environment and landscape for a prolonged period of time.

347         In terms of coping, the most frequently reported strategies during the expedition reflected  
348 emotion-oriented attempts aimed at modifying thoughts and feelings (i.e., comforting cognitions).  
349 Although all team members reported a baseline tendency to use active problem-solving strategies,  
350 there is a limit to the degree to which individuals are able to change the situation during an expedition.  
351 Furthermore, in the absence of particular challenges or when problem-focused strategies fail or are not  
352 needed, such strategies are less likely to be utilised. In this circumstance, we may expect emotion-  
353 oriented approaches, such as reappraisal and managing thoughts to take precedence. Finding from  
354 polar environments support this notion and emphasise the value of emotion-focused coping  
355 approaches (Kjaergaard et al., 2015; Leon et al., 2011a; Wagstaff & Weston, 2014). At the 1-month  
356 follow-up phase, there was a reduction in all of the coping strategies measured in the UCL, suggestive  
357 of a reduction in stress resilience (Sandal et al., 2016). At the 4-month assessment, coping strategy use  
358 returned to pre-expedition levels indicative of post-stress recovery.

359         Several changes in coping strategy use emerged during the expedition. There was an increase  
360 in thinking of something pleasant towards the end of the expedition. In the third and final phases of

361 the expedition there was also a significant decrease in attempts to see the situation in a positive way,  
362 which has previously been observed in the mid-to-latter phases of other extreme endeavours (Steel,  
363 2001). Together these changes in coping strategy indicate a refocusing of attention from the  
364 immediate situation to a future-time when the expedition is due to finish. An interesting observation  
365 was that discussing task concerns became less utilised by all team members later in the expedition,  
366 which coincided with a decrease in reports of camaraderie and reaffirms the interpretation of a less  
367 benevolent group (Sandal et al., 2011). It is important to note that there were differences between the  
368 expedition team members on the coping strategies used and not all team members displayed the same  
369 pattern. Therefore, individual differences in such coping approaches should still be considered (see  
370 Figures 2a-2c). In upcoming expedition work, it would be interesting to further explore the interaction  
371 between coping strategies and re-examine how a person's time-perspective shifts during the  
372 endeavour and the impact this has on coping with the demands of the environment. Outside of  
373 extreme settings, time-perspective has been linked to experiences of stress and the use of coping  
374 strategies pertinent to the present investigation (Ho & Yeung, 2016). The focus on time-perspective  
375 could be particularly relevant for expeditions or deployments that have a shifting end point, which  
376 may require individuals to focus more on the 'here-and-now' as opposed to the anticipated end point.

377 Links between expedition events and coping strategies were examined in relation to positive  
378 and negative affect. Satisfaction in making progress and being able to cope with the challenge were  
379 linked to higher daily positive affect scores. These events represent a sense of control, highlight the  
380 task effectiveness of the individuals and group, and would be expected to result in positive responses  
381 (Palinkas & Suedfeld, 2008). Muscle and joint pain was linked to lower daily positive affect,  
382 emphasising the importance of maintaining physical health whilst operating in demanding  
383 environments. A number of events (e.g., gear problems) also predicted elevated levels of daily  
384 negative affect. Of particular interest, were the positive associations found between concerns about  
385 safety decisions, team-working, and worries about friends and family, with raised negative affect.  
386 Such results reinforce the propositions that interpersonal and relational aspects, such as feeling  
387 homesick and missing family, are often the biggest source of stress in extreme settings (Sandal et al.,



388 2006; Stuster, Bachelard, & Suedfeld, 2000). These types of difficulties may need to be targeted  
389 during planning, group training, and information gathering prior to going into extreme environments.

390 Thinking of something pleasant, seeing the situation in a positive way, and relaxing, were all  
391 associated with elevated positive affect scores. These relationships highlight the value of emotion-  
392 oriented coping approaches when spending long-durations in challenging environments. Having  
393 negative feelings about a teammate and discussing personal concerns were related to lower positive  
394 affect and higher daily negative affect. When individuals endorse such techniques, it signals  
395 difficulties associated with group functioning and if left unmanaged could result in disruption and  
396 impaired psychological health. Keeping feelings to oneself was also linked to higher negative affect.  
397 Although concealing feelings may help preserve the status quo, over the long term this may be  
398 maladaptive for effective functioning especially in highly interdependent groups. Understanding  
399 which strategies can be used to maintain or boost positive affect, and mitigate negative affective  
400 experiences, will likely help sustain the performance and health of individuals and groups under  
401 duress. In a recent article, Leach (2016) suggested that when exposed to exceptional, extreme, and  
402 torturous environments small but regular bursts of positive emotion can help sustain psychological  
403 health. As such, having an appreciation of the strategies that will allow us to achieve this emotion  
404 regulation is important.

405 There are a number of limitations to acknowledge in relation to the present findings. Data  
406 presented are based on a very small number of participants and caution should be taken when  
407 generalising beyond this specific group. Sample-size issues pose a consistent challenge when  
408 conducting research with extreme environment populations. However, to overcome this challenge, a  
409 rigorous diary-study method was employed (Iida, Shrout, Laurenceau, & Bolger, 2012) and repeated  
410 measures were collected from the participants that resulted in high fidelity and a robust number of  
411 data points. Another limitation is related to the extent to which the expedition was experienced as  
412 stressful. On average, daily stress was reported as 2.79 suggesting a relatively low perception of  
413 difficulty. Whilst stress was reported as low, the characteristics of the expedition are similar to what  
414 might be experienced during other types of endeavour in challenging environments and do warrant

415 research attention (e.g., monotony, team difficulties). It is also important to note that data were  
416 collected by self-report questionnaire. Whilst more situational assessments were made using the daily  
417 rating forms, these reports remain subjective and it is possible that individuals may attempt to mask  
418 their true feelings. In future work it may be pertinent to include other more objective forms of data  
419 collection (e.g., behavioural observation, physiological monitoring) in order to triangulate the  
420 psychological information collected.

### 421 **Implications for individuals and groups in extreme environments**

422 In spite of the study limitations, results are promising and have clear practical application to  
423 other individuals and groups operating in extremis. There was modest evidence for temporal changes  
424 in the psychological experience of the expedition team. However, it remains unclear whether these  
425 changes align with a consistent phase-change model or instead represent the environment becoming  
426 normalised and the novelty of the experience subdued. Linking such findings to physiological changes  
427 e.g., changes in cortisol, would provide a better understanding of phase-changes related to stress.

428 Results linked to the predictive validity of the diary are particularly encouraging. If further  
429 research replicates the associations observed in the current work and suggests that the pattern of  
430 coping and emotional responses can be generalised to similar expeditions/deployments in other  
431 extreme contexts, it may be beneficial to brief personnel on what to expect during challenging  
432 activities, to prepare them for inevitable emotional ups and downs of endeavours in difficult  
433 environments. The present research highlighted the importance of monitoring social relationships.  
434 Attending to this in preparation for a mission or expedition (e.g., by discussing how the team will deal  
435 with interpersonal tensions as part of training) may enhance individuals' ability to cope when  
436 relationships start to become strained.

437 The method of assessment used to assess events and coping (yes/no response) is simple to use  
438 and not overly burdensome on participants, whilst also explaining variability in daily positive and  
439 negative affect scores. If such findings are replicated in upcoming work, this could inform  
440 development of a digitised system that would allow individuals to monitor events, coping, and

441 affective responses during assignments in a range of extreme settings. Retrospective analysis of such  
442 data could then inform the preparation of future missions. This approach also has the potential to  
443 develop into a tool for those supporting or participating in missions to track responses in real (or close  
444 to real) time. This could, in turn, inform decision-making about action to address a pattern of negative  
445 responses, including whether and when to abort a mission or expedition.

446 In sum, the current study offers a unique insight into the demands faced by individuals  
447 operating in a challenging hyper-arid desert environment. Addressing a gap in the research literature,  
448 we have identified specific events and coping strategies linked to situational changes in affect during  
449 an expedition in a desert environment. Such findings offer a foundation for developing a valid and  
450 reliable system that can be used by individuals and organisation to track situational-indicators of  
451 psychological health in extreme contexts.

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573 Table 1

574 Baseline scores for coping strategies, affect and mood

Participant	Pre					During					Post (1-month)					Follow (4-month)				
	M	A	B	C	D	M	A	B	C	D	M	A	B	C	D	M	A	B	C	D
Active Problem Solving	3.21	3.00	3.14	3.29	3.42	-	-	-	-	-	2.96	2.71	3.29	2.71	3.14	3.39	3.14	4.00	2.71	3.71
Palliative Reaction	2.06	2.00	2.38	2.25	1.63	-	-	-	-	-	1.97	2.00	1.75	2.00	2.13	1.88	1.75	2.00	2.00	1.75
Avoidance	2.28	2.50	2.38	2.13	2.13	-	-	-	-	-	2.06	2.38	2.00	2.00	1.88	1.75	2.25	1.13	2.13	1.50
Social Support	2.25	1.83	3.00	2.33	1.83	-	-	-	-	-	1.75	1.83	2.00	1.67	1.50	1.83	2.00	2.33	1.67	1.33
Depressive Reaction	1.57	2.29	1.29	1.29	1.43	-	-	-	-	-	1.57	1.86	1.86	1.00	1.57	1.50	2.00	1.71	1.29	1.00
Sharing Emotions	2.33	2.33	3.00	1.67	2.33	-	-	-	-	-	1.58	2.33	1.33	1.33	1.33	1.83	2.00	2.33	1.33	1.67
Comforting Cognitions	2.85	2.20	2.40	3.00	3.80	-	-	-	-	-	2.30	2.40	1.80	2.60	2.40	2.55	2.20	2.80	2.80	2.40
Positive Affect	3.80	3.90	3.80	4.40	3.10	3.56	4.33	1.91	4.06	3.46	3.80	4.40	2.10	4.10	4.60	4.43	3.50	4.80	4.50	4.90
Negative Affect	1.93	3.30	1.40	1.90	1.10	1.11	1.15	1.17	1.07	1.08	1.18	1.30	1.20	1.10	1.10	1.45	1.30	2.20	1.10	1.20
Depression	10.5	19.0	11.0	5.0	7.0	-	-	-	-	-	9.75	18.0	9.00	1.00	11.0	7.50	7.00	14.0	4.00	5.00

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577 Table 2

578 Changes in events by expedition week

		Phase							Total	Sig.
		1	2	3	4	5	6	7		
Physical/Medical	Personal hygiene	3	2	2	10	6	6	9	38	ns.
	Muscle or joint pain	7	7	6	4	2	2	0	28	ns.
	Fear of injury	1	3	5	0	3	0	1	13	ns.
	Constipation	1	2	1	2	1	0	0	7	ns.
	Headache	2	0	2	0	1	0	1	6	ns.
	Injury	0	0	3	0	0	0	0	3	ns.
	Diarrhoea	1	0	0	0	0	0	1	2	ns.
Logistical	Problems with gear and equipment	4	9	11	5	5	5	1	40	ns.
	Satisfaction equipment is working	12 <sup>234567</sup>	2 <sup>1</sup>	0 <sup>1</sup>	1 <sup>1</sup>	0 <sup>1</sup>	1 <sup>1</sup>	0 <sup>1</sup>	16	<0.001
	Lack of privacy	2	2	1	1	0	2	1	9	ns.
	Worried about encountering bad weather	0	0	2	1	1	0	0	4	ns.
Psychological - Social	Feeling of camaraderie	17	17	15	11	7	7	6	80	ns.
	Concern teammate wellbeing	13 <sup>3467</sup>	10	3 <sup>1</sup>	2 <sup>1</sup>	7	2 <sup>1</sup>	1 <sup>1</sup>	38	<0.001
	Worried about family, friends	7 <sup>6</sup>	8 <sup>67</sup>	6	3	5	0 <sup>12</sup>	0 <sup>2</sup>	29	0.001
	Concern about how teammates and I are working	0	2	0	0	2	2	1	7	ns.
	Feeling down because teammate(s) feeling that way	0	2	0	1	2	2	0	7	ns.

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Psychological - Individual	Tension with my teammate(s)	1	0	0	0	3	0	1	5	ns.
	Satisfaction in making good progress	19	14	15	16	13	13	14	104	ns.
	Enjoyed environment	19 <sup>5</sup>	18 <sup>5</sup>	20 <sup>5</sup>	16 <sup>5</sup>	4 <sup>1234</sup>	10	12	99	<0.001
	Satisfaction that I am able to cope	16	10	9	11	8	9	12	75	ns.
	Loneliness	1	2	3	1	0	0	0	7	ns.
	Concerns about safety of decisions I made today	0	1	0	0	0	0	0	1	ns.

579 *Note: \*p<.05; \*\*p<.01; ns. = non-significant. Superscript number 1-7 indicates significant difference to the respective week. A Bonferroni corrected p value*  
 580 *of .002 is used to determine significance*

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MONITORING EVENTS, COPING STRATEGIES, AND EMOTION

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591 Table 3

592 Changes in coping strategies by expedition week

		Phase							Total	Sig.
		1	2	3	4	5	6	7		
Active approaches	Broke task down, took it one day at a time	12	10	11	11	10	9	7	70	ns.
	Relaxed/meditated	3	1	7	4	2	3	2	22	ns.
	Engaged in effortful behaviour/Tried harder	5	3	2	1	1	3	4	19	ns.
	Tried to solve situation	0	4	1	2	2	0	0	9	ns.
	Prayed	0	0	0	0	0	0	0	0	ns.
	Cried	0	0	0	0	0	0	0	0	ns.
	Yelled, stomped	0	0	0	0	0	0	0	0	ns.
Emotion-focused approaches	Tried to think of something pleasant	12	11 <sup>7</sup>	9 <sup>67</sup>	13	13	19 <sup>3</sup>	19 <sup>23</sup>	96	0.002
	Kept the goal in sight	8	9	5	11	11	10	11	65	ns.
	Kept a positive attitude	12	8	7	7	6	9	8	57	ns.
	Kept feelings to myself	3	6	4	6	9	8	6	42	ns.
	Tried to see the situation in a positive way	7	9 <sup>6</sup>	9 <sup>6</sup>	9 <sup>6</sup>	2	0 <sup>234</sup>	2	38	0.002
	Had negative feelings about teammate(s))	0	0	0	0	3	0 <sup>5</sup>	0 <sup>5</sup>	3	ns.
	Had negative feelings about myself	0	1	0	0	0	0	0	1	ns.
Social approaches	Discussed task concerns	1 <sup>2</sup>	8 <sup>14567</sup>	4	1 <sup>2</sup>	1 <sup>2</sup>	0 <sup>2</sup>	1 <sup>2</sup>	16	0.002
	Discussed personal/emotional concerns	0	2	1	3	2	2	2	12	ns.

## MONITORING EVENTS, COPING STRATEGIES, AND EMOTION

593 *Note:* \* $p < .05$ ; \*\* $p < .01$ ; ns. = non-significant. Superscript number 1-7 indicates significant difference to the respective week. A Bonferroni corrected p value  
594 of .002 is used to determine significance

MONITORING EVENTS, COPING STRATEGIES, AND EMOTION

Table 4

MLM model predicting daily positive and negative affect using events experienced

		Daily Positive Affect		Daily Negative Affect	
		Estimate	Sig.	Estimate	Sig.
Physical/Medical	Personal hygiene	.07	.53	-.06	.12
	Muscle or joint pain	-.32*	.03	.01	.79
	Fear of injury	.16	.40	.13*	.03
	Constipation	.14	.55	-.09	.22
	Headache	.36	.15	.00	.79
	Injury	.43	.24	-.20	.09
	Diarrhoea	.29	.46	-.06	.66
Logistical	Role code (0 = support; 1 = lead group)	.59	.61	-.03	.66
	Problems with gear and equipment	.07	.54	.10*	.01
	Satisfaction equipment is working	.12	.47	.03	.50
	Lack of privacy	-.11	.59	.01	.88
	Worried about encountering bad weather	.21	.49	-.13	.16
Psychological - Social	Feeling of camaraderie	.16	.15	-.02	.55
	Concern teammate wellbeing	-.03	.77	.06	.12
	Worried about family, friends	.12	.49	.12*	.04
	Concern about how teammates and I are working	-.07	.76	.23**	.00
	Feeling down because teammate(s) feeling that	.22	.37	.01	.90

MONITORING EVENTS, COPING STRATEGIES, AND EMOTION

	way				
	Tension with my teammate(s)	-.13	.65	-.02	.81
Psychological - Individual	Satisfaction in making good progress	.35**	.00	-.03	.29
	Enjoyed environment	.17	.10	-.01	.71
	Satisfaction that I am able to cope	.21*	.05	-.05	.17
	Loneliness	.02	.92	-.05	.52
	Concerns about safety of decisions I made today	-.45	.45	.61**	.00

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*Note:* \*p<0.05; \*\*p<0.01

MONITORING EVENTS, COPING STRATEGIES, AND EMOTION

Table 5

MLM model predicting daily positive and negative affect using coping strategies

		Daily Positive Affect		Daily Negative Affect	
		Estimate	Sig.	Estimate	Sig.
Active approaches	Broke task down, took it one day at a time	-.10	.42	-.00	.99
	Relaxed/meditated	.07*	.65	-.03	.52
	Engaged in effortful behaviour/Tried harder	-.01	.95	-.01	.91
	Tried to solve situation	.11	.64	.11	.14
Emotion-focused approaches	Tried to think of something pleasant	.26*	.02	-.06*	.05
	Kept the goal in sight	.08	.45	-.06*	.05
	Kept a positive attitude	-.04	.74	.04	.24
	Kept feelings to myself	-.11	.31	.08*	.04
	Tried to see the situation in a positive way	.31*	.01	-.04	.23
	Had negative feelings about teammate(s)	-.71*	.04	.26*	.02
	Had negative feelings about myself	-.59	.34	.26	.19
Social approaches	Discussed task concerns	.02	.92	.11*	.03
	Discussed personal/emotional concerns	-.49*	.01	.21**	.00

Note: \*p<.05; \*\*p<.01