Resilient Polar Expedition Well-being: The importance of Basic Psychological Needs

BURGUM, PAUL

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Paul Burgum

This thesis examines the resilience of polar expeditioners through Basic Psychological Needs Theory (BPNT), integrating a socioecological perspective that views resilience as a dynamic interaction across individual, relational, and environmental levels. Resilience was assessed via well-being and ill-being using a mixed-methods approach across three empirical studies. The aim was to evaluate BPNT's applicability in extreme environments and its ability to predict mental health and explain relationships within a socioecological framework.

Study 1 employed a cross-sectional design to investigate factors at individual, micro, exo, and macro levels, with basic psychological needs (BPN) as mediators. Autonomy mediated the effects of personal resilience, community support, and nature connection on well-being. Relatedness fully mediated the relationships between personal resilience, social support, and nature connection with ill-being, highlighting the critical role of social relationships in reducing negative outcomes. Study 2 used an intensive repeated-measures design during polar expeditions. Aggregated BPN satisfaction consistently predicted well-being and ill-being. Nature relatedness and coping flexibility also supported well-being, emphasizing the role of adaptive strategies and environmental connection in mental health. Study 3 employed thematic analysis of interviews to explore how expeditioners navigate challenges and draw support across socioecological levels. Findings highlighted diverse sources of social support, the significance of the natural environment, and gender-related challenges for female personnel, calling for increased attention to equity and inclusion.

The findings demonstrate BPNT's applicability to extreme environments and its utility in understanding resilience. The research underscores the importance of needs-supportive environments, coping flexibility, and nature connection, offering practical recommendations for individuals, teams, and organizations. Despite challenges such as small sample sizes, this thesis provides novel insights into resilience in extreme settings and highlights BPNT's value for future theoretical and applied work.

Keywords**:** Basic psychological needs, Polar expeditions, Resilience, Social-ecological resilience, Nature connection, Social Support, Coping flexibility.

Resilient Polar Expedition Well-being: The role of Basic Psychological Needs Theory

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Declaration

I confirm that none of the material presented in this thesis has been submitted elsewhere for any other qualification and is my own work unless referenced otherwise.

Statement of copyright

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Dedication – My family

To Jody, Pavel (And Molly). You are my world, and I feel so blessed to have you!

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Dedication - Mam

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I love you dearly Mam,

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RIP Helen Angela Freda Mary Crockett (1953 – 2025)

In Memory

To my Grandparents, Fred & Molly Crockett and Glynis Jones, wonderful Mam to Jody and Nanna to Pavel.

“Do your best”.

Always and forever xxxx

Covid Impact Statement

The COVID-19 pandemic created significant disruption to the planned research activities in this thesis. Due to severe reductions in polar expeditions during the first year of the PhD, opportunities for field-based data collection were restricted. This affected the initial research design, which had intended to incorporate in-situ data collection methods such as diary studies as a larger part of the planned thesis. In response to these constraints, alternative designs were implemented, including retrospective cross-sectional surveys with polar expeditioners.

Restrictions on fieldwork and academic travel also limited opportunities for networking and relationship-building within the polar research community, which is particularly challenging given the specialised nature of the field and the researcher's initial lack of established connections.

The final study, which relied on within-expedition measures, was particularly impacted by these disruptions. However, mitigation strategies were successfully employed, and a credible and sufficient sample size was achieved to maintain the study's robustness and validity.

Despite the challenges presented by the pandemic, the core objectives of the research were preserved, and the thesis provides a substantive contribution to knowledge within the field of resilience in extreme environments.

Chapter 1: General Introduction

Polar expeditions are among the most challenging human endeavours, exposing individuals to extreme environmental conditions, prolonged isolation, and significant physical and psychosocial stressors (Palinkas & Suedfeld, 2021). These unique challenges test human resilience. While no single, universally agreed-upon definition exists, resilience is broadly understood as the capacity to adapt and maintain functioning in the face of adversity (Fletcher & Sarkar, 2013). However, while the term resilience is often used in relation to polar expeditioners, the application of resilience theory in polar research is relatively underexplored (Smith et al., 2024). Isolated, confined, and extreme (ICE) environments are characterized by prolonged isolation, confinement, limited resources, and harsh conditions. In such settings, even minor issues can escalate into life-threatening situations which require significant financial resources for emergency extraction (Kim et al., 2023). Beyond these immediate concerns, insights from polar expeditions are relevant to addressing significant societal challenges. For example, the learning on the impact of isolation and confinement has been applied to inform strategies to cope with global pandemics such as covid-19 and the increasing number of people of elderly living in care facilities who experience isolation and confinement (Palinkas & Suedfeld, 2021). Furthermore, resilience research in ICE environments is being used to deepen understanding of the psychological demands of future manned missions to Mars, where prolonged isolation, confinement, and extreme conditions will be experienced to levels not previously experienced by humans (Palinkas & Suedfeld, 2021).

Contemporary resilience research and studies on ICE environments converge on the view that adaptation and sustained functioning in the face of adversity require supportive individual traits. However, these traits must be complemented by resources provided by the wider

environment (e.g., Masten et al., 2021; Sandal, 2018). This perspective has driven the adoption of process-oriented approaches to resilience, which view resilience as a dynamic and context-dependent process shaped by interactions between individual and their environment (Bonanno, 2004; Liebenberg et al., 2017). The socio-ecological model is one conceptualization of a process approach, acknowledging that many variables contribute to resilience. It organizes these variables into a nested structure, ranging from proximal factors, such as personality traits, to distal factors, such as supportive infrastructure provided by organizations or governments (Bronfenbrenner, 1979; Cicchetti & Lynch, 1993; Ungar et al., 2021). This approach not only highlights where support may be best directed but also reveals how interactions across levels shape outcomes. These premises are aligned with Basic Psychological Needs Theory (BPNT; Vansteenkiste & Ryan, 2013; Vansteenkiste et al., 2020), which posits that the satisfaction of autonomy, competence and relatedness are central to the resilience process. Thus, basic psychological needs serve as key explanatory variables, explaining how factors at different levels of the person (e.g., personality, coping strategies) and environment (e.g., supportive infrastructure, necessary equipment) interact to shape resilience. Together, these approaches offer a powerful, integrative framework for understanding resilience. Simplifying this complexity is essential to ensure the construct's usefulness in applied contexts within polar studies.

The review is structured into three main sections. The first section examines resilience theory, focusing on key conceptualizations of the construct (e.g., trait versus process perspectives) and critical methodological considerations for studying the construct. The second section reviews polar expedition literature through the lens of the socio-ecological model. This includes an exploration of the stressors encountered and the assets and resources that support resilience at the individual, relational, and contextual levels. The third section introduces BPNT

as a unifying framework, highlighting its potential to explain relationships across all levels of the socio-ecological model. Lastly, the key aims of the present thesis are outlined, demonstrating how these foundations inform the empirical studies presented. By focusing on resilience within polar expeditions, this review not only provides a comprehensive synthesis of the existing literature but also establishes a theoretical foundation for the empirical studies presented in this thesis. The insights gained contribute to a deeper understanding of resilience in extreme environments and could inform practical strategies for enhancing well-being and performance in polar contexts and beyond.

1.1 Resilience Literature

1.1.1 Conceptual Perspectives

Resilience research has undergone significant evolution over the past several decades, with scholars identifying distinct "waves" that capture shifts in focus and methodology. The first wave emerged from developmental psychology, emphasizing the identification of protective factors in children exposed to adversity, such as supportive relationships and temperament (Masten, 2014; Werner, 1995). The second wave centred on understanding the processes and mechanisms underlying resilience, marking a shift toward dynamic, context-sensitive models (Luthar et al., 2000). The third wave introduced multi-level analyses, incorporating interactions across individual, relational, and environmental systems, often referred to as social-ecological models (Ungar, 2011). More recently, the fourth wave has embraced a multi-systemic resilience perspective, integrating insights from biology and neuroscience to explore resilience across the lifespan and in diverse contexts (Masten et al., 2021; Masten & Obradović, 2006). These advancements reflect an enduring debate within resilience research: whether resilience is best understood as a stable trait or as a dynamic process. While early studies often conceptualized resilience as a set of individual qualities, contemporary research increasingly emphasizes the interaction between individuals and their environment (Hiebel et al., 2021; Vella & Pai, 2019).

1.1.1.1 Trait Resilience Perspective

Trait resilience refers to a cluster of personal qualities or assets that enable individuals to effectively cope with adversity and maintain positive functioning across situations (Prince-Embury et al., 2017). Fundamental to this perspective has been the development of resilience scales designed to measure these attributes (Block & Kremen, 1996; Connor & Davidson, 2003; Minnett & Stephenson, 2024; Wagnild & Young, 1993). For example, Connor and Davidson

(2003) built upon earlier work, such as Kobasa's (1979) emphasis on control, commitment, and a challenge mindset, and Rutter's (1985) identification of goal orientation and a clear sense of purpose. They further incorporated traits like humour, self-efficacy, religiosity, and optimism, highlighting their role in fostering resilience. Beyond individual characteristics, Connor and Davidson (2003) also acknowledged the critical role of social support in promoting adaptive outcomes during adversity. Results have shown that the measure is able to predict clinical intervention efficacy with trait resilience levels associated with measures of anxiety, depression and PTSD (Connor & Davidson, 2003). Furthermore, a meta-analysis of 60 studies confirmed that trait resilience is significantly associated with better mental health outcomes, including reduced anxiety and depression, and higher levels of well-being (Hu et al., 2015). However, trait resilience accounted for only 13% of the variance from ill-being variables and 25% of well-being, which leaves a large proportion of mental health outcomes not explained by the trait perspective alone. These findings reinforce the key role of individual-level traits in resilience. However, they also underscore the need to consider broader factors such as the social and physical environment and how they dynamically interact with assets of the individual.

1.1.1.2 Resilience as a dynamic process

In recent years, resilience researchers across diverse disciplines have increasingly conceptualized resilience as a dynamic process of interaction between individual assets, relational resources, and contextual factors (Hiebel et al., 2021; Southwick et al., 2014; Ungar et al., 2021). Individual assets include internal qualities, such as those outlined by the trait perspective, while relational resources refer to support from close relationships, including family, friends, work or community connections. In contrast, contextual resources encompass broader environmental supports, such as access to healthcare, education systems, and the natural environment (Liebenberg et al., 2017).

These elements interact in a cyclical process, where environmental supports enhance individual capacities, which in turn facilitate greater access to external resources (Liebenberg et al., 2017). This process-oriented perspective aligns closely with the social-ecological model, which emphasizes the reciprocal relationship between individuals and their environments in shaping resilience.

1.1.1.3 Socio-ecological Models

A socio-ecological approach, rooted in the process perspective of resilience, emphasizes the nested and reciprocal interactions between individual characteristics and different levels of the environment in shaping resilience outcomes (Belsky, 1980; Bronfenbrenner, 1979; Cicchetti & Lynch, 1993; Ungar et al., 2008, 2021). Critical in this approach is the distinction of different 'levels' of measurement, which are inter-related and can offer both challenge and support. Whilst these levels are often conceptualized differently by scholars they typically include: the individual level, which represents internal attributes such as competence and adaptability; the microsystem, encompassing immediate relationships and environments like family and close social networks; the exosystem, which involves community-level factors such as access to resources and social support; and the macrosystem, referring to broader cultural, societal, and institutional influences. Importantly, the model emphasizes that supportive factors at one level can mitigate risks at another, highlighting the interconnected nature of resilience processes (Bronfenbrenner, 1979; Cicchetti & Lynch, 1993; Ungar et al., 2008, 2021). The socio-ecological model emphasizes the interplay between individual characteristics and environmental contexts in shaping resilience. At the microsystem level, supportive family relationships and intimate partnerships have consistently been shown to foster positive adaptation, particularly for individuals facing adversity in childhood. For instance, stable family structures, intra-family social support, and

socio-economic stability were identified as critical factors in promoting resilience in children (Benzies & Mychasiuk, 2009; Egeland et al., 1988). At the exosystem level, community involvement, peer acceptance, and access to resources such as schools and healthcare have been identified as protective factors (Benzies & Mychasiuk, 2009). Finally, the macrosystem level reflects the influence of cultural values and norms. Ungar (2008) found that resilience is shaped by both universal resources, such as social support, and culturally specific factors, emphasizing the need for culturally tailored approaches to resilience assessment. Despite these findings, Yule et al. (2019) noted that most resilience studies have focused on the individual and microsystem levels, with significantly fewer addressing the exosystem and almost none exploring the macrosystem. This highlights the need for research that spans multiple levels, particularly those that consider more distal and systemic factors. Furthermore, the research cited is predominately with child and adolescent populations, therefore there is scope for further work with adult populations.

1.1.2 Definition of resilience

While resilience is commonly associated with the ability to adapt in the face of adversity, it remains a contested construct, with its definition varying according to both the conceptual framework and the context in which it is applied (Windle, 2011). Although no single, universally agreed definition of psychological resilience exists, several components are commonly reflected across different conceptualisations. These typically include exposure to stress or adversity (Masten et al., 1999; Rutter, 2006; Werner, 1993), the capacity to maintain functioning during challenges (Bonanno, 2004), and adaptation to environmental demands (Garmezy, 1991; Rutter, 2006). However, these features are weighted differently depending on the conceptual lens through which resilience is understood. Such variability highlights the importance of establishing

conceptual clarity and methodological rigour, as inconsistent definitions and measurements limit the comparability and applicability of resilience research. The following section explores how these conceptual perspectives shape the way resilience is defined across the literature.

1.1.2.1 Trait Resilience Definitions

Trait-based definitions of resilience typically conceptualise it as arising from enduring internal qualities that promote stable functioning in the face of adversity. For example, Connor and Davidson (2003) define resilience as "the personal qualities that enable one to thrive in the face of adversity" (p. 76). These definitions emphasise characteristics such as optimism, self-efficacy, and emotional regulation (Hu et al., 2015; Prince-Embury et al., 2017). Trait-based perspectives have notably contributed to the development of psychometric assessments and clinical interventions aimed at fostering resilience. However, they have been critiqued for underestimating the role of environmental and social influences (e.g., Fletcher & Sarkar, 2013). As a result, more dynamic, context-sensitive models of resilience have gained prominence in the literature.

1.1.2.2 Process Resilience Definitions

Process-oriented definitions of resilience conceptualise it as a dynamic and ongoing interaction between the individual and their environment, focused on positive adaptation in response to adversity. A widely cited definition from this perspective is offered by Luthar et al. (2000), who describe resilience as "a dynamic process that encompasses positive adaptation within the context of significant adversity" (p. 543). While Luthar's definition has been influential in establishing resilience as a process, its broad framing leaves the mechanisms of adaptation largely unspecified. Richardson (2002) extends this perspective by offering a more detailed account of how individuals cope with adversity and strengthen protective factors over time. He

defines resilience as “the process of coping with stressors, adversity, change or opportunity in a manner that results in the identification, fortification, and enrichment of resilient qualities or protective factors” (p. 308). Definitions within this perspective tend to emphasise the importance of adaptation over time, coping strategies, and the role of protective factors in managing adversity. Unlike trait-based views, process-oriented definitions allow for resilience to vary across situations and developmental stages, and they often reflect interactional or transactional models of adjustment.

1.1.2.3 Socioecological Definitions

Socio-ecological models can be understood as an extension of process-oriented perspectives (Masten & Obradović, 2006; Ungar, 2011). They offer a more detailed account of the multiple interacting systems, including social, cultural, and environmental factors, that shape adaptive processes in response to adversity (Cicchetti & Lynch, 1993; Ungar, 2011; Ungar et al., 2021) . These definitions extend beyond individual traits or internal coping strategies by emphasising the critical interaction between individuals and the broader contexts in which they live. Resilience, from this perspective, emerges through the capacity to access, negotiate, and mobilise resources that sustain well-being (Ungar, 2008; Liebenberg et al., 2017). Definitions within this lens underscore that resilience is not solely an internal quality but an outcome of complex and reciprocal interactions between people and their environments (Panter-Brick & Leckman, 2013). They highlight factors such as community support, institutional policies, cultural values, and environmental conditions as essential contributors to resilience. While this approach offers a more comprehensive and contextually sensitive view, it also introduces challenges in measurement and operationalisation due to its inherent complexity (Windle, 2011; Ungar & Liebenberg, 2011). Nevertheless, socio-ecological perspectives are increasingly valued in studies

of resilience conducted in culturally diverse or non-normative settings, where broader systems of support are essential to understanding how individuals respond to adversity (Ungar, 2013; Theron, 2016).

1.1.2.4 Thesis Definition Adopted

Reflecting the need for a culturally sensitive and contextually grounded conceptualisation, this thesis adopts the socio-ecological definition of resilience proposed by Ungar (2008). Ungar defines resilience as "both the capacity of individuals to navigate their way to psychological, social, cultural, and physical resources that sustain their well-being, and their capacity individually and collectively to negotiate for these resources in culturally meaningful ways" (p. 225). This definition is informed by research with diverse populations, including Indigenous communities, and emphasises that resilience is not a universal process but is shaped by cultural values, social structures, and environmental conditions.

This approach aligns closely with research conducted with Arctic Indigenous groups, who have critiqued traditional Western notions of resilience as overly individualistic and culturally incongruent (Akearok et al., 2019). Studies in these communities have consistently found that resilience is more strongly associated with macro- and community-level factors, such as subsistence activities, connection to the land, kinship networks, and the maintenance of native languages and cultural practices (Allen et al., 2014; Ulturgasheva et al., 2014; Wexler, 2009). These findings highlight how colonial histories and structural inequalities can thwart psychological needs at systemic levels, consistent with social-ecological models of resilience and BPNT (Han et al., 2016; Ryan & Deci, 2017). They also underscore the limitations of trait-based or purely individual-level conceptualisations of resilience in culturally diverse or non-normative settings.

By drawing on these insights, the present thesis adopts Ungar's socio-ecological definition, providing a model of resilience that is sensitive to the unique environmental, social, and cultural contexts encountered by polar expeditioners. This definition allows for a more nuanced investigation of resilience as a dynamic, contextually embedded process, aligning with contemporary critiques and empirical findings from Indigenous and cross-cultural research.

1.1.3 Predictors of Resilience

Resilience is now acknowledged to represent a multifaceted construct with a large list of variables identified across the last 50-years of research. Systematic reviews focused on identifying resilience predictors have identified between thirty and over fifty variables to have a significant association to resilient outcomes (Herrman et al., 2011; Hiebel et al., 2021; Schäfer et al., 2024; Windle, 2011). However, there are certain variables that are consistently reported to associate with resilience, including personal attributes such as self-efficacy, self-esteem, optimism, coping strategies and exhibiting an internal locus of control. At the relational level, social support from various sources including intimate partners predicts resilience. At the contextual level, access to resources such as healthcare, education, and community facilities is positively associated with resilience. Additionally, broader socio-economic and cultural conditions play an important role in shaping the availability and impact of these resources. The variation in terms of predictors of resilience is proposed to vary greatly depending on the circumstances. Bonanno et al. (2024) proposes that this is the key reason why individual variables very rarely predict much of the variance in future resilience results, even using multi-variate or machine learning approaches. Therefore, consideration of the type of adversity faced, the group facing the challenge, and the duration of exposure are likely to influence which

specific factors best predict resilient outcomes. These points will be further discussed regarding polar expeditioners in the sections to follow.

1.1.4 Resilience Methodology & Methods

1.1.5 Defining Adversity in Resilience Research

Resilience refers to the capacity to overcome or adapt to levels of stress or adversity that exceed typical daily experiences for most people (Windle, 2011). A common critique of resilience research is the lack of clarity regarding details of the specific adversity, hindering the interpretation and comparability of findings. This is particularly relevant to studies of chronic or ongoing stressors (Denckla et al., 2020; Luthar et al., 2000). In contrast, George Bonanno and colleagues have focused on discrete, acute events such as terrorist attacks, natural disasters, and bereavement to better understand resilience (Bonanno et al., 2023). These events are valuable because they have well-defined timelines, allowing researchers to establish clear pre- and post-adversity phases. This clarity supports the use of prospective longitudinal designs, which are considered gold standard in resilience research (Gucciardi et al., 2021; Kalisch et al., 2017). By capturing pre-event baselines, prospective studies enable a more accurate measurement of resilience trajectories. Although the study of discrete events provides methodological advantages, they are of limited use when studying diffuse or ongoing stressors, where the onset and intensity of adversity are less clearly defined. This lack of clarity provides one reason for variability in operational definitions and poses challenges in comparing findings across studies. In this context, polar expeditions provide a valuable example of a clearly defined and measurable period of stressor exposure. Thus, polar expeditions can further inform how resilience is exhibited in a distinct context, which to date has been rarely studied using resilience theory (Smith et al., 2024).

1.1.6 Conceptualizing Resilient Outcomes

Another critique of the resilience construct is its inconsistent operationalization, which further complicates measurement and cross-study comparisons. This includes identifying which aspects of resilience are being assessed, such as traits, behaviors, or psychological factors like well-being. Early resilience research with children and adolescents often focused on the absence of disorder or pathology in those exposed to chronic conditions, such as poverty or parental mental illness, as well as the achievement of key developmental milestones (Werner, 1995). Resilience has also been studied in relation to maintaining performance across various domains, including education, sport, the workplace, and health (Brewer et al., 2019; Hartmann et al., 2020; Masten, 2014; Masten et al., 2021; Sarkar & Fletcher, 2014). With the rise of positive psychology, resilience is increasingly conceptualized not only as the absence of negative outcomes but also as the presence of positive states, such as well-being (Kalisch et al., 2017; Luthar et al., 2014). This includes studies examining mental health resilience, specifically the capacity to maintain or recover psychological well-being and functioning to pre-stressor levels, as highlighted by Bonanno's (2004) work on resilient/minimal impact resilience trajectories. Additionally, contemporary research highlights the importance of assessing both positive aspects, such as well-being, and negative aspects, such as ill-being (Zhao & Tay, 2023).

1.1.7 Criteria for being defined resilient.

A critical issue in resilience research is how the construct is defined and operationalized, particularly the debate between trait-based and process-oriented perspectives. Trait-focused approaches, which conceptualize resilience as a stable characteristic, often rely on cross-sectional designs to capture individual differences at a single time point. From this perspective, it is hypothesized that individuals with higher levels of trait resilience will consistently display

better well-being or performance outcomes, regardless of the time period (e.g., CD-RISC: Connor & Davidson,2003). For example, Connor and Davidson (2003) created a scale which purports to measure an individual's level of stress coping ability, or trait resilience. In their studies it was shown across multiple samples that those higher in this factor displayed larger improvements during treatment and better well-being.

In contrast, process-oriented designs acknowledge that cross-sectional designs maybe a useful step in identifying potential key variables and relationships. However, to apply the term resilience, it necessitates the use of longitudinal methods so changes across time can be measured (Bonanno, 2004; Bonanno & Diminich, 2013; Galatzer-Levy et al., 2018). For example, Bonanno and colleagues, using growth modelling techniques, have demonstrated consistent types of trajectories in responses to potentially traumatic events (PTEs). This type of analysis allows the tracking of individual differences in adaptation across time, adding more detail to how resilience may unfold. These trajectories are observed across pre-, mid-, and post-stressor exposure periods. This includes a resilient trajectory, where individuals show only minor deviations from their baseline psychological and social functioning, such as temporary distress, before swiftly returning to pre-stressor levels. This pattern, also termed minimal impact resilience (Bonanno & Diminich, 2013), reflects the capacity to adapt without significant long-term disruption. A second relevant trajectory is termed a recovery trajectory, where there is a more prolonged period of disruption, however, they still return to normal levels over time. Finally, some individuals show prolonged periods of severe disruption with clinically defined levels of psychopathology across numerous years termed chronic dysfunction, or delayed onset trajectory, where people are initially functioning normally, but with a significant decrease over time. Notably, resilience consistently emerges as the most common trajectory across studies,

reinforcing the view that resilience is not a rare or exceptional quality but rather a normative human response to adversity. This finding underscores the importance of process-oriented research in accurately capturing the prevalence and mechanisms of resilience.

1.1.8 Measuring resilience.

With resilience conceptualized as a process, this shapes the methodology that is best suited to investigate the construct. This review shall consider the role of different methods that are applied to resilience research from this perspective. Cross-sectional studies are among the most commonly used approaches in resilience research, particularly in studies employing resilience scales. These scales, such as the Connor-Davidson Resilience Scale (CD-RISC; Connor & Davidson, 2003), are widely used to assess individual differences in resilience-related traits, such as coping ability and stress tolerance. While such measures provide valuable insights into factors that may influence resilience, they are frequently used as outcome measures (Perlman et al., 2017), which presents a significant critique. Rather than assessing resilience as a dynamic process or a specific outcome following adversity, these scales typically measure an individual's likelihood of displaying resilience under stress (Bonanno, 2012; Windle, 2011). Process-oriented research acknowledges that stable personality traits, such as those measured by resilience scales, contribute to the resilience process. However, these traits are better conceptualized as resilience factors rather than outcomes (Bonanno, 2012). Furthermore, whilst cross-sectional designs cannot confirm resilience, they are informative and can highlight important relationships and key variables for further study.

To understand resilience as a dynamic process involving interactions between the individual, their resources, and the environment, it is essential to study relevant variables using longitudinal designs (Bonanno & Westphal, 2024; Galatzer-Levy et al., 2018). These designs

allow researchers to track changes over time, capturing the temporal and contextual dynamics of resilience. Furthermore, utilizing designs with a greater volume of measurement points, such as intensive repeated measures designs, offers unique advantages by providing detailed insights into how fluctuations in key variables relate to the maintenance or stability of resilient outcomes (e.g., well-being and ill-being). Such methods enable the identification of patterns of adaptation that underpin resilience, complementing traditional longitudinal approaches (Abadir et al., 2023).

1.1.9 Conceptualisation of Resilience in the present work

In this thesis, resilience is conceptualized as a dynamic process involving interactions between attributes and assets provided by both the social and physical environment. This perspective is consistent with contemporary process-oriented models and emphasizes the importance of studying resilience as an adaptive and context-dependent phenomenon (Bonanno, 2004; Ungar, 2011). Resilience is operationalized as the ability to maintain or recover mental health following adversity, incorporating both well-being (e.g., positive affect, vitality) and ill-being (e.g., negative affect, loneliness) as outcome measures. Methodologically, this thesis adopts a mixed methods approach, combining longitudinal designs to capture temporal dynamics with qualitative analyses to contextualize individual experiences. By focusing on polar expeditions, this research provides a unique opportunity to study resilience in extreme environments, contributing to our understanding of how individuals adapt to prolonged and severe stressors.

1.2 Resilience Research in the Polar Regions

Building on the previous section's review of resilience, this section focuses on applying the concept to polar expeditions. To ensure that the term resilience is appropriately used, the specific stressors and adversities faced by polar expeditioners will first be detailed. This begins with an outline of the types of expeditions relevant to this thesis, followed by a discussion of the key challenges experienced in these extreme environments. Finally, resilience will be examined through the lens of a socio-ecological model, identifying assets and resources at individual, relational, and contextual levels.

1.2.1 Risks and Stressors

Key to applying the term resilience, is that there is a clear exposure to a stressor(s) or adversity, either on an acute or chronic level. The conditions experienced by expeditioners in the polar regions fulfil these criteria. Polar expeditions expose individuals to a range of stressors at environmental, social, and individual levels.

1.2.2 Types of Polar Expedition

The Polar regions represent two large geographical areas in which diverse types of expeditions are undertaken by different groups and purpose. Antarctica only has temporary human populations, whilst in the Arctic there are many established communities and indigenous groups. Therefore, this review will consider the literature pertaining only to those undertaking temporary placements in either Antarctica or the Arctic.

There are numerous distinct types of polar expeditions, with each type having its own unique stressors. However, all facing challenges surpassed what would be expected in 'normal' life situations which complies with the use of the term resilience (Windle, 2011). The first type is

a polar trek which represents those completing journeys across areas of either the Arctic or Antarctic regions. This can include individuals or teams using their own physical power, such as a snowshoes, skis, and sled dogs. Additionally, mechanical methods of transport are now consistently used, such as snowmobiles and tracked vehicles (Palinkas & Suedfeld, 2008). These types of expedition have the greatest exposure to environmental stressors such as the weather conditions, dangerous crevasses or leads in the sea ice and restricted access to emergency support services or additional resources. A second type, which be very similar to the last type, are expeditions for the purpose of conducting scientific or commercial field work. Similar to treks they can involve journeys to reach the location and then require working and living in tents or other temporary structures for a prolonged period of time. Thirdly, there are expeditions by those who live and work in polar research stations, both in the Arctic and Antarctica. These are typically much longer duration than they first 2 types. They can include the shorter summer season, where levels of resources can be quite comprehensive and emergency support is more available. In contrast, overwintering teams spend a prolonged period in the region (>1 year) encompassing the dark polar winter, with reduced team sizes and reduced or even no ability for emergency extraction if required (Palinkas & Suedfeld, 2008). A final type that has less consideration in the literature are those researchers who live and work within communities in the high Arctic, such as anthropologists (e.g., Boyd, 2023). This may involve experiencing living conditions which are like the treks or field camps, or potentially living in a small village or town with some access to amenities. In summary, whilst the magnitude of different stressor may vary across types, it can be stated that all these types of expedition require adaptation to stressors that are surpassed what would be expected in daily life outside of these regions of the world,

therefore compliant with applying the term resilience. The key stressors generally experienced by polar expeditioners will now be discussed at each level of a socio-ecological model.

1.2.2.1 Contextual/Environmental Stressors

The polar regions are among the most challenging and hostile natural environments on Earth, with the ability to profoundly impact human functioning across multiple levels (Palinkas & Suedfeld, 2008, 2021). This includes experiencing the coldest temperatures on Earth, with the coldest recorded air temperature of −89.2°C at Vostok Station, Antarctica (Darack, 2013). Such severe cold can lead to injuries like frostbite and hypothermia, potentially resulting in limb loss or fatalities without appropriate equipment (Palinkas & Suedfeld, 2021). Additionally, polar weather systems can produce intense storms, causing white-out conditions and strong winds capable of confining expeditioners indoors or destroying temporary shelters (Palinkas & Suedfeld, 2021). Hazardous ground conditions can create serious risks from crevasses or leads (cracks in sea ice) for those completing polar treks or journeying to field camps. The unique polar light/dark cycles result in prolonged periods of complete darkness during winter and continuous daylight in summer, disrupting circadian rhythms and affecting human physiology (e.g., Shao et al., 2024). The extreme physical and environmental challenges of the region, combined with geographical distance from home and limited access to support, heighten the perception of isolation and confinement. These environmental factors collectively contribute to profound physiological changes, affecting endocrine and nervous system functioning, while also causing significant psychological strain, including impaired sleep, mood disturbances, and cognitive dysfunction (Palinkas & Houseal, 2000; Palinkas & Suedfeld, 2008; Pattyn et al., 2018). The isolation and confinement imposed by the expedition environment can also create considerable challenges at the relational level.

1.2.2.2 Relational Level Stressors

The inter-connected nature of socio-ecological relationships is well highlighted by the way that the environmental effects of isolation and confinement can lead to effects at the relational level. Numerous studies have reported how being isolated from wider social networks and confined with a small group of people can lead to a gradual decline in group cohesion and increases in social tension across the duration of an expedition (Gunderson, 1974; Nicolas, Suedfeld, et al., 2016; Palinkas, Glogower, et al., 2004; e.g., Palinkas, Johnson, et al., 2004, 2004; Wood et al., 1999). This effect has been referred to as the "goldfish bowl effect", describing how small insignificant issues are gradually amplified over time (Van Puyvelde et al., 2022, p. 13). For example, Wood and colleagues (1999) investigated psychological adaptation by examining two Australian Antarctic field teams during 100-day traverses. The study found that interpersonal tensions were the most frequently reported stressor, and that tensions increased during the expedition due to unresolved interpersonal conflicts developing and growing in magnitude. Notably, unlike other situations, expeditioners can rarely escape those they dislike and must continue to live and work in close proximity (Palinkas & Suedfeld, 2021).

A second area at this level is group dynamics, which may be influenced by an array of identity characteristics and the way the group is managed. One way cohesiveness can be decreased is when cliques or subgroups form within an expedition group (e.g., Palinkas et al., 2000). For example, Palinkas and colleagues (2000) examined the effects of clique structures versus those with a central core group. The results showed that crews which developed a clique structure reported significantly higher levels of tension, anxiety, and depression compared to groups with a more cohesive structure. While group dynamics are shaped by a range of factors, one of the most consistently reported sources of tension arises from differences in key facets of

identity, such as gender, occupation, and cultural factors, including language-related issues between nationalities (Gunderson, 1974; Nash, 2022; Rivolier et al., 1991; Rosnet et al., 2004). These identity-related differences often influence how individuals interact within the group, shaping cohesion and the potential for conflict. In recent years, numerous studies have illuminated the challenges faced by females, especially in Antarctic stations. For example, Nash and Nielsen's (2020) study found that over 60% of Australian women scientists reported experiencing harassment, often early in their careers, with the isolation of Antarctic settings exacerbating these issues. These challenges not only affected individual well-being but also disrupted group cohesion, further compounding relational stressors within expedition teams.

1.2.2.3 Individual Level Stressors

At the individual level, personal traits and attributes can interact with social and environmental challenges, often exacerbating the effects of isolation, confinement, and harsh conditions in polar environments. Building on the term popularized by Tom Wolfe's *The Right Stuff* (1979), researchers studying high-stress roles such as astronauts and polar expeditioners have identified personality traits linked to both the "right stuff" and the "wrong stuff." These frameworks have been used to identify individuals who may be unsuitable for high-stress missions based on traits like high competitiveness, negative instrumentality, and low positive expressivity (Chidester et al., 1991; Palinkas & Suedfeld, 2021). There is robust empirical support for these traits in polar expeditions, with studies documenting their association with interpersonal conflict and reduced performance (Corneliussen et al., 2017; Gunderson, 1974; Sandal, 2000). For example, Sandal (2000) highlights those individuals with negative instrumentality, such as hostility, impatience, and low emotional expressivity, are more likely to experience relational stress, interpersonal conflict, and decreased performance. Furthermore, related traits such as neuroticism have

consistently been linked to poorer expedition well-being and performance outcomes, including increased anxiety and depression (Palinkas et al., 1995; Steel et al., 1997; Van Fossen et al., 2021). However, studies indicate that neuroticism accounts for only a small proportion of variance in mental health and interpersonal conflict outcomes (e.g., Van Fossen et al., 2021). This underscores the importance of considering the specific context and the dynamic interplay between individual traits and environmental factors.

1.2.3 Polar Resilience Assets & Resources

While polar expeditions pose numerous challenges, resilience is supported by a range of individual and resources provided at the relational, and contextual levels. This section explores the mechanisms through which these factors contribute to the well-being and adaptation to polar environments.

1.2.3.1 Individual Level Resilience Assets

Among the factors contributing to resilience, the individual personality characteristics of expeditioners have been the most comprehensively studied. Research in this area has identified several key traits considered essential for personnel working in high-risk roles, including expeditioners in ICE environments (Gunderson, 1974; Musson et al., 2004; Sandal et al., 1998, 1999). Decades of research have identified three core clusters of attributes; task motivation, social compatibility, and emotional stability as critical for resilience and performance. These findings are consistently supported across multiple personality scales (Musson et al., 2004). The first cluster of attributes is strong task motivation, often associated with high conscientiousness. For example, Antarctic over-winterers who scored highly on these traits were better able to maintain performance and complete critical tasks, even during the harsh winter months. This, in turn, had a positive residual effect on the morale of other team members (e.g., Gunderson, 1974).

The second cluster of attributes involves social compatibility, which includes traits such as agreeableness and positive expressivity. These traits contribute to effective teamwork and interpersonal harmony, both of which are critical for resilience in ICE environments (Palinkas et al., 2004). The third cluster of attributes is high emotional stability, often described as low neuroticism. Individuals with high emotional stability are better able to maintain consistent behavior, experience significantly lower levels of anxiety and depression, and are less likely to create or exacerbate group conflict. These traits were particularly evident among Antarctic over-winterers (Gunderson, 1974). Palinkas and colleagues (2010), in their systematic review of resilience literature, further support the importance of global personality measures in predicting resilience. They also highlight the role of demographic factors, such as age, prior experience, and compatibility with other group members, as key contributors to successful adaptation in ICE environments. While individual differences provide a foundation for resilience, the strategies expeditioners use to cope with stress and challenges have also emerged as critical components in maintaining well-being and performance during expeditions.

1.2.3.1.1 Coping strategies.

The type of coping strategies that an individual utilizes during an expedition has been one of the most widely researched areas in polar studies (Palinkas & Suedfeld, 2008, 2021). There are numerous definitions of coping that exist but one that has been used previously in polar research is “coping identifies a response whose goal is to reduce physiological disruption of homeostasis and psychological negative affect caused by environmentally imposed challenge” (Suedfeld et al., 2009, p. 313). Research on coping has generally focused on the creation of broad categories of coping such as the distinction between problem- and emotion-focused coping styles (Lazarus & Folkman, 1984). Problem focused strategies are most useful when the person has some control

over the situation and can attempt to solve or change the situation. In contrast, emotion-focused strategies, are centred on actions or behaviours that reduce the emotional response to the problem (Lazarus & Folkman, 1984). Polar studies have frequently reported that expeditioners use both problem- and emotion-focused strategies. Among problem-focused strategies, planful problem-solving has been consistently associated with better well-being and performance (Kahn & Leon, 1994; Kjærgaard et al., 2015; Leon et al., 1989, 1991; Smith et al., 2017, 2021). This strategy makes sense in an environment where small issues can quickly cascade into potentially life-threatening ones if ignored. The use of positive cognitive reappraisal of the situation (Leon et al., 1989, 1991; Smith et al., 2017, 2021) and using comforting cognitions (Atlis et al., 2004; Kjærgaard et al., 2015) are examples of key emotion-focused strategies used. These strategies may be better fitting for situations where the individual cannot change the situation itself. Recent research highlights the importance of coping flexibility, defined as the ability to adapt strategies to changing demands and contexts, rather than relying on any single coping approach. Sandal and colleagues (2018) observed that during the third quarter of a 10-month Antarctic deployment, participants exhibited a marked reduction in coping efforts, a phenomenon they termed 'psychological hibernation.' This decline reflects the severe environmental challenges encountered during this phase and underscores the importance of adapting coping strategies to expedition stages.

Taking these points into account, the importance of displaying coping flexibility has begun to gain more consideration in both the general coping literature (Bonanno et al., 2011; Cheng et al., 2014) and polar expedition studies (Devonport et al., 2011; Kjærgaard et al., 2015; Smith et al., 2021). Bonanno and Burton (2013) proposing that showing sensitivity to the specific context, having a range of strategies that can be employed, and constantly evaluating the

efficacy of a strategy based on feedback are key components of flexibility. Smith and colleagues (2021) provide an example of context sensitivity through a diary study of an Antarctic ski expedition. Their findings showed that strategy preferences shifted depending on the stage of the trip. During the early stages, participants relied more on active problem-solving and task immersion, while in the later stages, they increasingly used emotion-focused strategies such as positive reappraisal. The authors noting that early on whilst the group is forming and adapting to the task demands encountered, high task focus and lower emotional sharing are well matched. Participants then progressed to more emotional focused coping as the team developed and the number of controllable changes they could make reduced. Previous studies have inferred coping flexibility from the variety of strategies used by participants. However, validated scales like the Perceived Ability to Cope with Trauma (PACT: Bonanno et al., 2011) now allow researchers to quantify flexibility more precisely by assessing how individuals switch between strategy types. Mindfulness is another construct often associated with coping and has been proposed as a mechanism that can enhance coping flexibility.

Mindfulness, which involves maintaining a present-focused awareness of experiences, has gained increasing attention for its role in enhancing resilience and coping in high-stress environments (Pagnini et al., 2024). One definition for the construct is provided by Brown and Ryan (2003) as “a receptive attention to and awareness of present events and experience” (p. 822). A large body of evidence, including meta-analytic evidence (e.g., Sala et al., 2020; Carpenter et al., 2019) shows that displaying higher levels of dispositional mindfulness is positively associated with better health and well-being and reduced negative affective symptoms. Furthermore, interventions aimed at improving levels of mindfulness result in moderate size effects on reducing ill-being and improving well-being (Eberth & Sedlmeier, 2012; Grossman et

al., 2004; Gu et al., 2015; Khoury et al., 2015). Although mindfulness has rarely been studied in polar expeditions, recent findings suggest its potential as a promising factor in enhancing resilience. Pagnini and colleagues (2019) investigated the relationship between trait mindfulness and stress among Antarctic over-winterers at the Concordia research station. Their findings revealed that individuals with higher baseline levels of mindfulness experienced lower stress throughout the expedition. Additionally, increases in mindfulness during the expedition were associated with further reductions in stress. These findings highlight the potential of mindfulness as a tool to enhance coping flexibility in high-stress environments, warranting further investigation in expedition contexts.

1.2.3.2 Relational Resilience Factors

1.2.3.2.1 Social Support.

The role of social support is widely acknowledged as a key resilience factor in non-extreme environments, yet its effectiveness during polar expeditions remains contentious. Social support can be defined as the assistance provided by others through emotional, informational, or instrumental means, which can represent actual support received or that it is perceived to be available if required (Thoits, 2011). This broad construct encompasses several key forms: emotional support, which involves empathy and care; informational support, which provides guidance or advice; instrumental support, which includes practical help or resources; and appraisal support, which helps individuals assess and select coping strategies (Jolly et al., 2021). The source of support, whether from intimate partners, family, close friends, or more distant groups such as colleagues or community organizations can significantly impact its effectiveness in promoting resilience (Thoits, 2021). These dimensions of social support play an important role

in a variety of populations and contexts but may function differently in extreme environments such as polar expeditions.

Several studies have linked the use of social support in polar expeditions to negative outcomes, such as decreased well-being, increased ill-being, and elevated levels of depression and anger (Leon et al., 1991; Palinkas, Johnson, et al., 2004, 2004; Smith et al., 2021). For example, Leon et al. (1991) found that in a Soviet-American mixed-gender expedition team, the use of social support was associated with higher stress reactivity and negative emotionality, suggesting that, under certain conditions, reliance on social support may exacerbate stress. Additionally, contextual factors, such as group dynamics and stressors unique to polar expeditions, may influence these outcomes.

Conversely, other studies report positive outcomes from social support, particularly in female-dominant groups. For instance, studies of all-female or female-majority polar expedition teams have found that emotional sharing and mutual support significantly enhance well-being and reduce stress (Atlis et al., 2004; Leon, 2005). Gender differences in how social support is utilized may help explain these inconsistent results, as males are generally less likely to seek emotional support compared to females (Taylor et al., 2004). Furthermore, the effectiveness of social support may depend on its form (e.g., perceived vs. actual support) and type (e.g., emotional, informational). Perceptions of support tend to have a larger positive effect on well-being than actual support, possibly because the belief in available support offers psychological comfort even if it is never used (Thoits, 2021). These findings suggest that the type, source, and perception of social support are crucial considerations when evaluating its role in extreme environments.

1.2.3.3 Contextual/Environmental

1.2.3.3.1 Natural environment

Polar environments are often associated with significant risks and challenges, but prolonged exposure to these extreme natural settings has also been linked to positive psychological effects and personal growth. (for review see Palinkas & Suedfeld, 2008, 2021). As noted by Leon and colleagues (2011), the positive aspects of the polar environment are often overlooked in favour of the associated hazards yet may play an important role in psychological health. Numerous studies, spanning from the diaries of the heroic age to present day have reported how expeditioners derive benefits from the natural environment (Atlis et al., 2004; Kahn & Leon, 1994; Kjærgaard et al., 2015; Mocellin & Suedfeld, 1991, 1991; Smith et al., 2017, 2021). Despite the hazards frequently highlighted in polar research, a growing body of literature suggests that these environments may foster resilience through their unique psychological benefits.

Several mechanisms have been proposed to explain how polar environments contribute to psychological resilience, including absorption (Barabasz, 1991; Leon et al., 1989), awe (Atlis et al., 2004; Løvoll & Sæther, 2022; Mocellin & Suedfeld, 1991), and place attachment (Palinkas et al., 1998). For example, Atlis et al. (2004) reported that during a traverse of Antarctica, two female expeditioners frequently experienced awe and deep engagement with the environment, which provided emotional support and helped them manage the expedition's mental and physical demands. Their ability to derive strength from the natural surroundings exemplifies how polar environments can offer psychological benefits beyond the challenges they present. To date however, few polar studies have empirically looked to study the role of nature. These include studies of the relationship between the trait of absorption and a deeper connection to the

environment which may be beneficial (Barabasz, 1991; Leon et al., 1989). A second proposition is that the size and scale of polar environments can induce positive emotions such as eliciting the emotion of awe (Mocellin & Suedfeld, 1991; Lovoll & Saether, 2022; Atlis et al., 2004; Smith et al., 2017). Thirdly, Palinkas (1998) proposed that one mechanism through which individuals may derive increased well-being from the environment was through developing a sense of place attachment. He stated that feelings of awe and transcendence could support psychological resilience. However, at present, no studies have empirically measured the level of attachment or connection between expeditioner and the polar environment. Furthermore, most studies have only touched on the psychologically restorative potential of the polar environment, usually as a secondary consideration rather than a primary focus. While place attachment offers a broad framework for understanding emotional bonds with polar environments, the concept of nature connection provides a more specific lens for exploring how these bonds impact resilience.

1.2.3.3.2 Nature connection.

Nature connection can be summarized as a multi-dimensional sense of emotional, cognitive, and self-identity bond with the natural world, where individuals experience a sense of belonging and recognize their interdependence with nature (Mayer & Frantz, 2004; Nisbet et al., 2009; Schultz et al., 2004). Evidence from non-extreme environments has established a strong relationship between nature connection and well-being. Meta-analyses have reported a moderate effect size for this association, highlighting the potential for nature connection to enhance resilience and psychological health across diverse contexts (McMahan & Estes, 2015; Pritchard et al., 2020; Sheffield et al., 2022). These findings suggest that fostering nature connection may play an important role in promoting resilience, particularly in environments where individuals are closely immersed in natural settings.

To date, while polar studies provide qualitative insights into nature connection, the construct has not yet been quantitatively measured in these settings. For example, Devonport et al. (2022) reported that one expeditioner acknowledged the challenges of the environment but consciously reframed nature as a positive part of their experience rather than a hostile force, leading to reduced threat appraisals. Similarly, Løvoll and Sæther (2022) found that immersion in the Arctic wilderness evoked feelings of awe, humility, and a profound sense of connection to nature, contributing to spiritual well-being among students participating in an advanced glacier course. These narratives highlight how emotional and cognitive engagement with the natural environment may enhance resilience and well-being in extreme settings. Despite these compelling findings, the potential for nature connection to foster resilience during polar expeditions remains underexplored. Studies conducted in non-polar contexts suggest that nature connection is associated with significant psychological benefits, but there is a strong rationale for quantitative research to measure and evaluate these relationships in polar environments. Such investigations could illuminate how nature connection contributes to adaptation and well-being in these unique and challenging settings.

Throughout this thesis, the terms “nature connection,” “connection to nature,” and “nature relatedness” are used intentionally. “Nature relatedness” is employed in reference to constructs assessed in specific studies, including a BPNT-derived measure used in Chapter 4, which is distinct from the social relatedness typically measured in BPNT research. It does not refer to the well-known Nature Relatedness Scale, which is conceptually similar to “connection to nature” (Nisbet et al., 2009). In contrast, “nature connection” and “connection to nature” are used more broadly to describe individuals’ emotional and cognitive affiliation with the natural

world. This distinction is maintained to ensure conceptual and methodological clarity across the different studies within the thesis.

1.3 Basic Psychological Needs Theory (BPNT)

The diversity of resilience factors identified in the literature highlights the need for theoretical frameworks that can provide structure and parsimony (Mukherjee & Kumar, 2017). When it comes to the interaction between the individual and the environment, another useful framework to consider is the Self-determination theory (SDT: Deci & Ryan, 2008). Congruent with the social-ecological perspective it proposes healthy development is supported by the social environment from childhood and throughout adulthood (Ryan & Deci, 2017). SDT has become one of the most empirically researched and applied in psychology (Ryan & Deci, 2019). As a broad theory it offers an explanation to understanding human motivation, personality, wellness and ill-being (Ryan & Deci, 2017). At the centre of the theory is the importance of three basic psychological needs.

According to SDT, healthy development is underpinned by the satisfaction of three psychological basic needs; Autonomy refers to a sense of volition or choice in activities a person undertakes and results in a sense of authenticity within self. Competence relates to a sense of mastery within activities undertaken and environments encountered. Finally, relatedness, represents a reciprocal feeling of connection both towards and from other people such as kinship bonds of warmth and caring (Vansteenkiste et al., 2020). In contrast, when these needs are actively thwarted, rather than simply unfulfilled it has been associated with psychopathology. Specifically, lack of autonomy, can result in a sense of pressure and conflict to do things against the will of the self. A lack of Relatedness can result in feelings of loneliness and exclusion and a lack of competence to feelings of failure and helplessness (Vansteenkiste et al., 2020). The importance of these needs is consistent with resilience research, where all three needs have independently been highlighted as key contributors to resilience (Werner, 1995; Windle, 2011).

This element of SDT formed a mini theory of SDT known as Basic Psychological Needs Theory (BPNT: Vansteenkiste & Ryan, 2013). The theory has built up a great deal of empirical support in diverse research domains with meta-analyses in areas such as performance in the workplace (Deci et al., 2017), health contexts (Ng et al., 2012) and physical education (Vasconcellos et al., 2020), all supporting a small to moderate effect of needs satisfaction on measures of well-being and task performance. Furthermore, the theory has shown efficacy cross-culturally, including individualistic and collectivistic cultures (Chen et al., 2015).

1.3.1 BPNT & Resilience

To date, there is a growing body of research that has examined the relationship between BPNT and resilience, with results consistently supporting a relationship between BPN satisfaction and resilience (Abualkibash & Lera, 2017; Diotaiuti et al., 2021, 2021; González et al., 2019; Lera & Abualkibash, 2022; Naemi, 2018; Perlman et al., 2017; Trigueros et al., 2019). However, often these studies have used cross-sectional designs in which trait measures of resilience have been used (González et al., 2019; Lera & Abualkibash, 2022; Naemi, 2018; Neufeld & Malin, 2019; Perlman et al., 2017; Trigueros et al., 2019), and often treating the measure itself as a resilience outcome (Perlman et al., 2017; Naemi, 2018; Trigueros et al., 2019; Gonzalez et al., 2019). A few studies have shown a relationship between BPN, Resilience and Well-being (Diab & Green, 2024; Liu & Huang, 2021; Neufeld & Malin, 2019; Xu et al., 2021). Furthermore, some studies have shown BPN to be predictive of resilience (Abualkibash & Lera, 2017; Diotaiuti et al., 2021; Naemi, 2018; Perlman et al., 2017; Trigueros et al., 2023), whilst others report relationships in the opposite direction (González et al., 2019; Xu et al., 2021). However, neither direction can be confirmed with all studies using cross-sectional designs. Additionally, some studies have reported that, dependent on the specific context investigated specific basic needs may be a

stronger predictor than others (e.g., Relatedness: Perlman et al., 2017). For example, Perlman and colleagues (2017) investigated if BPN explained levels of trait resilience in individuals living with mental health issues. The results showed that only relatedness was a significant predictor of resilience. In contrast, a study with medical students, showed that competence showed the strongest relationship with resilience (Neufeld & Malin, 2019) and in long-distance runners' autonomy and competence showed strong relationships with resilience (Diotaiuti et al., 2021). These findings are consistent with the notion that the specific profile of which individual BPN satisfaction are most important for resilience maybe dependent on the specific context being investigated.

At present, only a few studies have applied a socioecological resilience model in combination with BPNT (Abualkibash & Lera, 2017; Lera & Abualkibash, 2022). For instance, Abualkibash and Lera (2017), in their study of Palestinian school students living in adversity, used a cross-sectional design to investigate whether satisfaction of BPN was associated with socioecological resilience. Their results showed that BPN was positively associated with resilience at the individual, caregiving, and contextual levels, supporting the premise that satisfying basic needs contributes to resilience within a socioecological framework. However, due to the cross-sectional nature of the study, the direction of the relationship between BPN and resilience cannot be confirmed. Furthermore, their use of a resilience scale as an outcome variable, rather than actual resilient outcomes such as well-being or performance, limits the conclusions that can be drawn about how resilience manifest. To date, there are very few studies which have shown the relationship between BPN and resilience using longitudinal designs (Diab & Green, 2024; Liu & Huang, 2021; Xu et al., 2021).

Consistent with the critiques highlighted in the preceding paragraph, Bonanno (Bonanno, 2012) argues that cross-sectional designs fail to capture resilience as a dynamic process. Furthermore, trait-based measures of resilience, which conceptualise it as a stable personal characteristic, should not be used to infer resilient functioning. Instead, they reflect the presence of resilience-related factors that may support adaptation, rather than resilience itself as an outcome. Therefore, there is a gap in the literature for studies which have investigated the relationship between BPNT and socioecological resilience, which utilizes longitudinal designs and includes outcome measures of resilience, rather than the likelihood of displaying resilience which resilience scales measure. Key BPNT scholars, Vansteenkiste and Ryan (2013) support this view by emphasizing that the satisfaction of basic psychological needs, such as autonomy, strengthens inner resources that contribute to resilience. This aligns with Bonanno's (2004) model of resilience as a dynamic process shaped by ongoing need satisfaction rather than a fixed trait. Both perspectives underscore the importance of resilience being studied as an evolving trajectory. Therefore, BPNT and resilience theory together highlight the necessity of longitudinal designs to fully capture how need satisfaction fosters resilient functioning over time.

1.3.2 BPNT and Extreme Environment Research

At present, whilst BPNT has a large body of evidence supporting its general propositions, relatively few studies that have investigated its role in promoting resilience in extreme environments. In recent years, BPNT has been proposed as a key theory to understand resilience-related factors in various extreme environments, including polar expeditions (e.g., Smith et al., 2021), deep-space missions to Mars (Goemaere et al., 2016; Smith et al., 2023), and wilderness adventure racing (e.g., Houge Mackenzie & Hodge, 2020). However, whilst several studies have used BPNT to explain their qualitative analyses (Devonport et al., 2022; Kay et al., 2022), there

are very few studies that have quantitatively measured BPN in extreme environments (Goemaere, Van Caelenberg, et al., 2019) . For example, Goemaere et al. (2019) examined how basic psychological needs relate to various positive outcomes (e.g., happiness, performance) and negative outcomes (e.g., stress, irritation with mission support) during an analog space mission simulating future long-duration missions. Six volunteers completed weekly self-report measures, along with mission commander ratings of performance during a year-long mission. The results indicated that all three basic needs were significantly associated with a range of outcome variables. Notably, autonomy and relatedness with team members had the strongest relationships, with positive associations to happiness and performance and negative associations to stress.

In a related study, Goemaere et al. (2019) investigated whether a more autonomy-supportive environment, as perceived by participants, was associated with better outcomes. Autonomy-support is when leaders create an environment where individuals feel they have choices and can contribute to decision-making. This has been associated with positive outcomes both in terms of well-being and measures of task performance. In contrast, controlling environments that impose strict deadlines and limit choices can reduce feelings of not only autonomy, but also competence and relatedness (Pelletier et al., 2001). Consistent with this, results showed that, in weeks when the crew reported higher levels of perceived autonomy support from the ground crew, they experienced fewer conflicts and more positive working relationships (Goemaere et al., 2019b). These studies suggest that findings from extreme environments align with the broader literature, indicating that satisfying BPN is associated with a range of positive outcomes and fewer negative consequences.

1.3.3 BPNT & Relationships Across Levels

BPNT provides a promising framework for explaining resilience in extreme environments, which could aid parsimony in understanding a construct that is acknowledged to be multi-faceted and which specific variables are most important varies by context. BPNT provides a firm and well supported prediction that situations, contexts and variables which support the satisfaction of autonomy, competence, and relatedness will lead to improved well-being and reduced levels of ill-being (Ryan & Deci, 2017). Each of these needs aligns with well-established resilience factors, including coping strategies, social support, and nature connection, which are critical for individuals operating in high-stress settings such as polar expeditions. Together, these associations suggest that BPNT is likely to explain significant variance in well-being and ill-being outcomes of polar expeditioners, supporting its suitability as a framework for resilience in extreme environments.

1.3.3.1 BPN & Coping

The previous sections of this review have highlighted the crucial role of coping strategies in promoting resilience during expeditions. Both theoretical and empirical evidence suggests that fulfilling basic psychological needs (BPN) may underpin the positive effects of these strategies on mental health (Devonport et al., 2022; Ntoumanis et al., 2009; Skinner et al., 2003). For example, Skinner and Edge (2003) proposed a model in which they considered that appraisals of threat were assessed in terms of potential risks to the satisfaction of the basic needs for autonomy, competence and relatedness. Specifically, depending on which basic need the situation related to and the appraisal as either a challenge or threat, would influence the selection of individual coping strategies. Additionally, they proposed that social support and the need for autonomy were key factors. A recent study by Devonport et al. (2022) applied this model in a

polar expedition setting, finding that explorers' coping responses, such as problem-solving and negotiation, aligned with the satisfaction or frustration of these basic needs throughout their journey. Thus, according to Skinner and Edge's model, displaying flexibility in coping strategies may better enable individuals to select responses that protect and fulfil their basic psychological needs. This flexibility is especially valuable in high-stress environments, such as polar expeditions, where mental health is crucially supported by adaptive responses that satisfy autonomy, competence, and relatedness.

1.3.3.2 BPN & Social Support

Although evidence for social support's role in resilience during polar expeditions is somewhat mixed, broader resilience research and BPNT underscore its crucial role in supporting need satisfaction and, ultimately, resilience (Ibarra-Rovillard & Kuiper, 2011; La Guardia & Patrick, 2008; Ryan & Deci, 2017). A central tenet of BPNT is the proposition that the social conditions experienced in any situation will play a key role in whether the individual derives need support or, conversely, experiences need deprivation or even thwarting conditions, which are likely to result in reduced need fulfilment and negative well-being consequences (Deci & Ryan, 2008)).There are many studies across a range of contexts such as education, sport, the workplace which support that increased social support is associated with the satisfaction of basic needs and resulting in better well-being (Gillet et al., 2012; Kassis et al., 2019; Reinboth & Duda, 2006; Tian et al., 2016; Van den Broeck et al., 2016; Yuan et al., 2024). For example, Gillet and colleagues (2012) assessed how perceived support from supervisors and the organization generally influenced BPN satisfaction and employee well-being. The study found that both organizational and supervisor support significantly contributed to autonomy, competence, and relatedness satisfaction, which were positively associated with job satisfaction and overall

happiness. This highlights the importance of a supportive social environment for fulfilling BPN and resulting in better levels of well-being. Additionally, in numerous studies the fulfilment of relatedness has been shown to take the lead in terms of the strength of the relationship between social support and well-being outcomes (Maas et al., 2022; Patrick et al., 2007; Van Den Broeck et al., 2010). These findings underscore the important role that the social context plays in supporting well-being and how certain basic needs may account for this relationship.

1.3.3.3 BPN & Nature

Nature plays a pivotal role in BPNT, with its central proposition asserting that exposure to natural environments enhances the satisfaction of basic psychological needs compared to artificial, non-natural settings (Deci & Ryan, 2017). Extensive research demonstrates that much of nature's positive impact on well-being is mediated through the fulfilment of autonomy, competence, and relatedness needs (Landon et al., 2021; Lee et al., 2022; Vijaikis & Poškus, 2024; Weinstein et al., 2009; Yang et al., 2022). For instance, Yang et al. (2022) conducted experiments showing that exposure to natural settings, such as parks or scenic landscapes, significantly enhances psychological well-being through the fulfilment of autonomy and competence needs. Participants in natural environments reported higher life satisfaction and positive affect compared to those in urban settings. In addition, qualitative studies have shown that individuals often report developing deep connections to natural environments, attributing these bonds to the satisfaction of their basic psychological needs (Crockett et al., 2022; Landon et al., 2021). This dynamic may also explain why polar expeditioners frequently return to these regions, drawn by their perceived psychological benefits (e.g., Palinkas & Suedfeld, 2008). Collectively, these studies underscore nature's crucial role in promoting well-being through

BPNT. However, further research is needed to clarify the underlying mechanisms driving these effects.

Beyond supporting the existing basic psychological needs, some researchers have argued that nature connection or relatedness itself may qualify as an additional basic psychological need. This is distinct from relatedness which is represents social connectedness to other people. Thus, nature may both have a direct effect and could also support a greater level of social relatedness. This idea is supported by recent reviews (Baxter & Pelletier, 2019; Hurly & Walker, 2019), which assessed nature connection against Baumeister and Leary's (1995) criteria for defining a psychological need. These criteria include producing affective consequences, directing cognitive processing, leading to ill-effects when thwarted, prompting goal-oriented behavior to satisfy the need, being universal across cultures, and affecting a broad range of behaviors. Both reviews concluded that empirical evidence supports classifying nature connection as a basic psychological need. However, this proposition remains an area of active inquiry, as more research is needed to fully evaluate the extent to which nature connection meets the criteria for a psychological need.

1.4 Summary & Conclusions

This review began by exploring the diverse conceptualizations and definitions of resilience, highlighting the challenges posed by its application across varied contexts. Resilience, as a construct, has been studied in domains as diverse as childhood adversity and acute trauma in adulthood. While early developmental studies considered academic achievement in the face of adversity as indicative of resilience, adult resilience research often emphasizes maintaining daily functioning and the absence of psychopathology. A consistent finding across these domains is

that resilience is context-dependent, underscoring the need for researchers to clearly define both the adversities encountered and the criteria for positive adaptation.

Developmental studies have made significant contributions to resilience research, particularly through the use of longitudinal designs, which have demonstrated that resilience is a dynamic process, fluctuating over time and across life domains. This contrasts with later research relying heavily on cross-sectional designs, which can overstate resilience levels by capturing only a single time point. This reinforces the importance of interpreting resilience findings cautiously and avoiding overgeneralization.

The debate over whether resilience is best conceptualized as a personal attribute or as a dynamic process has begun to converge on the idea that personal traits are an important aspect of resilience, however, there interaction with environmental factors offers a more comprehensive understanding. Resilience involves a combination of inherent traits and the influence of environmental interactions, with environmental factors playing a critical role in fostering or hindering resilience. Recognizing the interplay between individual and environmental factors, the socio-ecological model of resilience has been proposed as a framework to organize the diverse range of factors influencing resilience.

The socio-ecological model acknowledges that support and risks to resilience operate at multiple levels, from individual traits to broader societal structures. However, much of the existing research remains focused on individual-level factors, with limited exploration of higher levels, such as relational and contextual influences. To address this gap, the integration of Basic Psychological Needs Theory (BPNT) is proposed. With its strong empirical base, BPNT offers a parsimonious framework that aligns with many factors implicated in resilience. Its core needs of

autonomy, competence, and relatedness have been shown to operate across socio-ecological levels, from individual to organizational contexts.

The combination of the socio-ecological model and BPNT appears particularly promising for understanding resilience in polar expeditions. These frameworks provide a way to reconcile the diverse resilience factors relevant to temporary operators, such as polar expeditioners, who face significant individual and contextual challenges. This focus highlights the importance of addressing resilience as a dynamic interplay between personal traits, relational dynamics, and environmental conditions.

In summary, the field of resilience research is shifting away from an exclusive focus on individual-level explanations of adaptation to adversity. Increasingly, there is recognition of the critical role of environmental and contextual interactions. The socio-ecological model provides a valuable framework for examining these interactions, but higher-level influences remain underexplored. Incorporating BPNT into this framework offers a parsimonious and universalist approach that can account for resilience across diverse contexts, including the unique challenges of polar environments. Within polar expeditions, resilience is predominantly influenced by individual and relational factors, shaped by the extreme environmental conditions. Individual traits such as coping flexibility, mindfulness, and positive emotional regulation strategies interact with relational dynamics, including team cohesion and effective leadership, to foster resilience. Contextual factors, such as the availability of resources and a connection to the natural environment, also play an essential role in supporting positive adaptation.

In conclusion, integrating the socio-ecological model with BPNT offers a robust framework for understanding resilience in polar contexts. This approach not only unifies diverse resilience factors but also emphasizes the dynamic interplay between individual and

environmental influences. By adopting this framework, future research can advance both theoretical understanding and practical strategies for enhancing resilience in extreme environments.

1.5 Thesis Aims and Research Questions

Despite decades of research on the resilience of polar expeditioners, there remains a critical gap in the application of resilience theory to understand their experiences. This thesis aims to address this gap by combining a socio-ecological model of resilience with Basic Psychological Needs Theory (BPNT) as a universal framework to explore resilience within the context of polar expeditions.

1.5.1 Specific Aims

The primary aim of this thesis is to examine if the basic psychological needs for autonomy, competence and relatedness can explain the resilience of Polar expeditioners. Aligned with a socio-ecological approach, this thesis hypothesizes that the satisfaction of basic psychological needs (autonomy, competence, and relatedness) will mediate relationships between resilience-related factors at individual, relational, and environmental levels and outcomes of well-being and ill-being.

1.5.2 Study Outline

To support investigation of this aim, the thesis contains four empirical chapters:

Chapter 2 presents a cross-sectional study conducted with polar expeditioners that investigated if BPN mediated the relationships between variables across the levels mentioned and composite measures of well-being and ill-being.

Chapter 3 presents a longitudinal study with polar expeditioners completing physical journeys. Using an intensive repeated measures daily diary design to investigate if BPN, coping flexibility, and nature relatedness could predict daily changes in expedition well-being and ill-being.

Chapter 4 presents a qualitative study which used semi-structured interviews with twenty-five polar expeditioners to further investigate the factors they believed created expeditioners stressors and conversely those that supported their successful completion of the expeditions.

Chapter 5 summarizes the key findings presented in this thesis and discusses the implications of the results. Additionally, reflecting on the limitations of this thesis and proposing directions for future research.

Chapter 2: Autonomy and Relatedness Support Polar Expedition Resilience

Abstract

Polar expedition resilience has been studied extensively over the past 50 years, producing a rich and detailed body of work. This study builds on this foundation by integrating the social ecological model of resilience with Basic Psychological Needs Theory (BPNT), providing a framework to offer new insights and firm predictions. The primary aim was to investigate whether the basic psychological needs for autonomy, competence and relatedness mediate the relationships between resilience predictors, including personal resilience, coping flexibility, connection to nature, and social support from friends, family, and community, representing multiple levels of the socioecological model. A cross-sectional study was completed with 95 Polar expeditioners who had completed expeditions in both hemispheres. Using R statistics package the data was analysed using Hayes PROCESS macro for testing multiple mediators. The results demonstrated that basic needs mediated relationships for most predictors, spanning all socioecological levels. The results showed that autonomy emerged as a key mediator, fully explaining the link between personal resilience and well-being while also partially mediating the effects of connection to nature and community support. Additionally, autonomy significantly mediated the relationship between connection to nature and ill-being. Relatedness primarily mediated the relationships with ill-being, fully explaining the effects of friend support, community support and connection to nature. Notably, competence did not mediate any significant relationships. Coping flexibility showed a direction positive affect on well-being, independent of basic needs. These findings highlight the

important role of autonomy and relatedness in polar resilience processes, offering theoretical insights and practical avenues for developing expedition support.

The Polar Regions present some of the most inhospitable conditions on earth, where extreme environmental and psychosocial stressors pose significant challenges to human functioning. These include prolonged periods of light or darkness, severe cold, and social isolation. (For a detailed overview of these challenges, see Chapter 1.) Given these conditions, there is a growing recognition of the need for robust theoretical frameworks to understand adaptation and resilience in such environments (Goemaere et al., 2016; N. Smith et al., 2021). The present study examines polar resilience through the lens of Basic Psychological Needs Theory (BPNT; Vansteenkiste & Ryan, 2013), which emphasizes the role of satisfying autonomy, competence, and relatedness in maintaining psychological well-being under adverse conditions.

2.1.1 Basic psychological needs theory

BPNT is a core component of Self-Determination Theory (SDT; Deci & Ryan, 2008), which posits that the satisfaction of autonomy, competence, and relatedness is essential for psychological well-being. Building on the theoretical background outlined in Chapter 1, this study applies BPNT to understand resilience among individuals operating in isolated, confined, and extreme (ICE) environments. Although research applying BPNT in ICE settings remains limited, initial findings are promising. Studies involving analog space missions, Himalayan mountaineering, and polar expeditions have reported that higher need satisfaction is associated with improved psychological outcomes (Devonport et al., 2022; Goemaere, Brenning, et al., 2019; Goemaere, Van Caelenberg, et al., 2019; Kay et al., 2022). For instance, in a four-month simulated Mars mission, greater autonomy satisfaction was linked to better collaboration with ground crew and reduced resistance to authority (Goemaere, Brenning, et al., 2019). Such findings are notable given that interpersonal tensions have consistently been identified as a key challenge in ICE environments (Palinkas & Suedfeld, 2021). These results highlight the potential

of BPNT as a framework for understanding resilience in extreme conditions, providing a foundation for the present study.

2.1.2 Resilience

Resilience is commonly understood as the capacity for positive adaptation in the face of significant adversity (Fisher et al., 2019; Masten et al., 2021). Contemporary perspectives emphasize that resilience is not solely an individual trait but involves the interplay of personal, relational, and environmental factors. In this research, resilience is examined using a social ecological model, which considers how multiple levels of environmental support, including immediate relationships, community structures, and broader societal factors, influence adaptation (Ungar et al., 2021)

Although this model has been widely supported in developmental research with children (Yule et al., 2019), its application to adults has been more limited. Recent advances, such as the development of the Adult Resilience Measure (ARM; Jefferies et al., 2019; Liebenberg & Moore, 2018), adapted from the Child and Youth Resilience Measure (CYRM-R; Ungar & Liebenberg, 2011), have begun to fill this gap. The ARM has demonstrated robust psychometric properties across diverse high-risk adult populations (Clark et al., 2022; Kurtz et al., 2019; Wall & Lowe, 2020). Furthermore, recent work integrating the ARM with BPNT has shown that need satisfaction mediates the relationship between resilience and psychological outcomes in populations exposed to extreme conditions (Lera & Abualkibash, 2022).

These findings suggest that resilience against extreme conditions requires more than individual coping abilities; external social and environmental supports play a critical role in satisfying psychological needs. Building on this foundation, the present study examines multiple

facets of resilience aligned with the levels of the social ecological model, identifying constructs relevant to the polar expedition context. While composite measures such as the ARM offer valuable insights, many scholars propose that resilience is best understood through the assessment of multiple independent predictors that reflect specific capacities and resources (Bonanno, 2012). Therefore, the following sections consider constructs relevant to polar expedition resilience at each level of the social ecological model.

2.1.2.1 Predictors Of Resilience

2.1.2.1 Individual level factors

2.1.2.1.1 Coping strategies.

When it comes to individual capacities that support resilience in extreme environments, polar expedition studies have consistently focused on coping strategies. While the use of certain strategies, for example, active problem-solving, positive reappraisal and comforting cognitions (Palinkas & Suedfeld, 2008, 2021) have been reported, recent studies have highlighted the importance of a broad repertoire of strategies and flexibility in their usage (Kjærgaard et al., 2015; Smith et al., 2017, 2021). This is consistent with critical theories of coping, which state that no single strategy should be deemed optimal; rather, effective coping depends on intra- and inter-individual differences, the specific context, and temporal dimensions such as the progression of stress over time (e.g., acute versus chronic stressors or different stages of an expedition). (e.g., Folkman & Moskowitz, 2004) .

As such, researchers have begun to investigate coping flexibility, which represents the ability to vary coping strategies both across and within certain situations and reflect and refine strategies selected (Bonanno & Burton, 2013; Cheng, 2001; Cheng et al., 2014). In the polar context, coping flexibility may help mitigate interpersonal conflicts among group members, who

cannot easily distance themselves from one another or leave the situation without significant risks (Wagstaff & Weston, 2014). Previous studies of successful expeditions reported that expeditioners use different strategy types depending on the stage of their expedition (Leon, Sandal, Fink, et al., 2011; Smith et al., 2021), and in response to seasonal changes, such as coping with 24-hour darkness during Antarctic over-winters (Décamps & Rosnet, 2005). These findings underscore the importance of considering the dynamic relationship between individuals and their environment. Coping flexibility, or the ability to adapt strategies to shifting demands, is associated with better well-being outcomes by enabling individuals to manage both predictable and unexpected stressors effectively (Bonanno & Burton, 2013).

Coping flexibility is commonly assessed using two distinct approaches where daily diary methods capture coping strategies as they are used in real-time, while survey-based measures assess individuals' general perceptions of their coping flexibility. Daily diary methods have become increasingly common in polar expedition research to capture the dynamic and context-sensitive nature of coping in extreme environments. The development of daily coping strategy checklists has been heavily influenced by earlier work with military personnel by Ben-Porath and colleagues (1991), whose checklist has provided a foundation for assessing coping behaviors in field settings. This approach has subsequently been adapted and applied in polar expedition studies as part of broader daily diary methodologies (Devonport et al., 2022; Kjærgaard et al., 2015; Smith et al., 2021, 2024).

In contrast, survey-based measures assess coping flexibility by capturing general tendencies to modify or adapt coping strategies in response to situational demands. Several validated instruments have been developed for this purpose. For instance, the Coping Flexibility Questionnaire (CFQ; Cheng, 2001) and the Coping Flexibility Scale (CFS; Kato, 2012) assess

the ability to appraise coping effectiveness and adjust strategies, emphasizing cognitive flexibility. Another measure, the Perceived Ability to Cope with Trauma Scale (PACT; Bonanno et al., 2011), captures two distinct coping orientations: trauma-focused coping and forward-focused coping, reflecting the capacity to engage with or move beyond adversity. Bonanno et al. (2011) also note that although laboratory and diary paradigms for assessing coping flexibility are theoretically valuable, they are often impractical for larger sample sizes and field research. The PACT was developed to address these limitations by providing a brief, validated questionnaire suitable for use in time-constrained, high-adversity contexts. Importantly, it was designed within a resilience framework to capture adaptive coping processes following exposure to trauma or significant adversity. This focus on resilient adaptation is particularly relevant to the polar expedition context, where individuals are exposed to extreme environmental and interpersonal stressors that can be conceptualized as potential traumatic events.

While daily diary methods based on context-specific coping strategy checklists (e.g., Ben-Porath et al., 1991) provide valuable real-time insights and are well-suited to within-expedition studies, they are less appropriate for retrospective, cross-sectional designs. In a retrospective format, such methods would capture only a general inventory of coping strategies used, without the temporal specificity or situational sensitivity that daily diaries are intended to provide. Given the cross-sectional nature of the present study and the need for a standardized, psychometrically validated measure of coping flexibility, a survey-based approach was deemed more appropriate. Among the available survey instruments, the PACT was selected for its strong psychometric properties and its dual-focus model, which was considered most relevant to the resilience processes faced by polar expeditioners.

2.1.2.2 Micro level factors

The microsystem level represents the immediate environment of the individual, including interactions with family and close friends. A review of studies has shown that strong family structure, intrafamily social support, and stability within intimate relationships can support resilience at this level (Benzies & Mychasiuk, 2009). Kjaergaard and colleagues (2015) provide an example of the potential adverse effects when resilience is not adequately supported. Their study, which focused on an Arctic military patrol group operating for prolonged periods in Greenland, highlighted significant challenges faced by expeditioners. One of the largest sources of stress stemmed from concerns related to intimate partners and spouses, including the breakdown of several relationships during the expedition period. From a theoretical perspective, both Basic Psychological Needs Theory and the social ecological model emphasize the critical role of close interpersonal relationships, which can serve as significant sources of both support and challenge (Ungar, 2011; Ryan & Deci, 2017). Accordingly, the present study considers perceived social support from both family and friends as representative of the microsystem level.

2.1.2.3 Exo level factors

The exo level relates to support that comes from outside of the individual's immediate vicinity. This may include community groups, work colleagues or leisure and recreational groups (Bronfenbrenner, 1979; Cichetti & Lynch, 1993). When it comes to support from the social environment, interpersonal relationships have been acknowledged as a crucial consideration in polar studies (Nicolas, Bishop, et al., 2016). The role of community level support within polar expeditions has been shown with Antarctic overwinter crews (Palinkas, Johnson, et al., 2004). They reported that those who reported a preference for support from their colleagues and work community displayed lower levels of depressed mood than those expeditioners stating family

members were their preferred support system. In the general literature, higher social support has been consistently associated with better physical and psychological outcomes (Thoits, 1995). However, the use of social support as a coping strategy during Polar expeditions has been associated with higher negative affect and lower well-being (Leon et al., 1991; Smith et al., 2021; Wagstaff & Weston, 2014). For example, Leon et al. (1991) found that in a Soviet-American mixed-gender expedition team, reliance on social support was linked to heightened stress reactivity and interpersonal tensions. These effects were attributed to the confined nature of polar environments, where limited privacy and prolonged proximity can amplify interpersonal conflicts. This highlights the complexities of social support in such extreme conditions.

In studying resilience, social support is a critical construct, encompassing the relational resources individuals draw upon to navigate adversity. Consequently, selecting an appropriate measure of social support is essential to capture the multi-layered relational dynamics relevant to polar expeditions. Although a wide range of social support measures exist, they often emphasize close relational support (for reviews see Fortney et al., 2024; Boateng et al., 2024). The present study required a measure capturing multiple relational levels in alignment with a socio-ecological model of resilience. One measure well matched to this purpose is the Social Support Index (SSI; McCubbin, Patterson, & Glynn, 1982; Distelberg et al., 2014), which captures perceived support from family, friends, and the broader community. Distelberg and colleagues (2014) explicitly linked the SSI's design to Ungar's (2005, 2011) socio-ecological conceptualization of resilience, mapping distinct sources of support to microsystem (family and friends) and exosystem (community) levels. This multi-layered structure provides a more comprehensive assessment of the social supports essential for resilience in isolated, high-stress environments such as polar expeditions.

2.1.2.4 Macro level factors

2.1.2.4.1 Relationship to Ethnic Identity.

The final system is the macrosystem, which is the least explicitly noticeable to individuals, and can influence all other levels which are nested within. Examples include cultural beliefs and social norms, as well as economic and political institutions (Bronfenbrenner, 1979; Cichetti & Lynch, 1993). However, this level of analysis has received limited coverage within resilience studies and rarely, if at all, within ICE environments. In contrast to Western focused literature, research from Arctic indigenous groups has considered cultural and societal level factors the greatest resilience challenges (Akearok et al., 2019). This highlights the need for more multicultural research on resilience, an area identified as critically important for future study (Masten et al., 2021).

One aspect that has been shown to result in differences in well-being between individuals from minority groups has been their relationship to their ethnic identity. Specific aspects include the level of commitment too, and exploration of their ethnic culture (Phinney, 1992). A meta-analysis reported that an individual's relationship to their ethnic group (e.g., higher commitment and exploration) has been shown to confer small but significant benefits in terms of well-being for those from minority ethnic groups. In contrast, these benefits are less commonly observed among individuals from white majority groups, where ethnic identity is generally less salient due to their majority status (Smith & Silva, 2011). Furthermore, in terms of BPN, the relationship from a stronger ethnic identity was associated with higher levels of belonginess (relatedness) and higher perceptions of competence to navigate complex environments (Smith & Silva, 2011). This finding would support considering how differences may exist between expeditioners depending

on their group status. Specifically, that for majority group ethnic backgrounds their relationship is less likely to confer any advantages, however, this should not be generalized to all individuals.

2.1.2.4.2 Connection to Nature.

The role of nature as a catalyst for resilience has been noted since the earliest days of polar exploration. Historical accounts from British polar expeditions highlight the restorative effects of natural beauty, including feelings of serenity and relaxation (Mocellin & Suedfeld, 1991). These findings align with modern studies documenting similar benefits for well-being among contemporary expeditioners (Atlis et al., 2004; Leon et al., 2002; N. Smith et al., 2021) and Indigenous Arctic groups, for whom connection to the natural environment is central to well-being (Allen et al., 2014). Beyond polar contexts, a robust literature now supports the salutogenic effects of nature on health and well-being more broadly (for meta-analyses see: McMahan & Estes, 2015; Sheffield et al., 2022). By quantitatively demonstrating these relationships in a polar context, this study extends these findings, highlighting the potential of nature to mitigate the unique stressors of extreme environments. There have also been several studies looking at the link between connection to nature and BPN (Ryan et al., 2010; Weinstein et al., 2009). A recent meta-analysis reported that the satisfaction of BPN could be a potential casual mechanism that explains the positive correlation between connection to nature and both eudaimonic well-being and personal growth (Pritchard et al., 2020).

Accurately measuring individuals' emotional connection to the natural world is essential for understanding its role in fostering resilience. One important factor to note is the numerous subtly different terms used to represent this relationship to nature. For example, terms such as "nature connection," "connection to nature," "nature relatedness," and "inclusion of self in nature" are each associated with their own unique measures (e.g., Nisbet et al., 2009; Schultz,

2001; Mayer & Frantz, 2004). However, strong evidence suggests that, while there may be small differences, these measures all assess the same underlying construct of subjective connection to nature (Capaldi et al., 2014). Several psychometrically validated instruments have been developed to assess this construct, varying in their emphasis on emotional, cognitive, and behavioral aspects of human–nature relationships (for reviews, see Tam, 2013; Tiscareno-Osorno et al., 2023). There is, however, clear evidence that affective measures show a consistent positive relationship to well-being, which is the central outcome of interest in this study (e.g., Pritchard et al., 2020). For example, the Connectedness to Nature Scale (CNS; Mayer & Frantz, 2004) and the Emotional Affinity Toward Nature Scale (EATN; Kals et al., 1999) both primarily assess individuals' emotional connection to the natural world. These instruments emphasize affective experiences such as feelings of belonging, emotional closeness, and love for nature, which align closely with the subjective well-being outcomes central to the present study. A systematic review of nature connection scales concluded that no single measure can be considered universally superior (Tiscareno-Osorno et al., 2023). However, the CNS is consistently reported as one of the most widely validated and utilized scales and has been employed across diverse populations.

2.1.3 Present Study

The broad aim of the present study is to address a gap in the literature by providing a theoretical explanation for the resilience of polar expeditioners using BPNT (Vansteenkiste et al., 2020; Vansteenkiste & Ryan, 2013). A secondary aim is to apply a socioecological approach to resilience, which examines variables at the individual, relational, and contextual or environmental levels. Building on these aims, it is hypothesized that predictor variables representing each level of the socioecological model (personal resilience, coping flexibility, relational resilience, family support, friend support, community support, and connection to

nature) will be positively associated with well-being and negatively associated with ill-being. In all cases, these relationships will be mediated by the satisfaction of the basic psychological needs for competence, relatedness, and autonomy, as posited by BPNT. Given the limited research in this population, the hypotheses are exploratory, aiming to identify which needs and predictors may be most salient in explaining resilience and well-being outcomes.[1]

A cross-sectional design was selected as the most appropriate initial approach to efficiently examine these key relationships within a diverse sample of polar expeditioners. This design enabled broad data capture within a population that is typically difficult to access due to the logistical challenges of polar research. Additionally, during the study period, global restrictions associated with the COVID-19 pandemic further limited opportunities for longitudinal data collection. The cross-sectional approach thus provided a practical and timely foundation to identify key predictors and mediators of resilience, informing the longitudinal and qualitative designs of the subsequent studies.

[1] While all predictors are hypothesized to be mediated by the satisfaction of basic psychological needs for competence, relatedness, and autonomy, certain variables are hypothesized to specific needs only. Coping flexibility is hypothesized to competence and autonomy, and relational resilience, family support, friend support, and community support are hypothesized to relatedness and autonomy.

2.2 Methods

2.2.1 Participants

One-hundred participants were recruited to take part in the study who had completed polar expeditions within the last 3 years. Participants were recruited using posts on social media sites and emails sent to polar research groups such as the Association of Polar Early Career Researchers (APECS) and Polar Network. Out of 100 participants that gave written informed consent, 5 participants were removed before completing the surveys due to not confirming proficiency in English language. This resulted in a final sample for analysis of 95 participants with demographic information provided in Table 2.1 The study was approved by the Durham University Dept of Psychology Research Ethics Committee.

Table 2.1

Demographic information of study participants

Variables	Level	Count/*M* (*SD*)	Variables	Level	Count/*M* (*SD*)
Gender	Female	42	Polar region	Arctic	50
	Male	49		Antarctica	45
	Non-binary	2	Trip purpose	Mobile expedition	16
	Not disclosed	2		Research	68
Age		37 (10.19)		Other	10
Marital status	Single & live alone	17		Not disclosed	1
	Single live family/friends	17	Ethnicity	White, Caucasian	92
	Relationship live together	22		Asian or Oriental	2
	Relationship live separate	11		Hispanic or Latino	1
	Married	28	Trip duration		45 (143.68)
Children	Yes	25			
	No	70	Days since expedition		636 (363)**

Note: ** Six participants were still on expedition when they completed the survey and were omitted from this calculation.

2.2.2 Procedure

The procedure consisted of the completion of a range of survey measures including demographic questions using the Qualtrics software system. The completion of surveys took approximately 15-20 minutes.

2.2.3 Materials

2.2.3.1 Composite Measure of Social-Ecological Resilience Support.

2.2.3.1.1 *Adult resilience measure – revised (arm-r).*

The Adult Resilience Measure (Resilience Research Centre, 2018) is a self-report measure of social-ecological resilience. The scale was derived from the Child and Youth Resilience Measure which was developed as part of the International Resilience Project, which involved 14 communities in 11 countries around the world. This updated version includes 17-items that are scored on a Likert scale (1-very untrue of me, 7-very true of me). The scale is made up by two subscales of individual resilience (e.g., Getting and improving qualifications or skills is important; I cooperate with people around me) and relational resilience (e.g., I feel secure when I am with my family/partner; I enjoy my family/partners cultural and family traditions). It is these two subscales that will be used for analysis in the present study. The measure has shown good levels of reliability and validity in previous studies (Jefferies et al., 2019). The internal consistency in the present study for both subscales were satisfactory (personal resilience = .79; relational resilience = .81).

2.2.3.2 Individual Level Measures

2.2.3.2.1 *The Perceived Ability to Cope with Trauma Scale.*

The Perceived Ability to Cope with Trauma Scale (PACT; Bonanno et al., 2011) is a 20-item self-report measure that assesses one's perceived ability to use coping strategies flexibly in response to trauma. Participants were instructed to rate each item on a 7-point Likert scale (1-strongly disagree, 7-strongly agree). The scale has two factors of trauma focus (8-items, e.g., carefully thinking about experienced traumatic life event, wholly accepting one's painful emotion) and forward focus (12-items; e.g., pay attention to one's present goals and plan, finding some activities to forget the event).Coping flexibility scores were calculated by subtracting the difference score of the trauma focus and forward focus subscales (forward focus – trauma focus) from the sum score of the two factors (forward focus + trauma focus) (see Bonanno et al. 2011). In this calculation, higher scores reflect relatively greater ability to use both coping strategies. Both subscales showed good internal consistency in the present study (forward focus = .83; trauma focus = .79).

2.2.3.2.2 The Connectedness to Nature Scale (CNS).

We used the Connectedness to Nature Scale to measure the relationship between individuals and the natural environment during their time in the polar regions (CNS; Mayer & Frantz, 2004). The scale includes 14-items scored on a Likert scale (1 = Strongly Disagree, to 7 = Strongly agree). It includes statements such as "I often feel a sense of oneness with the natural world around me," and "I often feel a kinship with animals and plants." The scale has shown adequate internal consistency in previous studies (Perrin & Benassi, 2009). In the present study the scale showed good internal consistency ($\alpha = .86$).

2.2.3.3 Micro and exo level measures

2.2.3.3.1 *Social Support.*

Family, friendship and community support will be measured using items derived from the Social Support Index (SSI; Distelberg et al., 2014). The SSI was originally developed to measure social support to extend on measures that had focused on the family level, to also include wider support in line with the exo-system level used in social-ecological systems. A review of the psychometric properties supported its reliability and validity and offered a 4-factor solution, which included family, friendship and community levels and positive perception of support (Distelberg et al., 2018). Items relating to the first three factors will be used in the present study. The positive perceptions of support subscale was not included, as it primarily assesses negative perceptions and dissatisfaction with support from family, friends, and community, rather than capturing the availability and presence of supportive resources. This focus was less directly aligned with the study's socio-ecological framework, which emphasized access to distinct relational supports that facilitate resilience.

Micro level.

Family support items represent support at the micro level and include items such as "The members of my family make an effort to show their love and affection for me". In the present study this subscale showed good internal consistency ($\alpha = .85$)

Exo level.

Friend and community support items represent support at the exo level. An example item for friend support is "I have friends who let me know they value who I am and what I can do". An example item for community support is "If I had an emergency even people I do not know in this

community would be willing to help." Both scales showed good internal consistency (Friends = .83; Community = .90).

2.2.3.4 Macro level.

To measure support at macro level, we used the Multigroup Ethnic Identity Measure (MEIM-R: Phinney, 1992; Phinney & Ong, 2007). The MEIM taps two facets of ethnic identity (exploration and commitment). In the present study scores were scored on a 7-point likert scale (1-strongly disagree, 7-strongly agree). Items for the commitment subscale included: ''I feel a strong attachment towards my own ethnic group; I have a strong sense of belonging to my own ethnic group.'' Items for the exploration subscale included: ''I have often done things that will help me understand my ethnic group.' The present study will use the total score for all analysis. The scale has showed good reliability and validity in previous studies (Phinney & Ong, 2007). In the present study the scale showed a good internal consistency (α = .87).

2.2.3.5 Basic Psychological Need Satisfaction & Frustration.

Psychological basic needs were measured using the Basic Psychological Need Satisfaction and Frustration Scale – Diary version (BPNSF; Van der Kaap-Deeder et al., 2020). The 16-item scale includes items that measure both the satisfaction and frustration of each basic need (autonomy, relatedness, and competence). Items are rated on a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree). Example items include: for autonomy, "I felt my decisions reflected what I really wanted"; for competence, "I felt competent to achieve my goals"; and for relatedness, "I experienced a warm feeling with the people I spent time with or spoke to." In the present study, a composite score was calculated from satisfaction and frustration items for each need, with frustration items reverse coded (Chen et al., 2015). All three need measures showed acceptable to good internal consistency (competence = .87; relatedness = .77; autonomy = .72).

2.2.3.6 Well-being

The variables for Vitality and Positive affect will be averaged to create the well-being variable.

2.2.3.6.1 Subjective Vitality Scale (SVS).

The Subjective Vitality Scale (SVS: Frederick & Ryan, 1993) includes seven items that indicate the extent to which a person feels alive and vital (e.g., I have energy and spirit). Participants are asked to respond using a 7-point scale ranging from 1 (not at all true) to 7 (very true). The SVS has shown acceptable psychometric properties when used as a measure of well-being, especially when 1-item is removed (Bostic et al., 2000). In the current study the measure showed very good internal consistency (α = .90).

2.2.3.6.2 Positive affect.

Positive affect will be measured using the Positive and Negative Affect Schedule (PANAS: Watson et al., 1988). The 20-item PANAS includes two subscales (10 items each), one for positive affective states (e.g., interested, enthusiastic) and the other for negative affective states (e.g., upset, scared). The scale is measured using a 5-point scale ranging from 1 (very slightly or not at all) to 5 (extremely). The PANAS is widely used as a measure of affect and has shown good validity and reliability in many studies (e.g., Crawford & Henry, 2004). In the current study both subscales showed good internal consistency (Negative affect = .86; Positive affect = .87).

2.2.3.7 Ill-being

The following variables for Loneliness and Negative effect will be averaged to create the composite score for Ill-being.

2.2.3.7.1 *Negative affect.*

Negative affect will be measured using the negative affect items from the PANAS reported above.

2.2.3.7.2 *Loneliness.*

To measure ill-being outcomes, we used the revised UCLA-Loneliness Scale (UCLA-R: D. Russell et al., 1980), which consists of 20 items (11 positive and 9 negative), describing subjective feelings of loneliness (e.g., I feel isolated from others). The 20 items are rated on a 7-point Likert scale (1-never true, 7-always true), with higher scores reflecting greater loneliness. The scale has shown good reliability and validity in previous studies (D. W. Russell, 1996). In the current study the scale showed excellent internal consistency ($\alpha = .92$).

2.2.4 Data Analytic Strategy

All statistical analyses were conducted using R programming software (R Foundation for Statistical Computing, 2023). Descriptive statistics, including means and standard deviations, were first computed for all survey measures to provide an overview of the dataset. Following this, correlation analyses were conducted to explore relationships between all relevant study variables.

To test the study hypotheses, parallel mediation analyses were conducted using the PROCESS macro for R (Hayes, 2022), employing Model 4 for analysing multiple mediators. This method was selected over structural equation modelling due to the limited sample size relative to the number of parameters (Preacher & Hayes, 2008). PROCESS was chosen for its robustness in small sample sizes and its ability to handle non-normal data distributions (Hayes et al., 2017). Separate models were conducted to test the direct and indirect effects for each predictor variable.

Link A represents the effect of the predictor (e.g., personal resilience, coping flexibility, family support, friend support, community support, nature connection) on the mediators (autonomy, competence, relatedness). Link B captures the effect of the mediators on the outcome variables (e.g., well-being, ill-being), controlling for the predictor. Link C' (direct effect) represents the effect of the predictor on the outcome, controlling for the mediators. The mediation (indirect effect) is calculated as the product of A and B, while Link C (total effect) represents the overall effect of the predictor on the outcome.

2.3 Results

2.3.1 Descriptive Statistics and Preliminary Analyses

Descriptive statistics for the measured and composite variables, including means, standard deviations are presented in Table 2.2. Results are reported for the total sample and separately by each expedition type. The mean scores reveal that participants, on average, scored moderately high on all predictor variables ($M > 5.10$, on 1-7 scale), except for the MEIM-R ($M = 3.83$, SD = 1.27). Satisfaction of the basic psychological needs for autonomy, competence, and relatedness were all moderately high levels ($M > 5.35$). Examination of the outcome variables revealed that participants scored high on both components of well-being ($M = 5.63$, SD = 0.89) and low on ill-being and its subcomponents ($M = 2.80$, SD = 0.87).

Table 2.2
Means, standard deviations all variables by sample and trip purpose

	Mean scores (SD)			
Variable	Total sample	Mobile (n = 14)	Research (n = 66)	Other (n = 10)
Personal resilience	5.94 (0.54)	5.99 (0.52)	5.87 (0.50)	5.53 (0.62)
Connection to Nature	5.70 (0.87)	5.68 (0.59)	5.73 (0.92)	5.27 (0.98)
PACT Forward focus	5.35 (0.78)	5.87 (0.79)	5.23 (0.72)	5.41 (0.91)
PACT Trauma focus	5.10 (0.96)	5.49 (1.23)	5.06 (0.86)	4.94 (0.92)
Relational Resilience	5.70 (0.87)	5.68 (0.59)	5.73 (0.92)	5.27 (0.98)
Family Support	5.39 (1.28)	5.88 (0.71)	5.35 (1.31)	5.17 (1.54)
Friend Support	5.75 (0.91)	5.94 (0.81)	5.72 (0.95)	5.73 (0.73)
Community Support	5.89 (1.09)	6.14 (0.88)	5.52 (1.17)	6.08 (0.85)
MEIM-R	3.83 (1.27)	3.90 (1.37)	3.91 (1.23)	3.65 (1.42)
Autonomy	5.35 (1.10)	6.00 (0.61)	5.25 (1.16)	5.11 (1.01)
Relatedness	5.62 (1.01)	6.19 (0.76)	5.58 (0.90)	5.06 (1.66)
Competence	5.46 (1.17)	5.92 (0.91)	5.39 (1.21)	5.25 (1.33)
Negative affect	2.95 (1.01)	2.51 (1.09)	3.03 (0.97)	3.27 (1.09)
Loneliness	2.85 (0.94)	2.05 (0.84)	2.72 (0.91)	3.11 (1.42)
Positive affect	5.80 (0.64)	6.17 (0.38)	5.68 (0.66)	5.94 (0.42)
Vitality	5.44 (1.26)	6.42 (0.40)	5.21 (1.27)	5.38 (1.46)
Well-being	5.63 (0.89)	6.32 (0.32)	5.47 (0.91)	5.62 (0.94)
Ill-being	2.80 (0.87)	2.21 (0.78)	2.87 (0.80)	3.25 (1.12)

Note: All scales were measured on scale from 1-7

Table 2.3

Correlation matrix with significance levels

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Personal Resilience	-												
2. Connection to Nature	.24*	-											
3. Coping Flexibility	.21*	.25*	-										
4. Relational Resilience	.41**	.08	.16	-									
5. Community Support	.29**	.30**	.10	.07	-								
6. Family Support	.41**	.27**	.24*	.67**	.21*	-							
7. Friend Support	.34**	.30**	.12	.12	.03	.26*	-						
8. MEIM-R	.10	.13	.01	.22*	.10	.17	.09	-					
9. Autonomy	.40**	.29**	.16	.19	.50**	.13	.17	.09	-				
10. Relatedness	.45**	.29**	.21*	.16	.35**	.18	.31**	.02	.66**	-			
11. Competence	.17	.13	.09	.09	.05	.10	.37**	-.01	.35**	-.43**	-		
12. Well-being	.40**	.44**	.30**	.14	.40**	.32**	.17	.14	.54**	.43**	.20	-	
13. Ill-being	-.34**	-.17	-.08	-.17	-.41**	.15	-.27**	-.00	-.63**	-.78**	-.36**	-.43**	-

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

Correlations among the study variables are presented in Table 3.3. The correlation matrix provides a preliminary overview of the relationships between the predictor, mediator, and outcome variables. As expected, most correlations were significant and in the anticipated direction, supporting the conditions for further mediation analyses.

The correlation matrix reveals several patterns relevant to the study hypotheses. Personal resilience demonstrated significant positive relationships with psychological well-being and a significant negative association with ill-being. Notably, personal resilience was positively associated with the satisfaction of autonomy and relatedness but showed no significant relationship with competence satisfaction.

Connection to nature exhibited a positive relationship with psychological well-being and significant associations with autonomy and relatedness satisfaction. Similarly, coping flexibility demonstrated a positive association with psychological well-being and relatedness, though no significant correlations emerged with competence satisfaction.

Family support was positively associated with psychological well-being but did not show significant relationships with any of the basic psychological needs. In contrast, friend support was significantly associated with both relatedness and competence satisfaction and negatively related to ill-being. Community support showed strong relationships with autonomy and relatedness satisfaction and demonstrated significant associations with both psychological well-being and ill-being.

Importantly, autonomy and relatedness satisfaction displayed more consistent and stronger correlations with the predictor and outcome variables in the expected directions, supporting their relevance as mediators in this study. In contrast, competence satisfaction

exhibited fewer significant associations, emerging only in its relationships with friend support and ill-being.

Relational resilience and the MEIM-R did not exhibit significant correlations with any outcome or mediator variables and were therefore excluded from subsequent mediation analyses.

2.3.2 Parallel Mediation Analyses

Table 2.4

Mediation results for Individual level variables with well-being and ill-being

IV	MV	DV	Total effect (link C)	Effect of IV on MV (link A)	Effect of MV on DV (link B)	Direct effect (link C')	Indirect effect
Personal Resilience		Well-being	**0.58****			0.29	**0.29**[a]
	Autonomy			0.84**	0.33**		**0.28**[a]
	Competence			0.38	-0.03		-0.01
	Relatedness			0.80**	0.04		0.03
		Ill-being	**-0.55****			0.04	**-0.60**[a]
	Autonomy			0.84**	-0.17*		**-0.14**[a]
	Competence			0.38	-0.03		-0.01
	Relatedness			0.80**	-0.55**		**-0.44**[a]
Coping Flexibility		Well-being	**0.12****			**0.08***	0.04
	Autonomy			0.10	0.35**		0.04
	Competence			0.05	-0.03		0.00
	Relatedness			0.11	0.06		0.01
		Ill-being	-0.04			0.04	-0.08
	Autonomy			0.10	-0.17**		-0.02
	Competence			0.05	-0.03		0.00
	Relatedness			0.11	-0.56**		-0.06

Final models: Personal resilience & well-being – F (4,85) = 10.80, p <.001, R^2 = 0.34; Personal Resilience & Ill-being – F (4,85) = 35.71, p < .001, R^2 = 0.63; Coping flexibility & well-being – F (4,85) = 11.30, p < .001, R^2=0.35; Coping flexibility & ill-being – F (4,85) = 36.81 ,p < .001, R^2=0.63; IV: independent variable; MV: mediating variable. DV: dependent variable; *p < .05; **p < .01. a = significant at a confidence interval of 95%

Table 2.4 presents the results of the mediation analysis examining the relationship between the individual level predictors of personal resilience and coping flexibility to both psychological well-being and ill-being, with autonomy, competence, and relatedness as mediators. The analysis considered both total, direct and indirect effects.

The results indicated that the total effect of personal resilience on psychological well-being was significant (b =0.58, SE = 0.15, t = 3.92, p < .001, 95% CI [0.29, 0.87]). However, the direct effect became non-significant when the mediators were included (b = 0.29, SE = 0.15, t = 1.92, p = 0.059, 95% CI [−0.01,0.58]), suggesting that mediation accounted for the observed effect. The total indirect effect of personal resilience on well-being was significant (b = 0.29, SE

= 0.12, 95% CI [0.09,0.57]). Among the mediators, autonomy emerged as a significant mediator (b = 0.28, SE = 0.14, 95% CI [0.03,0.57]), while competence (b = −0.01, SE = 0.03, 95% CI [−0.08,0.07]) and relatedness (b = 0.03, SE = 0.10, 95% CI [−0.13,0.28]) did not significantly mediate the relationship.

The results indicated that the total effect of personal resilience on psychological ill-being was significant (b = -0.55, SE = 0.17, t = -3.33, p = 0.001, 95% CI [-0.88, -0.22]). However, the direct effect became non-significant when the mediators were included in the model (b = 0.04, SE = 0.12, t = 0.34, p = 0.735, 95% CI [-0.20, 0.29]), suggesting that the relationship was fully mediated. The total indirect effect of personal resilience on ill-being was significant (b = -0.60, SE = 0.18, 95% CI [-0.98, -0.26]). Among the mediators, both autonomy (b = -0.14, SE = 0.09, 95% CI [-0.33, -0.01]) and relatedness (b = -0.44, SE = 0.17, 95% CI [-0.82, -0.15]) significantly mediated the relationship. Competence (b = -0.01, SE = 0.03, 95% CI [-0.09, 0.03]) did not demonstrate a significant mediation effect. Relatedness accounted for the largest portion of the total indirect effect, highlighting its key role in linking personal resilience to psychological ill-being.

The results indicated that the total effect of coping flexibility on psychological well-being was significant (b = 0.12, SE = 0.04, t = 2.94, p = 0.004, 95% CI [0.04, 0.21]). The direct effect of coping flexibility on well-being also remained significant (b = 0.08, SE = 0.04, t = 2.25, p = 0.027, 95% CI [0.01, 0.16]), indicating that coping flexibility directly influences psychological well-being. The total indirect effect was not significant (b = 0.04, SE = 0.03, 95% CI [-0.01, 0.10]), providing no evidence of mediation. Similarly, none of the individual mediators demonstrated significant effects: autonomy (b = 0.04, SE = 0.03, 95% CI [-0.01, 0.10]), competence (b = -0.00, SE = 0.01, 95% CI [-0.01, 0.01]), or relatedness (b = 0.01, SE = 0.01,

95% CI [-0.02, 0.04]). These findings suggest that coping flexibility influences psychological well-being directly and not through the mediation of basic psychological needs.

The results indicated that the total effect of coping flexibility on psychological ill-being was not significant (b = -0.04, SE = 0.05, t = -0.78, p = 0.439, 95% CI [-0.13, 0.06]). Similarly, the direct effect of coping flexibility on ill-being was not significant (b = 0.04, SE = 0.03, t = 1.33, p = 0.189, 95% CI [-0.02, 0.10]). These findings suggest no evidence of a direct or total relationship between coping flexibility and ill-being. The total indirect effect of coping flexibility on ill-being was also not significant (b = -0.08, SE = 0.04, 95% CI [-0.16, 0.01]). None of the individual mediators demonstrated significant effects: autonomy (b = -0.02, SE = 0.01, 95% CI [-0.05, 0.01]), competence (b = -0.00, SE = 0.00, 95% CI [-0.01, 0.01]), or relatedness (b = -0.06, SE = 0.04, 95% CI [-0.14, 0.01]). These results indicate that coping flexibility does not significantly influence psychological ill-being directly or indirectly through basic psychological needs.

Table 2.5

Mediation results for Micro level variables with well-being and ill-being

IV	MV	DV	Total effect (link C)	Effect of IV on MV (link A)	Effect of MV on DV (link B)	Direct effect (link C')	Indirect effect
Family Support		Well-being	**0.18****			**0.14****	0.04
	Autonomy			0.10	0.35**		0.04
	Competence			0.09	-0.04		0.00
	Relatedness			0.11	0.06		0.01
		Ill-being	-0.09			-0.01	-0.08
	Autonomy			0.10	-0.16		-0.02
	Competence			0.09	-0.03		0.00
	Relatedness			0.11	-0.55		-0.06
Friend Support		Well-being	0.14			0.06	0.08
	Autonomy			0.20	**0.36****		0.07
	Competence			**0.47****	-0.04		-0.02
	Relatedness			**0.33****	0.07		0.02
		Ill-being	**-0.26****			-0.04	**-0.22** [a]
	Autonomy			0.20	**-0.17****		-0.03
	Competence			**0.47****	-0.02		-0.01
	Relatedness			**0.33****	**-0.54****		**-0.18** [a]

Final models: Family support & well-being – F (4,85) = 11.93, $p < .001$, $R^2 = 0.36$; Family support & Ill-being – F (4,85) = 35.68, $p < .001$, $R^2 = 0.63$; Friend support & well-being – F (4,85) = 9.65, $p < .001$, $R^2 = 0.31$; Friend support & ill-being – F (4,85) = 35.84, $p < .001$, $R^2 = 0.63$; IV: independent variable; MV: mediating variable. DV: dependent variable; *p < .05; **p < .01. a = significant at a confidence interval of 95%

Table 2.5 presents the results of the mediation analyses examining the relationships between micro level predictor variables, family-, friend-support and both well-being and ill-being outcomes, mediated by autonomy, competence, and relatedness. The analyses focused on direct and indirect effects through the mediating variables.

The results indicated that the total effect of family support on psychological well-being was significant (b = 0.18, SE = 0.06, t = 2.83, p = 0.006, 95% CI [0.05, 0.31]). The direct effect of family support on well-being also remained significant after accounting for the mediators (b = 0.14, SE = 0.05, t = 2.61, p = 0.011, 95% CI [0.03, 0.25]). The total indirect effect was not significant (b = 0.04, SE = 0.04, 95% CI [-0.02, 0.13]), providing no evidence of mediation.

None of the individual mediators demonstrated significant effects: autonomy (b = 0.03, SE = 0.04, 95% CI [-0.02, 0.12]), competence (b = -0.00, SE = 0.01, 95% CI [-0.02, 0.02]), or relatedness (b = 0.01, SE = 0.02, 95% CI [-0.02, 0.06]). These results suggest that family support influences psychological well-being directly, without mediation through basic psychological needs.

The results indicated that the total effect of family support on psychological ill-being was not significant (b = -0.09, SE = 0.07, t = -1.24, p = 0.217, 95% CI [-0.23, 0.05]). Similarly, the direct effect of family support on ill-being was also not significant (b = -0.01, SE = 0.05, t = -0.26, p = 0.792, 95% CI [-0.10, 0.08]). The total indirect effect was not significant (b = -0.08, SE = 0.07, 95% CI [-0.24, 0.05]), indicating no evidence of mediation. None of the individual mediators demonstrated significant effects: autonomy (b = -0.02, SE = 0.02, 95% CI [-0.05, 0.01]), competence (b = -0.00, SE = 0.01, 95% CI [-0.02, 0.01]), or relatedness (b = -0.06, SE = 0.06, 95% CI [-0.20, 0.05]). These findings suggest that family support does not significantly influence psychological ill-being directly or indirectly through basic psychological needs.

The results indicated that the total effect of friend support on psychological well-being was not significant (b = 0.14, SE = 0.09, t = 1.48, p = 0.143, 95% CI [-0.05, 0.32]). Similarly, the direct effect of friend support on well-being was also not significant (b = 0.06, SE = 0.09, t = 0.70, p = 0.484, 95% CI [-0.11, 0.23]). The total indirect effect was also not significant (b = 0.08, SE = 0.06, 95% CI [-0.05, 0.21]). None of the individual mediators demonstrated significant effects: autonomy (b = 0.07, SE = 0.05, 95% CI [-0.01, 0.19]), competence (b = -0.02, SE = 0.04, 95% CI [-0.10, 0.05]), or relatedness (b = 0.02, SE = 0.04, 95% CI [-0.06, 0.12]). These findings suggest that friend support does not significantly influence psychological well-being directly or indirectly through basic psychological needs.

The results indicated that the total effect of friend support on psychological ill-being was significant (b = -0.26, SE = 0.10, t = -2.65, p = 0.009, 95% CI [-0.46, -0.07]). However, the direct effect was not significant (b = -0.04, SE = 0.07, t = -0.56, p = 0.578, 95% CI [-0.18, 0.10]), suggesting that the relationship was fully mediated. The total indirect effect was significant (b = -0.22, SE = 0.08, 95% CI [-0.41, -0.09]). Among the mediators, relatedness significantly mediated the relationship between friend support and ill-being (b = -0.18, SE = 0.06, 95% CI [-0.33, -0.08]). Autonomy (b = -0.03, SE = 0.03, 95% CI [-0.10, 0.01]) and competence (b = -0.01, SE = 0.03, 95% CI [-0.06, 0.04]) did not demonstrate significant mediation effects. These findings highlight relatedness as the key mechanism through which friend support influences psychological ill-being.

Table 2.6

Mediation results for Exo level variables with well-being and ill-being

IV	MV	DV	Total effect (link C)	Effect of IV on MV (link A)	Effect of MV on DV (link B)	Direct effect (link C')	Indirect effect
Community Support		Well-being	**0.30****			0.12	**0.18[a]**
	Autonomy			**0.53****			**0.16[a]**
	Competence			0.03			0.00
	Relatedness			**0.38****			0.02
		Ill-being	**-0.33****			-0.09	**-0.24[a]**
	Autonomy			**0.53****	-0.11		-0.60
	Competence			0.03	-0.05		0.00
	Relatedness			**0.33****	**-0.54****		**-0.18[a]**

Final models: Community support & well-being – F (4,85) = 10.32, $p < .001$, $R^2 = 0.33$; Community support & ill-being – F (4,85) = 37.05, $p < .001$, $R^2 = 0.64$; IV: independent variable; MV: mediating variable. DV: dependent variable; *p < .05; **p < .01. a = significant at a confidence interval of 95%

Table 2.6 presents the results of the mediation analyses examining the relationships between exo-level predictor variable community support and both well-being and ill-being outcomes, mediated by autonomy, competence, and relatedness. The analyses focused on the direct and indirect effects through the mediating variables.

The results indicated that the total effect of community support on psychological well-being was significant (b = 0.30, SE = 0.07, t = 4.22, $p < 0.001$, 95% CI [0.16, 0.44]). However, the direct effect was not significant (b = 0.12, SE = 0.08, t = 1.53, p = 0.130, 95% CI [-0.04, 0.27]), suggesting that the relationship was partially mediated. The total indirect effect of community support on well-being was significant (b = 0.18, SE = 0.07, 95% CI [0.06, 0.33]). Among the mediators, autonomy significantly mediated the relationship (b = 0.16, SE = 0.08, 95% CI [0.01, 0.31]), while competence (b = -0.00, SE = 0.01, 95% CI [-0.02, 0.02]) and relatedness (b = 0.02, SE = 0.05, 95% CI [-0.05, 0.13]) did not demonstrate significant mediation effects. These findings suggest that autonomy plays a key role in linking community support to psychological well-being.

The results indicated that the total effect of community support on psychological ill-being was significant (b = -0.33, SE = 0.08, t = -4.25, $p < 0.001$, 95% CI [-0.48, -0.18]). However, the direct effect was not significant (b = -0.09, SE = 0.06, t = -1.45, p = 0.150, 95% CI [-0.22, 0.03]), suggesting full mediation. The total indirect effect was significant (b = -0.24, SE = 0.07, 95% CI [-0.40, -0.11]). Among the mediators, relatedness significantly mediated the relationship between community support and ill-being (b = -0.18, SE = 0.07, 95% CI [-0.33, -0.07]). Autonomy (b = -0.06, SE = 0.05, 95% CI [-0.16, 0.03]) and competence (b = -0.00, SE = 0.01, 95% CI [-0.03, 0.01]) did not demonstrate significant mediation effects. These findings suggest that relatedness is a key mechanism linking community support to lower psychological ill-being.

Table 2.7

Mediation results for Macro level variables with well-being and ill-being

IV	MV	DV	Total effect (link C)	Effect of IV on MV (link A)	Effect of MV on DV (link B)	Direct effect (link C')	Indirect effect
Nature Connection		Well-being	**0.46****			**0.32****	**0.14[a]**
	Autonomy			**0.41****	**0.32****		0.13
	Competence			0.21	-0.03		-0.01
	Relatedness			**0.36****	0.04		0.01
		Ill-being	-0.18			0.10	**-0.28[a]**
	Autonomy			**0.41****	**-0.18****		**-0.07[a]**
	Competence			0.21	-0.03		-0.01
	Relatedness			**0.36****	-0.56**		**-0.20[a]**

Final models: Nature connection & well-being – F (4,85) = 14.27, p < .001, R^2=0.40; Nature connection & Ill-being – F (4,85) = 36.71, p <. 001, R^2 = 0.63; IV: independent variable; MV: mediating variable. DV: dependent variable; *p < .05; **p < .01. a = significant at a confidence interval of 95%

Table 2.7 presents the results of the mediation analyses examining the relationships between macro-level predictor variable nature connection and both well-being and ill-being outcomes, mediated by autonomy, competence, and relatedness. The analyses focused on direct and indirect effects through the mediating variables.

The results indicated that the total effect of nature connection on psychological well-being was significant (b = 0.46, SE = 0.09, t = 4.85, p < 0.001, 95% CI [0.27, 0.65]). The direct effect of nature connection on well-being was also significant (b = 0.32, SE = 0.09, t = 3.64, p = 0.001, 95% CI [0.15, 0.50]), indicating partial mediation. The total indirect effect was significant (b = 0.14, SE = 0.06, 95% CI [0.03, 0.26]). However, no basic need demonstrated individually significant effects: autonomy (b = 0.13, SE = 0.07, 95% CI [-0.00, 0.25]), competence (b = -0.01, SE = 0.02, 95% CI [-0.05, 0.03]), and relatedness (b = 0.01, SE = 0.04, 95% CI [-0.05, 0.13]) all failed to reach significance. These findings suggest that nature connection influences psychological well-being both directly and through combined effects of basic psychological needs.

The results indicated that the total effect of nature connection on psychological ill-being was not significant (b = -0.18, SE = 0.12, t = -1.59, p = 0.116, 95% CI [-0.42, 0.05]). Similarly, the direct effect of nature connection on ill-being was not significant (b = 0.10, SE = 0.08, t = 1.27, p = 0.208, 95% CI [-0.06, 0.25]). The total indirect effect was significant (b = -0.28, SE = 0.12, 95% CI [-0.54, -0.05]), indicating evidence of mediation. Among the mediators, relatedness significantly mediated the relationship between nature connection and ill-being (b = -0.20, SE = 0.11, 95% CI [-0.44, -0.01]). Autonomy (b = -0.07, SE = 0.04, 95% CI [-0.15, 0.00]) and competence (b = -0.01, SE = 0.02, 95% CI [-0.04, 0.02]) did not demonstrate significant mediation effects. These findings suggest that nature connection reduces psychological ill-being indirectly through relatedness, highlighting its role as the primary mechanism.

Figures 2.1 and 2.2 show a graphical representation of the significant direct and mediated relationships for both well-being and ill-being.

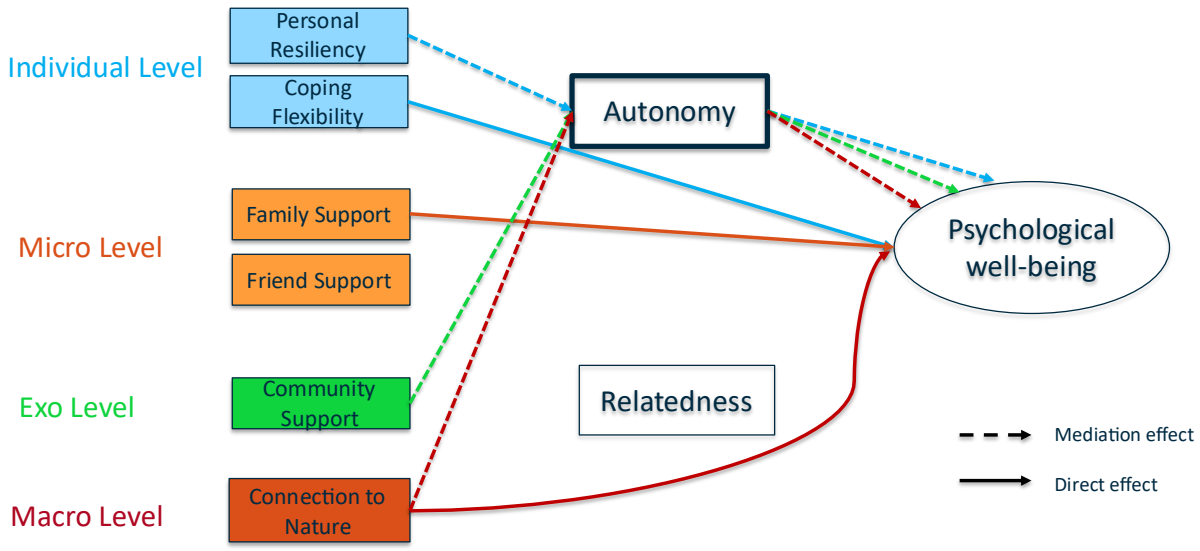


Figure 2.1 Final Structural Model of Significant Direct and Indirect Effects on Well-Being

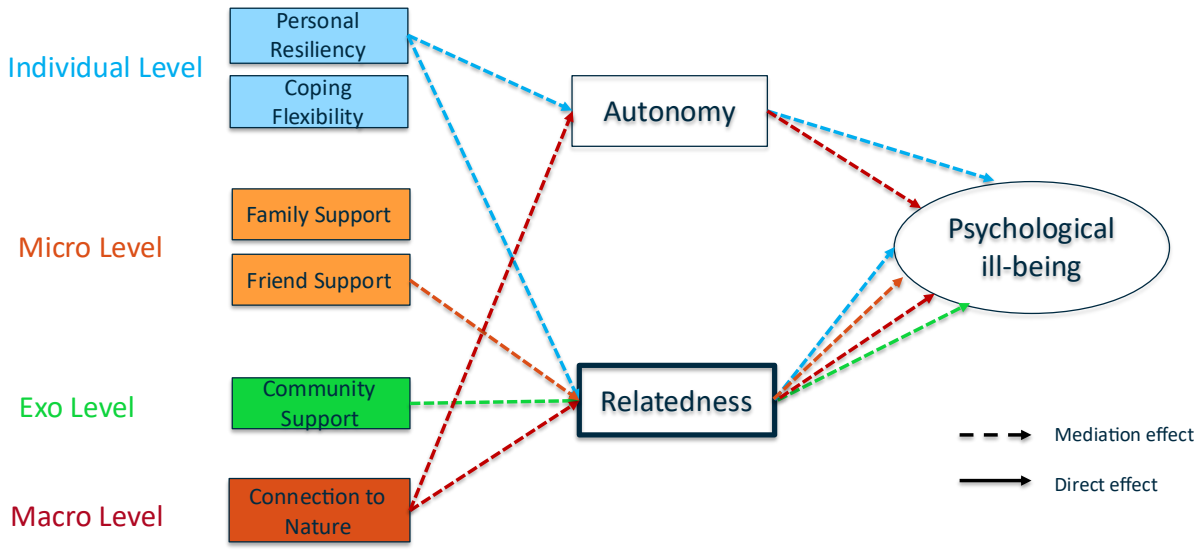


Figure 2.2 Final Structural Model of Significant Direct and Mediated Effects on Ill-Being

2.3.3 Summary of Hypotheses Results

Table 2.8. provides a summary of all results regarding whether they supported this study's hypotheses.

Table 2.8

Summary of results for all study hypotheses outcomes

Level	IV	DV	MV	Significant Association	Significant Indirect Effect	Hypothesis Outcome
Individual	Personal resilience	Well-being ↑	A, R, C	Yes	Yes (A)	**Partially**
Individual	Personal resilience	Ill-being ↓	A, R, C	Yes	Yes (A, R)	**Partially**
Individual	Coping flexibility	Well-being ↑	A, C	Yes	No	No
Individual	Coping flexibility	Ill-being ↓	A, C	No	No	No
Relational	Relational resilience	Well-being ↑	A, R	No	Excluded	No
Relational	Relational resilience	Ill-being ↓	A, R	No	Excluded	No
Micro	Family support	Well-being ↑	A, R	Yes	No	No
Micro	Family support	Ill-being ↓	A, R	No	No	No
Micro	Friend support	Well-being ↑	A, R	No	No	No
Micro	Friend support	Ill-being ↓	A, R	Yes	Yes (R)	**Partially**
Exo	Community support	Well-being ↑	A, R	Yes	Yes (A)	**Partially**
Exo	Community support	Ill-being ↓	A, R	Yes	Yes (R)	**Partially**
Macro	Connectedness to nature	Well-being ↑	A, R, C	Yes	Yes**	**Partially**
Macro	Connectedness to nature	Ill-being ↓	A, R, C	No	Yes (A, R)	**Partially**
Macro	MEIM-R	Well-being ↑	A, R, C	No	Excluded	No

Note: IV = Independent Variable, DV = Dependent Variable, MV = Mediators. A = Autonomy, R = Relatedness, C = Competence. ** Total effect of all BPN mediators significant only. ↓ = negatively association predicted; ↑ = positive association predicted.

2.4 Discussion

This study aimed to investigate whether combining the socioecological model of resilience and BPNT could provide a robust framework for understanding resilience in polar expeditioners. Polar expeditioners represent a unique population due to their exposure to stressors such as extreme cold, isolation, and prolonged darkness, making them critical for resilience research. By examining variables across four levels of the socioecological model, including individual, micro, exo, and macro, the study sought to explain variations in psychological well-being and ill-being. Given the limited application of BPNT to polar expeditioners, the exploratory hypotheses sought to identify the basic psychological needs most critical to resilience across socioecological levels.

Six of eight predictor variables showed significant associations with at least one outcome variable, including personal resilience at the individual level, community support at the exo level, and connection to nature at the macro level. Relational resilience and MEIM-R did not show significant associations and were therefore not included in mediation analyses. Although the inclusion of BPNs improved prediction for most predictors, the effects of coping flexibility on well-being and friend support on ill-being were independent of mediation by BPNs. This suggests that alternative mechanisms may be at play. Despite this, BPNs effectively explained variance across all levels of the socioecological model, reinforcing their relevance to understanding polar resilience. Autonomy and relatedness emerged as key mediators, with relatedness demonstrating a particularly strong mediatory role between social support and ill-being. These findings highlight the importance of interpersonal support, personal resources such as personal resilience, and the natural environment in fostering resilience. The following discussion explores the theoretical and conceptual implications of these findings, examines the

results across socioecological levels, and considers their potential application in supporting polar expeditioners.

2.4.1 Conceptual and Theoretical Implications

This study advances polar resilience research by integrating the socio-ecological model with BPNT to provide a multi-level framework for understanding resilience among polar expeditioners. In line with resilience theory (e.g., Ungar et al., 2011; Masten et al., 2021), polar psychology increasingly recognizes that comprehensive explanations of resilient outcomes must address both the positive and negative effects of factors nested across levels, including individual traits and the wider social and physical environment (e.g., Palinkas & Suedfeld, 2021). The present results support that a socio-ecological approach offers a valuable framework for organizing the many variables relevant to resilience. This structure enables researchers to systematically examine factors spanning individual, relational, and environmental levels. However, the integration of theoretically based variables, such as BPN, provides an additional advantage by offering a cohesive explanation for resilience processes across levels. The results of this study align with prior research emphasizing the importance of BPN in extreme environments. For example, Goemaere et al. (2019) found that autonomy and relatedness satisfaction were critical predictors of well-being and ill-being during a high-seas Mars mission simulation. Their findings demonstrated that these needs significantly influenced positive outcomes, such as well-being and motivation, while also reducing stress. The consistency between these findings and the present study underscores the role of autonomy and relatedness in promoting resilience across extreme contexts.

2.4.2 Social-ecological levels

2.4.2.1 Individual level.

2.4.2.1.1 Personal resilience

At the individual level, personal resilience was a significant predictor of both well-being and ill-being, with these relationships mediated by autonomy and relatedness. The use of a composite measure, such as the personal resilience subscale of the ARM-R (Resilience Research Centre, 2018), underscores the efficacy of socioecological-based tools for capturing the multidimensional nature of resilience. Previous studies have demonstrated the ARM's association with better psychological outcomes in vulnerable or high-risk adult populations, including those facing trauma or adversity (e.g., Clark et al., 2022; Kurtz et al., 2019; Liebenberg & Moore, 2018; Wall & Lowe, 2020). Unlike trait-based measures like the CD-RISC (Connor & Davidson, 2003), the ARM-R captures resilience as the ability to navigate and negotiate resources across individual and socioecological domains (Ungar et al., 2011). Its incorporation of personal attributes such as high goal orientation, and relational ones such as a sense of belonging, cooperation, and perceived social support aligns with the interpersonal and intrapersonal qualities deemed critical in polar expeditions (e.g., Palinkas & Suedfeld, 2008). Consistent with the present results, the ARM-R's brevity and focus on socioecological resilience make it particularly suited for polar expeditions, where time and resource constraints often limit assessments. Its utility may also extend to other high-risk environments, providing a brief yet comprehensive measure of resilience.

This study extends the utility of the ARM by exploring its relationship with BPNT, demonstrating that the mediating roles of autonomy and relatedness link personal resilience to psychological well-being and ill-being in a polar expedition context. These findings align with

prior research employing related measures in high-risk environments. For instance, Lera and Abualkibash (2022) found that that a total BPN variable mediated resilience and trauma impacts among Palestinian adolescents in moderately adverse contexts, while in extreme conditions, BPNS had an interactive effect, buffering against trauma. Similarly, Abualkibash and Lera (2017) demonstrated that BPN satisfaction predicted resilience factors across individual, relational, and contextual levels in youth exposed to adversity. The consistency between these findings and the present results underscores the relevance of BPNT and composite resilience measures like the ARM in explaining resilience processes across diverse and challenging environments.

2.4.2.1.2 Coping flexibility.

Coping flexibility was a significant predictor of well-being in this study, highlighting the adaptive advantage of employing diverse coping strategies in polar expedition contexts. This finding aligns with existing literature emphasizing the importance of flexibility in responding to dynamic environmental demands and stressors (Bonanno & Burton, 2013; Cheng et al., 2014). Smith et al. (2021), for example, demonstrated how Antarctic ski expeditioners adapted their strategies based on the stage of the trip, transitioning from problem-focused strategies early on to more emotion-focused approaches as controllable factors diminished. These findings underscore the context-dependent nature of coping, where rigid reliance on any single strategy can hinder adaptation. Unlike prior polar research that inferred coping flexibility from the variety of strategies used (e.g., Kjærgaard et al., 2015), the present study employed a validated scale, the Perceived Ability to Cope with Trauma (PACT; Bonanno et al., 2011), to quantify flexibility more precisely. This approach enhances our understanding of flexibility as a measurable construct and its contribution to psychological resilience in high-stress environments. The

finding that coping flexibility was the smallest predictor of well-being compared to other variables may reflect its role as a process-oriented rather than outcome-oriented construct, influencing well-being indirectly by enhancing adaptive responses to challenges.

Interestingly, coping flexibility was not associated with basic psychological needs (BPN) satisfaction in this study. This finding contrasts with theoretical models, which propose that flexible coping supports need satisfaction by enabling individuals to select strategies that protect BPN (Skinner & Edge, 2003; Ntoumanis et al., 2010). In polar contexts, Smith et al. (2021) hypothesized that the effects of coping on well-being during an Antarctic expedition could be explained through BPN satisfaction. Building on this, Devonport et al. (2022) qualitatively observed that polar explorers' coping responses aligned with the fulfilment or frustration of BPN throughout their journey. Together, these studies provided theoretical and empirical foundations for expecting a significant association between coping flexibility and BPN satisfaction in this study.

However, this relationship has not yet been quantitatively assessed in polar contexts, potentially explaining the discrepancy with our findings. One possible explanation is that coping flexibility may operate through mechanisms not directly tied to BPN, such as mindfulness or emotional regulation, which were not measured in the present study. Furthermore, while the PACT scale effectively captures flexibility, it does not differentiate between the types of coping strategies employed, limiting its ability to detect specific links to autonomy, competence, or relatedness. These findings suggest that while coping flexibility contributes to well-being, its relationship with psychological needs may be more nuanced or mediated by additional factors not assessed in this research.

2.4.2.2 Micro level.

2.4.2.2.1 Family and friend support.

At the micro level, perceived social support from family and friends influenced well-being and ill-being in distinct ways, with varied links to BPN. Higher levels of family support were directly associated with increased well-being, without mediation through BPN, and had no significant impact on ill-being. In contrast, friend support did not relate to well-being but significantly reduced levels of ill-being. This effect was entirely explained by its ability to satisfy the need for relatedness, fostering a sense of connection with others. Social support is widely recognized as a key component of resilience across diverse populations (e.g., Thoits, 2011, 2021; Cohen & Wills, 1985). However, its role within polar expeditions is less consistent, with several studies linking social support to negative outcomes such as increased stress and decreased well-being (e.g., Leon et al., 1991; Smith et al., 2021; Palinkas et al., 2004; Wagstaff & Weston, 2014). Conversely, other studies have reported positive outcomes from social support during polar expeditions, including enhanced well-being, improved cohesion, and reduced stress (e.g., Kahn & Leon, 1994; Leon, 2005; Leon et al., 2002). This variability in findings underscores the complexity of social support's role in extreme environments, prompting a closer examination of reasons that may account for these differences.

The differences in the form of social support measured could account for discrepancies between past and present findings. Social support can be classified as either received support or perceived availability of support (Thoits, 2011). Research consistently shows that perceived support has a stronger and more consistent positive effect on well-being compared to received support (for meta-analysis see; Haber et al., 2007). Unlike the present study, which focused on perceived support, prior polar research often measured actual support seeking using coping

strategy scales. As Smith et al. (2021) observed, actual support is typically sought during negative events, which are more likely to correlate with adverse outcomes. This distinction highlights the critical role of perceived support in promoting well-being, particularly in the challenging contexts of polar expeditions.

The present findings demonstrate that the relationship between social support and psychological outcomes differs depending on the source of support and its link to the satisfaction of BPN. Family support showed a direct association with well-being without mediation through BPN, suggesting its supports expeditioners in different ways. This finding may reflect the physical separation between expeditioners and their families, which limits opportunities for direct relatedness fulfilment through shared experiences or reciprocal interactions. Instead, family support may primarily offer emotional security or reassurance, which contributes to well-being without actively engaging BPN. This interpretation aligns with studies where close family members were present on the expedition. For instance, Leon et al. (2002) observed positive outcomes in polar couples, where family members were physically present during the expedition, allowing for greater reciprocity and shared coping experiences. These findings suggest that proximity and availability may moderate in the role of family support, shaping whether it fulfils relatedness needs or other mechanisms.

Expeditioners who reported higher levels of perceived friend support experienced lower levels of ill-being, an effect fully mediated by their enhanced sense of relatedness. This contrast with family support can be understood through the lens of significant and similar others, who provide distinct types of support (Thoits, 2021). As Wortman and Lehman (1985) observed in bereaved adults, those closest to the individual may be less effective at alleviating distress due to their emotional investment and potential lack of objectivity. Similarly, for expeditioners enduring

significant hardships, family members often lack the contextual understanding necessary to provide tailored support. In contrast, similar others, such as friends, frequently share common interests, values, and experiences (Thoits, 2021), making them better suited to offering informational and emotional support. This may be especially true for expeditioners, as friends with firsthand experience of polar challenges can provide both empathy and practical advice. Consistent with this, Palinkas et al. (2004) found that Antarctic overwinterers who relied on colleagues rather than distant family members reported lower levels of depression comparatively. Nevertheless, the most consistent and impactful source of support across both well-being and ill-being was community support from fellow expeditioners.

It is also important to consider the demographic characteristics of the sample when interpreting the findings related to family and friend support. Many expeditioners in this study were single, in non-cohabiting relationships, and without children, reflecting the high mobility and demanding nature of polar careers. These characteristics may have reduced the salience or availability of close family ties and long-standing friendship networks, potentially attenuating the observed effects of family and friend support. Thus, while perceived support was still associated with well-being and ill-being, the strength and nature of these relationships may have been influenced by the sample profile, highlighting the importance of considering the results in relation to the specific context investigated.

2.4.2.3 Exo level.

2.4.2.3.1 Community support.

In the present study, perceived support from the expedition community uniquely explained both well-being and ill-being. These relationships were fully mediated by the satisfaction of autonomy (well-being) and relatedness (ill-being). This finding aligns with the limited research comparing

different types of interpersonal support during polar expeditions (e.g., Palinkas, 2004). Expeditioners operate in highly isolated environments, such as Antarctic overwinters, where external sources of support are limited to emotional assistance. Consistent with social support theory, BPNT, and social-ecological resilience frameworks, the most impactful sources of support are typically those most available and proximal to the individual (e.g., Thoits, 2011; Bronfenbrenner, 1979; Ungar et al., 2011; Ryan & Deci, 2017). This proximity may explain why friends and family played less of a role compared to support from expedition peers. Additionally, it gives further support to continuing conversations on the role of social support in polar expeditions.

The distinction in how autonomy and relatedness mediated the effects of community support on well-being and ill-being likely reflects their distinct psychological roles in polar expeditions. Autonomy is central to fostering a sense of personal agency and control that enhances well-being (Vansteenkiste & Ryan, 2013). The role of autonomy has been regularly shown to mediate relationships to well-being in this study and previous ones in ICE environments (e.g., Goemaere et al., 2019). This can be understood if the attributes of the polar environment are considered. The remote and isolated locations that can often be increased further by weather and other physical attributes have the potential to be incredibly controlling. Therefore, maintaining a sense of autonomy would make sense to successfully cope with such conditions. In contrast, relatedness, which underpins feelings of connection and belonging, appears more critical for mitigating ill-being. Elevated levels of ill-being in ICE environments have been considered as an important marker for potential issues (Smith et al., 2023) particularly in the isolating conditions of polar expeditions. Therefore, the findings showing how important the interpersonal level is for positive expedition outcomes. These findings align with BPNT's

premise that specific needs take precedence depending on the psychological outcome being influenced (Ryan & Deci, 2017).

2.4.2.4 Macro level.

2.4.2.4.1 Exploration & Commitment to Ethnic Identity.

In the present study, the inclusion of ethnic identity as a variable represented an exploratory effort to investigate macrosystem-level factors influencing resilience, acknowledging the broader cultural and societal influences that may shape psychological outcomes in polar expeditioners. This decision was informed by research on Arctic Indigenous populations, which highlights those barriers at the cultural level, such as systemic marginalization and erosion of traditional practices, often represent their primary resilience challenges (Akearok et al., 2019). Furthermore, differences in nationality and language, have been shown to impact group dynamics leading to stress in polar expeditions (Bishop et al., 2010; Leon et al., 1994; Suedfeld et al., 2012a, b), underscore the relevance of exploring cultural identity in the polar context. However, the results showed that there was no relationship to either of the outcome variables. A simple explanation that the sample was almost completely homogenous white/Caucasian, even though recruitment occurred through global networks. An alternative approach to ensure the voice of minority groups would be to employ qualitative designs that don't rely on large numbers of participants to ensure their perspective is reflected.

2.4.2.4.2 Connection to Nature.

Connection to nature emerged as the strongest predictor of well-being in this study and was also associated with reduced ill-being, with both relationships partially mediated by the satisfaction of BPN. This represents the first quantitative examination of its role in polar expeditions, offering a novel perspective on its impact. The role of nature as a catalyst for

resilience has been noted since the earliest days of polar exploration. Historical accounts from British polar expeditions highlight the restorative effects of natural beauty, including feelings of serenity and relaxation (Mocellin & Suedfeld, 1991). These findings align with modern studies documenting similar benefits for well-being among contemporary expeditioners (Atlis et al., 2004; Leon et al., 2002; Smith et al., 2021) and Indigenous Arctic groups, for whom connection to the natural environment is central to well-being (Allen et al., 2014). Beyond polar contexts, a robust body of literature supports the salutogenic effects of nature on health and well-being more broadly (for meta-analysis see: Sheffield et al., 2022). By quantitatively demonstrating these relationships in a polar context, this study extends these findings, highlighting the potential of nature to mitigate the unique stressors of extreme environments.

The mediation results demonstrated that the positive relationship between connection to nature and well-being, was partly explained by the effect of all three needs collectively, with autonomy approaching significance. Whilst, consistent with support from the social environment, the negative association with ill-being, was explained by fulfilling the need for relatedness. To date, no other studies have investigated this relationship in the polar environment, however consistent with previous findings from general studies (Ryan et al., 2010; Weinstein et al., 2009). In the context of polar expeditions, the natural environment may provide a sense of autonomy through its vastness and freedom, and relatedness by fostering a deep connection to the environment which may be shared experiences with teammates. These findings emphasize that the natural environment itself can be a key source of resilience support, rather than just a secondary consideration.

2.4.3 Interventions & Training Implications

The central finding of this study highlights the importance of satisfying autonomy and relatedness needs in promoting well-being and reducing ill-being during polar expeditions. Training interventions to foster autonomy-supportive environments could be integrated across all levels of the socio-ecological model. At the individual level, pre-expedition workshops can guide expeditioners to identify activities that support their basic needs, a method shown to enhance need satisfaction and well-being (Behzadnia & FatahModares, 2020, 2023; Weinstein et al., 2016). At the team level, shared knowledge of team members' need preferences can foster autonomy-supportive relationships, which have been consistently linked to greater well-being in workplace settings (Moreau & Mageau, 2012; Jungert et al., 2021). Leaders trained in autonomy-supportive practices could further reinforce these benefits, as evidenced by interventions that improved supervisees' need satisfaction and psychological outcomes (Reeve, 2015). Finally, at the organizational level, embedding a needs-supportive culture into policies and training programs could ensure resilience strategies are sustained across all levels (Ryan & Deci, 2017).

2.4.4 Limitations

There are several limitations to consider when interpreting the findings of this study.

One key limitation is the cross-sectional design, which relied on retrospective recall of expeditions that may have occurred up to three years earlier, introducing potential recall bias. Future research could mitigate this limitation by employing longitudinal approaches, such as diary methodologies, which have been successfully used in polar research to capture real-time data (e.g., Smith et al., 2021).

Another limitation is the relatively small sample size for the number of variables analysed, limiting the use of more advanced statistical techniques, such as structural equation modelling, to examine complex relationships. This challenge reflects the broader difficulty of recruiting large samples in polar research due to the small and often inaccessible population of expeditioners.

A further consideration is the study's cross-sectional nature, which precludes strong causal inferences or confirmation of mediatory relationships. While this research offers a preliminary exploration of these relationships, future studies should use intensive repeated measures designs to confirm temporal ordering. Additionally, qualitative methods could provide deeper contextual insights, complementing quantitative findings and enriching the understanding of resilience processes in polar contexts (e.g., Devonport et al., 2022).

An additional limitation relates to the lack of ethnic diversity in the sample, which limits the generalizability of the findings to underrepresented groups. Addressing this issue in future studies through targeted recruitment or qualitative designs could provide a more inclusive understanding of resilience in diverse expedition populations.

Finally, there are potential limitations related to the measure of coping flexibility employed. The PACT (Bonanno et al., 2011) was originally developed to assess coping flexibility in response to potentially traumatic events. While polar expeditions involve significant and prolonged environmental and interpersonal stressors, these may not be universally perceived as traumatic. Consequently, the trauma-oriented framing of the PACT could have influenced how participants interpreted and responded to items, potentially affecting the validity of findings. Although the PACT's dual-orientation model aligns conceptually with the demands of expedition

environments, future research would benefit from developing or employing measures designed specifically for high-challenge, non-clinical populations.

2.4.5 Conclusions

The results of the present study have shown that a range of variables representing aspects of the individual and support from both their social and natural environments of were associated with levels of well-being and ill-being in polar expeditioners. and that in all cases the prediction was improved significantly with the addition of basic psychological needs for autonomy and relatedness. The inclusion of basic psychological needs, particularly autonomy and relatedness, significantly enhanced the explanatory power of many, but not all, of the relationships. Some predictors, such as coping flexibility and family support, demonstrated effects independent of BPN. These findings highlight the utility of BPN in providing a cohesive framework to explain relationships across multiple predictors. However, resilience remains a multifaceted construct, and some predictors influenced outcomes independently of BPN, emphasizing the need for continued exploration of additional mechanisms. This could have value for where intervention and support are focused. Furthermore, need satisfaction has been shown to be modifiable through interventions targeting individuals, teams, and organizational policies. These interventions could be tailored to different expedition phases, including pre-expedition preparation, mid-expedition support, and post-expedition debriefs, to optimize their effectiveness.

Overall, the present research provides important theoretical insights into resilience by integrating BPNT with the social-ecological model and offers practical recommendations for enhancing well-being and reducing ill-being during polar expeditions.

Chapter 3: Polar Expedition Resilience: Basic Psychological Needs Fulfilment through Person, People, and Place - A Thematic Analysis

Abstract

Objective: The purpose of this study was to explore the challenges encountered by polar expeditioners with focus on contextual, relational, and individual level factors and to investigate what and who helped them to meet these challenges using Basic Psychological Needs Theory.

Method: Reflexive thematic analysis was conducted using responses from semi-structured interviews with twenty-two participants, conducted online. Participants represented a diverse range of polar expeditions, including physical expeditions (e.g., ski or sled journeys), research station placements, and community-based research within Arctic communities.

Results: Three themes represented the key challenges. At the contextual level, participants reported the physical risks of the polar environment. At the relational level, conflict and issues relating to differences in group identity, especially gender, were significant challenges. At the individual level, participants highlighted negative beliefs about their ability to physically cope with expedition demands, particularly in comparison to their peers. Five themes were reported to represent supporting factors. At the contextual level, participants emphasized the importance of having sufficient physical resources, such as food, shelter, and equipment. At the relational level, social support was important at different levels which included, feeling part of a supportive community; developing close relationships that allowed for honest disclosure; and having remote support from friends and family. At the individual level, participants reported previous experience as assisting with meeting current demands; Deriving positive benefits from the natural environment which were consistent with connection to nature and experiencing awe

states. And finally, utilising aspects of mindfulness including developing a non-judgemental awareness and a level of acceptance and benevolence towards both the environment and other individuals.

Conclusion: These findings demonstrate that the person, people, and place relevant to expeditions should be considered when investigating expedition resilience. Furthermore, that basic psychological needs theory provides a theoretical framework which can offer explanation at all levels of a resilient system.

Building on the socio-ecological framework and BPNT outlined in Chapter 1 alongside the quantitative findings from Chapter 2, this study adopts a qualitative methodology to further explore resilience among polar expeditioners. While Study 1 demonstrated that well-being and ill-being were predicted by the satisfaction of basic psychological needs across individual, relational, and environmental levels, a deeper understanding of how these needs are experienced and supported in context requires a qualitative lens. Chapter 3 therefore employs post-expedition interviews to capture nuanced, contextually embedded challenges and resources beyond those identified through quantitative analysis.

3.1.1 Contextual-Level

The polar regions expose expeditioners to extreme environmental conditions, including severe cold, hazardous terrain, and prolonged periods of isolation, confinement and extreme conditions. These ICE stressors profoundly impact physical and psychological functioning (Palinkas & Suedfeld, 2008, 2021). A detailed review of these environmental challenges and their psychological effects is presented in Chapter 1. Rather than reiterating these points, this chapter focuses on how expeditioners subjectively experience these conditions and how the environment interacts with social dynamics and psychological adaptation.

The extreme conditions of the polar environment can intensify interpersonal tensions within expedition teams, a phenomenon often described as the "goldfish bowl effect" (Van Puyvelde et al., 2022, p. 08). Prolonged exposure to these stressors has also been associated with psychological strain, including hostility, depression, and anxiety, collectively referred to as winter over syndrome (Palinkas & Houseal, 2000; Strange & Klein, 1973). As reviewed in Chapter 1, such outcomes vary across settings, with some studies reporting lower depression rates in the most extreme environments, potentially due to stronger group cohesion and a shared

sense of purpose (Palinkas et al., 1989; Palinkas, 1991; Palinkas & Houseal, 2000). These findings underscore the importance of contextual and social dynamics in shaping resilience, particularly how group composition and interpersonal processes interact with environmental stressors.

Beyond its challenges, the polar environment also offers a profound source of psychological support. Multiple qualitative accounts describe experiences of awe, serenity, and emotional connection amidst the extreme conditions of the polar regions (Mocellin & Suedfeld, 1991; Atlis et al., 2004). In Chapter 2, connection to nature was found to be positively associated with well-being among expeditioners, highlighting the potential role of the natural environment in supporting resilience. Building on these findings, the present study seeks to explore how expeditioners subjectively experience the natural environment and the psychological resources it may provide. Previous research suggests that early-life experiences with nature can foster a deeper sense of connectedness later in life (Lengieza & Swim, 2021), but little is known about how these formative experiences might shape adaptation in extreme environments. Similar patterns have been observed in other high-stress settings, where individuals report feelings of awe triggered by vast, overwhelming landscapes, such as in space exploration (Keltner & Haidt, 2003; Yaden et al., 2016). In polar contexts, expeditioners have similarly described moments of wonder and emotional closeness to their surroundings (Mocellin & Suedfeld, 1991), suggesting that the natural environment may provide unique psychological resources even amid extreme adversity.

3.1.2 Relational-Level

Interpersonal issues have been widely acknowledged as a key source of stress during polar expeditions, with demographic or identity differences frequently cited as contributing

factors (Palinkas & Suedfeld, 2008; Sandal et al., 2006). The degree of similarity or difference between team members in terms of age (Cusack, 2010; Gunderson, 1974; Palinkas et al., 1989), occupation (Gunderson, 1974; Palmai, 1963; Palinkas, 1992), nationality and language (Bishop et al., 2010; Leon et al., 1994; Suedfeld et al., 2012a, b), and gender (Leon et al., 2005) has been associated with either heightened conflict or enhanced cohesion. As expedition teams have become increasingly diverse, the potential for interpersonal tensions related to identity differences has grown (Nash et al., 2019), highlighting the complex social dynamics expeditioners must navigate.

Among these identity factors, gender has received increasing attention. Several high-profile reports have documented the mistreatment of female staff on Antarctic research bases, raising concerns about harassment and the persistence of exclusionary cultural norms (Nash, 2022; Nash et al., 2019; USAP, 2022). For instance, Nash and colleagues (2019) found that 63% of a sample of Australian Antarctic staff reported experiencing inappropriate or sexual remarks in the field, with many choosing not to report these incidents due to fears of career repercussions or personal safety. Silence and non-disclosure have been identified as cultural norms in these environments (Kaiser & White, 2022), reinforcing the risks faced by individuals who deviate from dominant group expectations. These dynamics have implications not only for the well-being of affected individuals but also for team cohesion, with lower levels of well-being reported in teams where cliques form and group divisions are evident (Palinkas, 1992).

Social support is often cited as a critical buffer against the stresses of expedition life, but its role in ICE environments appears complex. Traditional sources of support, such as friends and family, are generally unavailable during expeditions, increasing reliance on team relationships. Expedition teams are frequently described as embodying a collectivistic culture, where group

needs are prioritized over individual ones (Van Puyvelde et al., 2022). While this ethos can foster mutual aid and collaboration, it may also discourage individuals from seeking emotional support if doing so is perceived as threatening team cohesion. Although social support is generally associated with positive outcomes in broader literature (Thoits, 2021), studies in ICE settings have reported mixed findings. Some research has linked social support use to increased stress reactivity and negative emotions (Leon et al., 1991; Smith et al., 2021; Palinkas et al., 2004; Wagstaff & Weston, 2014), while other studies, particularly those involving more gender-diverse teams, suggest that emotional sharing among team members can enhance well-being (Atlis et al., 2004; Kahn & Leon, 1994; Leon et al., 2002). Consistent with these findings, results from Study 1 of the present thesis showed that perceptions of social support from friends, family, and fellow expeditioners were positively associated with well-being and negatively associated with ill-being. These patterns suggest that the availability and efficacy of social support in polar settings may be shaped by team composition and individual differences, highlighting the need for further exploration of these dynamics through qualitative approaches.

3.1.3 Individual-level

Individual characteristics have long been considered critical for successful adaptation in extreme environments. One of the largest studies with Antarctic winter over personnel identified three key aspects associated with resilience: emotional stability, task performance, and interpersonal compatibility (Gunderson, 1974; Palinkas, 2011). High emotional stability has consistently been linked to successful adaptation across diverse polar expeditioner groups, including scientists, military personnel, and logistics staff (Kjærgaard et al., 2015; Palinkas et al., 1995, 2000; Sarris, 2006). Other important traits include self-efficacy, confidence, and interpersonal warmth, with higher levels of benevolence, tolerance, and patience associated with reduced interpersonal

conflict (Corneliussen et al., 2017; Sandal, 2000; Sarris, 2017). However, the predictive power of any single personality trait is relatively weak, with adaptation outcomes often contingent on situational factors and team dynamics (Palinkas & Suedfeld, 2021).

More recently, research attention has shifted toward dynamic psychological capacities such as mindfulness, which may offer more flexible and adaptive strategies for coping with ICE stressors (e.g., Pagnini et al., 2019). Mindfulness, broadly defined as present-centred, non-judgmental awareness (Kabat-Zinn, 2003), has been associated with a range of positive outcomes in general and clinical populations (Pagnini et al., 2019). Interest in its application to ICE environments has grown, with space agencies such as NASA and the ESA identifying mindfulness as a research priority for analog studies (ESA, 2021; Pagnini et al., 2019). Preliminary studies with Antarctic personnel have shown that higher baseline mindfulness scores are predictive of lower stress levels over time, and mindfulness practice has been linked to reduced stress reactivity and improved attentional control (Brown & Ryan, 2003; Johnson et al., 2014; Meland et al., 2015; Jha et al., 2015, 2017, 2020; Nassif et al., 2023). Despite these promising findings, research on mindfulness in ICE environments remains limited, suggesting a need for further exploration of how mindfulness may function as a coping resource in extreme settings. Additionally, mindfulness is increasingly recognized as relevant to Basic Psychological Needs Theory, particularly in supporting autonomy and well-being through enhanced self-awareness and emotional regulation (Ryan & Deci, 2017).

3.1.4 Basic Psychological Needs Theory (BPNT)

Inherent in applying a systems approach to resilience is the acknowledgment that multiple factors contribute to resilient outcomes. A theoretical framework that can explain and predict across individual, relational, and contextual levels offers considerable value. Study 1 of

the present thesis provided support for the efficacy of Basic Psychological Needs Theory (BPNT) in fulfilling this role, adding to a growing body of research in isolated, confined, and extreme environments (e.g., Devonport et al., 2022; Goemaere et al., 2019; Kay et al., 2022). BPNT proposes that the satisfaction of three fundamental needs, autonomy, relatedness, and competence, is essential for psychological well-being, whereas the frustration of these needs is associated with ill-being (Ryan & Vansteenkiste, 2013; Vansteenkiste et al., 2021). Numerous meta-analyses have confirmed these associations across diverse populations (Ng et al., 2012; Van den Broeck et al., 2016; Slemp et al., 2018; Chen et al., 2015).

BPNT also predicts the environmental and relational conditions that are conducive or detrimental to need satisfaction. For example, at the contextual level, exposure to natural environments has been shown to enhance well-being relative to non-natural settings (Weinstein et al., 2009). Findings from Study 1 supported this proposition, demonstrating that the positive effect of nature connectedness on well-being was partially mediated by satisfaction of the need for autonomy.

At the relational level, BPNT suggests that social relationships vary in how effectively they satisfy basic needs. Relationships that allow individuals to present their authentic identities are particularly important for supporting well-being (Ryan & Deci, 2017). This has relevance for understanding how individuals experiencing social pressures during expeditions may cope. At the individual level, mindfulness, understood as an open and receptive awareness of present experiences, has been linked to greater need satisfaction and enhanced well-being (Ryan & Deci, 2019). Empirical studies have supported this relationship, showing that basic psychological needs mediate the link between mindfulness and well-being (Campbell et al., 2015, 2018; Chang et al., 2015).

3.1.5 Present Study

Building on the background presented, the present study aims to address gaps in understanding how polar expeditioners experience and respond to challenges across individual, relational, and contextual levels. Semi-structured interviews were conducted with 22 expeditioners, including those who had completed both short- and long-duration polar treks in both hemispheres, personnel stationed at Antarctic bases and field camps, and researchers working in Arctic community settings. Reflexive thematic analysis was employed to gain detailed insights into the specific challenges encountered and the factors that supported participants in meeting these challenges. While Study 1 identified key predictors and mediators, quantitative methods are limited in capturing the subjective experiences, complex social dynamics, and contextual nuances that underpin resilience processes. Therefore, a qualitative approach was essential to explore how basic psychological needs are satisfied or frustrated in practice and to uncover mechanisms not readily accessible through closed-question survey-based designs.

3.2 Methods

3.2.1 Participants

Twenty-two polar expeditioners were purposively sampled to take part in one semi-structured interview. In this study, expeditions were included that were in either polar or sub-polar regions of either the Arctic (*n* = 10) or Antarctica (*n* = 12). The sample was relatively balanced in terms of gender (Male = 12; Female = 10) and role (Journeying = 11, Science research = 11). The mean age of participants was 39 years old (*M* = 39.06; *SD* = 11.43). The average expedition duration was 108 days (*M* = 108.27; *SD* = 115.93). The study was approved by the Durham University Dept of Psychology Research Ethics Committee.

Table 3.1

Demographic information of study participants

Variables	Level	No/*M* (SD)	Variables	Level	No/*M* (SD)
Gender	Female	10	Region	Arctic	10
	Male	12		Antarctica	12
Age		39 (11.43)	Type	Journeying	11
Marital status	Single - live alone	3		Research	11
	Single - live family/friends	1	Ethnicity	White, Caucasian	22
	Relationship - live together	9			
	Relationship - live separate	4			
	Married	5	Trip duration		108 (115.93)
Children	Yes	1			
	No	21			

The key characteristics of the individual participants are provided in Table 3.2. below.

Table 3.2.

Individual Expeditioner Characteristics

	Gender	Region	Exped. Type	Relationship Status	Have Children	Time Since Expedition
P1	Female	Arctic	Research	Relationship – live together	No	< 2.5 years
P2	Male	Arctic	Research	Relationship – live together	No	< 6 months
P3	Female	Arctic	Research	Relationship – live separately	No	< 1.5 years
P4	Male	Arctic	Journeying	Relationship – live together	No	< 3 years
P5	Male	Arctic	Journeying	Relationship – live together	No	< 2.5 years
P6	Female	Arctic	Research	Single - living alone	No	< 1 year
P7	Male	Antarctica	Research	Relationship – live together	No	< 1 year
P8	Male	Arctic	Research	Married/Long-term partner	No	~ 2.5 years
P9	Male	Arctic	Research	Relationship – live together	No	~ 2.5 years
P10	Female	Antarctica	Research	Relationship – live separately	No	~ 2 years
P11	Female	Antarctica	Research	Relationship – live separately	No	~ 1.5 years
P12	Female	Antarctica	Research	Relationship – live together	No	~ 3 months
P13	Male	Antarctica	Journeying	Relationship – live together	Yes	~ 3 months
P14	Female	Antarctica	Journeying	Single - living alone	No	~ 3 months
P15	Male	Antarctica	Journeying	Married/Long-term partner	No	~ 3 months
P16	Male	Antarctica	Journeying	Married/Long-term partner	Yes	~ 3 months
P17	Male	Antarctica	Journeying	Married/Long-term partner	Yes	~ 3 months
P18	Male	Antarctica	Research	Relationship – live separately	Yes	~ 3 months
P19	Female	Antarctica	Journeying	Single - living alone	No	~ 3 months
P20	Female	Arctic	Journeying	Single - live with family/friends	No	~ 3 years
P21	Male	Antarctica	Journeying	Married/Long-term partner	No	~ 3 years
P22	Female	Arctic	Journeying	Relationship – live together	No	~ 2 months

3.2.2 Data collection

A semi-structured interview guide comprised of open-ended questions (available in a supplementary file) was produced. To improve the rigor of the interview questions, I conducted an expert panel session with the Durham Arctic multi-disciplinary research group. The group includes researchers with a wide range of Polar experience from across disciplines (e.g., Biosciences, Geography, Anthropology, Law) who have all personally spent time on placement in the Arctic region. Following the session, the protocol was revised and then on multiple

occasions following conversations with my primary supervisor. Topics covered in the interview asked participants to think about the challenges they experienced, with consideration of the context (e.g., environmental demands), relational factors, and personal attributions (e.g., personality traits or dispositions). Questions addressed in the interviews included: *Did you find your time challenging or relatively manageable? Were there any particular challenges that stick out to you or maybe there were not? If so can you give me some examples of the challenges for you? What personal qualities may you have that contribute to that evaluation? Did you have any methods or strategies to cope with those challenges?* Finally, all participants were asked if they had any further thoughts on the matters discussed they would like to share.

Prior to starting interviews, all participants had provided informed consent and completed a demographic questionnaire. This information was used to classify the participants and ensure representation of certain characteristics such as gender (Male & Female), polar region (Arctic & Antarctic) and expedition type (Research stations, field camps, traverses and community-based researchers). Whilst there are no strict guidelines for sample size in qualitative research, it has been suggested that a minimum of six participants be conducted(Braun et al., 2016). Therefore, at least this number was collected for each of the categories outlined above. The sample size was also dictated in relation to what could be achieved as part of a fixed-term PhD project. Interviews ranged from 41 min to 99 min (M_{time} = 64 min). Interviews were audio recorded and transcribed verbatim. Ethical approval for this study was obtained from Durham University Psychology Ethics Committee, with approval reference number PSYCH-2020-11-13T17_39_23-rbdt65

3.2.3 Data Analysis

A reflexive thematic analysis (Braun & Clarke, 2019) was used to identify patterns within the data regarding participants' experiences of the challenges they faced and the factors that

supported them during polar expeditions. The thematic analysis was conducted by the author. A deductive approach to analysis was adopted, guided by Basic Psychological Needs Theory (BPNT; Vansteenkiste & Ryan, 2013) and a social-ecological resilience framework (Ungar, 2003). The social-ecological perspective informed the design of the interview guide, with questions aimed at exploring different levels of the system (e.g., individual, relational, and contextual factors). While these frameworks shaped the initial structure of the inquiry, the coding process and theme development were grounded in the participants' reported experiences. BPNT provided a theoretical lens for interpreting and discussing the identified themes.

The six-stage process of thematic analysis (Braun & Clarke, 2022) was applied to conduct data analysis. The first stage was a familiarization with the final transcriptions, involving reading each transcript and listening to the audio recordings, noting any observations using the comments function in Microsoft word. In the second stage, each transcript was reviewed for salient features relevant to the research question, with initial codes created. This process was conducted using Microsoft word with a table listing each code chunk parallel to the relevant text from the participant. In stage three, initial codes were organised using the broad categorisations of the social-ecological model (e.g., Individual, relational, Contextual). Sub-themes were then created within each of these categories. This section of data analyses was conducted using Microsoft Excel, with the code chunks placed below theme headings and relevant text added as a comment to each individual box. In the fourth stage, initial themes and sub-themes were reviewed. During this stage of the process, certain themes were merged with others and those that were shown to be reported by a small number of individuals were removed from further analysis. Thematic maps were also created at this stage, to visualise the relationships between themes. At stage five, theme descriptions were written and saved alongside

the relevant codes, and text from participants for further review. The process of writing the introduction and discussion were begun at this point too, this was to aid further refinement of the themes prior to the final write-up. Finally, the complete report was produced in the final stage. This included the selection of data extracts with justifications to represent the participants experiences and to generate an argument in relation to our proposed research question.

3.2.4 Reflexivity and quality criteria

The philosophical orientation underpinning this research was aligned with a critical realist paradigm. Critical realism assumes that there is a reality independent of our perceptions, but that our understanding of it is mediated by social, cultural, and historical contexts (Archer, 2016; Bhaskar, 2008). This ontological position acknowledges the existence of an objective reality, while recognising that knowledge of these experiences is fallible and shaped by the perspectives of both participants and researchers. Epistemologically, this implies a relativist stance where research acknowledges the contextual and contingent nature of knowledge.

Critical realism was particularly well suited to the theoretical and methodological approach adopted in this study. In examining resilience from a socioecological perspective, the research acknowledges that resilience arises not solely from individual traits but from the dynamic interplay between individuals and the relational and environmental systems they inhabit. Similarly, BPNT proposes that while autonomy, competence, and relatedness are universal needs, the ways in which these needs are satisfied and their relative prominence can vary substantially depending on the context (Deci & Ryan, 2017). A critical realist stance therefore provided a framework that supported the use of BPNT and socioecological models while remaining sensitive to the situated and contextual nature of participants' experiences.

My research training to date had been predominantly within postpositivist and quantitative traditions, where bias is often conceptualised as something to be minimised or eliminated. As such, this project was foundational in developing my qualitative research skills and deepening my appreciation of reflexive, interpretive approaches. Transitioning to a perspective that sees researcher influence as inevitable and valuable was challenging, but ultimately it has broadened and enriched my view of what constitutes rigorous research. In this context, adopting a critical realist position felt like a logical philosophical progression, offering a framework that preserves the importance of empirical rigour while acknowledging the complex, layered nature of reality and the contextual shaping of knowledge.

Throughout the process of conducting thematic analysis, I remained aware of my positionality as a researcher with both prior academic knowledge and personal interests in resilience and equity within polar expeditions. This awareness was critical in recognising how my preconceptions and theoretical orientation, including familiarity with BPNT and the socioecological model, might shape the identification and interpretation of themes. Rather than viewing my positionality as a source of bias to be eradicated, it was treated reflexively as a valuable lens that informed and enriched the analysis. For example, my personal background, including growing up in an environment affected by domestic abuse, has shaped my sensitivity to issues of marginalisation, discrimination, and power dynamics. This life experience instilled a strong commitment to highlighting underexplored issues such as gender, class, and broader equality, diversity and inclusion challenges faced by polar expeditioners, which may otherwise have been overlooked.

During the later stages of this research, I undertook a placement at the British Antarctic Survey (BAS), working under the supervision of the BAS Equality, Diversity and Inclusion

Manager. My project focused on equality, diversity and inclusion issues within polar research, providing further opportunity for critical reflection and deepening my understanding of the systemic factors affecting expeditioners' experiences. These conversations and experiences aligned closely with my own values and aims, reinforcing the importance of giving voice to equity related issues that might not have been captured by researchers with different positionalities. This placement was also important as it was conducted during a key period of coding and developing themes from my existing interview data.

Steps were taken to embed reflexivity throughout the research process. For example, during the familiarisation stage of thematic analysis, I purposefully delayed referring to theoretical frameworks, focusing solely on participants' narratives. Initial coding emphasised participants' language to capture their experiences authentically before grouping codes under pre-existing theoretical constructs. Reflexive journaling was also employed to document moments where my assumptions might have influenced theme development, and these reflections informed discussions during the review and refinement stages. For example, after attending a seminar with a high representation of female expeditioners, I reflected more deeply on my own social position, as captured in the following diary entry:

> "The diversity of the group allowed for critiques or comments that came from angles I would not have necessarily noted. One example, the impact of gender within Polar work, and how the social experiences for females may differ and be a central challenge. This thought led me to also reflect on my own positionality in regard to macro level factors in the project. Does coming from a 'working-class background' where I believe advantages do occur along these lines, led me to focusing more on this area and missing this one. This point, will be reflected in my design by having the confidence to use broader

> questions that allow participants to bring their own challenges, rather than me impose narrower thinking."

Additionally, during the interpretation phase, I sought to balance the inductive insights emerging directly from the data with deductive interpretations informed by theory. This iterative process ensured that participants' voices remained central while situating findings within the broader theoretical framework of BPNT and socioecological resilience. By integrating reflexivity into every stage of the analysis, I aimed to produce findings that were both rigorous and grounded in participants' lived experiences.

3.3 Results

The following results section presents the themes identified, beginning with those relating to challenges at each level (contextual, relational, individual), followed by supportive themes. Each theme is evaluated in relation to the basic psychological needs for autonomy, competence, and relatedness. A thematic map (Figure 3.1) is provided below to illustrate the overarching structure of stressors and supports influencing basic psychological needs satisfaction among polar expeditioners.

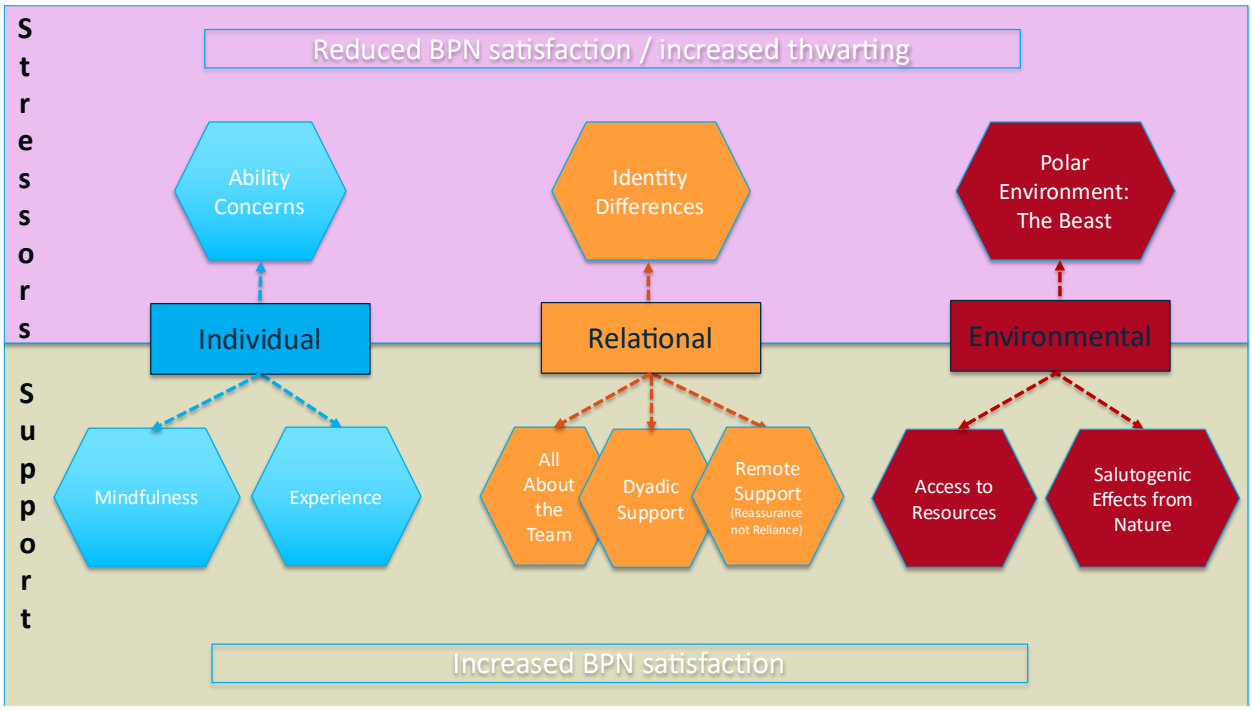


Figure 3.1. Thematic map representing key themes identified in the analysis

3.3.1 Challenges

3.3.1.1 Contextual Challenges.

3.3.1.1.1 Polar environments: the beast.

The natural environment was the most consistently reported challenge. Almost all participants reported the concerns and stress caused by the level of isolation and confinement, disrupted sleep (especially over-winterers) and the direct physical risks of the natural environment, including risks from falls into crevasses, extreme cold related injuries, high winds and for those in the Arctic the risk of attack by Polar bears, as the following extracts highlight.

> "During the course of that day the expedition leader collapsed, so I had to go and help them, and it was real classic stuff, you know, trying to get a tent up, getting into a sleeping bag with them to warm them up because they were unconscious. I just started to get them sorted out and another person came to me and their hands were completely white. I've seen frostbite before but never like that…" (P5).

> "But we got to the top of the [name of large Antarctic glacier], and then we got slammed by this wind. And part of it was katabatic coming down of the mountains that were to the left of us... And we ended up in our tent for the best part on and off for probably that two weeks" (P14)

> "And I remember second day, we camped overnight... bit of a storm came up and we were standing on this beach... and basically a polar bear came round and ripped through the tent, whilst we were sleeping. This was second day, so there we felt that, I mean, we dealt with it and managed to get rid of it, but it came back a few times we had a bit of a battle with them with nicked some gear out of our kayaks..." (**P4**)

These environmental challenges are likely to thwart psychological needs in several ways. These environmental challenges could undermine psychological autonomy by reducing participants' sense of control over their surroundings. The unpredictability of extreme weather, wildlife threats, and environmental dangers might leave individuals feeling constrained and reducing a sense of volition in managing the environmental demands. The risks and uncertainties associated with polar conditions may undermine participants' sense of competence, as they face physical challenges beyond their control. Isolation and confinement, as highlighted by being tent bound alone, are likely to reduce opportunities for relatedness due to limiting meaningful social interactions. (Ryan & Deci, 2017).

3.3.1.2 Relational Challenges.

3.3.1.2.1 Identity related challenges.

This theme relates to issues related to demographic or identity differences that existed between the individual and other group members. And conversely, the advantage or privilege that may be provided by sharing key characteristics with the group. The most notable aspect of this was the challenges faced by female expeditioners. The issues ranged from having to deal with aggressive/domineering approaches in the workplace and opinions being given less consideration than male counterparts, to the extreme of worrying about the risk of sexual assault, as highlighted by the extracts below. The most severe concerns were reported by those operating on Antarctic research stations.

> "I think there's a challenge that I think might be unique to being like a woman in these settings… But sometimes there's like, kind of like, alpha men. And they just take up so much space. And like, auditory space, they're the dominant voice. They make the decision, and which is fine. But, as somebody who's like, quite capable in my own right,

> in the field, it does kind of grate to constantly just be kind of giving up my own, like, to just kind of acquiesce to like the most dominant voice." (**P6**)
>
> "I think being a woman there gives a whole new suite of challenges and that like in... full honesty at sometimes you're like fending off men. You know, if you go have drinks, at one of the bars there people get super drunk there and miss-read friendliness for interest. So, I definitely felt at times, sort of like, trapped with like men in a situation that I did not feel comfortable in… And I see a lot of issues with safety for women in the Antarctic on station especially. Especially with alcohol, so yeah, I think the problem is like, so, I remember before I first went down, some of my female lab mates talk to me, and were like, don't go to this bar and, you know, always stay with your team and sort of like instilled this like sense of fear, almost of like, all these men are gonna, like, try and, like, prey on you" (**P10**).

Whilst gender was the most reported aspect of identity, numerous other group differences were reported, including (in order of prevalence), nationality/language, occupation, social class, age, and sexuality. Differences in group identification were linked to difficulties communicating with others, the language difference being an obvious barrier. However, group affiliations were also related to different values and beliefs regarding how things should be done, for example, a military culture compared to civilians.

> "You know, when I look at the behavior, wherever, except as a civilian, would I've accepted in the military, no, because inherently, other team members are at risk. And it confused the, the whole process of how we were doing our decision making. Individuals cannot be completely individualistic and then decide that they're going to do something different to an aggrieved client because then that threatens everybody." (**P13**).

These identity related challenges underscore the impact of group dynamics on the satisfaction of basic psychological needs. Gender differences, particularly the issues faced by women, highlight how concerns over safety and marginalization can thwart the need for relatedness by reducing opportunities for meaningful social connections (Weinstein et al., 2012). The dominance of particular social groups within teams may also undermine autonomy by limiting individuals' capacity to express their views or make volitional choices, as seen in the pressure to conform to dominant voices (Legate et al., 2011). Moreover, when participants must suppress key aspects of their identity, such as their sexuality or cultural background, it can erode both autonomy and relatedness. Power imbalances and lack of inclusive decision-making processes may further impact perceptions of competence, reducing individuals' sense of effectiveness and value within the team (Kachanoff et al., 2020). These findings illustrate how identity-based differences can fundamentally shape the degree to which basic psychological needs are satisfied or thwarted during polar expeditions.

3.3.1.3 Individual level challenges

The challenges associated with certain personal characteristics can be amplified through intersectionality, with around a quarter of participants reporting issues related to minority status across multiple factors. For example, some described how being a young female scientist shaped their experience in ways that compounded existing inequalities.

A second aspect was the report of feeling the need to actively hide an important aspect of their identity, specifically their sexuality. This was due to the deep concern of how they would be treated in a certain area of the world.

> "One is that when we were in [City Name, in different country], the company that we went to see they were very, very hospitable, very friendly, and they took us out to dinner.

> The [person who was the main contact] said, “Oh, we're gonna go out and have dinner”. And then I had to say to him (colleague), before we went out for dinner, I said, if the conversation turns to families and relationships, I said, I'm not comfortable coming out to these people in a city that's full of evangelical churches… And in fact, sure enough, it did come up… I just said I don't have kids in a kind of that's the end of the sentence kind of way, as if maybe they've been some tragedy or being infertile or whatever it was, and they were hospitable enough to change the subject… That was the first time in in a very long time that I've felt the need to do something like that in order to preserve my own safety or feeling of safety psychological safety.” (P8)

This example highlights when individuals must actively suppress parts of their identity in fear of negative consequences, behave in certain ways, display or hide certain attributes, to fit with the majority group. In contrast, individuals who share characteristics of the dominant majority may enjoy privilege and have less challenges due to in-group affiliation. For example, as the following quote shows, the advantage is clear for those who have a dominant ethnic and national identity.

> “But then I am male, I am white. I'm British English, like, UK, we've got this incredible affection for and this sort of connection with polar exploration there. So there's a whole there are a whole tonne of advantages that I had without doing any work.” (P21).

Identity-related challenges highlighted in these responses underscore the impact of group dynamics on BPN. Gender differences, particularly issues faced by women, were prominent. These challenges included concerns over safety and marginalization, which can thwart the need for relatedness by limiting authentic interactions and fostering an environment of exclusion (Weinstein et al., 2012). Additionally, participants' need for autonomy may be undermined when

they feel pressured to conform or suppress aspects of their identity to fit group norms, as observed in participants who concealed their sexual orientation to avoid discrimination (Legate et al., 2011). The role of identity is also evident in group interactions where dominance by the majority group may limit opportunities for minority individuals to express their competence and autonomy (Kachanoff et al., 2020). Conversely, participants who shared characteristics with the majority group experienced privilege, benefiting from in-group support that enhanced relatedness and competence (Luyckx et al., 2009; Soenens & Vansteenkiste, 2011). This dynamic illustrates how minority and majority group status can distinctly shape access to resources and needs satisfaction, impacting well-being outcomes.

3.3.1.3.1.1 Concerns regarding personal ability.

Participants reported feeling concerned regarding their ability to cope with the demands of the expedition. Those concerns were related to their physical ability to cope with the environmental demands and in comparison, to their fellow expedition members or professional colleagues. The concerns regarding physical ability to meet the expedition demands were predominately from those completing physical journeys, as this extract shows:

> "And my biggest fear, when I started it was that I wasn't going to be able to haul my own kit up these hills because they're steep hills you're covering... And I was really worried I wasn't gonna be strong enough to pull and you do it in split loads" (**P14**).

Similar concerns were voiced about self-imposed pressure that came from making social comparisons to others, especially across genders:

> "I think it's a little bit just comparison where you go like, how are others doing. And I was with three guys, so naturally, physically, one guy was about twice as tall as me, I'm

> quite short, the shortest, I'm the only female and so I think, like, you know, there's sort of this like, oh, shit, am I fit enough. Like, there's some of that" (P22).

Regarding BPN, the concerns about ability could thwart or at least reduce competence satisfaction, as participants might perceive themselves as less effective or capable in handling the physical and social demands of the expedition. This undermines their sense of mastery, which is central to the need for competence (Ryan & Deci, 2017). Relatedness could also be affected, as participants may withdraw from others to avoid negative judgments, potentially reducing opportunities for meaningful social connections (Legate et al., 2011). Finally, these reductions in self-efficacy could impact feelings of autonomy, as participants might feel less volitional in their actions, perceiving external pressures as controlling (Weinstein et al., 2012).

3.3.2 Supportive Themes

3.3.2.1 Contextual

3.3.2.1.1 Resources: For necessity and thriving.

Participants reported the importance of having certain resources for successful expeditions, including sufficient finance, equipment, accommodation, food and communications capabilities. Financial demands depend on expedition types, for example finance was more applicable to independent expeditioners conducting polar journeys as the following quote highlights:

> "Polar expeditions is so complex, logistically, getting out the, you can't do it on your own, you can't hitchhike to Antarctica. It's gotta be… six figure budget, minimum, and they involve a lot of people to get you down there. There's always a team" (P21).

Food represented more than just providing the calories required, but more so, providing a source of comfort and reassurance to expeditioners.

> “I think like, physically, almost always, I've been in a done field work where food has been good quality and tasted good. And I actually think that's really important for keeping spirits up... and just like mental health...” (P6)

Accommodation was also reported to play an important role. This fulfilled various roles, from a place of safety from the conditions, and from a social perspective providing either a place of socialization or conversely, a place for escape.

> “I could go in my tent in the evening because the convention is you're not disturbed in your tent, unless it's urgent. You know, if you want some privacy, that's where you go. Where we have a central mess tent, where you go in there, and there's a conversation going on all the time. So, I could go in my tent and exchange messages with my partner, let off some frustrations, you know, that kind of thing” (**P8**).

Participants reported that communications played an important role, such as increasing safety support and maintaining a 'connection' with home. However, it was also noted that when connections with those back home were not expected, having too much can lead to removing oneself from the team and undermining cohesion.

> “… And it was the most bizarre thing… we’re as remote as we possibly could be on an expedition. And yet you know, we could just turn on and I could, we could be connected without touching, you know what I mean, to our folks at home. And as soon as I turned that box on, people just, they disappeared from the team, they don’t care about the team anymore, they’re just there in their own little communications bubble with the folks back home” (**P18**).

This theme underscores the paradox of communication technology in polar expeditions: while providing essential resources for safety and emotional support, its misuse or overuse can inadvertently isolate individuals from their teams, undermining the very cohesion needed for resilience in such extreme environments.

3.3.2.1.2 Deriving Salutogenic effects from natural environment.

Whilst participants consistently reported the danger, they also remarked on the beauty and positive value that they derived from the environment itself, in which the risk and latent power of the environment were themselves part of this positive perception.

> "Well, it's a real stressor, you know, wherever you go, so what would it be in Greenland, it'd be crevasses, it'd be those bloody melt rivers that are just beautiful when you look at them, the lovely turquoise blue waters, but you know, they're down ice gullies, and if you fall into one of them you're not coming out again." (P5)

This extract frames how even within dangerous places, expeditioners can acknowledge the inherent beauty that is intertwined with the danger. As the following extracts highlights, participants reported at times feeling a sense of awe or privilege and viewing the environment as a principal support to their well-being.

> "And just like looking out on the frozen sea ice, like just every day, I would see that and say, like, I'm so fucking lucky to be here, just so unbelievably lucky. And I was even more lucky than so many people who go and that I got to go out on the sea ice and see penguins and seals and dive and see all of the life that's under the ice like on the surface it looks very barren. But once you go underwater it is like teeming with life. And so, I just felt like so awestruck at the environment. And that's what keeps me going." (**P10**)

> “I think it's like, whatever the weather was, because it's beautiful, but also, because it's sort of nature quite like that, you know, it doesn't always sunshine I can quite easily enjoy, like, a day where it’s like a white out, everything was white, like, you know, the sky and like everything is just the same. It’s just like totally beautiful in its own way. And so you're kind of feel like, I can get a lot from it, whatever the state is, I think, quite happy, like I love a day in the rain. You know, I think I just like that.” (P22)

Participants consistently reported deriving psychological benefits from their interactions with the polar environment, despite its inherent risks. This aligns with BPNT's proposition that natural environments are particularly conducive to the satisfaction of basic psychological needs. Awe, frequently described in participant narratives, supports autonomy by fostering a sense of volitional engagement. The vastness and beauty of the polar regions challenge individuals to embrace and adapt to their surroundings, enhancing competence through the mastery of skills needed. Furthermore, the sense of connection participants described, such as feeling "on the same team" with nature or marvelling at its life and beauty, supports relatedness by cultivating a profound emotional bond with the environment. (Ryan & Deci, 2017; Mayer & Frantz, 2004; Liu et al., 2023).

3.3.2.2 Relational Level

3.3.2.2.1 All about the team: The expectation of reciprocity.

Participants spoke about the importance of ‘feeling’ part of a team and/or community whilst on expedition. And this was represented across expedition types including research stations in Antarctica, those in field camps or physical traverse and Arctic community settings. The responses relate to participants gaining a sense that people were generally supportive. This

response from a participant talks to the idea that individual's "sense" that they are in an environment of mutual support.

> "One really big supportive thing down there is just a sense of community… I mean, pretty early on in winter, you get this very strong sense of you're all in this together, you know, win or lose succeed or fail in it together. And so, people really actively seek out and help other people that they feel need it or that you know, that ask for it. Yeah, that's, it's not something that I necessarily leaned on much. But just knowing it's there, it's really a helpful thing. Knowing that people have your back and you know, If something goes terribly wrong, you're you know, you're a team and you'll get through it kind of thing" (P11).

The idea of 'actively seeking to help other people' is a second key aspect that was reported. Building on the idea that supporting others was an important part of being part of an expedition team. And further, that helping others had a positive impact on both parties. For example:

> "I will say is that I have the power to make people happy and feel seen and safe, you know. And… with that, we've been able to do that for other people I helped myself. I need a team to be able to put out the best in myself, you know, both physically and mentally… So, I'm dependent on the team, as the team is dependent on a person that like me, you know, because I find everything that is good in me with the power of the team." (**P15**).

Participants identified several ways that they believed positive relationships could be developed which included sharing social activities together, sharing humour and finding commonality with other group members. For those on physical journeys, the activities as simple as sharing a game

of cards in the tent or creating/participating in a range of activities all year round for those on station in Antarctica, as the extracts below show.

> "And we did chess, we had card games, we had banter. We had meal times and everything like that" (**P17**).

> "I think one thing that kind of builds that is the work weeks are long down there, it's theoretically you're working six, nine-hour days a week, and then you have Sunday off. But, you know, because you're not commuting and not buying groceries and not cooking your meals, you actually have a fair bit of free time… And what people do is they, they just kind of organise activities for each other, like, like I did with the escape room. That was just kind of a one week kind of thing, but people do… 'Okay, I'm gonna run volleyball Wednesday nights', there's a knitting circle, which ended up being more of a drinking and griping session, which was a lot of fun… So it's just people just people just kind of come together and create these activities for each other like to keep us all entertained and sane" (**P11**).

The extracts provided speak of an environment where the team is everything and that people actively contribute to fostering the development of such communities. However, the idea of banter and humour were also reported in ways that speak to a less positive aspect. For example, one participant reporting that banter was a method used to "keep people in their place." This relates to the consistent reporting of reasons why people did not get along, relating to identity differences.

These results highlight the satisfaction of relatedness through strong social bonds and shared group activities. The sense of being part of a team that prioritizes mutual support is also

likely to support autonomy, as participants freely chose to contribute to team welfare and participate in group activities. Additionally, supporting others may enhance competence, as individuals see their contributions as valued and impactful within the group context providing them with relevant feedback to develop their skills. Finally, the use of humour is obviously an important tool in extreme environments. However, negative uses of humour, such as banter aimed at controlling or marginalizing others, could thwart both relatedness and autonomy through people feeling excluded and/or controlled or division.

3.3.2.2.2 Dyadic Support: Developing close relationships.

This theme relates to participants having a close relationship with an individual team member with whom they could disclose their inner thoughts and feelings and was reported by most participants. There were two distinct types of relationship reported, with the first akin to the role of mentorship and predominately relating to providing support in terms of their professional role (e.g., scientist), as shown by the following quote.

> "So, I think I mentioned the researcher who was with me and it was, to some periods of time. There was actually one period where he had his graduate student with him as well, but he was an anthropologist. He's probably in his 40s. And he had researched in the community for like, 20 years. So, there were a lot of times when I could ask him questions or use that sort of thing. Know what the cultural norms was, he would usually be on hand used when he was in the community to help questions... That definitely helped my mental health. It wasn't the stress of trying to run your project when you don't have any real guidance, which I think is can be susceptible to when you go" (P9).

The second aspect which was reported by half the participants was the support offered by developing a close relationship, more in line with either, a close friend or potentially an intimate relationship, although this is not explicitly reported.

> "But also, I had a very close connection with one of the other members of the team who I just felt I could talk to you know, really honestly about a lot of things, we've had quite a few shared life experiences in the lead up to the trip that we were both quite open about. And it meant that there was just somebody who, when there are those really kind of big philosophical questions that you maybe chew over all day when you're skiing. And I would then be able to chew over with somebody else. At the end of day, if I choose too, and quite a lot of time I wouldn't choose too, but kind of knowing that there was, there was at least one person within the team who I could do that with was really important to me" (P19).

Developing close dyadic relationships is likely to have supported participants' psychological needs in several ways. Such relationships fostered a sense of relatedness, as participants felt emotionally connected and able to disclose their inner thoughts and feelings to someone they trusted. The ability to share personal experiences and emotions within a trusted relationship is a key mechanism through which relatedness is fulfilled (Deci & Ryan, 2000). Mentorship relationships, in particular, bolstered competence by offering informational and professional support, enabling participants to feel more capable in their roles and reducing work-related stress. These relationships align with BPNT's proposition that competence is satisfied when individuals feel effective in managing their environments and achieving valued outcomes (Vansteenkiste et al., 2020). Furthermore, having a trusted confidant may enhance autonomy by

creating a space for participants to process their thoughts and decisions freely, thereby reinforcing their sense of volition (Ryan & Deci, 2017).

3.3.2.2.3 Remote Support: Reassurance not Reliance.

This theme relates to the idea that having the perception of support from family and friends was generally supportive and reassuring. However, for those who were actively trying to gain or provide support to those at home, this created worry and stress. Numerous participants reported feeling a deep-rooted sense of support, including from parents across the lifespan, such as the following quotation.

> "Definitely thinking about and understanding relationships back home, knowing like, receiving feedback support without really needing to receive it and kind of reflecting on friendships and the support that I've been given both in the run up to the trip and over my lifetime... Just knowing that there were people that had my back…" (P19).

The boundary condition for the place of these relationships is highlighted by following example. A participant who had reported feeling very supported generally by his family, equally acknowledging that to lean on them during a remote expedition was a distraction away from where they needed to be, focused on the team around them and the expedition.

> "I do not use any other things or satellite phones when I'm out. And it's only for the necessities, you know. But it makes me see as well about the internet, and connection with a life at home, that actually, at that time doesn't mean anything. So, its only there that we mean something, it's only the team, and that everyone is healthy and well and happy. That's what means anything there" (**P15**).

For those that did look to remote support, it was often associated with feelings such as guilt or an "obligation," or carrying forward issues from relationships such as not fulfilling key roles prior to departure, such as a spouse or parent.

> "Before I went there was a lot of emotional stress with home because my wife quite rightly was annoyed with my detachment. You know, I didn't buy all the Christmas presents i'd planned to, I didn't even manage to wrap them because I was so busy finishing my work, my full-time job and my expedition that create an emotional stress at home. And Christmas with the children... now is a big deal. You know, it was really quite hard to miss" (**P16**).

Remote support from family and friends was generally perceived as a source of reassurance, with participants describing a sense of emotional and instrumental support. This aligns with BPNT's emphasis on the importance of secure relationships in fulfilling the need for relatedness (Deci & Ryan, 2014). Knowing that family and friends "had their back" should promote resilience during expeditions. However, attempts to actively engage with these relationships while on an expedition were sometimes described as a distraction, detracting from the focus on immediate tasks and the expedition team. This dynamic suggests that while supportive relationships back home can enhance relatedness, excessive reliance on them may undermine the sense of autonomy and competence required for polar expeditions.

3.3.2.3 Individual Level.

3.3.2.3.1 Mindfulness & acceptance.

This theme relates to a core idea that developing an open awareness regarding their own thoughts, feelings and behaviours can help with coping with challenging conditions. There were three aspects to this theme, non-judgemental awareness, acceptance, and benevolence. Applying

a non-judgmental awareness was often reported as a strategy applied to coping with the environmental conditions, as highlighted by the experiences of an Antarctic over-winterer.

> "I think one of those things would be that I kind of have this little bit of a kind of a Buddhist mindset when it comes to adversity or challenges. I just kind of step back. And instead of focusing on how difficult or painful or unpleasant this experience is just like focus on the experience, what it's like, you know, what does it feel like… to have frost nip on your face because you're walking back and forth to the telescope, you know, so just kind of focusing more on that…Like I think my coldest walk was minus 140 fahrenheit with windchill so. Yeah seriously cold temperatures, and, you know, you're putting on all the gear and like 'Oh, why am I doing this?' And so, so one of my adaptations from I think from a kid is just focusing on like the uniqueness of the experience and what it feels like to have -140 on your face for a few seconds. And, you know, instead of just I'm gonna die or it's miserable, or whatever." (P11).

A second related aspect was having a sense of acceptance, especially regarding uncontrollable stressors, such as the weather conditions, vast distances to be covered or long durations of the deployments.

> "So, in the field, it was really good lesson to see that, for example, when the weather conditions are not ideal you cannot do your work. And you can do nothing but accept it and that's been a great lesson. So, it is like nature is something that we cannot control. And it's not a matter of failure, but it's really matter of acceptance." (P3).

A final aspect relates to individuals taking a more benevolent approach to other team members and being supportive.

> "Probably the next most important thing to have within a team is empathy. So really, you know, when someone's not doing well, it's not going to help to be an asshole about it. Support that person, help that person. And just as any, you know, anyone in the team will realize that as soon as one part of the team is falling over, the rest of its going to be pretty soon after. So just keeping that support network there is just as important." (P7).

The three aspects of acceptance, present-centered attention and empathy for others are all associated with aspects of awareness which relate to abilities of self-regulation. These factors used to meet the physical demands of the environment and the interpersonal ones.

BPNT would propose that mindfulness can supports the satisfaction of basic psychological needs in several ways. It enhances autonomy by fostering a better alignment with their own personal values, reducing automatic responses that may not be conducive to their best interests, such as reacting with anger when someone's behaviour is negative (Brown & Ryan, 2003; Schultz et al., 2015). Competence could be supported through improved emotional regulation, which enables better management of challenges (Chang et al., 2015; Olafsen & Niemiec, 2021). Finally, mindfulness can enhance relatedness by promoting openness and empathy, thus supporting better social interactions and relationships (Schultz et al., 2015; Campbell et al., 2016).

3.3.2.3.2 Past experience.

This theme builds on the idea that resiliency is one component of the broader resilience, including as a personal resource or trait level of resilience is developed through exposure to stressors, both using previous polar expeditions and experience from other aspects of life. As the example below illustrates, this individual associated his confidence in operating in one of the most dangerous types of terrain to a high degree of previous exposure.

> “But then in terms of moving in the environment, living in the environment, more broadly you know, skiing, climbing, crevasses, avalanche risk that for me is like whatever... I don't find that particularly nervy... But then I realized I was chatting to one of the team about it... I said, ‘how many crevasses have you fallen in?’. Any way they were like, "none, why how many have you fallen in?", and I was like "countless" genuinely I have jumped into more crevasses than I can remember for training. And I have fallen in, I don't know how many whilst out skiing, climbing, hill walking... So, I'm aware of the risk but then, … I realized that my comfort in the environment, in that sense, comes from experience, whereas others potentially didn't. And we are all creatures of our experience.” (P8).

Outside of polar environments at least half of the participants reported how learning and the overcoming of challenges across their lifetime, supported their ability to cope during polar expeditions. As the quote below from an Antarctic station manager states, reflecting that individuals who had previously reported overcoming such challenges were better able to meet the demands of living on station

> “And I think... I can't see how it doesn't come from people's personal experience, you know, like what people have gone through in their lives. Like, if you've had somebody who's worked in the same trades workshop for a long period of time, not had anything significantly stressful go on, they're not resilient, that we see that time and time again. And so it's a real strange mix of trying to select for people who've gone ironically gone through challenges, or mental health challenges, or physical challenges or whatever, life challenges to have tested their own resilience enough to be able to put something on a scale of like, relevant or irrelevant, and then act accordingly. Whereas if you haven't had

those resilience challenges, you just tend to react even if it's not particularly significant." (P12).

These extracts highlight the importance of exposure to stressors both in the polar environment directly and across other environments, building resources to successfully complete polar expeditions. From a BPN perspective, repeated exposure to challenging environments, including polar regions, fosters competence by allowing individuals to develop the skills and confidence specific to the actual demands encountered. The familiarity gained through experience may also enhance autonomy, as individuals feel more capable of making effective decisions in high-stakes environments and undertaking repeated exposures is highly likely signal volitional choices. Additionally, past shared experiences may support relatedness, as expeditioners have a more accurate understanding of the best ways they can gain the necessary support for their own individual preferences.

3.4 Discussion

This study explored polar expeditioners experiences of the challenges they faced, and what supported them to successfully overcome them. Using reflexive thematic analysis, three key challenge themes were identified, which included one at the contextual, relational, and individual levels. At contextual level, the challenge of meeting the physical and psychological demands of the Polar environment was reported by almost all participants. At the relational level, operating with individuals of different identity characteristics was consistently reported, with females reporting issues regarding male behaviour the largest single factor. At the individual level, participants expressed doubts or worries about their ability to meet the physical demands of the expedition or perform at a level comparable to their peers.

There were five themes related to the support that the participants rely on during their expeditions. At the contextual level, feeling a sense of connectedness to the natural environment and experiencing awe were reported by a large majority of participants. A second theme at this level related to having sufficient resources in terms of finance, equipment and meeting their basic needs for shelter and food. At the relational level a cluster of sub-themes which represented sources of social support were reported. The importance of the team or community in providing reciprocal support was emphasized, alongside the value of dyadic relationships where individuals felt able to disclose inner thoughts and feelings. Additionally, perceiving support from friends and family was reported as supportive when these relationships were strong and positive. Finally, at the individual level, participants reported facets relating to mindfulness of staying centred on the present, using acceptance when adverse events occurred, and being empathetic of others. These themes shall now be discussed with focus on how each theme relates to the BPNT.

The natural environment was reported by most participants as a key stressor in terms of the risks to life from the physical conditions, the impact of prolonged isolation and confinement and physiological issues such as reduced sleep. These risks from the natural polar environment are universally acknowledged (e.g., Palinkas & Suedfeld, 2008, 2021; Mairesse et al., 2019). Therefore, the remainder of this discussion will focus on the role of the natural environment as a source of support.

3.4.1 Contextual Level

The salutogenic or health-supportive aspects of the polar environment are consistently reported in qualitative studies (Van Puyvelde et al., 2022; Palinkas & Suedfeld, 2021). Consistent with this, the supportive qualities of the natural environment were reported by almost all participants. Investigation of the responses showed that many participants felt a sense of closeness or connection to the natural environment, which was supportive of their psychological well-being and ability to cope with the challenges of polar expeditions. The responses were consistent with the concept of nature connectedness, which has been defined as experiencing feelings of closeness or oneness with nature (Mayer & Frantz, 2004; Lengieza & Swim, 2021). These findings are consistent with the quantitative results reported in Chapter 2, which showed higher connectedness was positively associated with well-being and negatively to ill-being. Furthermore, indicating that the basic needs of autonomy and relatedness (social) explained a significant amount of these relationships. The present qualitative findings deepen this understanding by illustrating how experiences of awe and prior exposure to nature contribute to fostering these psychological connections. Studies of nature connection have identified a multitude of factors that may contribute to the development of a sense of connectedness to nature, though they acknowledge that these factors are highly heterogeneous (Lengieza & Swim,

2021). Therefore, understanding the antecedents specific to this environment is of value to expeditioners and the general study of the topic. Several themes from the present study appear relevant to this relationship.

Awe has been described to encompass feelings of amazement and that represents something so vast, it is difficult to comprehend using existing schemas or representations (see Keltner & Haidt, 2003). The vastness of their surroundings was often reported and additionally, the potential threat and incredible beauty. These additional components may influence the hedonic tone of the experience (Keltner & Haidt, 2003). The relationship between awe and ICE environments is not a new proposition, with astronauts often reporting experiences of awe (e.g., Yaden et al., 2016). Additionally, this is consistent with written accounts from polar expeditioners (Johnson & Suedfeld, 1996). The examples of the poles and space highlight places that are well suited to experiencing awe (e.g., vastness and novelty), and an example of the importance of considering context. Building on the present findings and those reported in Chapter 2, a hypothesized relationship is proposed where the positive effect of awe on well-being is partly mediated through increasing nature connectedness through fulfilling BPN. This is also consistent with a key proposition of BPNT that natural environments comparative to non-natural ones are more likely to increase subjective vitality, through supporting need satisfaction (Ryan & Deci, 2017).

A second individual level factor which was reported to support a more positive relationship to the natural environment was mindfulness. This makes intuitive sense, when the risks of the environment mean that small mistakes such as a misplaced piece of clothing, or neglecting concentration whilst navigating crevasse field, could result in serious injury or even fatality. These responses are consistent with results from a recent Antarctic longitudinal study which

showed that higher pre-expedition levels of mindfulness predicted reduced stress levels across the 12-month duration (Pagnini et al., 2024). And studies with military personnel where increased trait mindfulness supported a buffering effect against declines in psychological health (Aufaurve-Poupon et al., 2021; Nassif et al., 2018). There is also strong support for a reciprocal relationship between mindfulness and nature connectedness (Schutte & Malouff, 2018). In terms of possible causal explanations of the positive effects of mindfulness, one of the core propositions of BPNT is that having a non-judgmental awareness can support a greater satisfaction of the basic needs for competence, autonomy, and relatedness. This is supported by studies showing that BPN mediates the relationship between mindfulness and well-being (e.g., Brown & Ryan, 2003; Chang et al., 2015; Campbell et al., 2016; Chang et al., 2018; Soon et al., 2021; Chuang et al., 2023).

The importance of previous experience in natural environments including direct experience of the polar regions and in other previous life situations including childhood would support how connectedness is developed over time. With both type of exposure and time spent in nature regularly reported as antecedents of nature connection (Lengieza & Swim, 2021). Numerous participants reported how experience was an important aspect of support, and noting experiences within the outdoors from childhood, such as experiences with families, scout groups and into adulthood. It may be hypothesized that the relationship with nature is developed through repetitive exposure prior to polar expeditions. This graded exposure to more challenging environments, in keeping with the idea that when environment provide challenge that is relevant to ability individuals will make challenge appraisals rather than threat (Lazarus & Folkman, 1984). From a resilience perspective, this explanation fits with the idea that a suitable level of challenge or adversity is required for resilience to be developed, rather than becoming traumatic

(Southwick et al., 2014). Furthermore, the choice to continue undertaking activities in ever more challenging environments fitting with the idea that people are more likely to select pursuits or activities that are fulfilling of their own BPN (Ryan & Deci, 2017).

Continuing the importance of a relevant level of challenge is the importance of individuals having access to sufficient levels of physical resources. Without resources such as tents or accommodation and suitable clothing and supplies, survival in these regions is impossible. And again, the experience rather than positive, being stressful or even traumatic. For example, whilst positive awe leads to positive well-being increases; when awe is perceived as threatening the positive effect is completely eroded (Liu et al., 2023). Interpreted from the perspective of BPN, when individuals have sufficient resources, experience and have developed a strong relationship with nature, the environment is likely to be more supportive of needs satisfaction, rather than feeling overwhelmed or controlled by it. The previous paragraphs highlight how expeditioners resilience to the demand of the natural environment are supported by individual psychological resources, which are likely to be developed by previous experiences and would not be sufficient without having the required physical resources.

3.4.2 Relational Level

Alongside the challenges created by the natural environment, issues at a social level are often reported as the greatest source of stress and conflict. In the present study, identity differences were reported as an area that led to difficulties and on occasions even conflict. This included differences on gender, occupation, age, social class, nationality, and sexuality. This is consistent with earlier studies which have reported that differences in well-being can differ dependent on group identity (Palinkas, 1986, 1989, 1991; Palinkas et al., 2000, 2004; Wang et al., 2022). The most consistently reported identity factor was that of gender, and specifically,

females reporting issues with the conduct of male expeditioners. The reports of domineering or aggressive behaviour, misogyny, and the fear of sexual harassment or worse is consistent with numerous recent reports from Antarctic national programmes (e.g., Sarris, 2017; Nash et al., 2019; USAP, 2022). From a BPNT perspective, the impact on individuals is an increased chance of perceiving the socio-cultural context as controlling rather than supportive and likely to lead to a reduced level of both autonomy and relatedness satisfaction which would be consistent with the findings of study 1. For example, participants identifying as LGBTQ reported feeling pressure to conceal their identities, and females described modifying their behaviour to avoid perceived risks. Such suppression of self-expression may frustrate the development of supportive relationships and contribute to feelings of being controlled by the social environment, ultimately undermining well-being. These results may be relevant to understanding why, from whom and when expeditioners utilize social support.

The receipt of social support from multiple sources was reported, which could be explained by considering how these different sources support the satisfaction of basic psychological needs. Studies applying BPNT have shown that the way needs are supported by the social environment can fluctuate depending on the cultural setting and the norms and customs associated with the specific culture (Chen et al., 2015). A large majority of participants highlighted feeling a sense of community and the need to actively support the needs of others. This aligns with previous expedition studies that emphasize a collectivistic culture being well suited for ICE environments (e.g., Van Puyvelde et al., 2022). In such a culture, the needs of the group are prioritized over individual concerns, which makes sense in environments where interdependence is critical for key tasks, such as managing a research base or pitching camp during a traverse. BPNT proposes that freely supporting others in a collectivist culture likely

enhances the satisfaction of autonomy and relatedness needs (Chen et al., 2015). The idea that a collectivist culture is well suited to ICE environments is supported by the results of Chapter 2, where autonomy and relatedness were found to mediate the relationship between community support, ill-being, and well-being. However, relying solely on community-level support may not suffice for fulfilling all psychological needs, as it may neglect individual differences or lead to dependency that hinders autonomy.

Firstly, expeditioners may not have developed within a culture of this type. Westernized cultures are more likely to promote the rights and needs of an individual (Chen et al., 2015). This point becomes particularly relevant when cases of perceived unfairness or injustice arise, as group members from less collectivistic cultures may be more likely to value gaining personal justice than protecting the needs of the group (Van Puyvelde et al., 2022). This speaks to the importance of experience in matched conditions or those similar. For example, former military personnel provided insights into how their experiences in collectivistic organizations, such as the military, shaped their expectations and adaptability in polar settings. Military culture is deeply aligned with collectivistic principles, emphasizing teamwork, shared goals, and unit cohesion (Gerras et al., 2008). This cultural alignment is particularly evident in the emphasis on adhering to hierarchical decision-making and prioritizing the group's needs over individual preferences. Participants with such backgrounds reported finding it easier to integrate into the interdependent and collectivist-oriented dynamics required in polar expeditions. Conversely, civilians unfamiliar with such cultural frameworks may struggle to accept leadership decisions or prioritize group goals, viewing these through the lens of their own individualistic values. This distinction underscores the importance of prior experience in environments with similar collectivistic

demands, as it can influence how effectively expeditioners fulfil their basic psychological needs for relatedness, competence, and autonomy in such contexts.

A second relevant example is the consideration of identity status and whether individuals are part of the majority perspective or a minority. This study showed that individuals who are within the minority on key characteristics (e.g., gender, sexuality etc.), may have to inhibit their behaviour to reduce the risks of negative interpersonal altercations. This fits with previous work which has highlighted that for females in Antarctica, fitting in with a very masculine, aggressive male dominated culture can be incredibly challenging (Sarris & Kirby, 2007). This could result in those individuals being less likely to receive the social support at a group level and reduce the level of needs satisfaction, leading to well-being costs. Gaining support from other sources could negate the impact of issues at this level.

A large majority of participants reported the importance of having a close supportive relationship which created a space for emotional disclosure and provision of 1-1 informational or professional support. Furthermore, participants often reported viewing such relationships as akin to surrogate family (e.g., parental, sibling, child's roles). Notably, all females in the present study reported the use of such a relationship, with a slightly lower percentage of males. This difference is consistent with general studies of social support, which shows differences between genders in preference for support, with males less likely to seek social support and more so emotional support (e.g., Thoits, 1995; Zhou et al., 2017). The difference is also reported in polar expeditions. Studies which have included either all-male or predominately male participants report that emotional disclosure in close, supportive, dyadic relationships was associated with negative outcomes (e.g., Leon et al., 1989, 1991; Sandal et al., 2003), whilst those with either all-female or more balanced samples report more positive outcomes for emotional disclosure in such

relationships (e.g., Atlis et al., 2004; Leon et al., 2002; Kahn & Leon, 1994). Therefore, it is proposed that, depending on the person-environment fit, individuals may derive more or less support from close, supportive relationships, with this association extending to how much need satisfaction is fulfilled through these interactions. Although, this hypothesis requires empirical testing in future studies.

A final area of support which was highlighted in the present study was from friends and family back home. Expeditioners reporting that support from family could be helpful but also may be associated with feelings of guilt or worry that were stressful rather than supportive. Previous studies with Antarctic over-winterers have shown that a higher preference for family support rather than fellow expeditioners was more likely to be associated with increased depression during winter (Palinkas et al., 2004). Family and intimate partners are often key sources of emotional and instrumental support (Thoits, 2021). However, due to restrictions that are imposed from operating in polar regions this support is often less available and inconsistent. Therefore, this may explain why expeditioners look to develop close relationships within the expedition that often mimic or act as a surrogate family. The idea of creating a surrogate family during expeditions has been reported since the early days of polar expeditions (Johnson & Suedfeld, 1996), especially, if they are a key source of needs support when at home.

3.4.3 Individual Level

Similar to the relationship with the physical environment, mindfulness may be supportive of needs satisfaction and navigating the social expedition environment. Utilising both acceptance, a non-judgmental awareness and developing benevolence may reduce risks of conflict occurring and detrimental impact and increase likelihood of sourcing social support that is better matched to their needs. BPNT proposes that increased mindfulness can reduce

automatized reactions that may not be aligned with their values, identity, and lead to a reduced satisfaction of basic needs (Schultz & Ryan, 2015; Ryan & Deci, 2017). For instance, an expeditioner who is experiencing issues of bullying or misogyny could react with anger or hostility, which leads to further conflict and feeling controlled by the situation. Instead, they may be able to 'choose' to acknowledge the situation and reduce unhelpful automatized responses, allowing for more constructive actions that preserve their sense of autonomy and well-being. This perspective aligns with findings that mindfulness can buffer against stress and enhance emotional regulation, as demonstrated in Antarctic studies showing its association with lower stress over time (Pagnini et al., 2024). From the opposite perspective, embedding mindfulness practices within a team may encourage majority group members to better recognize and address the needs of their teammates. Increased levels of mindfulness have been shown to reduce threat coping appraisals, which are more likely to lead to hostile responses (Weinstein et al., 2009; Pagnini et al., 2019). This suggests that mindfulness can support individuals by reducing unhelpful reactions to social stressors, which may indirectly foster more harmonious group dynamics. While the primary evidence relates to individual benefits, such as reduced negative self-perceptions and increased confidence, these individual improvements could contribute to a more cohesive team environment if practiced collectively.

At the individual level, numerous participants reported that a source of stress was worrying about their level of ability, both in terms of the physical demands and about their ability relative to their colleagues. Thoughts and concerns of this type are consistent with previous literature which has reached consensus that a low level of self-esteem, confidence or high neuroticism can be detrimental to both expedition performance and well-being (Sandal, 2018). From the perspective of BPNT, issues of self-esteem or confidence are proposed to be

more likely when individuals are in environments where their basic needs are not being met (Ryan & Deci, 2017). This relationship is consistent with the findings of a recent meta-analysis which included over 10,000 participants and 200 unique effect sizes. Results showing a moderate negative relationship between neuroticism and all three basic needs (Hlupic et al., 2022). However, rather than being viewed solely as negative individual traits, these concerns may be better understood as responses to environmental demands. The themes reported have highlighted either threats to life from the physical environment or dealing with issues at a social level. Furthermore, that such feelings within an expedition are a natural response to operating in such challenging conditions. Therefore, identifying areas which may be impacting needs satisfaction either at the environmental or social levels and utilizing the approaches reported across person, people and place may reduce such feelings and maintain high levels of need satisfaction, leading to increased well-being and reduced ill-being.

3.4.4 Limitations

One key limitation of the present sample was the inclusion of participants from a diverse range of expedition types. This included individuals completing both summer and winter-over Antarctic placements, Arctic field science, shorter-duration sojourns, and a small number of community-based scientists (e.g., anthropologists). This diversity resulted in a wide range of topics being reported, potentially limiting the level of contextual specificity that could be drawn. However, this limitation is addressed by focusing on patterns of meaning that were broadly relevant across diverse participants, rather than isolated or idiosyncratic accounts. Furthermore, the study is grounded in Basic Psychological Needs Theory (BPNT), which has strong empirical support as a universally applicable framework for understanding human well-being.

3.4.5 Conclusions

To conclude, the responses in this study highlight the importance of considering challenges that arise at individual, relational, and contextual or environmental levels. The combined influence of these levels shaped the overall level of challenge experienced. Key supports were also identified at each of these levels, and rather than functioning only to address specific challenges, they often provided resources that spanned across levels. For example, drawing on nature connectedness helped buffer the effects of interpersonal difficulties, while social support was sometimes used to help meet the demands of the physical environment. Applying the perspective of BPNT, has highlighted how each level may be supportive of needs satisfaction for competence, relatedness, and autonomy which are important to maintain well-being and reduce ill-being. Additionally, this study has highlighted once again how differences in group identity is likely to be an important consideration in terms of the specific challenges that may be encountered and what the best sources of support may be depending on those characteristics. Consistent with previous studies this study has highlighted issues regarding additional challenges for minority groups and especially gender-issues. By acknowledging that these factors are likely to be experienced and that the optimum ways of supporting individuals may differ depending on the person, needs-supportive training may be developed, where individuals can be better prepared to source support during expeditions. Finally, the role of mindfulness has been clearly reported. This attribute is one which may support better coping via a range of different mechanisms and is again malleable to training interventions and of value to all expeditioners. The present qualitative findings enrich the quantitative results by illustrating how key predictors such as social support and nature connectedness operate to satisfy or frustrate basic needs in context. By uncovering mechanisms like awe, identity-based barriers, and mindfulness practices, this study offers a more nuanced

understanding of how these predictors, and emerging ones, may support the satisfaction of basic psychological needs and, in turn, foster greater well-being.

Chapter 4: Polar Expeditions: Coping Flexibility and Nature Relatedness Predict Well-being, but only Basic Psychological Needs Predicts Ill-being too

Abstract

In this study I examined profiles of resilient mental health in twelve people completing polar expeditions in either Antarctica or the Arctic. Using a structured daily diary, participants reported daily levels of well-being and ill-being, and the potential explanatory factors of basic psychological needs satisfaction, coping flexibility and nature relatedness. Using idiographic methods showed that generally expeditioners displayed at least moderate levels of well-being and low Ill-being during expeditions, consistent with previous studies. However, one participant did not display resilience, showing increasing ill-being throughout the expedition. This participant also reported lower levels of personal resilience, social support, and nature connectedness before the expedition compared to others in the sample. A series of linear mixed models were conducted to examine if daily fluctuations of basic psychological needs, coping flexibility and nature relatedness could predict within-person changes in well-being and ill-being. The results showed that nature relatedness was the strongest predictor of well-being but had no significant relationship with ill-being. This finding aligns with its role as a well-being enhancer rather than a basic need. Coping flexibility also predicted well-being, however, with a smaller effect than BPN and Nature. Finally, basic psychological needs were the only predictor to show significant relationships to both well-being and ill-being. The results extend the findings from our Chapter 2 which showed significant relationships between the same predictor variables in a

cross-sectional study. Thus, extending the support for considering BPNT as a theoretical base for better understanding socioecological resilience in extreme environments.

Introduction

Polar expeditions expose individuals to a complex array of physical and psychosocial challenges across individual, relational, and environmental levels (Palinkas and Suedfeld, 2008, 2021). Building on the socioecological model of resilience (Ungar, 2011), Study 1 of this thesis identified key predictors of well-being and ill-being at each level, including personal resilience and coping flexibility at the individual level, social support at the relational level, and connection to nature at the environmental level, with their effects partially mediated by the satisfaction of basic psychological needs (BPNT; Vansteenkiste and Ryan, 2013). However, Study 1 employed a cross-sectional design, limiting the ability to capture how these factors fluctuate over time, which is a key consideration for resilience research that emphasizes dynamic adaptation processes (Ong and Leger, 2022). Study 2 extended this work through qualitative exploration, offering a deeper understanding of the challenges expeditioners face and the resources they draw on across individual, relational, and environmental levels. The findings identified specific coping strategies, sources of social support, and interactions with the natural environment that expeditioners described, highlighting their potential role in supporting BPN satisfaction and expanding on the results of Study 1. However, a critical element of investigating resilience is examining these relationships across time, which can be addressed by using an intensive longitudinal approach during polar expeditions. The present study therefore employed a daily diary design to examine within-person fluctuations in key variables identified in Study 1 and Study 2. Specifically, we investigated whether daily changes in basic psychological need satisfaction, nature relatedness, and coping flexibility predict corresponding changes in well-being and ill-being during expeditions.

Socioecological Resilience Theory

Contemporary scholars of psychological resilience increasingly agree that resilience is best understood as a dynamic process of adaptation influenced by numerous factors (Kalisch et al., 2017; Masten et al., 2021; Southwick et al., 2014). This dynamic process involves interactions between individual assets (e.g., personal resiliency, coping flexibility) and resources at a relational (e.g., family-, friend-, community-support) and contextual levels (access to infrastructure such as housing/shelter, basic amenities, and resources of the natural environment etc.). These interactions either positively or negatively affect the on-going development of individual assets and overall resilience (Liebenberg et al., 2017).

Consistent with the idea of resilience as a process the study of resilience across the period of stress exposure is critical (Bonanno & Diminich, 2013; Gucciardi et al., 2021). Scholars argue that resilience should be self-referenced, ideally measured prospectively or in the early stages of stressor exposure, with multiple assessments conducted throughout the exposure period (Bonanno & Diminich, 2013). This approach fits idiographic methods, which highlight patterns of variability and change within individuals, as well as nomothetic approaches that compare these changes across individuals (Ong & Leger, 2022). Approaches like the daily process paradigm (e.g., Bolger & Zuckerman, 1995), which use daily diary designs to capture intensive longitudinal data, are well-suited for measuring resilience in real time. This is partly because measuring in real-time environments increases ecological validity and reduces recall bias, as assessments occur closer to the event (Tennen & Affleck, 1996). These methods, alongside considering socioecological variables are beginning to become the gold standard for resilience assessment in polar environments.

4.1.1 Resilience Polar Diary Studies

In recent years, socio-ecological perspectives and intensive repeated-measures designs have increasingly been adopted to better capture the stressors and adaptive processes faced by polar expeditioners. Yet few studies have explicitly integrated resilience frameworks with intensive repeated measures designs (e.g., Smith et al., 2024). The importance of using daily measurements has begun to reveal important variability in well-being outcomes, which would not be seen in studies with less frequent assessment. However, scholars have noted that weekly or monthly assessments may miss important daily variability in expeditioners' experiences (Smith et al.,2018, 2021). To remedy these points, recent research has increasingly adopted intensive repeated-measures designs, capturing daily fluctuations in mental health outcomes and key predictors. These studies generally report that, while expeditioners show high levels of well-being, there is considerable day-to-day variability in responses (e.g., Anton-Solanas et al., 2016; Blackadder-Weinstein et al., 2019; Pedlar et al., 2007; Smith et al., 2018, 2021, 2024). For example, Smith and colleagues (2024) applied a resilience theoretical approach to a daily diary study of seven Arctic expeditioners, measuring outcomes such as physical health, affect, team cohesion, and performance, along with predictors like sleep and stress appraisals. Results showed that while daily fluctuations in psychosocial outcomes were observed, all participants displayed stable or quickly recovering trajectories following acute stressors, illustrating the dynamic resilience process in extreme environments. Collectively, such studies demonstrate the value of intensive longitudinal designs for capturing real-time adaptation in high-stress, confined settings, and underscore the relevance of applying resilience frameworks to polar research.

4.1.2 Basic psychological needs theory

Basic Psychological Needs Theory (BPNT; Vansteenkiste and Ryan, 2013) proposes that the satisfaction of three fundamental needs for autonomy, competence, and relatedness supports individual growth and well-being. Extensive research has demonstrated that when these needs are satisfied, individuals experience enhanced well-being and reduced mental ill-health (Slemp et al., 2024; Tang et al., 2020; Schutte and Malouff, 2021). Furthermore, intensive repeated measures studies have shown that daily fluctuations in basic need satisfaction predict corresponding fluctuations in well-being across diverse contexts such as work, education, and sport (Sheldon et al., 1996, 2000; Coxen et al., 2021). These findings underscore the importance of capturing within-person variability, rather than relying solely on cross-sectional designs. Despite the growing evidence base, few studies have applied BPNT in extreme environments using daily diary methods. Study 1 of this thesis supported BPNT's relevance to polar expeditions but relied on retrospective, cross-sectional data. Similarly, Goemaere et al. (2019) examined basic need satisfaction in an analog space environment using weekly measures but assessed only autonomy. Therefore, to advance the understanding of how basic need satisfaction fluctuates during expeditions and its role in resilient adaptation, the present study will employ a daily diary design to capture these dynamics in real time.

4.1.3 Nature Relatedness

Nature connection, sometimes referred to as nature relatedness or connection to nature, describes an individual's emotional, cognitive, and experiential bond with the natural world (Mayer and Frantz, 2004; Nisbet et al., 2009). Extensive research has demonstrated that individuals with higher levels of nature connection experience greater well-being across diverse populations and settings (McMahan and Estes, 2015; Pritchard et al., 2020; Sheffield et al., 2022). In particular,

exposure to natural environments has been consistently associated with positive outcomes such as reduced stress, enhanced mood, and increased vitality.

Although the concept of relatedness within BPNT primarily refers to meaningful connections with other people (Ryan and Deci, 2017), nature connection represents a distinct, non-social bond. While not traditionally classified as a basic psychological need, some scholars have suggested that nature relatedness may represent an additional psychological need, although this extension has not yet been formally integrated into BPNT frameworks (Baxter and Pelletier, 2018; Hurly and Walker, 2019).Thus, while social relatedness concerns the need for interpersonal closeness, nature connection provides a complementary but distinct form of affiliation, characterized by emotional closeness to the natural world.

In the context of polar expeditions, where individuals are immersed in vast and often harsh environments, the capacity to cultivate a positive relationship with nature may serve as a critical psychological resource. The findings from Study 1 demonstrated that nature connection was a significant predictor of well-being, highlighting its relevance in extreme environments and consistent with previous research (e.g., Leon et al., 1989; Kjaergaard et al., 2013; Kahn & Leon, 1994). Study 2 built on this by providing qualitative insights into how expeditioners experienced and interpreted their connection with the polar environment. Participants consistently described deriving psychological benefits from their interactions with nature, including feelings of awe, privilege, and emotional closeness, despite the inherent risks posed by the environment. These findings are consistent with the notion that nature connection can contribute to the satisfaction of basic psychological needs by fostering a sense of autonomy, competence, and relatedness in non-social ways (Ryan and Deci, 2017; Mayer and Frantz, 2004; Liu et al., 2023).Together, the

results of Studies 1 and 2 provide converging evidence that connection to nature plays an important role in supporting well-being during polar expeditions.

Additionally, scholars in adventure tourism have proposed a model suggesting that both basic psychological needs and nature connectedness influence well-being in extreme environments, including polar expeditions (Houge-Mackenzie et al., 2023). Although the model has not yet been empirically tested, the findings from Study 1 provide initial support by demonstrating significant associations for both factors. The intensive longitudinal design used in the present study offers a novel opportunity to extend this model by capturing daily dynamics in these relationships.

4.1.4 Coping Flexibility

Coping strategies are a key individual asset influencing outcomes during polar expeditions, particularly the ability to flexibly adapt strategies to changing conditions. Study 1 found that greater coping flexibility, measured using the Perceived Ability to Cope with Trauma scale (PACT; Bonanno et al., 2011), was associated with higher well-being. The PACT assesses two dimensions of coping: trauma-focus, which emphasizes confronting sources of distress, and forward-focus, which involves shifting attention toward future-oriented goals (Bonanno et al., 2011). These findings align with a socioecological approach to resilience, emphasizing dynamic, time-sensitive interactions between individuals and their environments (Ungar, 2011; Bonanno & Burton, 2013).

Previous research using daily coping checklists in polar expeditions has shown that expeditioners employ a range of strategies that vary across different stages of the journey (e.g., Smith et al., 2017, 2021; Kjaergaard et al., 2015; Leon et al., 2011; Sandal et al., 2018). For instance, Smith and colleagues (2021) observed that during an Antarctic crossing, expeditioners

initially relied more on task-focused strategies, shifting toward future-oriented, emotion-focused approaches later in the expedition. This pattern reflects the adaptability crucial for managing dynamic and prolonged stressors in extreme environments. However, in Study 1, coping flexibility was assessed retrospectively, limiting insights into how this capacity fluctuates over time. Capturing coping flexibility through daily assessments would offer a more nuanced understanding of its day-to-day dynamics and how it contributes to resilient adaptation during expeditions.

4.1.5 Present Study

The present study aims to build on the findings of Studies 1 and 2 by using an intensive repeated measures design to examine within-person fluctuations in well-being and ill-being during polar expeditions. While Study 1 employed a cross-sectional design, limiting the ability to capture dynamic processes, Study 2 offered qualitative insights into the types of coping strategies, sources of social support, and interactions with the natural environment that expeditioners described as supportive of basic psychological needs. Together, these studies identified basic psychological need satisfaction, nature connection, and coping flexibility as key contributors to well-being. The present study extends this work by investigating how daily fluctuations in these variables are associated with daily well-being and ill-being. In addition, idiographic methods will be used to assess resilient functioning by analysing individual trajectories of adaptation throughout the expedition.

4.2 Methods

4.2.1 Participants

Fifteen participants were recruited to take part in the study who were planning to complete self-supported polar expeditions lasting at least 9 days. Participants were recruited using posts on social media sites and emails sent to polar research groups such as the Association of Polar Early Career Researchers (APECS) and Polar Network. Out of the 15 participants that gave written informed consent, two participants did not receive the paper measures in time due to UK Brexit customs delays to Europe. Data from 1 other participant was removed due to the level of missing entries during the expedition. This resulted in a final sample for analysis of 12 participants. This included 8 females and 4 males, with a mean age of 40 years old (SD = 7.16). Participants were based in a range of countries (UK = 7; Ireland = 1; USA = 1, Iceland = 1; New Zealand = 1; France = 1). Those speaking English as a second language confirmed their proficiency in the language. All participants identified their ethnicity as white, Caucasian or European. Ten participants completed their expeditions in the high Arctic and two in Antarctica. The study was approved by the Durham University Dept of Psychology Research Ethics Committee. Further demographic information is provided below on both the expeditioners and the types of expeditions undertaken.

Expedition 1

One person participated in a 33-day ski-traverse pulling all required equipment on pulks in the Antarctic peninsula which was intended to span approximately 300km but was restricted in terms of distance due to severe weather conditions. This resulted in numerous days spent restricted to their tent.

Expedition 2 & 3

Two participants participated in separate, 10-day ski-traverses, with one following a marked trail in the Swedish Lapland and the other navigating to areas of interest in the region, both pulling all their own equipment by pulk.

Expedition 4

Four participants completed a 9-day ski-traverse on Svalbard covering approximately 120km. With all participants hauling all their own kit and items required for research to be conducted during the trip.

Expedition 5

Three participants participated in a 9-day ski-traverse of an Icelandic glacier. With all participants hauling all their own kit and items required for research to be conducted during the trip.

Expedition 6

One participant completed a 30-day ski-traverse crossing the Greenland icesheet covering approximately 575km.

4.2.2 Procedure

All participants who replied after seeing the study advert were contacted by the lead researcher who provided further information, and discussed participation in respect to their own specific expedition demands. After participants consented to take part in the study, they completed demographic and pre-expedition surveys using Qualtrics online survey system. Paper and pencil copies of the within-expedition measures were then posted to each participant. The measures were provided in a bound A5 booklet with each day across a double-sided A5 sheet. On receipt the lead researcher held an online call with each participant to ensure they were happy with the protocol for the completion of the measures. Specifically, each participant was asked to complete the measures starting on the first day of the expedition until the final day. Furthermore, they were also asked to complete the measures each evening once they had completed all necessary camp tasks and self-care. During the expeditions, participants spent approximately five minutes completing the daily measure at the end of the day. All participants were provided with an envelope in which the completed measures could be posted back to the lead researcher.

4.2.3 Materials

The present study was designed in parallel with Study 1, with data collection timed to coincide with the Antarctic expedition season. As such, many measures used in Study 1 were adopted here to allow for comparability across studies. Full justifications for the selection of key measures, including the PACT for coping flexibility, are provided in Chapter 2. Limitations noted in relation to these measures in Study 1 similarly apply to the present study and are discussed in detail therein.

4.2.3.1 Pre-Expedition Measures.

4.2.3.1.1 Adult resilience measure – revised (arm-r).

As in Study 1, resilience was measured using the Adult Resilience Measure – Revised (ARM-R; Resilience Research Centre, 2018). For a full description of the scale and its psychometric properties, see Chapter 2.

4.2.3.1.2 Social Support.

As in Study 1, social support was assessed using selected subscales from the Social Support Index (SSI; Distelberg et al., 2014), capturing support from family, friends, and community. Full details on the scale's structure and validation are provided in Chapter 2.

4.2.3.1.3 The Connectedness to Nature Scale (CNS).

As in Study 1, connection to nature was measured using the Connectedness to Nature Scale (CNS; Mayer & Frantz, 2004). For a detailed description of the scale's content and psychometric properties, see Chapter 2.

4.2.3.2 Within-expedition measures

4.2.3.2.1 Basic psychological need satisfaction.

Psychological basic needs will be measured using the Need Satisfaction in interpersonal relationships scale (La Guardia et al., 2000). The 9-item scale includes items that measure the satisfaction of each basic need (autonomy, relatedness and competence). The scale is scored on a 7-point Likert scale (1-strongly disagree, 7-strongly agree). This scale includes statements including for autonomy "I have felt free to be who I am." Representing competence "I have felt like a competent person," and relatedness "I have felt loved and cared about." Additionally, the relatedness items were also adapted to create a nature relatedness measure. Items included "I felt

a lot of closeness and intimacy in my relationship to the natural environment." In the present study each basic need will be calculated with an average score produced. Competence and Relatedness and Nature relatedness showed acceptable internal consistency, however poor for Relatedness (Competence = .75; Relatedness = .54; Autonomy = .63; Nature relatedness = .60).

4.2.3.2.2 Coping Flexibility

As in Study 1, coping flexibility was assessed using the Perceived Ability to Cope with Trauma Scale (PACT; Bonanno et al., 2011). Full details of the scale's development and psychometric properties are provided in Chapter 2.

4.2.3.2.3 Subjective vitality scale.

A 4-item version (Kokou-Kpolou & Park, 2020) of the Subjective Vitality Scale (SVS; Ryan & Frederick, 1997) that indicates the extent to which a person feels alive and energized (e.g., I have energy and spirit). Participants are asked to respond using a 7-point scale ranging from 1 (not at all true) to 7 (very true). In the current study the measure showed very good internal consistency ($\alpha = .96$).

4.2.3.2.4 Positive and Negative Affect.

Positive affect will be measured using the 10-item a 10-item international Positive and Negative Affect Schedule (PANAS) Short Form (I-PANAS-SF; Thompson, 2007) which is derived from the original version (PANAS; Watson, Clark, & Tellegen, 1988). The 10-item I-PANAS-SF includes two subscales (5 items each), one for positive affective states (e.g., alert, active) and the other for negative affective states (e.g., upset, hostile). The scale is measured using a 5-point scale ranging from 1 (very slightly or not at all) to 5 (extremely). The I-PANAS-SF is widely used as a measure of affect and has shown good validity and reliability in many

studies (e.g., Crawford & Henry, 2004). In the current study both subscales showed good internal consistency (Negative affect = .80; Positive affect = .80).

4.2.3.2.5 Loneliness.

To measure ill-being outcomes, we used the three-item loneliness scale revised UCLA-Loneliness Scale (Hughes et al., 2004), which consists of 3 items, describing subjective feelings of loneliness (e.g., How often do you feel that you lack companionship). The 3 items are rated on a 5-point Likert scale (1-never true, 5-always true), with higher scores reflecting greater loneliness. The scale has shown acceptable reliability and validity in previous studies (e.g., Das et al., 2021). In the current study the scale showed excellent internal consistency ($\alpha = .94$).

4.2.4 Analysis plan

4.2.4.1.1 Outcome variables

Well-being scores were calculated by averaging responses from the Positive Affect subscale of the I-PANAS-SF (Thompson, 2007) and the Subjective Vitality Scale (Ryan & Frederick, 1997). Ill-being scores were calculated by averaging responses from the Negative Affect subscale of the I-PANAS-SF (Thompson, 2007) and the Loneliness Scale (Hughes et al., 2004). Both scores were computed for each day of the expedition.

4.2.4.1.2 Missing Data Treatment.

Overall, the response rate from participants during the expeditions was 92% (missing days = 15). All days missing were from a single participant who only completed 51% of possible responses. Furthermore, very few days were reported consecutively. Therefore, this participant was removed from the analysis and the level of missing data reassessed. For the remaining participants the response rate above 99%, with only 9 missing responses across all participants. Further investigation showed that 1 participant accounted for 7 missing items, with 6-items

missed on a single day on the same scale (Coping flexibility). Two other participants accounted for the remaining 2 missing responses. The missing data were first visually inspected and were found to be distributed across two scales: eight values were missing from the coping flexibility scale, and one from the PANAS.

4.2.4.1.3 Descriptive statistics

After computing all sub-scale and overall scores for each variable the data will then be presented in a series of tables with descriptive statistics produced for each participant and the total sample. Due to the limited sample size, no further statistical analyses will be conducted on the pre-expedition measures that were collected with the intention of testing their role as moderating variables.

4.2.4.1.4 Variable standardization

Due to different scoring scales used on the variables used to create the summed variables for well-being (Positive affect and Vitality) and ill-being (Negative affect and Loneliness) scores were calculated using standardized scores (e.g., PA/NA = 1-5; Vitality/Loneliness = 1-7). All three predictor variables were also standardized (BPN, Nature relatedness and Coping flexibility). The person-mean-SD standardization method (Wang et al., 2019) was used to create individual plots for each participant and to analyze their mental health across the expedition period against their own average score. Whilst the sample mean was used to create scatterplots and used in the linear mixed effect models conducted.

4.2.4.2 Hypotheses

4.2.4.2.1 Criteria for classification as resilient.

To investigate if the expeditioners can be classified as displaying resilient functioning, this will be reviewed by using visual inspection and descriptive summary techniques that are often

applied to single subject design studies (McDonald et al., 2017, 2020). Specifically, the following analyses will be conducted:

1. **Data Visualization**: A series of line graphs will be plotted for each participant, with separate plots for each of the three within-expedition predictors (e.g., Basic Psychological Needs [BPN], Nature Relatedness, and Coping Flexibility) against both outcome variables (e.g., Well-being and Ill-being). This approach allows for the visualization of individual variable trends and the relationships between predictor and outcome variables for each participant.
2. **Baseline Comparison**: Each participant's scores will be assessed relative to their baseline, defined by their first day's scores.
3. **Trend Analysis**: Participant scores will be examined to identify general trends (e.g., rising or falling) over the course of the expedition. Additionally, any fluctuations will be reviewed to determine whether scores return to or exceed baseline in subsequent time periods.
4. **Stability Assessment**: A stability envelope analysis (Lane & Gast, 2014) will be conducted for each participant across the four well-being and ill-being variables. This analysis will classify participants as "stable" if 80% or more of their scores fall within ±25% of their median score.
5. **Comparative Well-being Levels**: Previous studies with polar expeditioners have consistently shown that average levels of well-being tend to be higher than levels of ill-being among successful expeditioners (e.g., Smith et al., 2023). This criterion will also be considered in assessing resilience.

To synthesize these findings, a descriptive analysis will be provided for each participant in the study.

Due to the large difference in the amount of datapoints provided by different participants, the sample will be analysed by dividing the participants into a short-expedition (e.g., <10 days, *n* = 9, datapoints = 72) and a long-expedition (e.g., >29 days; n = 3, datapoints = 90).

4.2.4.2.2 Analyses and model selection processes

To statistically test each hypothesis all analyses were conducted using R programming software (RStudio team, 2023). Data visualization was made in R using the ggplot2 package (Wickham, 2016).

To test the relationships between predictors of BPN, Nature relatedness and Coping flexibility and their relationships with Well-being and BPN, a series of linear models were conducted using "lmer" function in "lme4" package (Bates et al., 2015) or the "lm" function from the "stats" package (R Core Team, 2013) if no random effects were identified for inclusion in the optimal model. The analysis was conducted using two alternative approaches. The first followed the procedure proposed by Bates et al. (2018), which involves starting with a maximal model and then iteratively removing components (e.g., correlations of random effects, random slopes) to achieve optimal model fit. The second approach used the 'buildmer' package (version 2.1; Voeten, 2021) to automate the model selection process. Notably, both approaches produced similar results; therefore, the results reported here are based on the 'buildmer' output. The alternative analysis is included in the appendices. Consistent with the notion that participants resilience is assessed against their own baseline, person-centered standardization was applied to all analysis. As such, random intercepts were not included in the initial maximal model. However, random slopes for BPN, Nature relatedness and Coping flexibility for each participant

were included. The fixed effects of BPN, Nature relatedness, and Coping flexibility were also included in each initial maximal model. The best fitting model for each analysis was achieved by using stepwise elimination-based method. For several models, this process resulted in no random effects being included in the final model, and thus a standard regression analysis was conducted. Interactions were not investigated due to the size of the dataset and not wanting to attempt overfitting the models.

4.3 Results

4.3.1 Descriptive Statistics for Pre-Expedition Measures

Scores for all pre-expedition measurements for each participant and the total sample are presented in table 4.1. Overall, the expeditioners reported a high level of personal and relational resilience (M_{pr} = 5.72, SD = 0.62; M_{rr} = 5.71, SD = 0.74). Both Nature connection (M = 5.16, SD = 1.05), and all three facets of social support; family (M = 5.42, SD = 5.42, 0.83), friend (M = 5.64, SD = 0.95), and community (M = 5.05, SD = 0.86) were moderately high. Due to the limited sample size, no further analysis will be conducted on these variables.

Table 4.1

Descriptive information for pre-expedition measures by participant and total sample.

				Social Support		
Participant	Per. resilience	Rel. resilience	Nature Connection	Family support	Friend support	Community support
2	6.10	6.00	4.71	6.00	6.00	6.00
3	6.00	6.00	5.14	6.00	6.00	5.00
5	5.70	6.43	5.57	5.00	5.00	4.25
6	4.90	4.29	4.71	5.00	4.67	4.00
7	5.90	5.57	6.50	6.00	5.67	5.25
8	5.70	6.00	3.29	4.33	7.00	5.00
9	5.90	5.86	6.14	5.00	5.33	4.25
10	4.90	4.57	3.50	4.33	5.00	5.00
11	5.80	6.14	6.21	6.00	6.33	5.25
12	7.00	6.71	5.50	7.00	7.00	7.00
13	5.00	5.29	5.50	5.00	4.00	4.50
Sample Mean	**5.72**	**5.71**	**5.16**	**5.42**	**5.64**	**5.05**
Sample SD	**0.62**	**0.74**	**1.05**	**0.83**	**0.95**	**0.86**
Sample Range	**2.10**	**2.43**	**3.21**	**2.67**	**3.00**	**3.00**

Notes: All scales scored 1-7; Per. Resilience = Personal Resilience; Rel. resilience = Relational resilience.

4.3.2 Within-Expedition Descriptive Statistics

Mean and SD scores for individual participants and the total sample for the variables measuring well-being and ill-being are presented in Table 4.2. This includes both the raw scores for the individual variables and standardized scores for Well-being and Ill-being. Overall, participants rated Well-being related variables of PA and Vitality as moderately high (M_{pa} = 3.72 out of???, SD = 0.87; $M_{Vitality}$ = 4.98, SD = 1.28). Whilst the variables relating to Ill-being of NA and loneliness were both low, however, loneliness shows much greater variability (M_{na} = 1.68 out off???, SD = 0.65; $M_{Loneliness}$ = 1.70, SD = 1.26). There is only P6 who shows a higher level of ill-being (M = 2.70, SD = 0.86) compared to well-being (M = 2.48, SD = 0.79). All further analysis will use the composite variables of Well-being and Ill-being which are based on participant-centered z-scores.

Table 4.2

Descriptive results by participant and overall sample at expedition level for individual and composite variables of well-being and ill-being

	Well-being				Ill-being			
	Positive Affect		Vitality		Negative Affect		Loneliness	
Participant	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
2	4.26	1.40	4.60	1.60	1.79	0.57	1.15	0.39
3	3.80	0.44	5.56	0.98	1.71	0.62	2.11	0.93
4	3.78	0.40	5.48	0.95	1.40	0.38	1.00	0.00
5	3.73	0.33	4.50	0.38	2.67	0.69	2.37	0.39
6	2.48	0.79	2.44	0.51	2.70	0.86	4.83	1.81
7	3.60	0.57	5.31	1.91	1.83	0.69	1.79	1.61
8	3.70	0.26	4.50	0.76	1.25	0.21	1.54	1.05
9	4.73	0.27	6.50	0.32	1.97	0.32	2.78	0.75
10	3.15	0.40	5.29	0.37	1.43	0.44	1.30	0.70
11	4.08	0.26	5.28	0.62	1.30	0.35	1.04	0.12
12	3.90	0.51	4.34	1.48	1.90	0.67	1.83	1.59
13	3.60	0.66	5.19	1.03	1.20	0.26	3.33	1.45
Total	**3.72**	**0.87**	**4.98**	**1.28**	**1.68**	**0.65**	**1.70**	**1.26**

Notes: Scoring scales: Positive Affect (1-5); Vitality (1-7); Negative Affect (1-5); Loneliness (1-7).

Means and range scores for basic psychological needs satisfaction for each participant and the total sample for the expedition are presented in Table 4.3. Overall, participants reported moderate to high levels of basic psychological needs satisfaction and Nature relatedness. However, the range of scores showed variability across the participants. The variability was highest for scores on Nature relatedness. A paired-samples t-test revealed that participants used significantly more forward-focus coping strategies (M = 5.20) compared to trauma-focus strategies (M = 4.40), $t(161) = 12.11$, $p < .001$.

Table 4.3

Descriptives for all predictor variables by participant and total sample

	Autonomy		Competence		Relatedness		Nature Relatedness		BPN total		Trauma focus		Forward focus	
Participant	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	SD	*M*	*SD*	*M*	*SD*
2	5.59	0.66	5.32	0.74	5.42	0.71	5.00	0.60	5.44	0.58	2.67	1.00	4.09	0.81
3	5.67	0.83	5.70	1.25	4.41	1.05	6.19	0.75	5.26	0.99	4.84	0.57	4.99	0.47
4	6.42	0.38	6.80	0.19	5.74	0.34	6.14	0.73	6.32	0.28	6.11	0.48	6.65	0.13
5	4.89	0.80	4.85	0.80	4.37	0.89	4.81	1.13	4.70	0.59	5.46	0.41	4.94	0.55
6	2.79	0.67	3.58	0.56	3.21	0.25	3.42	0.30	3.19	0.19	6.08	0.52	6.22	0.47
7	4.21	0.56	4.75	0.90	4.21	0.96	6.54	0.40	4.39	0.68	5.13	0.82	5.77	0.52
8	6.42	0.24	6.04	0.58	4.79	0.73	4.08	0.35	5.75	0.36	2.98	0.71	4.04	0.82
9	5.50	0.62	5.39	0.65	5.33	0.37	7.00	0.00	5.41	0.33	5.85	0.46	6.04	0.50
10	4.85	0.55	4.85	0.92	4.72	0.66	3.41	0.44	4.81	0.53	3.45	0.40	4.37	0.32
11	6.04	0.38	5.71	0.28	5.42	0.61	5.83	0.40	5.72	0.24	4.77	0.66	5.48	0.36
12	6.13	1.32	5.63	1.15	5.88	1.53	5.58	1.00	5.88	1.14	3.98	0.44	6.18	0.84
13	5.29	0.63	5.58	0.75	3.88	0.43	4.38	0.38	4.92	0.49	5.06	0.43	5.89	0.62
Total	**5.42**	**1.07**	**5.45**	**1.08**	**4.97**	**0.99**	**5.01**	**1.29**	**5.28**	**0.92**	**4.40**	**1.45**	**5.20**	**1.12**

Notes: All scales scored 1-7: BPN total includes Autonomy, Competence & Relatedness.

Table 4.4

Stability Envelope Analysis for outcome variables by participant and total sample using % scores within +- 25% of Median score

		Well-being		Ill-being	
Participant	Data points	PA	Vitality	NA	Loneliness
2	31	18 (58.06)	22 (70.97)	20 (64.52)	26 (83.87)
3	9	9 (100.00)	8 (88.89)	7 (77.78)	3 (33.33)
4	28	28 (100.00)	23 (82.14)	9 (32.14)	28 (100.00)
5	9	9 (100.00)	9 (100.00)	6 (66.67)	7 (77.78)
6	8	6 (75.00)	6 (75.00)	6 (75.00)	5 (62.50)
7	8	8 (100.00)	6 (75.00)	3 (37.50)	5 (62.50)
8	8	8 (100.00)	7 (87.50)	7 (87.50)	5 (62.50)
9	6	6 (100.00)	6 (100.00)	5 (83.33)	3 (50.00)
10	31	31 (100.00)	31 (100.00)	13 (41.94)	22 (70.97)
11	8	8 (100.00)	8 (100.00)	6 (75.00)	7 (87.50)
12	8	8 (100.00)	5 (62.50)	2 (25.00)	5 (62.50)
13	8	7 (87.50)	6 (75.00)	6 (75.00)	3 (37.50)
Total	**162**	**146 (90.12)**	**137 (84.57)**	**90 (55.56)**	**119 (73.46)**

Notes: Score denotes number of data points within stability envelope (overall % in brackets)

Table 4.4 reports the results of a stability envelope analysis to measure the stability of participant responses across the duration of their expedition. The scores are reported for each variable that make up well-being and ill-being composite scores. Using this analysis, scores above 80% are classified as ‘stable’ and those below ‘not stable’. Overall, the table shows that WB displayed a generally stable trajectory with only two participants (P2 = 58.06%; P6 = 75.00%) not displaying stable trajectories across their expeditions for PA. Whilst in terms of Ill-being, Loneliness was approaching a stable categorization (73.46%). However, NA displayed a much higher level of variability (55.56%), with only 1 participant (P9 = 83.33%) being classified as stable on this variable. The stability level of each participant will be further summarized in the next section.

Table 4.5

Correlation matrix for all variables with significance levels calculated using person-centered z-scores

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Autonomy	-													
2. Competence	.67*	-												
3. Relatedness	.88**	.79**	-											
4. BPN	.91**	.89**	.97**	-										
5. Nature Relatedness	-0.08	0.17	-0.13	-0.04	-									
6. Trauma focus	-0.15	-0.01	-0.09	-0.11	0.10	-								
7. Forward focus	0.49	0.54*	0.45	0.51	0.07	0.55*	-							
8. Coping flexibility	0.42	0.50	0.43	0.46	0.17	0.82**	0.92**	-						
9. Positive affect	0.25	.64*	0.36	0.43	0.43	0.33	0.45	0.53	-					
10. Vitality	0.34	.71**	0.38	0.50	0.48	0.20	0.54*	0.51	0.82	-				
11. Negative affect	-0.74	-0.87	-0.78	-0.86	-0.17	-0.08	-0.72**	-0.59	-0.54	-0.66	-			
12. Loneliness	-0.88	-0.86	-0.94	-0.96	-0.07	-0.06	-0.59*	-0.55	-0.51	-0.56	0.78	-		
13. Well-being	0.31	.71**	0.39	0.48	0.48	0.28	0.52	0.54	0.95	0.96	-0.63	-0.56	-	
14. Ill-being	-0.86	-0.92	-0.91	-0.96	-0.13	-0.07	-0.70**	-0.60	-0.56	-0.64	0.94	0.95	-0.63	-

Notes: * = $p < .05$, ** $p < .01$

Table 4.5 shows correlations between predictor variables, including the three basic psychological needs, total BPN satisfaction, nature relatedness, and coping flexibility, and outcome variables, including positive affect, vitality, negative affect, and loneliness, along with the composite variables for well-being and ill-being. Large correlations can be observed between the three basic psychological needs for Autonomy, Competence, and Relatedness. Due to the large correlations reported and to aid model parsimony when conducting linear mixed effect analysis, the overall BPN satisfaction variable will be used in all additional analysis conducted. BPN can be seen to have a large relationship to Well-being, however, not significant and a very large and significant relationship to Ill-being. Nature relatedness shows a high correlation with Well-being. Examining the coping strategies from the PACT scale shows that Trauma-focus does not show any significant correlations with well-being or ill-beingHowever, forward-focus shows a large and significant correlation with vitality. It also shows a positive correlation with well-being, though this is not statistically significant. And large negative associations with loneliness and negative affect, resulting in a significant large negative association with Ill-being overall. Coping flexibility shows large correlations with both Well-being and Ill-being, however, only the one to Ill-being significant. Caution should be taken when interpreting the correlation coefficients due to the inclusion of repeated datapoints from the same participants and the small number of participants.

4.3.3 Within-Participant Plots

To visualize the data at the within-participant level individual plots for each participant are reported in Figure 4.1-4.3 which display a single predictor variable (e.g., BPN, Nature relatedness, Coping flexibility) and both outcome variables (WB, IB) in each plot. Due to the large difference in the expedition durations, the plots and all further analysis have been separated into those completing longer and shorter expeditions. A summary of each participant's resilience profile will then be reviewed.

4.3.3.1 Short-duration Expeditions

Figure 4.1

Short Duration Expeditions BPN, well-being and ill-being by Participant

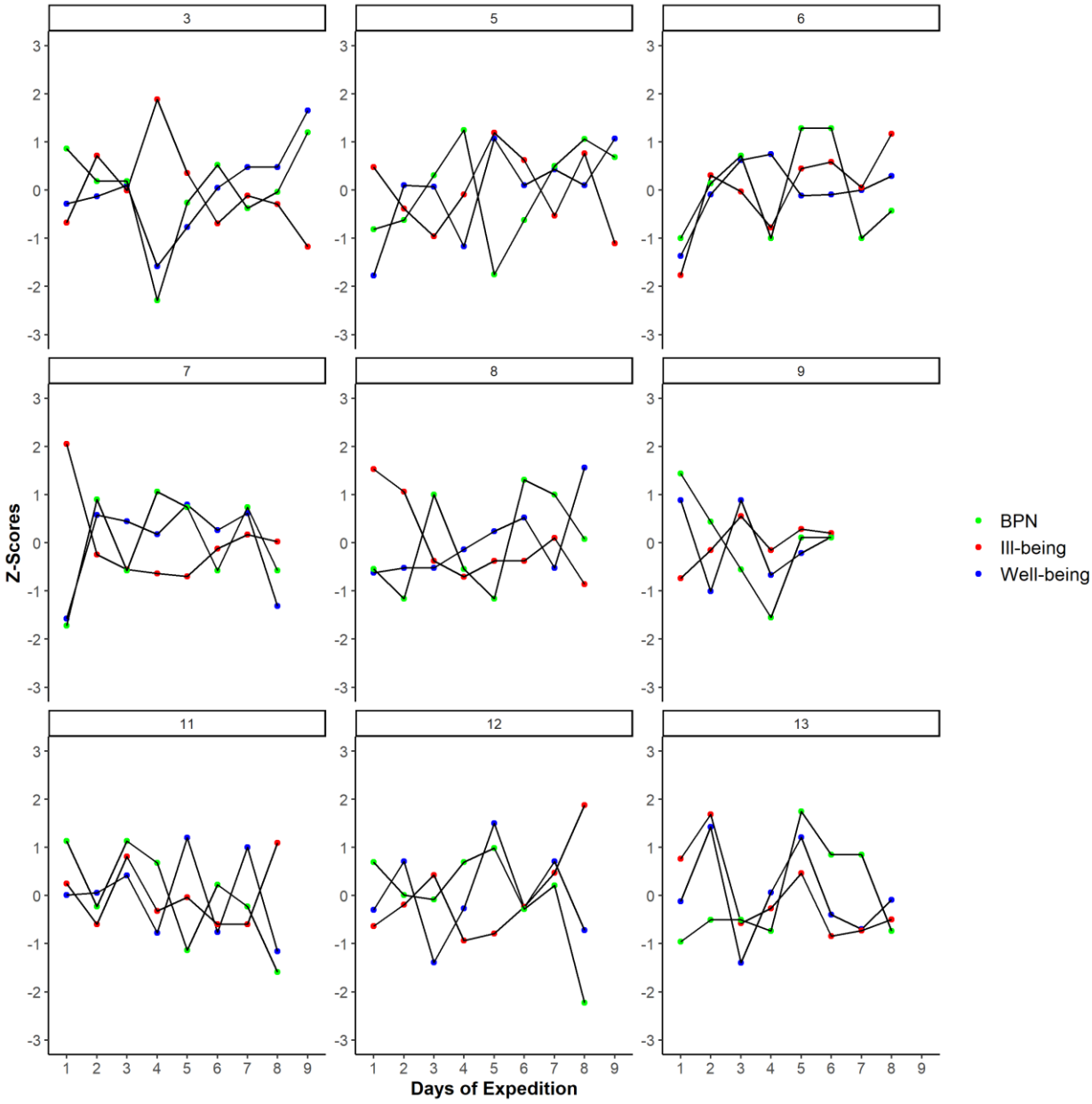


Figure 4.2

Short Duration Expeditions coping Flexibility, well-being and ill-being by Participant

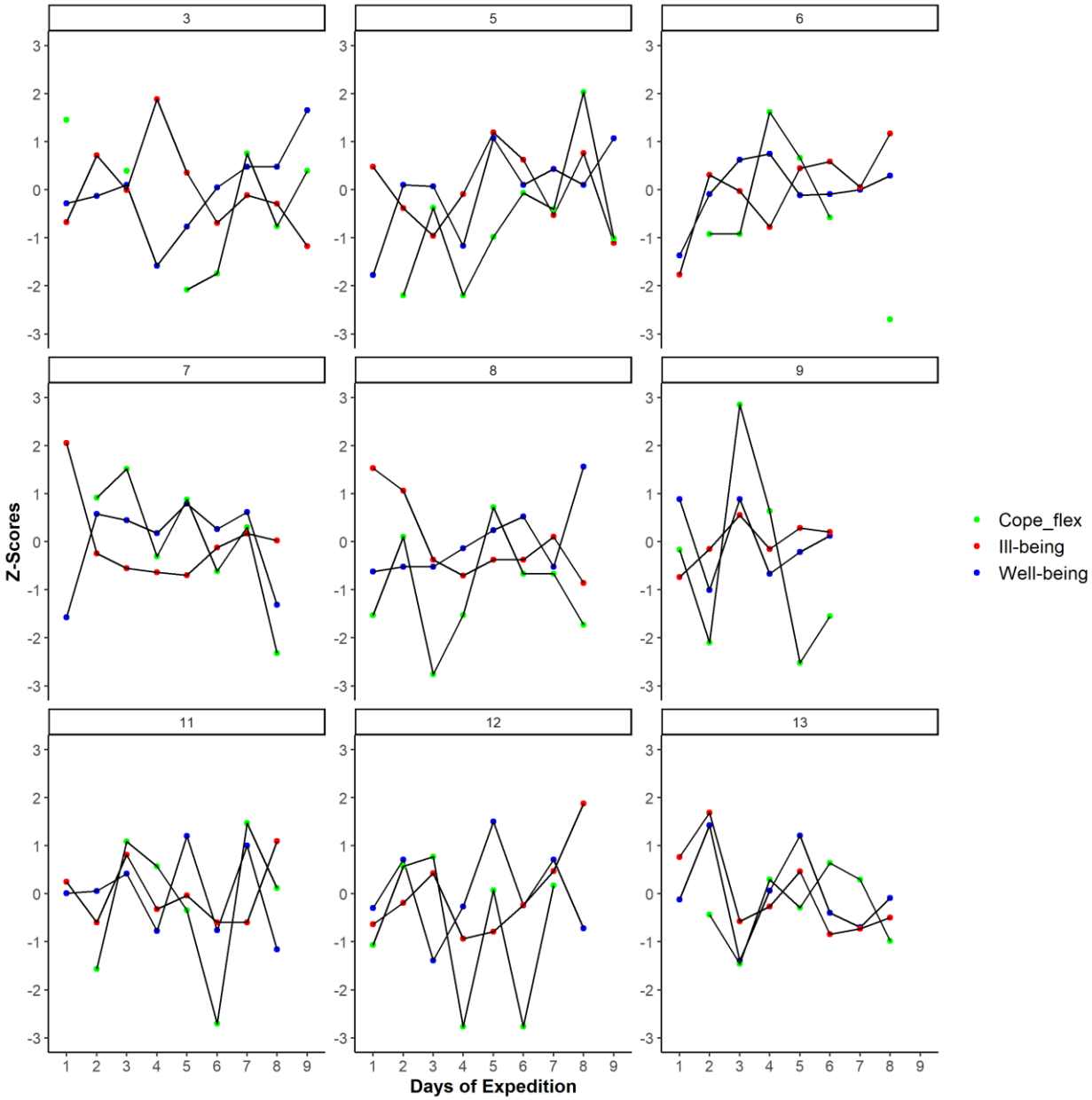
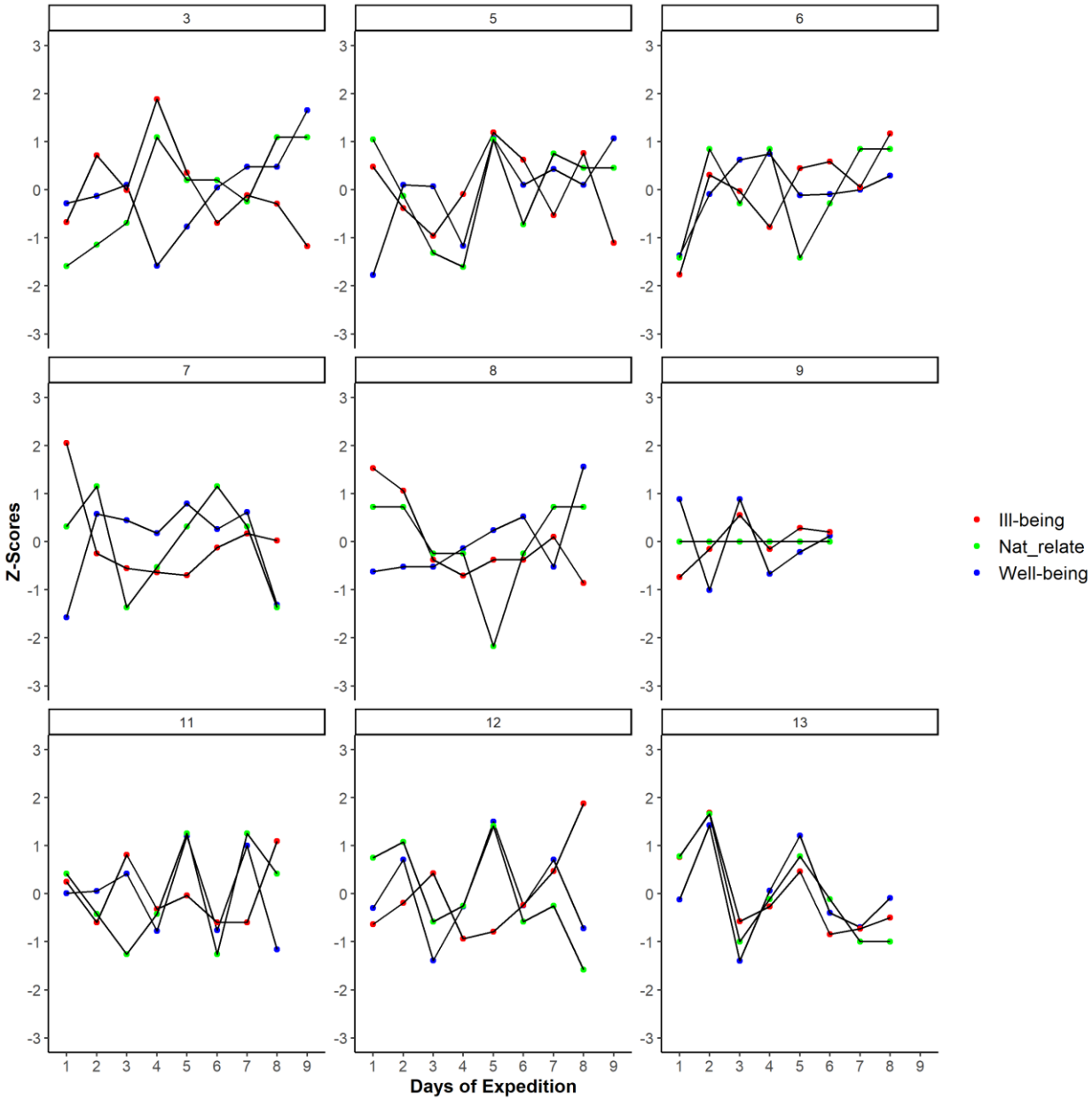


Figure 4.3

Short Duration Expeditions nature relatednesss, well-being and ill-being by participant



4.3.3.1.1 Individual Participant Summary (Short-duration expeditions)

Using both the descriptive data (e.g., Tables 4.1 - 4.4) and visually analysing the within-expedition plots (Figures 4.1 - 4.3) a summary of each participants level of resilient functioning was assessed.

4.3.3.1.1.1 Participant Three.

Examining the pre-expedition measures of Participant three shows that they scored high on Personal and Relational resilience, and all three facets of social support (All scores $M > 6.00$), which was above the sample mean for each variable. Their score on Nature connection was moderate ($M = 4.71$), which was just below the sample mean.

Their within-expedition results show that both constituent measures of well-being were moderate to high ($M_{pa} = 3.80$, $SD = 1.40$; $M_{vitality} = 5.56$). Conversely, both measures relating to ill-being were low ($M_{na} = 1.71$, $SD = 0.62$; $M_{loneliness} = 2.11$, $SD = 0.93$). Visual analysis of the within-expedition plots shows that WB displayed an increasing trend with IB decreasing across the expedition. Additionally, stability envelope analysis showed that PA (100.00%) and Vitality (88.89%) were classified as stable. Whilst NA was approaching stability (77.78%), levels of loneliness were less stable (33.33%). However, any negative changes were quickly followed by a return to at least baseline levels or above. Therefore, this participant is classified as displaying resilient functioning.

4.3.3.1.1.2 Participant Five.

Examining the pre-expedition measures of Participant Five shows that they scored high on both measures of resilience (MP.res = 5.70, MR.res = 6.43), nature connection (M = 5.57), and both family and friend support (both M = 5.00), while community support was moderate (M = 4.25).

Their within-expedition results show that both measures of well-being were moderately high ($M_{pa} = 3.73$, $SD = 0.33$; $M_{vitality} = 4.50$, $SD = 0.32$). In terms of ill-being, NA

was moderate (M = 2.67, SD = 0.69), with low levels of Loneliness (M = 2.37, SD = 0.39). Visual analysis of the within-expedition plots shows that WB displayed an increasing trend with only limited variability, which is supported by the results of the stability envelope analysis showing that PA (100.00%) and Vitality (100.00%) were classified as stable. IB displayed a generally decreasing trend across the expedition. Scores can be seen to fluctuate across days, however, results of the stability analysis show that both NA (66.67%), and loneliness (77.78%) were approaching stability. Furthermore, any increases were followed by a swift return to lower levels. Therefore, this participant is classified as displaying resilient functioning.

4.3.3.1.1.3 Participant Six.

Examining the pre-expedition measures of Participant six shows that they reported moderate levels on both measures of resilience ($M_{P.res}$ = 4.90, $M_{R.res}$ = 4.29), Nature connection (*M* = 4.71) and Friend (*M* = 4.67) and Community support (*M* = 4.00). With moderately high levels of Family support (*M* = 5.00).

Their within-expedition results show that both measures of well-being were moderately low (M_{pa} = 2.48, *SD* = 0.79; $M_{vitality}$ = 2.44, *SD* = 0.51). The stability envelope analysis showed that PA (75.00%) and Vitality (75.00%) were classified were both approaching a stable catergorisation. Although, the trend for WB was seen to be increasing across the expedition duration. Examining ill-being, NA was higher than PA (M_{pa} = 2.70, *SD* = 0.86), with a moderately high level of loneliness reported (*M* = 4.83, *SD* = 1.81). Visual analysis shows that IB displayed an increasing trend across the expedition. Notably, IB showed several increases that did not then return to lower levels across the following days. The stability envelope analysis showed that NA was approaching stability (77.78%), however, levels of loneliness were less stable (33.33%). Therefore, this participant is classified as experiencing resilience challenges and not displaying resilient functioning.

4.3.3.1.1.4 Participant Seven.

Examining the pre-expedition measures of Participant seven shows that they reported high scores on all variables. With resilience ($M_{P.res}$ = 5.90, $M_{R.res}$ = 5.57), Nature connection (M = 6.50), Friend support (M = 5.67), Family support (M = 6.00) and Community support (M = 5.25).

Participant seven's within-expedition results show that both constituent measures of well-being were moderate and moderately high (M_{pa} = 3.60, SD = 0.57; $M_{vitality}$ = 5.31, SD = 1.91). Examining the within-expedition plot showed the trend for WB to be strongly influenced by sharp increase after the first day, and similar decrease on the last day, with a relatively flat line on all other days. The stability envelope analysis showed that PA (100.00%) was stable and Vitality (75.00%) approaching a stable catergorisation. Examining ill-being, both NA and Loneliness were low (M_{na} = 1.83, SD = 0.69; $M_{loneliness}$ = 1.79, SD = 1.61). Visual analysis shows that IB displayed a decreasing trend across the expedition. The stability envelope analysis showed that NA was quite variable (37.50%), and levels of loneliness (62.50%) whilst less variable was still classified as not stable. Therefore, this participant is classified as displaying resilient functioning.

4.3.3.1.1.5 Participant Eight.

Examining the pre-expedition measures of Participant eight shows that they reported high scores on both types of resilience ($M_{P.res}$ = 5.70, $M_{R.res}$ = 6.00), Friend support (M = 7.00), and Community support (M = 5.00). Family support was moderate (M = 6.00) and Nature connection moderately low (M = 3.29).

Participant eight's within-expedition results show that both measures of well-being were moderate (M_{pa} = 3.70, SD = 0.26; $M_{vitality}$ = 4.50, SD = 0.76). Examining the within-expedition plot showed the trend for WB to be increasing steadily across the expedition on all days apart from one. The stability envelope analysis showed that generally PA (100.00%) and

Vitality (87.50%) were both stable. Examining ill-being, both NA and Loneliness were low (M_{na} = 1.25, *SD* = 0.21; $M_{loneliness}$ = 1.54, SD = 1.05). Visual analysis shows that IB displayed a decreasing trend across the expedition. The stability envelope analysis showed that NA was stable (87.50%), and thus levels of loneliness displayed greater variability and influence on the changes observed (62.50%). Overall, this participant is classified as displaying resilient functioning.

4.3.3.1.1.6 Participant Nine.

Examining the pre-expedition measures of Participant nine shows that they reported high scores on both types of resilience ($M_{P.res}$ = 5.90, $M_{R.res}$ = 5.86), Nature connection (*M* = 6.14), Family support (*M* = 5.00) and Friend support (*M* = 5.33). With moderate levels of Community support (*M* = 4.25).

Participant nine's within-expedition results show that both measures of well-being were high (M_{pa} = 4.73, *SD* = 0.27; $M_{vitality}$ = 6.50, *SD* = 0.32). Examining the within-expedition plot showed that the trend for well-being was quite variable. However, any decreases were swiftly followed by increases on all occasions. The stability envelope analysis showed that these changes were relatively small with both PA (100.00%) and Vitality (100.00%) classified as stable. Examining ill-being, both NA and Loneliness were low (M_{na} = 1.97, *SD* = 0.32; $M_{loneliness}$ = 2.78, SD = 0.75). Visual analysis shows that IB displayed an increasing trend across the expedition. The stability envelope analysis showed that NA was stable (83.33%), however, that loneliness was not (50.00%) and the greater influence on the increases in IB. Overall, this participant is classified as displaying resilient functioning.

4.3.3.1.1.7 Participant Eleven.

Examining the pre-expedition measures of Participant eleven shows that they reported high scores on both types of resilience ($M_{P.res}$ = 5.80, $M_{R.res}$ = 6.14), Nature connection (*M* = 6.21),

Family support (*M* = 6.00) and Friend support (*M* = 6.33), with moderately high levels of Community support (*M* = 5.25).

Participant eleven's within-expedition results show that both measures of well-being were high (M_{pa} = 4.08, *SD* = 0.26; $M_{vitality}$ = 5.28, *SD* = 0.62). Examining the within-expedition plot showed some variability across expedition days. However, the stability envelope analysis showed that these changes were relatively small with both PA (100.00%) and Vitality (100.00%) classified as stable. Examining ill-being, both NA and Loneliness were low (M_{na} = 1.30, *SD* = 0.35; $M_{loneliness}$ = 1.04, SD = 0.12). Visual analysis shows that IB showed some variability across the expedition. The stability envelope analysis showed that Loneliness was stable (87.50%), with NA approaching a stable catergorisation (75.00%). This shows that IB was relatively stable across the expedition. Therefore, overall, this participant is classified as displaying resilient functioning during the expedition.

4.3.3.1.1.8 Participant Twelve.

Examining the pre-expedition measures of Participant twelve shows that they reported very high scores on both types of resilience ($M_{P.res}$ = 7.00, $M_{R.res}$ = 6.71), and all three types of social support (M_{family} = 7.00; M_{friend} = 7.00; M_{Comm} = 7.00). Nature connection was moderately high (*M* = 5.50).

Participant twelve's within-expedition results show that both measures of well-being were moderate (M_{pa} = 3.90, *SD* = 0.51; $M_{vitality}$ = 4.34, *SD* = 1.48). Examining the within-expedition plot showed that WB showed both upward and downward fluctuations, but generally returning to baseline levels. However, the stability envelope analysis showed that these changes were relatively small and predominately influenced by changes in Vitality (62.50%) with PA categorized as stable (100%). Examining ill-being, both NA and Loneliness were reported to be low (M_{na} = 1.90, *SD* = 0.67; $M_{loneliness}$ = 1.83, SD = 1.59). Visual analysis shows that IB was shown to increase across the expedition, especially in the

later stages. The stability envelope analysis showed neither NA (25.00%) or Loneliness (62.50) were categorized as stable. Therefore, overall, this participant is classified as displaying resilient functioning during the expedition.

4.3.3.1.1.9 Participant Thirteen.

Examining the pre-expedition measures of Participant thirteen shows that they reported moderately high scores on both types of resilience ($M_{P.res}$ = 5.00, $M_{R.res}$ = 5.29), Nature connection (M = 5.50), and Family support (M = 5.00). Whilst Friend support (M = 4.00) and Community support (M = 4.50) were both moderate.

Participant thirteen's within-expedition results show that both measures of well-being were moderately high (M_{pa} = 3.60, *SD* = 0.66; $M_{vitality}$ = 5.19, *SD* = 1.03). Examining the within-expedition plot showed that WB showed both upward and downward fluctuations, but generally returning to baseline levels. However, the stability envelope analysis showed Vitality was approaching stable (75.00%) and PA categorized as stable (87.50%). Examining ill-being, NA was generally low (M_{na} = 1.20, *SD* = 0.26), with moderate levels of Loneliness ($M_{loneliness}$ = 3.33, SD = 1.59). Visual analysis shows that IB decreased across the expedition. The stability envelope analysis showed NA (75.00%) was approaching stable, however, Loneliness was quite unstable (37.50%) and likely accounting for more of the change in IB. Overall, this participant is classified as displaying resilient functioning during the expedition.

4.3.3.1.2 Overall Summary of Short-duration Expeditioners

Overall, the vast majority (8 out of 9) of short-duration expeditioners were classified as displaying resilient functioning during their expedition. These resilient participants generally had moderate to high average levels of well-being (WB) and low levels of ill-being (IB). They exhibited higher well-being than ill-being, with well-being in most cases remaining stable. Any increases or decreases associated with negative events were typically followed by a return to higher or lower levels, respectively. In contrast, the participant who was not

classified as resilient (P6) showed lower levels of well-being than ill-being, with consistently low well-being and higher ill-being across the expedition. Additionally, this participant had lower pre-expedition scores on resilience, social support, and nature connection measures compared to the rest of the sample.

Examining the participant plots (Figures 4.1 - 4.3) shows an apparent relationship between BPN and both WB and IB. A clear example can be seen with P3, where BPN can be seen to decrease in line with increases in IB and increase in line with WB. These relationships appear to be consistent in most cases, although with noticeable variability in the strength of relationship. Nature relatedness shows some evidence of a relationship to WB; however, this appears quite variable across participants. Finally, coping flexibility also shows evidence of a positive relationship to WB, although again with variability across the participants.

Figure 4.4

Short Duration Expedition Scatterplots between BPN, Nature Relatedness and Coping Flexibility to Well-being and Ill-being using Participant-centred Z-scores

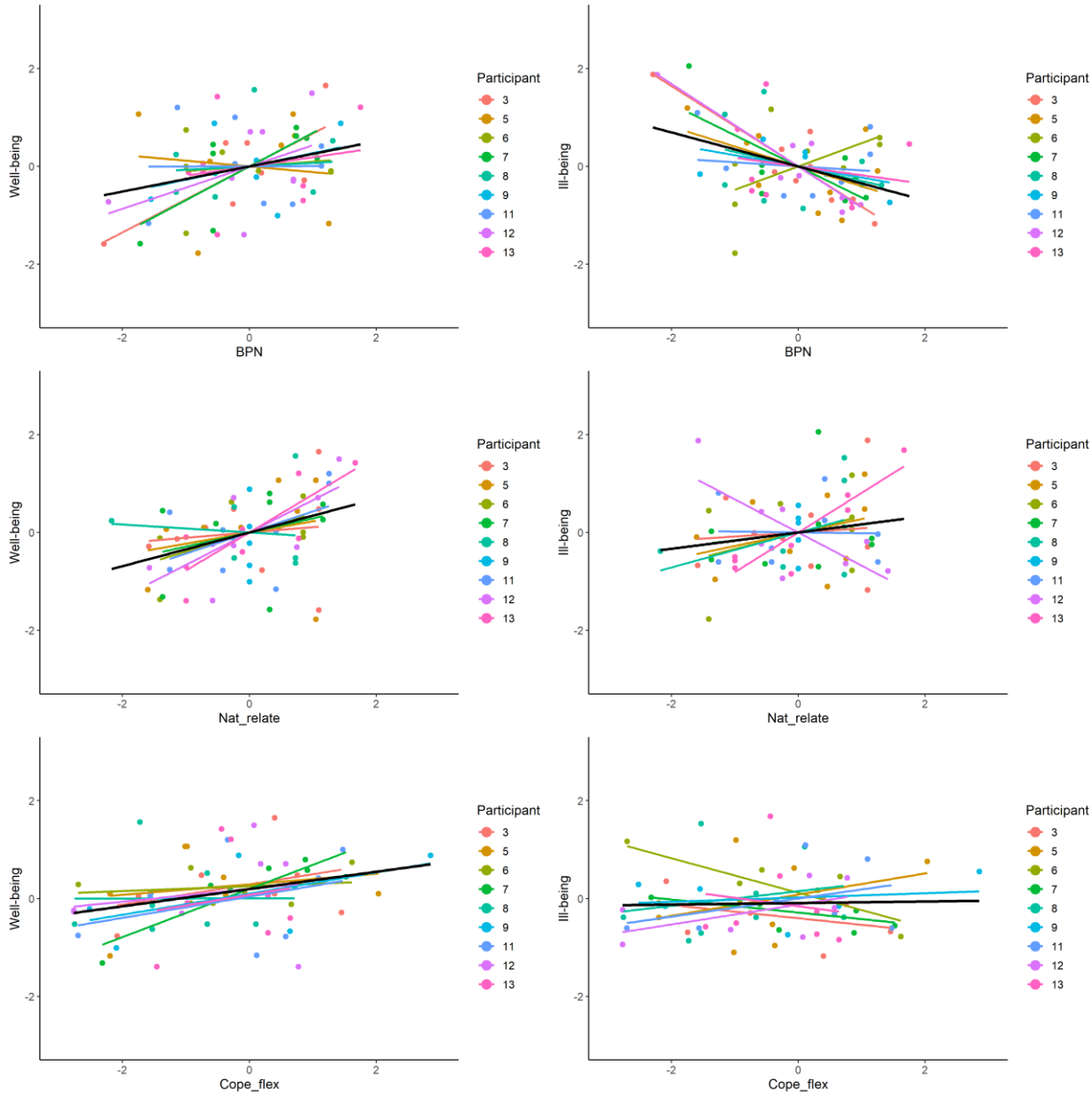


Figure 4.4 shows the relationships between the predictor variables BPN, Nature relatedness and Coping flexibility to the outcome variables of WB and IB. The plots show that there appears to be variation between participants in terms of the direction of relationship across all the six sub-plots. Visually examining BPN shows a positive relationship to WB and a negative relationship to IB. Nature relatedness, shows a strong positive relationship to WB,

however, no noticeable relationship to IB. Finally, Coping flexibility appears to show a very small positive relationship to WB and a stronger positive relationship to IB. To investigate these relationships further linear mixed effect models will be conducted, following reporting of the long-expedition participants.

4.3.3.2 Long Expedition Participants

Figure 4.5

Long Duration Expeditions BPN, well-being and ill-being by Participant

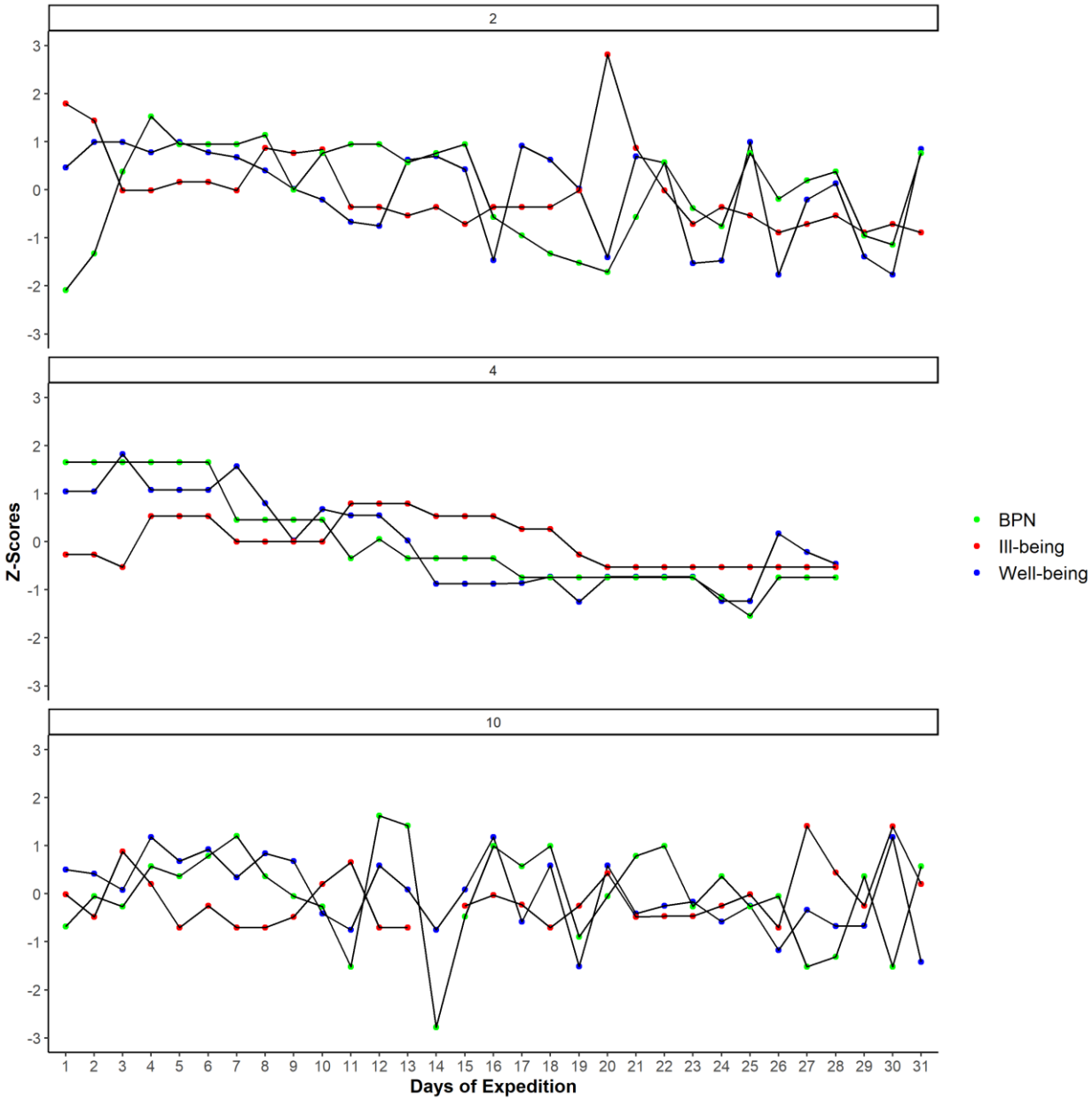


Figure 4.6

Long Duration Expeditions Coping Flexibility, well-being, ill-being by Participant

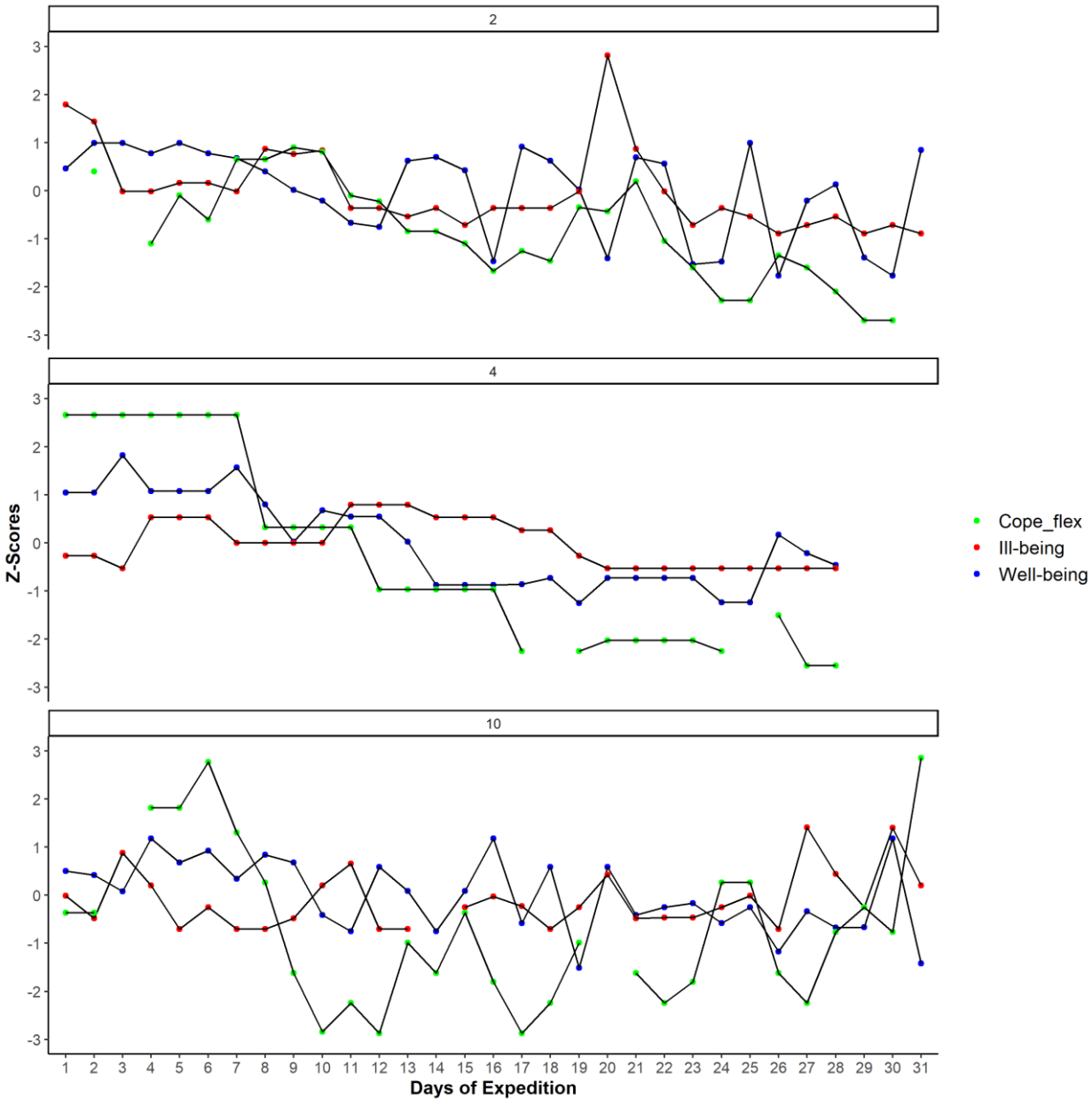
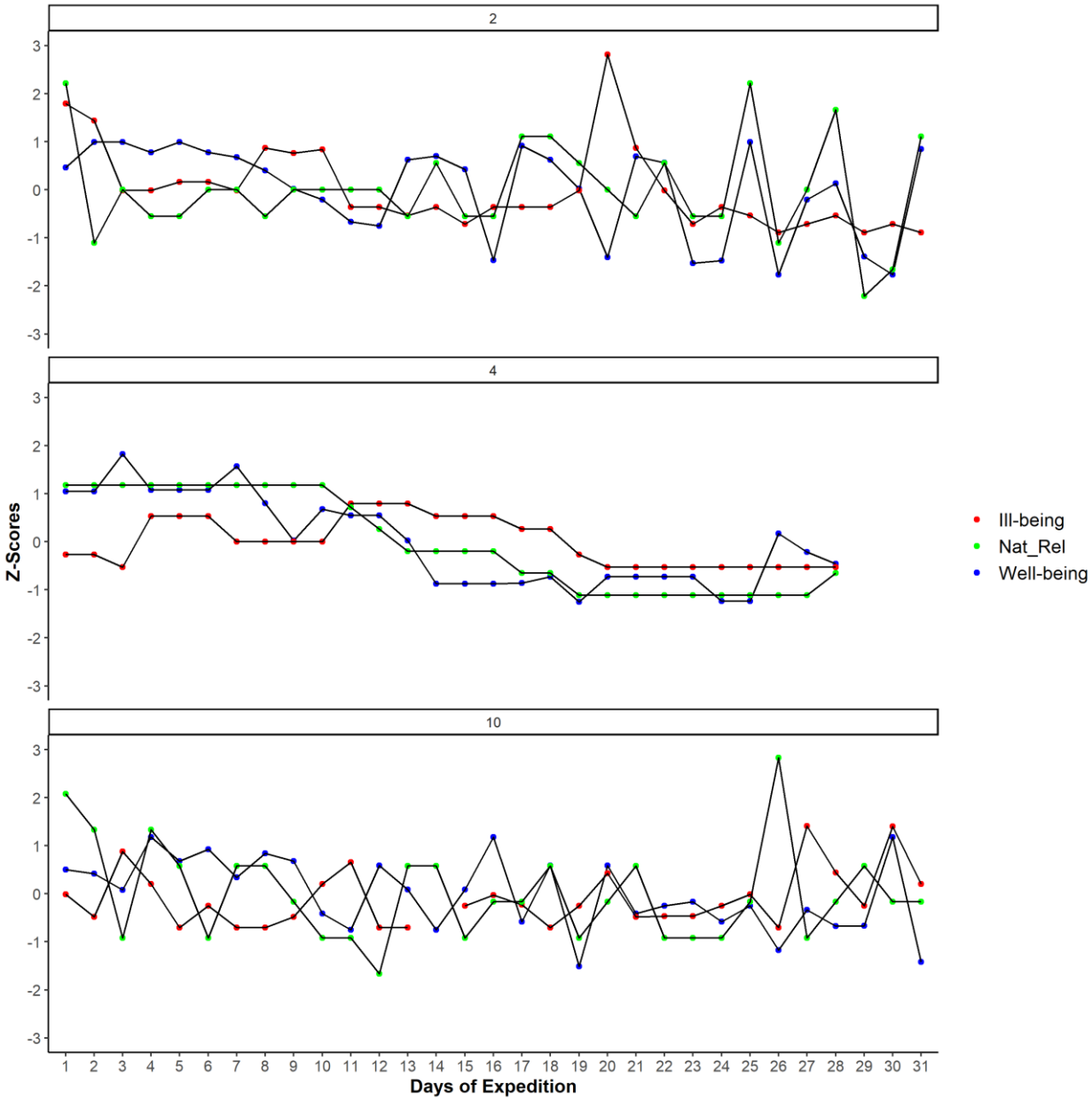


Figure 4.7

Long Duration Expeditions nature relatedness, well-being and ill-being by articipant



4.3.3.2.1 Individual Participant Summary (Long-duration expeditions)

Using both the descriptive data (e.g., Tables 4.1- 4.4) and visually analysing the within-expe dition plots (Figures 4.5-4.7) a summary of each participants level of resilient functioning w as assessed.

4.3.3.2.1.1 Participant Two.

Examining the pre-expedition measures of Participant two shows that they reported high scores on both types of resilience ($M_{P.res}$ = 6.10, $M_{R.res}$ = 6.00), and all three measures of social support (M_{family} = 6.00; M_{friend} = 6.00; M_{comm} = 6.00). With a moderate level of Nature connection (M = 4.71).

Participant two's within-expedition results show that for WB measures, PA was high (M = 4.26, SD = 1.40) and moderate for Vitality (M = 4.60, SD = 1.60). Examining the within-expedition plot showed that WB showed a gradual decline in the first half of the expedition, then in the second half the individual showed returns to baseline levels, however, this was punctuated by consistent downward fluctuations. Consistent with this, the stability envelope analysis showed that PA was not stable (58.06%) and Vitality (70.97) whilst displaying more stability is still classified as not stable. Examining ill-being, both NA and Loneliness were generally low (M_{na} = 1.79, SD = 0.57; $M_{loneliness}$ = 1.15, SD = 0.39). Visual analysis shows that IB showed a decrease after several days that was generally maintained, apart from several fluctuations which returned to the lower level the next day. The stability envelope analysis showed Loneliness was stable (83.87%), however, NA explained more of the variability being classified as unstable (64.52%). Overall, this participant is classified as displaying resilient functioning during the expedition.

4.3.3.2.1.2 Participant Four.

Participant four did not complete the pre-expedition measures so no results are provided for this section.

Participant four's within-expedition results show that for WB measures, PA was moderate (M = 3.15, SD = 0.40) and Vitality was moderately high (M = 5.29, SD = 0.37). Examining the within-expedition plot showed that WB was generally elevated for the first third of the expedition, before showing small regular decreases which were always followed by a rebounding effect. In the final period, they showed a small decline generally with again fluctuations in both directions. The stability envelope analysis confirms these fluctuations were relatively small with both PA (100.00%) and Vitality (82.14) completely stable. Examining ill-being, both NA and Loneliness were generally low (M_{na} = 1.40, SD = 0.38; $M_{loneliness}$ = 1.00, SD = 0.00). These scores resulted in their overall ill-being scoring lower than the sample mean (Z = -0.35, SD = 0.). Visual analysis shows that IB showed a small increase in the first part of the expedition, before decreasing in the second period and then remaining consistently lower than their mean level for the remainder of the expedition. The stability envelope analysis showed that Loneliness was highly stable (100.00%), and the small variations were explained by fluctuations in NA which was not stable (32.14%). Overall, this participant is classified as displaying resilient functioning during the expedition.

4.3.3.2.1.3 Participant Ten.

Examining the pre-expedition measures of Participant ten shows that they reported moderate scores on both types of resilience ($M_{P.res}$ = 4.90, $M_{R.res}$ = 4.57), Nature connection (M = 3.50) and Family support (M = 4.33). Whilst Friend and Community support were both moderately high (M_{friend} = 6.00; M_{comm} = 6.00).

Participant ten's within-expedition results show that both measures of well-being were moderately high (M_{pa} = 3.78, SD = 0.40; $M_{vitality}$ = 5.48, SD = 0.95). Examining the within-expedition plot showed that WB was consistently above their mean for the first week of the expedition. Following this period, their scores show a general decrease and then relatively stable scores at this lower level before a slight rebound towards the end of the

expedition. The stability envelope analysis showed that these fluctuations were relatively small with both PA (100.00%) and Vitality (82.14) classified as stable. Examining ill-being, both NA and Loneliness were generally low (M_{na} = 1.40, *SD* = 0.38; $M_{loneliness}$ = 1.00, SD = 0.00). Visual analysis shows that IB showed small fluctuations interspersed with periods of stable scores, whilst in the last week scores became more variable and IB appears to increase marginally. The stability envelope analysis whilst Loneliness was approaching stable levels (70.97%), there were greater fluctuations in NA which was not stable (41.94%). Overall, this participant is classified as displaying resilient functioning during the expedition.

4.3.3.2.2 Overall Summary of Long-duration Expeditioners

Overall, using participants overall expedition means and variability and examining their well-being and ill-being across the expedition period all three expeditioners were classified as displaying resilient functioning during their expedition. The participants who were classified as resilient can be summarized as displaying generally higher well-being than ill-being, with well-being in most cases classified as stable. And any increases or decreases being followed by a return to higher/lower levels.

Examining the participant plots shows a similar relationship to that observed in short-duration expeditioners between BPN and both WB and IB. For example, P2, where BPN can be seen to decrease in line with increases in IB and increase in line with WB. Nature relatedness shows some evidence of a relationship to WB; however this appears quite variable across participants. Finally, the relationships to Coping flexibility are not clearly visible, due to the amount of missing data on this variable.

Figure 4.8

Long Duration Expedition Scatterplots between BPN, Nature Relatedness and Coping Flexibility to Well-being and Ill-being.

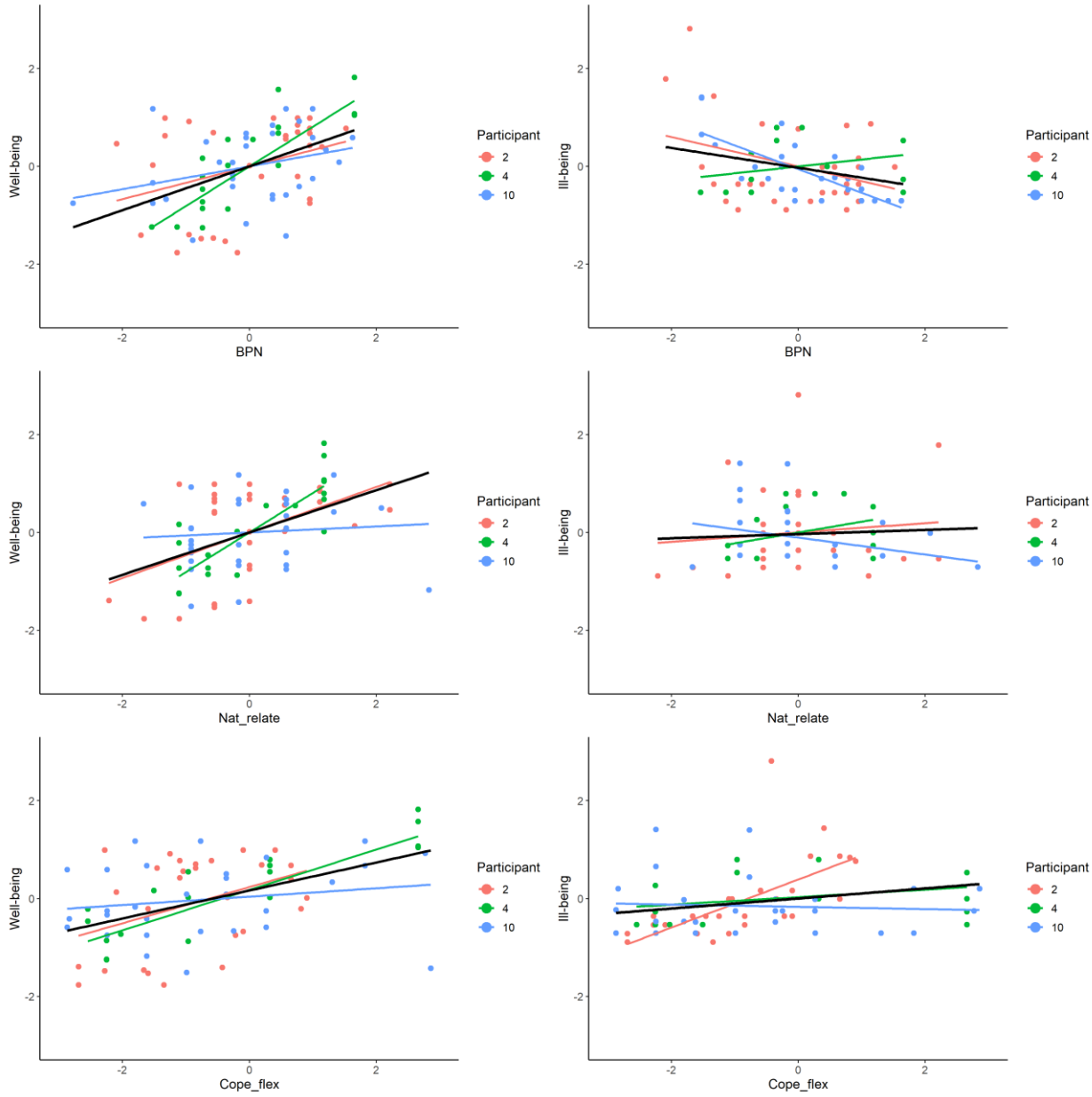


Figure 4.8 shows the relationships between the predictor variables BPN, Nature relatedness and Coping flexibility to the outcome variables of WB and IB. Visually examining BPN shows a positive relationship to WB and a negative relationship to IB overall. However, with noticeable variability between the participants, especially on IB. Nature relatedness, shows a positive relationship to WB with a positive relationship noted across all participants. However, there is no noticeable relationship to IB, with differences between the participants. Finally, Coping flexibility appears to show a very small positive relationship to WB and a stronger positive relationship to IB. To further investigate these relationships statistically, a linear mixed model analysis was conducted.

4.3.4 Total Sample Linear Mixed Model

Table 4.6

Results of mixed effects linear regression testing the effect of BPN, Nature relatedness, and Coping flexibility predicting Well-being and Ill-being using total sample.

	Predicting Well-being				**Predicting Ill-being**			
Fixed effects	***b***	***SE***	***t***	***p***	***b***	***SE***	***t***	***p***
(Intercept)	0.08	0.06	1.46	0.147	0.02	0.05	0.42	0.677
BPN	0.26	0.06	4.50	<0.001	-0.31	0.11	-2.83	0.005
Coping flexibility	0.11	0.03	3.59	<0.001	-0.01	0.05	-0.24	0.808
Nature relatedness	0.31	0.06	5.36	<0.001				
Random Effects					**Variance**	**SD**	**Corr**	
Coping flexibility					0.02	0.15		
BPN					0.10	0.31	-0.30	

Notes: Participants = 12; datapoints = 162. **Well-being Model**: R model equation: lm(Well-being ~ 1 + Nature relatedness + Flexibility + BPN); AdjR2 = 0.37. **Ill-being Model**: R model equation: lmer (Ill-being ~ 1 + BPN + Flexibility + (0 + Flexibility + BPN | PerNo) ; $R^2m = 0.16$, $R^2c = 0.42$.

Table 4.6. shows the results for the final models conducted using the total sample for both well-being and ill-being. The results show that all three variables were significant predictors of WB. Nature relatedness was the strongest predictor ($b = 0.31$, $SE = 0.06$, $t = 5.36$, $p < 0.001$). With BPN also significant and with only a marginally smaller coefficient ($b = 0.26$, $SE = 0.06$, $t = 4.50$, $p < 0.001$). Coping flexibility was also significant but showing a much

smaller effect than the other two predictors (b = 0.11, SE = 0.03, t = 3.59, p < 0.001). Notably, there were no random effects included in this model. Further examination showed that this was due to the very low level of variance within participants for well-being. The final model for WB was shown to account for 37% of the variance using adjusted R^2 statistic. Additionally, Table 7. shows that BPN was the only significant predictor of IB (b = -0.31, SE = 0.11, t = -2.83, p = 0.005). The random effects for BPN and Coping flexibility were included in this model. Differences between the slopes were relatively low, thus the effect was generally consistent across participants. The model's marginal R^2 (R^2_m), showed that the fixed effects explained 0.16 of the variances, while the conditional R^2 (R^2_c), showed an overall model fit of 0.42, indicating a well-fitted model.

4.4 Discussion

This study had two main aims. The first was to investigate whether polar expeditioners could be classified as displaying resilient functioning during their expedition, with resilience referring to measures of mental health (well-being and ill-being). The second aim was to extend the quantitative findings from Study 1 by examining whether the key predictors of mental health; basic psychological needs (BPN), nature relatedness, and coping flexibility accounted for within-person changes during the expedition using an intensive repeated measures design. The results demonstrated that most participants maintained resilient functioning, with well-being levels generally stable across the expedition. In contrast, ill-being displayed greater variability, which may reflect dynamic responses to acute stressors in the polar environment. Notably, BPN emerged as a critical predictor, showing consistent positive relationships with well-being and significant negative relationships with ill-being. This highlights its unique role in supporting both dimensions of mental health. Nature relatedness and coping flexibility also predicted well-being, reinforcing their importance as well-being enhancers in extreme environments. These findings underscore the relevance of socioecological resilience frameworks and the need to address basic psychological needs to promote adaptive functioning in challenging conditions.

4.4.1 Idiographic perspective

Using an idiographic approach, this study supports the notion that polar expeditioners are generally resilient during expeditions. In line with previous polar diary studies, most of the sample displayed higher positive affect than negative affect (e.g., Blackadder-Weinstein et al., 2019; Leon et al., 1991; Kahn & Leon, 1994; Atlis et al., 2004; Kjaergaard et al., 2015; Smith et al., 2021, 2024). Furthermore, the trajectories of well-being and ill-being displayed either a stable pattern with minimal variability or any negative decrements followed by a return to better levels in the days to follow. This finding is consistent with the results reported

by Smith et al. (2024), who applied a resilience framework using a daily diary design with seven Arctic expeditioners. Their participants showed similar trajectories of mental health. The finding that polar expeditioners display resilient mental health is not surprising, as they represent a highly trained and motivated population (Palinkas & Suedfeld, 2008, 2021). However, in contrast to Smith and colleagues (2024), the present study found that not all expeditioners were classified as displaying resilience.

In the present study, eleven out of the twelve participants were classified as displaying resilient functioning. One participant, however, displayed a much lower average level of well-being and a higher level of ill-being. Furthermore, their trajectory of ill-being showed an increasing pattern across the expedition. Notably, this participant also scored lowest on trait measures of personal resiliency, social support, and nature connectedness compared to the rest of the sample. These findings suggest that, at a trait level, this person was less likely to seek or derive support from either personal relationships or the natural environment. This point is further supported by their low scores on BPN and nature relatedness during the expedition. These findings underscore the relevance of pre-expedition trait assessments. Although such traits may account for only a small proportion of variance in resilience during the expedition compared to situational variables (Smith et al., 2021), when used alongside situational measures, they may collectively assist with identifying those at greater risk of serious issues.

The rise in ill-being across the expedition for this individual is relevant to identifying markers that could signal a heightened risk of serious harm to either the individual or other team members. Previous studies that have utilized prospective designs in both the Arctic and Antarctica have shown how participants who later required evacuation from the regions, displayed elevated scores on variables relating to ill-being (e.g., anxiety, depression) several months prior (Kim et al., 2023; Temp et al., 2020). Therefore, the use of regular monitoring

may provide better identification of those who may require further support, prior to a costly and dangerous evacuation. A second aspect relevant to better identification of expedition issues is the use of several markers of ill-being (e.g., Negative affect and Loneliness). Further examination of participant six showed that they scored the lowest on both negative affect and loneliness compared to the rest of the sample. However, loneliness showed a larger increase during the expedition. This finding aligns with Smith et al. (2021), who reported that increased loneliness is associated with multiple negative health outcomes in an Antarctic ski expedition. Loneliness, defined as a subjective feeling of social isolation leading to distress (Hawkley & Cacioppo, 2010), contrasts with NA, which is more associated with general difficulties in coping with challenging situations (Griewosz, 2023). Diener (2006) posited that loneliness, alongside NA, can be a key contributor to ill-being. Thus, elevated loneliness, as seen in participant six may be linked to issues with team cohesion and could identify members who require additional management support.

4.4.2 Role of BPN in polar expeditions

This study contributes novel empirical evidence as one of the first to use longitudinal data to measure the relationship between Basic Psychological Needs (BPN) and resilience in a polar expedition setting. Empirical research on BPN in polar environments remains limited, with most studies employing qualitative approaches (e.g., Devonport et al., 2022; Kay et al., 2022) or using BPN as a theoretical framework without direct measurement (e.g., Smith et al., 2021, 2023). However, the findings align with those of Goemaere and colleagues (2019) from their year-long analog space simulation which collected weekly measurements. Their results showed that on weeks when BPN satisfaction was positively associated with increased well-being and negatively to ill-being. The findings from both studies in this thesis build on these results, demonstrating that BPN predicts mental health at both the between- and within-participant levels in extreme environments, providing further evidence for the theory's

universality. The principle of universality suggests that basic psychological needs are applicable across all cultures and contexts (Vansteenkiste et al., 2020). Although the theory has substantial support across various environments, few studies have demonstrated its expected relationships in extreme environments (e.g., Goemaere et al., 2019a, 2019b).

The ability of BPN to predict dynamic changes in both well-being and ill-being, as the only significant predictor in this study, offers a mechanism for early detection of psychological challenges and a framework to promote resilience among all expeditioners. Recent polar studies have emphasized the risks associated with elevated levels of ill-being, which have been shown to be associated with future problematic behavior or incidents such as medical evacuation (e.g., Kim et al., 2023; Temp et al., 2020; Smith et al., 2022). Incidents such as this are both very costly and create additional risks for the personnel required to complete such evacuations. Therefore, focusing on ways in which basic need satisfaction may be maximised may prevent an escalation of issues. Consistent with the socioecological approach, the maximization of needs satisfaction may be achieved at multiple levels.

At the individual level, developing a greater understanding of basic psychological needs and aligning expedition coping strategies with activities that could increase satisfaction is one area. In recent years, several intervention studies have shown that developing a greater awareness of basic needs and identifying daily activities that fulfill one or more needs leads to better need satisfaction, increased well-being, and reduced stress (Behzadnia & FatahModares, 2020, 2023; Weinstein et al., 2016). For example, Weinstein and colleagues (2016) implemented an intervention with Syrian refugees that helped individuals identify small daily acts they could do to support their basic needs. These acts included helping someone else (Relatedness), finding a task in which they felt effective (Competence), and engaging in self-expression (Autonomy). The results showed that in a group encountering severe stress, the intervention decreased general stress and depressive symptoms by reducing

need frustration. This study highlights how such an approach can be effective in highly stressful environments and could be replicated during expeditions. Focusing on the individual themselves is important, when considering that interpersonal stress is a prevalent issue during polar expeditioners.

Basic needs can also be supported at the relational and contextual levels by creating a more needs-supportive environment. This can include ensuring that communications from management aren't perceived as controlling, but instead, support individuals to feel a sense of choice and to fully endorse the actions requested of them. In the study by Goemaere and colleagues (2019), on weeks when communications with Mission support were deemed autonomy-supportive it was associated with increased needs satisfaction and well-being. In contrast, when communications were perceived as controlling, they were negatively associated with need satisfaction and positively linked to ill-being. This positive finding is consistent with studies conducted in educational settings (Cheon et al., 2020) and when workplace leadership adopts such an approach (Slemp et al., 2018). At the contextual level, expedition management could offer individuals choice in which specific tasks to complete on a given day, or in how and when to perform those tasks (Goemaere et al., 2019). These findings coupled with the present results, highlight how basic needs may provide a framework for improving levels of expedition well-being, that is applicable to all and supported at all levels of the socioecological system.

4.4.3 Nature Relatedness

While the natural environment is widely acknowledged as a stressor, the present study is the first to empirically demonstrate that nature relatedness is a predictor of well-being, highlighting its positive influence during polar expeditions. This finding is consistent with the results of study 1, which showed that trait nature connection predicted well-being in a cross-

sectional study. To date, the role of the natural environment in terms of supporting well-being has been restricted to being mentioned in numerous qualitative interviews (e.g., Atlis et al., 2004; Leon et al., 1989, 2011; Kjaergaard et al., 2013; Kahn & Leon, 1994; Mocellin & Suedfeld, 1991). And in several mixed methods studies linking those reports to high scores on personality traits such as absorption or the values of universalism (Kjaergaard et al., 2013), but not empirically measuring the relationship. However, the findings are consistent with a growing literature which supports that having a stronger connection to nature has direct benefits for an individual's level of well-being which is supported by several meta-analyses (e.g., Capaldi et al., 2014; Pritchard et al., 2020). In terms of developing a greater level of connection, the amount of contact time and level of immersion are both acknowledged as significant predictors (e.g., Sheffield et al., 2022). This would fit with polar expeditioners where there is a high level of prolonged immersion to the environment. Additionally, the training and preparation for such endeavours likely to require similarly high levels of exposure to nature over a prolonged period prior to the actual expedition.

At the conceptual level, the importance of considering the independent contributions of both BPN and nature relatedness is consistent with recent models proposed to explain the well-being benefits of Adventure tourism. This is a field that has some overlap with polar expeditioners who may fit the criteria of an adventure tourist. The term is characterized by leisure pursuits which include physical activities which involve an interaction with the natural environment and that include risk elements (Houge-Mackenzie & Hodge, 2020). Houge-Mackenzie and colleagues (2023) recently proposed a conceptual model to explain how the positive benefits of adventure with both nature relatedness and BPN the key elements of the model. The model proposes that the type of activity, group dynamics and the motivational climate all support BPN satisfaction. Whilst, developing an affiliation to the destination itself, will result increased nature relatedness, with both contributing to within-adventure levels of

well-being. The authors at the time of writing, noted the model had not been tested, however, the results are consistent with the findings of the present study, with synergy in terms of the types of activities completed by most participants.

At a theoretical level, the results regarding nature relatedness add to the ongoing conversation within BPNT, as to what the specific status of nature is within the theory. While the role of nature has been acknowledged as an important aspect of well-being, the exact relationship still to be determined (Ryan & Deci, 2017). In recent years, there have been numerous calls for nature relatedness to be considered a basic psychological need (e.g., Baxter & Pelletier, 2018; Hurly & Walker, 2019). The authors propose that the construct fulfils all necessary criteria for candidate needs (for full list see: Baumeister & Leary, 1995). However, they also acknowledge that the evidence regarding the 'ill-effects if unsatisfied' criterion is less consistent (Baxter & Pelletier, 2018). The results from this study and study one, add further doubt to nature relatedness fulfilling the criteria as a full basic need. Specifically, whilst nature showed a significant relationship to well-being independently of BPN, it did not show any relationship to ill-being in either study, consistent with findings from numerous other studies (e.g., Mayer et al, 2009; Nisbet & Zelenski, 2011; Valtchanov & Ellard, 2010). Therefore, rather than nature relatedness/connectedness being a basic need, it may instead fit with being categorized as a 'wellness enhancer', similar to the role of beneficence (Martela & Ryan, 2020). They define wellness enhancers as "similar to basic needs in that their satisfaction should lead to well-being. But their frustration does not have to have unique effects on negative outcomes" (p. 130). This categorization fits with the results of our studies and would reconcile the inconsistency of findings in general literature. In the context of polar expeditioners, it is proposed that those who have developed a stronger sense of connection with the expedition destination may be more likely to derive positive support from it during the expedition. This is consistent with the fact that many polar expeditioners

invest considerable time and energy learning about their environments prior to departure, either through physical training or, for scientists, many years of studying the environment.

4.4.4 Coping Flexibility

The present results also develop our understanding of the role of coping strategies deployed during expeditions, particularly in terms of flexibility. Consistent with study 1, coping flexibility was positively associated with well-being. Numerous polar studies have highlighted how expeditioners use a large array of strategies during the expedition (e.g., Devonport et al., 2022; Smith et al., 2018). Scholars argue that, rather than relying on a single category of strategy (e.g., emotion- vs problem-focused), flexibly adapting strategies to the specific stressor and stage of the expedition is crucial (e.g., Leon et al., 2011; Kjaergaard et al., 2015; Smith et al., 2021).

While these findings support this proposition, there is a notable exception. Coping flexibility showed no significant relationships to ill-being in this study or study 1. Bonanno and colleagues (2023) suggest that, depending on the circumstances encountered, flexible switching, trauma-focus, or forward-focus may be preferable. In the present study, forward-focus had a strong negative association with ill-being and was used significantly more than trauma-focus. It may be, given the majority of participants were on short duration expeditions, focusing on the future was effective, knowing that they would finish soon. However, consistent with considering the specific context, this approach may differ for those conducting much longer expeditions. As Smith and colleagues (2018) note, it can be dangerous to avoid thinking about stressors in such a high-risk environment where issues can accumulate and cascade.

4.4.5 Limitations

The first limitation is that the sample size was very small, which is a common issue for research in extreme environments. Due to the intensive sampling design, it still resulted in 162 daily reports which justified the use of statistical analyses to produce inferential statistics. Furthermore, the study adopted idiographic analysis which allow for greater depth of understanding when working with smaller sample sizes. However, there is no claim made in terms of generalizing the results to other populations.

A second limitation relates to not being able to differentiate the effects of the three basic psychological needs for autonomy, competence, and relatedness independently due to the very high correlations between the three variables. This is not uncommon with many studies having reported high correlations, thus using an overall BPN measure (Ryan & Deci, 2017; Martela et al., 2023). Whilst it restricts drawing strong conclusions about the role of each basic need, it shows their collective importance at predicting mental health in an extreme environment.

A final limitation worth noting, is the lack of individual measurement of the relational level of a socioecological model. Due to restrictions in terms of the number of items it is feasible to measure during an expedition certain variables were omitted from the within-expedition measurements. Therefore, no details can be provided on the specific sources of relational support. However, relatedness can be seen to show very large correlations with both components of ill-being which is consistent with study 1 and supports the overall importance of support at this level.

4.4.6 Conclusions

In conclusion, this research has contributed to our understanding of resilience in polar environments in several ways. The results, aligned with a socioecological approach to resilience, demonstrate that resources at the individual, relational, and contextual levels all

play a significant role in supporting within-expedition mental health. The study also confirmed that, consistent with prior research, polar expeditioners generally display stable mental health, with relatively low variability. However, idiographic analysis revealed more variation in ill-being, with loneliness showing the most fluctuation, highlighting that team dynamics are often the primary source of expedition-related stress. As shown in our previous study, relatedness and coping flexibility were predictors of well-being, but basic psychological needs were the only predictor of ill-being. These findings underscore the universal role of basic psychological needs in promoting polar resilience. Additionally, while nature is frequently referred to by expeditioners as important, this study elevates its role to that of a key well-being enhancer. Future studies should continue to measure basic needs during expeditions, while also exploring the sources of support, whether personal, relational, or environmental that maximize their fulfilment.

Chapter 5: General Discussion

The overarching aim of this thesis was to investigate the role of basic psychological needs theory in explaining the resilience of polar expeditioners. Furthermore, in line with contemporary theories of resilience, the thesis aimed to apply a social-ecological perspective to resilience. This meant devising a model of social-ecological resilience tailored to polar expeditioners, considering the distinct contributions of individual, relational, and environmental factors, with BPNT proposed to have explanatory power across all levels.

Across two quantitative studies employing cross-sectional and longitudinal designs, results consistently demonstrated the significant role of BPNT in predicting resilience, operationalized as using measures of well-being and ill-being. In Chapter 2, Autonomy took the lead in mediating relationships to well-being, while relatedness consistently mediated relationships with ill-being, underscoring its critical role in mitigating negative outcomes. These findings provide robust evidence for the explanatory power of BPNT in understanding resilience in extreme environments.

5.2 Summary of findings

Chapter 2 presented cross-sectional data from polar expeditioners who had completed expeditions across both hemispheres. Using a social-ecological model of resilience which included predictor variables representing multiple levels (e.g., individual, micro, exo, and macro), the relationship to both well-being and ill-being was tested, with BPN proposed to mediate these relationships. The results showed that all three basic needs showed significant associations to either well-being (autonomy & relatedness) and/or ill-being (autonomy, relatedness, & competence). Furthermore, using the PROCESS mediation analysis showed that the basic need for autonomy mediated the relationship between personal resiliency, community support and connection to nature on levels of well-being. Finally, relatedness

fully mediated the relationship between friend support, community support, nature connection and ill-being. These results support the role of BPN in explaining the resilience of polar expeditioners and able to account for differences at a personal, social and environmental levels. This cross-sectional study indicated the existence of causal relationships between the satisfaction of BPN and resilience /well-being in polar environments that can be tested using appropriate longitudinal designs.

Chapter 3 aimed to provide greater depth and understanding to the specific challenges encountered by polar expeditioners with consideration of individual, relational, and environmental factors. Furthermore, to understand what supported them to meet these challenges and how they may be explained using basic psychological needs. Three themes represented the key challenges. Unsurprisingly, the physical risks from the physical environment and risks from wild animals in the Arctic (Polar bears) was mentioned by almost all participants. Support at the environmental level was provided by having suitable physical resources, such as shelter, food and equipment. At the relational level, the most consistent issue related to differences due to identity factors leading to issues and conflict. Support at the relational level showed that various sources of social support were employed. This included feeling part of an inclusive and supportive community; developing close relationships that allowed for open disclosure and seemed to mimic both family and intimate-type relationships that may be sought in non-extreme environments. Additionally, remote support from friends and family back home provided emotional encouragement and a sense of connection to life outside the expedition. Participants often cited this support to bolster their support during difficult periods, particularly when interpersonal tensions arose within the expedition team. At the individual level, participants reported worries and concerns about their own personal ability to meet the demands of the expedition physically and being perceived to be competent by their peers Participants reported that having direct experience

in similar environments, as well as training in analogous settings, helped them develop the skills needed to feel confident in their abilities and reduced concerns about meeting the expedition's demands. They also reported using the natural environment as a source of support. Finally, participants reported using aspects of mindfulness to assist with coping with both the physical and social demands.

Chapter 4 aimed to extend the results of study 1 by investigating the same variables using an intensive repeated measures design to show if BPN and the predictor variables of Coping flexibility and Nature relatedness could predict daily fluctuations in mental health (Well-being and Ill-being). The results showed that an aggregated BPN variable was the only predictor that was able to account for both well-being and ill-being in both short and long duration expeditioners. Nature relatedness and coping flexibility were also significant predictors of well-being. Furthermore, using idiographic methods the study reported that eleven out of twelve participants could be classified as displaying resilient functioning. Pre-expedition measures of personal resiliency, and social support showed that the individual who showed resilience challenges was the lowest scoring on all these pre-expedition measures. Due to the small sample size the moderating effect of trait variables was not tested. However, this finding underscores the importance of further exploring the role of pre-expedition traits in larger samples. Overall, these two quantitative studies provide firm support for the positive role of BPN in supporting polar expeditioners' resilience.

5.3 Theoretical Perspective

5.3.1 BPNT as a theory of Polar Resilience

The main aim of this thesis was to examine BPNT as a theoretical framework for understanding the resilience of polar expeditioners. Consistent with contemporary resilience research, this thesis conceptualizes resilience using a socio-ecological perspective. This

perspective views resilience as a dynamic process shaped by interactions between individuals and multiple environmental levels (Ungar, 2011) In this thesis, resilience was assessed using mental health indicators, with well-being and ill-being conceptualized as independent constructs. This is consistent with the literature which shows that both uniquely effect a person's functioning and can have different biological and psychological antecedents (e.g., Headey et al., 1984, 1985; Ryff et al., 2006). Therefore, to address the research question, it was necessary to investigate whether the three basic needs of autonomy, competence, and relatedness could account for both positive and negative aspects of well-being while explaining variance across different levels of the environment (e.g., person, relations, and environment). According to BPNT, autonomy, competence, and relatedness are fundamental psychological needs essential for promoting resilience and mental health universally (Vansteenkiste & Ryan, 2013; Vansteenkiste et al., 2020). The findings from both cross-sectional and longitudinal designs (Chapters 2 & 4) supported this proposition, demonstrating significant associations between total needs satisfaction, the individual needs of autonomy, competence, and relatedness, and both well-being and ill-being. Compared to other variables examined in this thesis (e.g., coping flexibility, social support), BPNT emerged as the only framework capable of explaining variance in both positive (well-being) and negative (ill-being) outcomes. While BPN accounted for a significant proportion of the variance in resilience outcomes across studies, a notable portion of variance remains unexplained, reflecting the complex and multi-faceted nature of resilience. Nonetheless, the explanatory power of BPNT is substantial and warrants further investigation in both empirical research and applied settings.

The results from the present thesis are consistent with the only other studies which have investigated basic needs in an extreme environment. To date, whilst numerous scholars have proposed BPNT as an important theory for understanding well-being in extreme

environments (e.g., Goemaere et al., 2016; Smith et al., 2021, 2023; Houge-Mackenzie & Hodge, 2020), no studies have measured BPN during polar expeditions. Goemaere and colleagues (2019a, b) are the only researchers to have measured the relationship between basic needs and mental health outcomes in an extreme environment, during a one-year analog space mission. Their findings demonstrated that all three basic needs were associated with well-being or ill-being outcomes, with autonomy and relatedness emerging as the strongest predictors of happiness and stress reduction. Competence did not show significant relationships to either variable, although it did predict motivation and oppositional defiance. The findings of Goemaere et al. (2019) align closely with the present thesis, where autonomy and relatedness consistently emerged as the strongest predictors of mental health outcomes. The present work extends these findings by demonstrating the role of autonomy and relatedness across both cross-sectional and longitudinal designs, specifically in polar expedition contexts. Goemaere et al. (2019) also highlighted the importance of relatedness to fellow crew as a strong predictor of mental health outcomes, while relatedness to home showed weaker associations. Similarly, the results of Study 1 in this thesis found that community support, representing accessible and proximal relationships, was the strongest source of social support, further emphasizing the role of environment-specific relational dynamics.

The findings of this thesis can also be situated within the broader context of resilience studies and the larger body of research on stress and coping frameworks, highlighting both consistency with previous literature and the unique explanatory potential of BPNT. One area of alignment between the results of this thesis and prior research is the observed profiles of mental health, specifically levels of well-being and ill-being. The results from both quantitative studies in this thesis consistently demonstrated that well-being scores were significantly higher than ill-being scores, a pattern also observed in numerous previous

studies employing diary designs (e.g., Blackadder-Weinstein et al., 2019; Leon et al., 1991; Kahn & Leon, 1994; Atlis et al., 2004; Kjaergaard et al., 2015; Smith et al., 2021, 2024). Within the expedition context it has been acknowledged that whilst negative affect is generally low, increases in this variable may be related to more serious adaptation issues (e.g., Smith et al., 2024). This further underscores the unique explanatory potential of BPNT, as it consistently predicted changes in ill-being across both quantitative studies. Specifically, the findings in Chapter 2 demonstrated that relatedness had a particularly strong association with ill-being, emphasizing the critical role of interpersonal relationships in mitigating negative outcomes associated with stressors in the polar environment. These results highlight the importance of group cohesion and supportive social environments in maintaining low levels of ill-being during polar expeditions, further validating BPNT's framework in this context.

5.3.1.1 Advancement of BPNT

5.3.1.2 BPNT & Resilience – Universally.

The satisfaction of basic psychological needs (BPN) has been proposed as a critical mechanism that supports resilient functioning in the present and builds resources for future resilience. This thesis provides strong evidence for this proposition, demonstrating that satisfying autonomy and relatedness is central to promoting mental health and adaptive functioning in polar expeditioners. Consistent with the claims made by Vansteenkiste and Ryan (2013), need satisfaction supports resilience in the present moment and fostering resources for future resilience. Firstly, contemporary resilience research is clear in their agreement that resilience is supported by resources of both the individual and the environment. Across all three studies in the present thesis, the satisfaction of BPN was positively associated with well-being and negatively associated with ill-being, demonstrating consistent predictive ability for resilient outcomes.

To date, very few studies have examined the relationship between BPN and resilient outcomes (e.g., well-being) at multiple levels. Notably, studies by Abualkibash & Lera (2017) and Lera & Abualkibash (2022) explored resilience within a socioecological framework, assessing resilience at the individual, caregiving, and contextual levels. However, they used the CYRM scale (Jefferies et al., 2019) as an outcome variable, which denotes the relationship between BPN and likelihood of resilient outcomes, rather than measuring them directly In Chapter 2, using a scale derived from the CYRM, we instead used the scale to predict well-being and ill-being. The results showed that a measure of socioecological resilience explained both positive and negative attributes of well-being, with autonomy and relatedness mediating this relationship.

Few studies have examined the relationship between BPN and resilience across time, which is considered crucial for understanding process resilience (e.g., Bonanno, 2021). Liu and Huang (2021) investigated this relationship but used a highly context-specific measure of resilience based on mathematics ability. While their findings may offer valuable insights into educational settings, they are unlikely to generalize to extreme environments, such as those faced by polar expeditioners. This highlights the need for research addressing resilience in contexts where individuals must adapt to complex, multi-level stressors over extended periods.

The depth of knowledge on the relationship between BPN and resilience has also been expanded through qualitative investigations, which highlighted how different types of support operate within polar environments. This thesis extends existing literature by offering novel insights into the ways BPN are satisfied in these extreme settings. Specifically, it demonstrates that relatedness plays a critical role in mitigating ill-being by fostering supportive interpersonal dynamics within expedition teams and deriving a relatedness to the natural environment, while autonomy enhances well-being through personal resources,

relationships and then natural environment. These findings underscore the importance of integrating both quantitative and qualitative methods to capture the nuanced interplay between individual, relational, and environmental factors in extreme environments.

5.4 Results by Socioecological Level

5.4.1 Individual Level

5.4.1.1 Coping Flexibility.

The present studies consistently showed positive associations between coping flexibility and well-being in both quantitative studies (Chapters 2 & 4). These findings align with theoretical frameworks on resilience and coping (e.g., Bonanno & Burton, 2013) and reflect polar research emphasizing the importance of adapting strategies to dynamic expeditionary stressors (e.g., Devonport et al., 2011, 2022; Leon et al., 1989, 2002, 2011; Smith et al., 2021; Kjaergaard et al., 2015). Prior polar studies have largely inferred coping flexibility through indirect measures, such as the range of strategies reported or changes in strategy preferences over time. For example, Kjaergaard et al. (2015) demonstrated the utility of flexible coping across different stages of an expedition but relied on retrospective self-reports to evaluate adaptability. Similarly, Smith et al. (2021) highlighted the role of diverse coping repertoires in mitigating stress but did not utilize tools specifically designed to measure coping flexibility. By employing the PACT scale (Bonanno et al., 2011), the present research offers a more precise and reliable assessment of coping flexibility, advancing methodological rigor. These findings underscore the importance of flexibility as a resilience factor and provide a stronger foundation for future research and application in polar and other extreme environments.

5.4.1.1.1 Link to BPN

While coping flexibility demonstrated a significant main effect on well-being in both studies (Chapters 2 and 4), its influence was partially mediated through the fulfilment of the basic need for autonomy (Chapter 2). Autonomy, defined as the experience of volition and self-determination, supports adaptive coping by enabling individuals to appraise stressors as challenges rather than threats, aligning their responses with personal values and goals (Vansteenkiste & Ryan, 2013; Skinner & Edge, 2002). This dynamic was evident in the present findings, where expeditioners who employed diverse coping strategies reported greater perceptions of autonomy, allowing them to feel in control of their environment despite its challenges. These results align with Devonport et al. (2022), who identified autonomy-supportive coping strategies, such as problem-solving and planning, as central to managing stress in polar contexts. By fulfilling autonomy, coping efforts are not only more effective but also enhance well-being, underscoring the value of integrating BPN into resilience frameworks for high-stress environments.

5.4.2 Relational Level

5.4.2.1 Social Support

Social support is widely recognized as a critical resilience factor in non-extreme environments; however, its role in polar expeditions has produced mixed findings. While the present studies identified clear positive associations between social support and mental health positively influencing well-being and reducing ill-being (Chapters 2 & 4) prior polar studies have reported associations with increased negative affect, stress, and interpersonal conflict (e.g., Leon et al., 1991; Palinkas et al., 2004; Smith et al., 2021). These discrepancies may partly stem from methodological differences. Whereas prior studies predominantly assessed actual or requested support, the present research measured perceived social support, which has consistently demonstrated stronger and more stable positive associations with well-being

(Haber et al., 2007; Prati & Pietrantoni, 2010). This distinction is crucial, as perceived support reflects confidence in the availability of supportive resources, rather than reactive responses to stress.

The findings also underscore the dynamic nature of social support, aligning with contemporary theory that its effectiveness depends on the source, type, and context of the support provided (Thoits, 2011, 2021). Family support, for example, showed a positive relationship with well-being but no effect on ill-being, while friend support negatively predicted ill-being without influencing well-being. Community support emerged as the most impactful, positively predicting well-being and reducing ill-being. This aligns with studies emphasizing the unique significance of proximal support sources during expeditions, where access to distant family and friends is often limited (Palinkas et al., 2004). Community members, as 'similar others,' not only provide emotional and instrumental support but also foster relatedness through shared experiences, a key element of resilience and need satisfaction (Thoits, 2021).

The need for adaptation in social support structures during polar expeditions is evident. Restricted access to typical support sources requires individuals to form surrogate relationships within the expedition community. These relationships, while fulfilling vital emotional and informational support needs, are not without challenges. Expeditioners reported that the rapid formation of close bonds could lead to relational strains, particularly when expectations of emotional closeness were misaligned. This supports prior findings that close interpersonal relationships require both time and autonomy to develop effectively (Deci & Ryan, 2017; Baumeister & Leary, 1995). Furthermore, qualitative results (Chapter 4) highlighted the dual role of social support and interpersonal conflict in shaping relatedness satisfaction, suggesting that future models of expedition resilience should account for both positive and negative interpersonal dynamics.

By integrating a BPNT framework, the present studies provide a nuanced understanding of how social support influences resilience. Satisfying the need for relatedness through supportive relationships appears critical for reducing ill-being, while autonomy likely moderates how effectively these relationships are maintained. These findings reinforce the importance of fostering autonomy-supportive environments, where mutual respect and reciprocity underpin effective social support systems.

5.4.3 Environmental/Contextual Level

5.4.3.1 Nature Connectedness & Polar Studies

Across all studies in this thesis, consistent results highlighted the positive relationship between nature connectedness and well-being, emphasizing the crucial role of the environment in supporting expedition resilience. Findings from cross-sectional, longitudinal, and qualitative interview studies (Chapters 2, 3, and 4) confirmed that greater nature connection was associated with increased well-being. While prior polar research has acknowledged the positive psychological effects of the natural environment (e.g., Mocellin & Suedfeld, 1991; Atlis et al., 2004; Devonport et al., 2022; Smith et al., 2017, 2021), this thesis is the first to quantitatively measure and demonstrate the direct impact of nature connection in this population. These results align with the broader proposition that natural environments convey salutogenic benefits (e.g., Palinkas & Suedfeld, 2021).

To date, there have been numerous studies which have reported expeditioners gaining positive benefits from the polar environment, such as experiencing as sense of enjoyment or awe states (e.g., Mocellin & Suedfeld, 1991; Atlis et al., 2004; Devonport et al., 2022; Smith et al., 2017, 2021; Van Puyvelde et al., 2022); the environment providing a source of motivation (e.g., Lovoll & Staether, 2022; Van Puyvelde, 2022); and the positive aspects of developing place attachment or nature connection (Lovoll & Staether, 2022; Devonport et al., 2022). However, none of these studies used quantitative methods to investigate this

relationship. Therefore, these studies represent the first to confirm the important role of the perception of the individual of the expedition environment itself. To deepen our understanding of this relationship, the following section explores key antecedents of nature connectedness, with a focus on the role of awe which was reported during interviews conducted.

5.4.3.1.1 Antecedents of Nature connection

In the broader literature on nature connectedness, a key unresolved question is what mechanisms lead to increased connection, with various factors proposed as important, several of which align with the interview findings discussed in Chapter 3. Among these, participants in the interview study emphasized the ability of the natural environment to elicit feelings of awe, describing these as a key source of well-being support. These experiences may contribute to a greater sense of nature connection by fostering a deep emotional engagement with the natural environment, as participants described moments of wonder at the vastness that heightened their appreciation for the polar landscape. This connection, in turn, supports autonomy and improves well-being (Chapters 2 and 4). In previous studies, expeditioners have reported enjoying the environment as part of their coping repertoire, describing moments of appreciation for the natural beauty and serenity it offers (e.g., Smith et al., 2017, 2021; Devonport et al., 2022; Kjaergaard et al., 2015; Van Puyvelde et al., 2022). However, other reports highlight more profound, transcendental experiences fitting with the concept of awe. These awe-inspired moments, characterized by a sense of vastness and a shift in worldview, have been observed in polar studies (e.g., Atlis et al., 2004; Lovell & Staether, 2022; Mocellin & Suedfeld, 1991) and analogous extreme environments like spaceflight (e.g., Yaden et al., 2016). Awe is an emotion that arises from perceiving vastness, often challenging and transforming an individual's worldview (Keltner & Haidt, 2003). This transformative experience fosters a heightened sense of connectedness to the environment

and others, making it particularly relevant to polar expeditioners navigating expansive and isolated natural settings. The proposition that awe enhances nature connectedness aligns with findings by Liu et al. (2023), who demonstrated in experimental studies that awe indirectly supports well-being through its positive effect on nature connectedness. These findings reinforce the importance of awe in fostering resilience, particularly in polar expeditions where vast and awe-inspiring environments are a central feature.

5.4.3.2 Nature & BPNT.

The findings from Chapter 2 highlight autonomy as a key mechanism linking nature connectedness to well-being, reinforcing its central importance in isolated and confined environments such as the polar regions. To date, no studies have investigated this relationship in either polar regions or ICE environments. However, numerous studies in broader contexts have reported how the fulfillment of the need for autonomy mediates the relationship between nature and well-being (e.g., Crockett et al., 2020; Landon et al., 2020; Vijaikis & Poskus, 2024; Weinstein et al., 2009; Yang et al., 2022). These findings provide a framework to interpret how the remote and isolated environment of polar expeditions might uniquely facilitate autonomy.

In the context of polar expeditions, the remote and isolated environment may foster autonomy by providing a break from daily life stressors, as suggested by the broader literature on nature and well-being (e.g., Weinstein et al., 2009; Stein & Lee, 1995). This removal of external pressures allows individuals to fully engage with their environment and focus on tasks aligned with their personal values and interests. This explanation is particularly relevant for shorter-duration expeditions, where the temporary removal from daily hassles enhances autonomy. In contrast, for long-term expeditions such as Antarctic over-winterers, the expedition environment itself may become a new home, creating its own set of daily stressors.

Additionally, the natural environment's capacity to capture and hold attention (e.g., Weinstein et al., 2009) may further enhance autonomy by fostering a present-focused awareness. This aligns with the concept of mindfulness, which emerged as a key theme in Chapter 4 and has been proposed as a critical psychological resource for polar expeditioners in recent studies (e.g., Pagnini et al., 2019). The experience of mindfulness allows expeditioners to remain grounded and engaged with their immediate surroundings, supporting resilience in high-stress environments.

Finally, for the satisfaction of autonomy to be fully realized, individuals are unlikely to experience heightened fear or worry (e.g., Baumeister & Leary, 1995). This highlights the critical importance of adequate resources to safely operate in polar conditions, beyond psychological resources alone. Equipment, training, and support services—discussed in Chapter 3—are essential for expeditioners to feel a sense of control and volition in their environment. This perspective underscores the socio-ecological basis of resilience, where autonomy is supported not just by the environment but also by the systems and resources that facilitate safe and effective functioning.

5.4.3.2.1 Nature – A key role in BPNT

The consistent findings regarding the role of nature for supporting well-being contribute to the on-going conversation on how nature should be classified within the BPNT. In recent years several scholars have published reviews of the literature on nature connection to propose the case that it should be classified as a full basic psychological need alongside the existing three (e.g., Baxter & Pelletier, 2018; Hurly & Walker, 2019). BPNT scholars have been consistent in their view that there may be other basic needs, however they must meet key assumptions (e.g., Psychological, Essential, Inherent, Distinct, Universal; Vansteenkiste et al., 2020). Both reviews reported proposed there was sufficient evidence that nature met all the necessary criteria. However, it was noted that the support for the criteria was smaller and

showing more variability. This finding aligns with the present thesis, where nature connection consistently predicted well-being but showed no significant relationship with ill-being. These results, while underscoring nature's critical role in promoting well-being, do not support its classification as a full basic psychological need. Instead, they align with the concept of a "well-being enhancer," introduced by Martela and Ryan (2020).

Martela and Ryan (2020) proposed the category of well-being enhancers for constructs that consistently support well-being but do not meet all the criteria for basic need status. Their investigations into beneficence—a sense of contributing to others—found that while it reliably predicted positive outcomes, it lacked a robust relationship with ill-being or its reduction. Similarly, the present findings suggest that nature connection meets many of the criteria for a basic need but falls short of being essential in the strict BPNT sense. Recognizing nature as a well-being enhancer is nonetheless important. This perspective highlights the practical significance of fostering strong connections to the natural environment, particularly for polar expeditioners operating in extreme conditions. Expeditioners who feel a deeper connection to their environment may derive greater psychological support, enhancing their resilience and potentially buffering against the negative consequences of operating in hostile environments.

5.5 Applied Implications

5.5.1 Fostering Needs-Supportive Environments

The findings across all empirical chapters of this thesis consistently demonstrate the critical role of BPN satisfaction in supporting resilience and well-being during polar expeditions. Specifically, autonomy and relatedness emerged as the strongest predictors of well-being and ill-being, respectively, highlighting their universal relevance across individual, relational, and contextual levels. Building on these results and the socioecological framework, it is proposed that needs-supportive environments can be actively fostered at multiple levels: by individuals, within teams, and through organizational leadership. These findings underscore the notion that fostering needs-supportive environments is not merely beneficial but essential for enhancing resilience and well-being. The following discussion explores specific strategies to achieve this goal, grounded in both the present findings and existing literature.

5.5.1.1.1 Individual level.

At the individual level, resilience can be understood through the lens of Ungar's (2008) definition, which emphasizes the capacity of individuals to navigate and negotiate for resources that sustain well-being, encompassing psychological, social, cultural, and physical elements (p. 225). In line with the findings of the present thesis, the fulfilment of BPN represents a critical resource that supports resilience and well-being during polar expeditions. The results suggest that individuals who can draw support from within themselves, their relationships, and the wider environment are more likely to experience increased well-being and reduced ill-being during expeditions.

One approach to operationalising these theoretical insights into meaningful actions is cultivating self-awareness of need preferences. Practices such as mindfulness have been shown to increase present-moment awareness and self-regulation, allowing individuals to

better identify their needs and seek appropriate resources (Brown & Ryan, 2003; Deci & Ryan, 2000; Ryan et al., 2007). For example, mindfulness interventions have been associated with improved well-being and reduced stress in extreme environments (Pagnini et al., 2019). Mindfulness also supports coping flexibility, enabling individuals to adjust their strategies to suit the demands of their situation.

Coping flexibility emerged as a significant predictor of well-being across the studies in this thesis. This ability allows individuals to dynamically shift between strategies, depending on the context. Bonanno and Burton (2013) proposed that coping flexibility involves sensitivity to situational demands and the ability to employ strategies that maintain BPN satisfaction. Expeditioners can benefit from developing this skill to manage challenges more effectively and sustain psychological well-being.

The natural environment was a key resource in supporting autonomy and well-being, as highlighted in this thesis. Results from chapter 3, indicated that expeditioners used strategies that relied on intentional engagement with the natural world (e.g. such as appreciating its beauty or reframing its challenges), which are likely to foster a deeper sense of connection and need fulfilment. This aligns with findings from studies by Weinstein et al. (2009), which demonstrated that nature exposure facilitates autonomy and enhances well-being by reducing external pressures and promoting intrinsic motivation.

Evidence from intervention studies (e.g., Behzadnia & Fatah-Modares, 2020; Sheldon et al., 2021; Weinstein et al., 2019) supports the notion that individuals can enhance their ability to satisfy their own BPN. Training programs aimed at increasing awareness of need satisfaction and encouraging individuals to identify activities that promote autonomy and competence have shown promising results. For expeditioners, incorporating pre-expedition workshops on need satisfaction and resource navigation could provide practical tools for enhancing resilience.

5.5.1.1.2 Relational level.

Relationships within polar expeditions are a critical factor for resilience, serving both as a significant source of stress and a foundation for support. Findings from the present thesis demonstrated that the fulfilment of relatedness was the strongest predictor of ill-being, while strong social support also enhanced feelings of autonomy. The impact of isolation and confinement can cause even the smallest of issues between individuals to cascade into serious issues over time (e.g., Van Puyvelde et al., 2023). Furthermore, and consistent with the present thesis, differences on key demographics can cause difficulties and result in clique structures forming that can be detrimental to both the individuals and the overall expedition (e.g., Palinkas et al., 1995).

To address these challenges, prior to departure teams, can collectively consider their own needs preferences and those of their colleagues. Devonport et al. (2022) proposed that a lack of understanding between expeditioners in terms of their need's preferences led to increased stress that could have been resolved if they had a greater understanding of each other. This fits with developing an autonomy-supportive environment which has strong and growing evidence base, including recent studies in ICE environment (e.g., Slemp et al., 2018; Goemaere et al., 2019). This includes offering opportunities for people to share their opinions and providing clear rationale for decisions, especially ones that may have a short-term detrimental effect on the individual (Ryan & Deci, 2017). Finally, drawing on the role of awareness and mindfulness, expeditioners can practice developing skills to reduce instant responses whilst under pressure that may exacerbate issues for all parties (e.g., Pagnini et al., 2019).

5.5.1.1.3 Organisational.

At the organisational level, fostering need-supportive environments has consistently been linked to positive outcomes such as enhanced well-being, job satisfaction, and prosocial

behavior (Gagne, 2003; Slemp et al., 2018). Developing a need-supportive environment involves offering choices, where feasible, about how and when tasks are completed, thereby demonstrating respect for the individual's perspective and expertise. When offering choices is not possible, managers should provide a clear and thoughtful rationale to help team members understand the reasoning behind decisions. Additionally, when decisions may lead to negative responses, it is important for managers to acknowledge and validate these feelings leading to increased trust (Slemp et al., 2018). Organisational leaders who adopt need-supportive practices foster greater need satisfaction, improved well-being, and productive team behaviours, as demonstrated in a meta-analysis by Slemp et al. (2018). Evidence from ICE environments further supports this proposition. Goemaere et al. (2019) found that autonomy-supportive communication by ground crews enhanced compliance with task requests, reduced behavioural issues, and improved satisfaction of basic psychological needs. In polar expeditions, particularly within Antarctic national programmes, advancements in communication technology now allow central offices to maintain connectivity with remote locations at levels comparable to standard workplaces (British Antarctic Survey, 2024). This increased connectivity facilitates more frequent meetings and provides greater opportunities for leaders to influence on-site staff. Therefore, equipping leaders with the necessary tools to supervise remotely and foster need-supportive communication is essential for maintaining positive outcomes. In contrast, environments perceived as controlling are strongly associated with the thwarting of autonomy, which undermines an individual's sense of volition and can lead to adverse outcomes (Deci & Ryan, 2017). This, in turn, contributes to adverse outcomes for both individuals and organizations, including increased stress, burnout, and oppositional defiance to task requests. As highlighted in Chapter 4 of this thesis and corroborated by existing research (e.g., Nash & Nielsen, 2020), individuals from minority groups are particularly vulnerable to the negative consequences of controlling environments, such as

reduced autonomy and increased relational conflict, underscoring the need for targeted interventions to promote equity and inclusivity.

5.5.2 EDI Issues

Another area where this thesis offers new insights is the challenges faced by minority groups in polar workplaces and the potential for advancing equality, diversity, and inclusion (EDI). The interviews discussed in Chapter 2 revealed challenges faced by individuals related to their gender, sexuality, age, occupation, and class. These findings align with reports from Antarctic research stations highlighting similar identity-related issues (e.g., Palinkas et al., 1995; Nash et al., 2019; Nash & Nielsen, 2020; National Science Foundation, 2022). Such challenges can undermine equality and inclusivity, further supporting the need for systematic change.

Applying a BPNT perspective, an individual's multifaceted identity both influences and is influenced by their preferences for need satisfaction. Key aspects of identity are intrinsically tied to behavioral preferences for need satisfaction (Deci & Ryan, 2017). When individuals are placed in controlling environments that compel them to suppress or conceal aspects of their identity, it is likely to thwart their basic psychological needs (Luyckx et al., 2009). This thwarting has been associated with negative outcomes, such as increased stress, substance misuse, and potential psychopathology (Deci & Ryan, 2017). To address these challenges and better support all expeditioners, particularly those from minority groups, several targeted recommendations can be made.

Firstly, organisations can support the development of needs-supportive environments through training and development programs that enhance understanding of basic psychological needs. These programs should address how need preferences may vary across diverse identities and the importance of creating inclusive practices. During pre-deployment training, teams can identify and discuss both individual preferences and collective strategies

to ensure that need satisfaction is facilitated for all team members, not just the majority. For example, such discussions could be institutionalized as part of team norms or station rules, as implemented in British Antarctic stations (The British Antarctic Survey, 2022).

Secondly, organisations should acknowledge that individuals with minority group characteristics may face additional challenges in finding interpersonal support compared to those who align more closely with the majority. Results from Chapters 2 and 3 highlighted how expeditioners draw support from diverse sources to fulfil their need for relatedness, which was shown to be critical in reducing ill-being. Based on these findings and consistent with both social support theories and BPNT, it is recommended that organisations help expeditioners identify their relatedness preferences during pre-expedition training. Additionally, peer mentoring programs could be implemented to connect new staff with individuals who can offer mutually supportive relationships tailored to their needs.

Finally, mindfulness training, grounded in BPNT principles, could be used to help expeditioners develop greater self-awareness and emotional regulation. By fostering mindfulness, expeditioners can better manage conflict and reduce automatic, reactive behaviors that may escalate tensions. This approach encourages responses that align with need-supportive behaviors, promoting need satisfaction rather than exacerbating need thwarting (Ryan & Deci, 2017).

5.6 Limitations and future research

5.6.1 Integrating a Socioecological Framework

The testing of a socioecological model presented key challenges, particularly when aiming to incorporate variables across multiple environmental levels. In Study 1, the use of Bronfenbrenner's ecological systems framework required the inclusion of a large set of variables, which placed additional demands on the sample size and statistical techniques

available. While this approach provided valuable insights, it became evident that a more streamlined framework was necessary for subsequent studies. Therefore, Studies 2 and 3 adopted Ungar's (2011) socioecological resilience model, which emphasizes fewer levels and thus better suited to the smaller sample sizes. Furthermore, I believed that the change in terminology to the latter model, was best suited for wider understanding at an applied level.

A second limitation across both quantitative studies was the small sample size, a challenge commonly encountered in research with polar expeditioners and ICE environment populations. In Chapter 2 the sample size restricted the use of advanced statistical techniques, such as structural equation modelling, which could have further elucidated the relationships between variables. Similarly, in Chapter 4 I again faced constraints which led to the decision to use a total basic need satisfaction variable in the analysis and prohibited any further investigation into moderation or mediational relationships. However, this was partially mitigated by the collection of 162 daily reports and the use of idiographic methods, which provided depth and insights despite the small sample. This depth and insight are particularly valuable given the scarcity of previous studies in this area. Furthermore, the small sample sizes across studies inherently limit the generalizability of findings to wider populations. This limitation is common in research conducted in extreme environments, where participant availability is restricted. However, it is important to note that the primary aim of this thesis was not to generalize findings beyond the context of polar expeditions. Instead, the research sought to provide a nuanced understanding of resilience within this specific population, where findings can inform both theoretical and applied advancements. Future studies could address this limitation by collaborating with larger expedition organizations to facilitate access to more participants and the use of multi expedition designs, enhancing both sample size and statistical power.

A third limitation across all three studies is the challenge of establishing causality. While Study 3 employed an intensive repeated measures design, which strengthens the ability to assess within-person changes over time, the relationships remain correlational. Experimental or intervention-based designs would be required to draw definitive causal conclusions.. The mixed-methods approach adopted in this thesis offers compensatory strengths by providing both breadth and depth to the findings. Future research could benefit from collaborations with larger polar organizations to increase sample sizes, allowing for greater generalizability and more robust causal testing. This may include quasi-experimental designs across locations which have successfully been completed in previous polar work in partnership with national Antarctic programmes.

5.7 Personal Reflections

During my time as a PhD student, my learning and development of research understanding has been supported through completing several cold-weather expeditions of my own in Norway (Hardangervidda, Svalbard) and completing a placement with BAS. These activities allowed me to develop a greater knowledge of the realities of conducting research with this specific population or series of populations, polar expeditioners are in themselves a remarkably diverse group of people. In this section, I will talk about my personal reflections and lessons learned to improve research in these environments.

It was noted early on when attending events with polar expeditioners that one of the first questions when asked about doing polar research was, “Have you been south or to the high north?” In my first year of study, when the answer was no, I often noticed a disengagement with many of the people I spoke with. It became clear that in the polar community, credibility is closely tied to lived experience in the field. Without firsthand expedition experience, I was often perceived as an outsider, someone who might lack the practical understanding necessary to engage meaningfully with their realities. Compounding

this challenge, the first year of my PhD coincided with the COVID-19 pandemic, during which lockdowns and travel restrictions severely limited opportunities to gain field experience or interact with the community beyond online seminars and virtual meetings. These circumstances delayed the development of experiential knowledge that is often considered foundational within the polar community. However, they also prompted critical reflection on the role of experiential knowledge in research credibility and positionality. Over time, conducting my own expeditions not only improved my ability to build rapport with participants but also deepened my appreciation of the psychological and environmental demands they faced, enriching both the data collection process and the interpretation of participants' narratives.

Another reflection was on the scale and scope of my research aim. Working with a niche population creates immediate challenges in terms of the ability to recruit and potentially retain participants across periods of time. This project was conducted independently, in terms of not having any partners or collaborators who could assist with recruiting suitable sample sizes for the research questions being asked. My placement with BAS allowed me to discuss what was feasible for their personnel and what had worked or hadn't worked with other social science research they had been involved with. An important note, that the topic had to have potentially applied value to the organisation for the support of their own personnel. These conversations led to the considering simple models of resilience than the one in which my first study was conducted. To ensure it not only had empirical merit, but additionally, could be translatable for staff working in the field and the possible development of training and support for expeditioners.

Throughout the course of my PhD, I reflected deeply on my own experiences completing arduous expeditions and endurance events. Over time, I began to recognise that much of what I had previously attributed to internal psychological resources was, in fact,

heavily dependent on external physical and social supports. This realisation challenged the dominant narrative of resilience as an individual accomplishment. I came to believe that success in extreme environments, including my own experiences, was not solely the product of personal strength, but the result of accessing a wide array of resources and supports. Through the process of writing and critical reflection, it became increasingly important to me to integrate this broader understanding into the resilience model proposed in this thesis, in an effort to offer a more socio-ecological view of resilience. Additionally, reading about the experiences of marginalised groups, such as Indigenous Arctic communities and minorities working in Antarctic research, prompted me to reflect on my own background growing up in a single parent family affected by domestic abuse. These reflections reinforced for me that while adversity can sometimes foster psychological strength, it often leaves significant distress or trauma in its wake, which are not resilience enhancing. My positionality, shaped by these experiences, sensitised me to the complex realities faced by many expeditioners and motivated me to ensure that their narratives were represented in ways that moved beyond simplistic or individualistic interpretations of resilience.

5.8 Conclusions

This thesis investigated whether BPNT provides a suitable framework for understanding the resilience of polar expeditioners' mental health. Resilience was conceptualized as a dynamic process shaped by interactions between individuals and their environments. The thesis also examined how different levels of the environment (individual, relational, and contextual) contribute to resilience outcomes, consistent with a socioecological model of resilience. Using a mixed-methods approach, it was demonstrated that BPNT plays a significant role in explaining both the well-being and ill-being of polar expeditioners. The theory also accounted for significant variance in mental health outcomes across different levels of the socio-ecological environment, emphasizing its applicability to understanding resilience as

conceptualised by modern research. Maintaining a sense of autonomy during ICE exposure emerged as a key factor in preserving well-being, while relational support was the most significant contributor to minimizing ill-being. This aligns with the understanding that well-being and ill-being are influenced by distinct antecedents, highlighting the importance of addressing these factors separately. The thesis demonstrates that resilience is supported by the ability to draw on internal psychological resources as well as external support from social and natural environments. This aligns with Ungar's (2011) concept of resilience, which emphasizes an individual's ability to navigate toward and negotiate for psychological, social, cultural, and physical resources that sustain well-being, especially in the face of adversity. The results underscore the importance of implementing needs-supportive practices at both individual and organizational levels, as these approaches have the potential to enhance resilience by fostering autonomy, competence, and relatedness, thereby improving well-being and reducing ill-being among future polar expeditioners.

The results of these studies align with recent reports highlighting the challenges faced by minority groups, particularly females, in Antarctic bases. The findings suggest that these challenges often lead to thwarted need satisfaction, particularly autonomy and relatedness, emphasizing the necessity for targeted interventions to create more inclusive and supportive environments. Further examination of basic psychological needs is proposed as highly relevant to ongoing EDI conversations in polar science, particularly in understanding how diverse identities and experiences influence need satisfaction and resilience in extreme environments. While the studies provide valuable insights, the limited sample size restricts generalizability. However, the findings offer strong support for future research exploring BPNT in polar expedition populations. This thesis integrates both theoretical and practical implications, highlighting the value of BPNT in understanding resilience and offering actionable insights to better support future polar expeditioners.

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Appendix A: Chapter 2 Qualtrics Surveys

Resilience in Polar Environments.

Start of Block: LAN

Is English your first language?

- ○ Yes (1)
- ○ No (2)

Page Break

Do you have any difficulty speaking English to people for day to day activities when based in an environment where English is the 1st language?

- ○ Yes (1)
- ○ No (2)

Do you have any difficulty reading formal letters or documents written in English?

- ○ Yes (1)
- ○ No (2)

End of Block: LAN

Start of Block: Demographic Information

Age?

_____

Gender?

- ○ Male (1)
- ○ Female (2)
- ○ Non-binary / third gender (3)
- ○ Prefer not to say (4)

What is your marital / relationship status?

- ○ Single - living alone (1)
- ○ Single - live with family / housemates (2)
- ○ In relationship - living with partner (3)
- ○ In relationship - living separately (4)
- ○ Married /Long-term partner (5)

Do you have any children (including stepchildren)?

- ○ Yes, and when home they live with me (1)
- ○ Yes, but do not live with me when home. (2)
- ○ No (3)

Are you currently based in either of the Polar regions?

- ○ Yes (1)
- ○ No (2)

What was / is the purpose of your trip to the Polar regions

- ○ Adventure/Exploration by physical means (Ski-ing, walking, sled-dogs etc.) (1)
- ○ Fixed Research base or field worker (2)
- ○ Other (3)

If selected other, please state what the purpose of your trip to the Polar regions was / is?

_____

Which specific Polar Region did your last / current trip include?

- ○ Arctic (1)
- ○ Antarctic (2)

Where is your permanent place of residence (Town and Country)

_____

What was the date of the completion of your last Polar trip (If current, predicted end date)?

_____

What was the length of your last trip in days, months and years (If current, predicted duration)?

_____

Location(s) of most recent Polar trip?

_____

_____

_____

_____

_____

End of Block: Demographic Information

Start of Block: Part One

The following surveys asks you to think about yourself in general rather than based on your time in Polar regions.

Start of Block: MEIM-R

Across the globe, people come from a lot of different cultures and there are many different words to describe the different backgrounds or ethnic groups that people come from. Some examples of the names of ethnic groups are Scandinavian, Hispanic, Black, British-Asian, American Indian, Afro-Caribbean, and White. Every person is born into an ethnic group, or sometimes two groups, but people differ on how important their ethnicity is to them, how they feel about it, and how much their behavior is affected by it.

These questions are about your ethnicity or your ethnic group and how you feel about it or react to it.

In terms of ethnic group, I consider myself to be

_____

Please answer your agreement or disagreement to the following questions.

	1 - Strongly disagree (1)	2 - Somewhat disagree (2)	3 - Somewhat agree (3)	4 - Strongly Agree (4)
I have spent time trying to find out more about my ethnic group, such as its history, traditions, and customs (1)	○	○	○	○
I have a strong sense of belonging to my own ethnic group (2)	○	○	○	○
I understand pretty well what my ethnic group membership means to me. (3)	○	○	○	○

I have often done things that will help me understand my ethnic background better. (4)	○	○	○	○
I have often talked to other people in order to learn more about my ethnic group. (5)	○	○	○	○
I feel a strong attachment towards my own ethnic group. (6)	○	○	○	○

My ethnicity is

- ○ Asian, Asian & Country (e.g. Asian & British), or Oriental (1)
- ○ Black or African & Country (e.g. African & British) (2)
- ○ Hispanic or Latino (3)
- ○ White, Caucasian, European, not Hispanic (4)
- ○ Other (6)

If replied other to the question above, please write in your specific group

_____

My father's ethnicity is

- ○ Asian, Asian & Country (e.g. Asian & British), or Oriental (4)
- ○ Black or African & Country (e.g. African & British) (5)
- ○ Hispanic or Latino (6)
- ○ White, Caucasian, European, not Hispanic (7)
- ○ Other (8)

If answered other, please write in your Father's ethnicity

_____

My mother's ethnicity is

- ○ Asian, Asian & Country (e.g. Asian & British), or Oriental (4)
- ○ Black or African & Country (e.g. African & British) (5)
- ○ Hispanic or Latino (6)
- ○ White, Caucasian, European, not Hispanic (7)
- ○ Other (8)

If answered other, please write in your Mother's ethnicity

_____

In terms of how you would identify yourself, how important would you say the following things are to you, please rate from not at all to A lot.

	1- Not at all (1)	2 (2)	3 - Moderately (3)	4 (4)	5 - A lot (5)
My profession (Current or past) (1)	○	○	○	○	○
Religion or Spirituality (2)	○	○	○	○	○
National Identity (3)	○	○	○	○	○
Regional Identity (4)	○	○	○	○	○
Indigenous/Tribal Identity (5)	○	○	○	○	○

Are you part of any other groups that you would say are an important source of support to you, this may include social groups, clubs or associations, sports and recreational, professional networks etc. Please list all that you feel apply to you?

	1 - Not at all (1)	2 (2)	3 - Moderately (3)	4 (4)	5 - A lot (5)
Family (4)	○	○	○	○	○
Work Colleagues (5)	○	○	○	○	○
Sport & Leisure Groups (6)	○	○	○	○	○
Art & Creative Activities & Groups (7)	○	○	○	○	○
Religious or Spiritual Groups (8)	○	○	○	○	○
Professional Associations (9)	○	○	○	○	○
Voluntary, Charity or Community Groups (10)	○	○	○	○	○

End of Block: MEIM-R

Start of Block: ARM-R

To what extent do the following statements apply to you?

	Not at all (1)	A Little (2)	Somewhat (3)	Quite a bit (4)	A lot (5)
I cooperate with people around me (1)	○	○	○	○	○
Getting and improving qualifications or skills is important (2)	○	○	○	○	○
I know how to behave in different social situations (3)	○	○	○	○	○
My family have usually supported me through life (4)	○	○	○	○	○
My family knows a lot about me (5)	○	○	○	○	○

If I am hungry, I can get food to eat (6)	○	○	○	○	○
People like to spend time with me (7)	○	○	○	○	○
I talk to my family/partner about how I feel (8)	○	○	○	○	○
I feel supported by my friends (9)	○	○	○	○	○
I feel that I belong in my community (10)	○	○	○	○	○
My family/partner stands by me in difficult times (11)	○	○	○	○	○
My friends stand by me in difficult times (12)	○	○	○	○	○

I am treated fairly in my community (13)	○	○	○	○	○
I have opportunities to show others that I can act responsibly (14)	○	○	○	○	○
I feel secure when I am with my family/partner (15)	○	○	○	○	○
I have opportunities to apply my abilities in life (like skills, a job, caring for others) (16)	○	○	○	○	○

I enjoy my family's/partners cultural and family traditions (17)	○	○	○	○	○

End of Block: ARM-R

Start of Block: Part Two

The following group of surveys ask you to think specifically from your trip to Polar regions.

End of Block: Part Two

Start of Block: CNS

During your time in Polar Regions please answer how much or little you think that the following phrases were (are) representative of you?

	1 - Strongly Disagree (1)	2 (2)	3 - Neutral (3)	4 (4)	5 - Strongly Agree (5)
I often feel a sense of oneness with the natural world around me (1)	○	○	○	○	○
I think of the natural world as a community to which i belong (2)	○	○	○	○	○
I recognize and appreciate the intelligence of other living organisms (3)	○	○	○	○	○

I often feel disconnected from nature (4)	○	○	○	○	○
When i think of my life, I imagine myself to be part of a larger cyclical process of living (5)	○	○	○	○	○
I often feel a kinship with animals and plants (6)	○	○	○	○	○
I feel as though I belong to the Earth as equally as it belongs to me (7)	○	○	○	○	○

I have a deep understanding of how my actions affect the natural world (8)	○	○	○	○	○
I often feel part of the web of life (9)	○	○	○	○	○
I feel that all inhabitants of Earth, human, and nonhuman, share a common 'life force' (10)	○	○	○	○	○

Like a tree can be part of a forest, I feel embedded within the broader natural world (11)	○	○	○	○	○
When i think of my place on Earth, I consider myself to be a top member of a hierachy that exists in nature (12)	○	○	○	○	○

I often feel like I am only a small part of the natural world around me, and that I am no more important than the grass on the ground or the birds in the trees (13)	○	○	○	○	○
My personal welfare is independent of the welfare of the natural world (14)	○	○	○	○	○

End of Block: CNS

Start of Block: PACT

Specifically thinking back to your last / current trip can you answer the following phrases starting with;

During the trip i was able to

	1 (Not at all able) (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (Extremely Able) (7)
Keep myself serious and calm (1)	○	○	○	○	○	○	○
Stay focused on my current goals and plans (2)	○	○	○	○	○	○	○
Remind myself that things will get better (3)	○	○	○	○	○	○	○
Look for a silver lining (4)	○	○	○	○	○	○	○

Try to lessen the experience of painful emotions (5)	○	○	○	○	○	○	○
Keep my schedule and activities as constant as possible (6)	○	○	○	○	○	○	○
Distract myself to keep from thinking about the demands (7)	○	○	○	○	○	○	○

Find activities to help me keep the demands off my mind (8)	○	○	○	○	○	○	○
Enjoy something that I would normally find funny or amusing (9)	○	○	○	○	○	○	○
Comfort other people (10)	○	○	○	○	○	○	○
Laugh (11)	○	○	○	○	○	○	○

Focus my attention on or care for the needs of other people (12)	○	○	○	○	○	○	○
Pay attention to the distressing feelings that result from the demands (13)	○	○	○	○	○	○	○
Reflect on the meaning of the demands (14)	○	○	○	○	○	○	○

Let myself fully experience some of the painful emotions linked with the demands (15)	○	○	○	○	○	○	○
Spend time alone (16)	○	○	○	○	○	○	○
Focus on the detail of the stressful demands (17)	○	○	○	○	○	○	○
Face the grim reality head on (18)	○	○	○	○	○	○	○

Reduce my normal social obligations (19)	○	○	○	○	○	○	○
Alter my daily routine (20)	○	○	○	○	○	○	○

End of Block: PACT

Start of Block: SVS

Please respond to each of the following statements by indicating the degree to which the statement is true for you during your trip to Polar regions.

Use the following scale: 1 (Not at all), 2, 3, ,4 (Somewhat true), 5, 6, 7 (Very True)

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
I felt alive and vital (1)	○	○	○	○	○	○	○
I did't feel very energetic (2)	○	○	○	○	○	○	○
Sometimes I felt so alive I just want to burst (3)	○	○	○	○	○	○	○
I had energy and spirit (4)	○	○	○	○	○	○	○
I look forward to each new day (5)	○	○	○	○	○	○	○

I nearly always felt alert and awake (6)	○	○	○	○	○	○	○
I felt energized. (7)	○	○	○	○	○	○	○

End of Block: SVS

Start of Block: PANAS

During your last / current trip, using the words below please indicate to what extent you felt this way during the trip.

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)
Interested (1)	○	○	○	○	○
Distressed (2)	○	○	○	○	○
Excited (3)	○	○	○	○	○
Upset (4)	○	○	○	○	○
Strong (5)	○	○	○	○	○
Guilty (6)	○	○	○	○	○
Scared (7)	○	○	○	○	○
Hostile (8)	○	○	○	○	○
Enthusiastic (9)	○	○	○	○	○
Proud (10)	○	○	○	○	○
Irritable (11)	○	○	○	○	○
Alert (12)	○	○	○	○	○
Ashamed (13)	○	○	○	○	○
Inspired (14)	○	○	○	○	○
Nervous (15)	○	○	○	○	○

Determined (16)	○	○	○	○	○
Attentive (17)	○	○	○	○	○
Jittery (18)	○	○	○	○	○
Active (19)	○	○	○	○	○
Afraid (20)	○	○	○	○	○

End of Block: PANAS

Start of Block: UCLA-L

During your last / current trip, please indicate how often you felt the way described in each of the following statements.

	1 - Never (1)	2 - Rarely (2)	3 - Sometimes (3)	4 - Often (4)
I felt in tune with the people around me (1)	○	○	○	○
I lacked companionship (2)	○	○	○	○
There was no one I could turn to (3)	○	○	○	○
I did not feel alone (4)	○	○	○	○
I felt part of a group of friends (5)	○	○	○	○
I had a lot in common with the people around me (6)	○	○	○	○
I was an outgoing person (7)	○	○	○	○

There was a lot of people I felt close to (8)	○	○	○	○
I felt left out (9)	○	○	○	○
My social relationships were superficial (10)	○	○	○	○
No one really knew me well (11)	○	○	○	○
I felt isolated from others (12)	○	○	○	○
I could find companionship when I wanted it (13)	○	○	○	○
There were people who really understand me (14)	○	○	○	○

I was unhappy being so withdrawn (15)	○	○	○	○
People were around me but not with me (16)	○	○	○	○
There were people I can talk to (17)	○	○	○	○
There are people i can turn to (18)	○	○	○	○
I was no longer close to anyone (19)	○	○	○	○
My interests and ideas were not shared by those around me (20)	○	○	○	○

End of Block: UCLA-L

Start of Block: NS-BPN

In general, during my Polar trip...

	1- Disagree strongly (1)	2- Disagree a little (2)	Neither agree or disagree (3)	Agree somewhat (4)	Agree strongly (5)
I felt my decisions reflected what I really wanted (1)	○	○	○	○	○
I felt I did novel things (2)	○	○	○	○	○
I felt connected with people who cared for me, and for whom I cared (3)	○	○	○	○	○
I felt confident that I could do things well (5)	○	○	○	○	○

I felt competent to achieve my goals (6)	○	○	○	○	○
I felt a sense of choice and freedom in the things I did (7)	○	○	○	○	○
I experienced new situations (8)	○	○	○	○	○
I experienced a warm feeling with the people I spent time with/spoke to (9)	○	○	○	○	○
I felt a sense of monotony (11)	○	○	○	○	○

I felt that what I did was repetitive (12)	○	○	○	○	○
I felt disappointed with many of my performances (13)	○	○	○	○	○
I felt that people who are important to me were cold and distant (14)	○	○	○	○	○
Most of the things I did felt like 'I had to' (15)	○	○	○	○	○
I felt excluded from the group I want to belong to (16)	○	○	○	○	○

I felt forced to do many things I wouldn't choose to do (17)	○	○	○	○	○
I felt insecure about my abilities (18)	○	○	○	○	○

End of Block: NS-BPN

Start of Block: GPA

To what extent would you feel able to meet the following needs during your last / current trip.

During my trip, I was able to... (Please answer 1=Not true at all, to 7=Extremely able

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Adequately rest and recover (1)	○	○	○	○	○	○	○
Satisfy my needs for food and water (2)	○	○	○	○	○	○	○
Stay safe from harm (3)	○	○	○	○	○	○	○
Get enough sleep (4)	○	○	○	○	○	○	○
Eat and drink enough (5)	○	○	○	○	○	○	○
Protect myself from the environment (6)	○	○	○	○	○	○	○

End of Block: GPA

Start of Block: Interview-Interest

As a follow-up to this study we will be looking for participants from the same group who would be prepared to complete online interviews regarding the same topics. If you would be interested in taking part in this part of the study, I would be very grateful if you could leave your email address and I will contact you in due course.

_____

End of Block: Interview-Interest

Appendix B: Chapter 3 Interview Guide

Opening Section – Building Rapport

- **Would you like to tell me a little bit about yourself in general?**
  - Where are you from / Occupation / Interests & hobbies

Confirming adversity /role/context (Resilience definition)

- **What comes to mind when you hear the word "resilience"?**
  - What do you think may have led to you having that viewpoint?
- **Can you tell me about any Previous Polar experience you may have?**
- **What was your specific role or task whilst operating in the Polar regions? (Last trip if multiple!)**
  - Did you work as part of a team or were you working mostly alone or half and half if so, what was the size and make up of this team?
  - Was this work or tasks you had done before, or completed similar tasks in other places (Non-Polar)?
- **Did you find your time challenging or relatively manageable? Were there any particular challenges that stick out to you or maybe there were not?, if so can you give me some examples of the challenges for you?**
  - Environmental (Phys & Social) challenges / Loneliness / Inter-group challenges / Physical demands
  - Think about physical danger/risks versus daily struggles?
  - **If not challenging, have you any thoughts why that may have been the case too?**
- **What personal qualities may you have that contribute to that evaluation?**

    - **Successful**
    - **Unsuccessful**

- **Did you have any methods or strategies to cope with those challenges?**
    - Was there one strategy or were there more than one strategies? If there was no specific strategy you can pinpoint, that is OK too. Generally, I just like to hear how you approach the challenges you face.
    - Did you feel they were effective or ineffective?
    - If multiple; did you use them all simultaneously or were there specific situation when you used them?

- **Did you receive any support during your time in the regions?, if so can you tell me about it?**
    - Support physically available
    - Remote / Perceived support

- **Can you tell me about your thoughts on the physical environment where you were, things such as wildlife, the landscape surrounding you, your own living/working environment?**
    - Did you view this as a stressor, something of support, both maybe?
    - Did this contrast with your usual working / living conditions when not in the Polar regions?

Macro Level Factors

- **Thinking a little more broadly, do you think that there are things that have been supportive (or creating challenges) for you personally that might not be so obvious to an outside observers? Perhaps from social network, your previous experiences, anything at all?**
    - For example, your gender, ethnic group, country of birth, social status

Participant Personal Thoughts

- **Do you have any other personal thoughts on things that you believe support resilience whilst operating in Polar regions we haven't discussed?**
- **Finally, is there anything else you would like to add in regard to anything we have discussed today?**

Appendix C: Chapter 4 – Pre-Expedition Surveys

Pre-expedition Surveys & Items

Descriptive questions
Age
Gender
Marital/Relationship status
Do you have children
Previous Polar experience
Trip region
Primary trip purpose
Have you served in the military
Ethnicity

Expedition Related
How many days do you aim to complete your expedition in?

Subscales of Social Support Index	**Scoring**
If I had an emergency, even people I do not know in this community would be willing to help.	1-7 Strongly disagree to Strongly agree

People here know they can get help from the community if they are in trouble.

People can depend on each other in this community.

Living in this community gives me a secure feeling.

I feel good about myself when I give time and energy to thinking about members of my family.

Thinking about the things I do for members of my family and they do for me make me feel part of this very important group even whilst away.

The members of my family still make an effort to show their love and affection for me.

I have friends who let me know they value who I am and what I can do

I feel secure that I am important to my friends as they are to me

I have some very close friends outside the family who I know really care for me and love me

---

The Connectedness to Nature Scale (Mayer & Frantz, 2004)

I often feel a sense of oneness with the natural world around me	1-7 Strongly disagree to Strongly agree
I think of the natural world as a community to which I belong	
I recognise and appreciate the intelligence of other living organisms	
I often feel disconnected from nature	
When I think of my life, I imagine myself to be part of a larger cyclical process of living	
I often feel a kinship with animals and plants	
I often feel as though I belong to the Earth as equally as it belongs to me	
I have a deep understanding of how my actions affect the natural world	
I often feel part of the web of life	
I feel that all inhabitants of Earth, human, and nonhuman, share a common 'life force'	
Like a tree can be part of a forest, I feel embedded within the broader natural world	
When I think of my place on Earth, I consider myself to be a top member of a hierachy that exists in nature	
I often feel like I am only a small part of the natural world around me, and that I am no more important than the grass on the ground or the birds in the trees	
My personal welfare is independent of the welfare of the natural world	

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I cooperate with people around me	1-7 Very untrue of me to Very true of me

Getting and improving qualifications or skills is important

I know how to behave in different social situations

My family have usually supported me through life

My family knows alot about me

If I am hungry, I can get food to eat

People like to spend time with me

I talk to my family/partner about how I feel

I feel supported by my friends

I feel that I belong in my community

My family/partner stands by me in difficult times

My friends stand by me in difficult times

I am treated fairly in my community

I have opportunities to show others that I can act responsibility

I feel secure when I am with my family/partner

I have opportunities to apply my abilities in life (like skills, a job, caring for others)

I enjoy my family's/partners cultural and family traditions

Appendix D: Chapter 4 – Within-Expedition Measures

Participant code: **Expedition Day**: **Date:**

Please answer the items in terms of how you have **felt today**. Scores relate to **1 – Never true to 7 – Always true**

Please circle a response to indicate overall today when faced with stressful demands, how able were you to...	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Kept myself serious and calm							
Stayed focused on my current goals and aims							
Reminded myself that things will get better							
Looked for a silver lining							
Try to lessen the experience of painful emotions							
Kept my schedule and activities as constant as possible							
Distracted myself to keep from thinking about the demands							
Found activities to help me keep the demands off my mind							
Enjoyed something that I would normally find funny or amusing							
Comforted other people							
Laughed							
Focused my attention on or care for the needs of other people							
Paid attention to the distressing feelings that result from the demands							
Reflected on the meaning of the demands							

Let myself fully experience some of the painful emotions linked with the demands							
Spent time alone							
Focused on the detail of the stressful demands							
Faced the grim reality head on							
Reduced my normal social obligations							
Alter my daily routine							
Please circle a response to indicate overall, today to what extend have you felt…							
Upset							
Hostile							
Alert							
Ashamed							
Inspired							
Nervous							
Determined							
Attentive							
Afraid							
Active							

PLEASE TURNOVER AND COMPLETE PAGE 2

	Not true at all						**Very true**

Please circle a response to indicate overall today, how much have you...	**1**	**2**	**3**	**4**	**5**	**6**	**7**
I have felt free to be who I am							
I have felt like a competent person							
I felt supported and cared about							
I often felt inadequate or incompetent							
I had a say in what happened and I could voice my opinion							
I often felt a lot of distance in my relationships with others							
I felt very capable and effective							
I felt a lot of closeness with others							
I felt controlled and pressured to behave in certain ways							
I have felt supported by the natural environment around me							
I felt a lot of distance in my relationship to the natural environment							
Please circle a response to indicate, overall, how often you felt that you....							
Lacked companionship							
Felt left out							
Isolated from others							
Please circle a response to indicate, overall how you have felt today							
I felt alive and vital							

I had energy and spirit							
I nearly always felt alert and awake							
I felt energized							