

# Psychological Adaptation to Extreme Environments: Antarctica as a Space Analogue



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## Abstract

Space analogues are settings where conditions can be reproduced to study physiological and psychological variables experienced in space. Antarctica is one of the most reliable analogues to assess the effects of isolation, confinement, light-dark cycle and extreme environmental conditions in human being. In the present review we describe some of the aspects of psychological adaptation to extreme latitudes. Most of the studies found some evidence about changes in emotional states during Antarctica expeditions. However, these changes are highly variable, and beneficial as well as detrimental aspects of adaptation have been described. Adaptation to extreme environments is a complex phenomenon that needs multidimensional studies to be fully understood, comprising aspects such as seasonality, psychological traits, isolation conditions and social interactions.

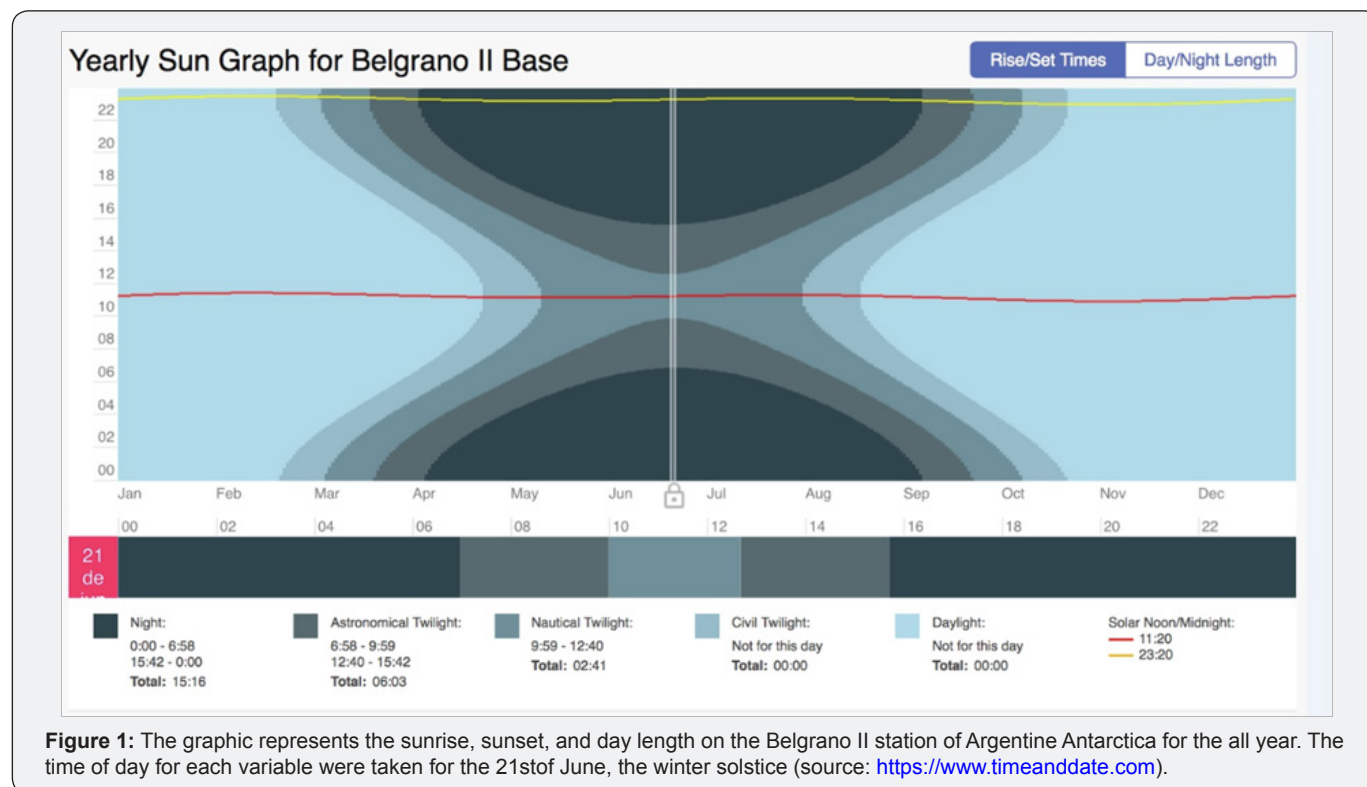
## Introduction

Exploring and controlling variables implicated in a spaceflight is one of the most challenging aspects of space science, since space missions provide the only real environment where these studies can be conducted [1]. However, there are terrestrial settings that can be used as analogues to assess factors associated to space exploration. Also known as “space analogues”, they are a way to reproduce and study some of the conditions that a subject may deal with in a space mission. There are several scenarios in Earth that might guide us to enrich our knowledge about space challenges and to think about possible interventions to extend human adaptability to them [2-7]. Researchers have centered their attention on different psychological dimensions that can be affected in space modulated by the analogues. Numerous studies focus on the impact of confinement and isolation over psychological variables, describing changes in emotional states caused by these conditions [8-10]. Others propose the importance of light exposure to maintain psychophysiological functions in space [11], as it was observed that it might play

a main role in affective disorders [12]. With about 14-million square kilometers covered by thick ice layers, located in the Antarctic Polar Cycle [13], Antarctica is characterized by 24-hours of darkness during winter (polar night) and constant light conditions during summer (Figure 1). Extreme temperature and environmental conditions make Antarctica a tough place to live in. Thus, mostly military personnel and scientific researchers stay in small groups for special expeditions. These characteristics define Antarctica as one of the most reliable space analogues where isolation, confinement, light-dark cycle and extreme environmental conditions can be examined [8,14,15]. Mood fluctuations, emotional disruptions and psychological disorders were claimed to be related to some of Antarctica’s characteristics already mentioned. One of the most studied disorders associated to changes in dark-light cycle is the seasonal affective disorder (SAD). It is a subtype of depression defined by major depressive episodes during fall or winter months [16]. Many researchers have centered their attention

in what happens with mental health in the absence of natural light exposure, considering that almost 5% of the expeditioners meet DSM-IV or ICD criteria for psychiatric disorder like anxiety and depression [17]. Although there are a lot of studies that try to find out the relationship between polar night and emotional states, there is no consensus about the real link between

seasonal affective disorder and Antarctica expeditions. Some studies agree to conclude depression symptoms are noticeable during Antarctica winter due mainly to poor sleep, changes in light-dark cycle and psychosocial stress, while others affirm to find decreases in depression and anxiety symptoms along the expedition [17].



**Figure 1:** The graphic represents the sunrise, sunset, and day length on the Belgrano II station of Argentine Antarctica for the all year. The time of day for each variable were taken for the 21st of June, the winter solstice (source: <https://www.timeanddate.com>).

On one hand, moderate findings were achieved regarding the modulation of subject's mood by polar night. After evaluating a crew of 70 men and women which stayed at different Antarctica USA Stations, only one person developed seasonal affective disorder during mid-winter while the prevalence of subsyndromal SAD was of 18% in the same period [18]. It has been reported, that SAD is associated to circadian rhythms, which are modulated by the light-dark cycle of Antarctica [19]. However, only subsyndromal SAD was evidenced [20], exhibiting increased depression symptoms, sleep disorders, increased appetite, weight gain, fatigue and decreased sociability [21]. Regarding gender differences, females seemed to have more incidence of SAD [22]. Furthermore, studies reported that seasonal changes seemed to modulate other psychological variables, as evidenced by an increase in depressive symptoms [23], hostility, sleep disturbance and a decrease in cognitive performance, configuring the «winter - over syndrome» [17]. In concordance with these results, psychological parameters such as negative affect, tension, anger and confusion also increased during overwintering [21]. Not only seasonality is considered to modulate affection, but also bad weather, which was associated with negative mood fluctuations [24]. Additionally, social

variables such as adjustment to a group, monotony environment and absence of emotional satisfaction, appeared to play a main role in the development of psychological stress during isolated Antarctic stays [25].

On the other hand, some studies claim to find non-significant or positive results about the influence of Antarctica's conditions over psychological variables. Comparing stress and anxiety levels before and after an Antarctic expedition, psychometric parameters showed higher scores for measures taken immediately before traveling [26]. In addition, depression symptoms, fatigue, anxiety and confusion showed a decline during a three-week expedition demonstrating a good psychological adjustment [27]. In this regard, it was reported that depression diagnoses during winter were not significant, but that symptoms related to this disorder were associated to sleepiness and tiredness [23]. A positive correlation was found between physical activity during the day and evening subjective mood [24]. This result may evidence the importance of the daily routine on achieving positive emotional states. A satisfactory use of coping strategies and the tendency to take advantage of the experience to develop personal maturity was also informed [28]; (Table 1).

**Table 1:** Principal findings in Antarctica chronological order.

| Year | Finding   | Authors                 |
|------|---|-------------------------|
| 1995 | SAD had more incidence in women   | Levine [22]             |
| 1995 | Define in depression symptoms, fatigue, anxiety and confusion                     | Palinkas [27]           |
| 2001 | Satisfactory use of coping strategies   | Barbarito[28]           |
| 2003 | Less stress and anxiety   | Steine [26]             |
| 2006 | Psychosocial variables impact on stress   | Mullin [25]             |
| 2010 | Depressive symptoms during winter   | Harris [23]             |
| 2012 | Subsyndromal SAD  | Arendt J [20]           |
| 2016 | Bad weather correlated with mood fluctuations                                     | Anto-solanas[24]        |
| 2016 | Increased depression symptoms, sleep disorders, appetite, weight gain and fatigue | Chen [21]               |
| 2017 | Define in libido  | Arendt & Middleton [19] |
| 1996 | Subsyndromal SAD increased a 18% during mid-winter                                | Palinkas LA [33]        |

As it was briefly described, most studies found some evidence about changes in emotional states during Antarctica staying. However, these changes are highly variable, and beneficial as well as detrimental aspects of adaptation have been reported. Thus, extreme conditions are not necessarily related with adverse psychological outcomes. Some limitations of the researches should be considered. In general, samples tend to be small and individual differences can alter conclusions. In some cases, data were registered only during summer [29]. Finally, studies that centered their attention on the influence of extreme photoperiods set aside other main aspects such as group dynamics, interpersonal relations and prolonged confinement and isolation. At the same time, analysis, which spotlight psychosocial characteristics, did not consider the influence of chronobiological changes.

Antarctica is well known as a model to study the impact of darkness in psychological variables, including depression and anxiety symptoms [30]. In addition, other aspects of confinement impact on mental health, including, interpersonal relationship, daily monotony and absence of privacy [21,31-33]. Emotional state in space missions is a complex phenomenon that can be influenced by many individual, interpersonal and contextual variables. In this regard, multidimensional studies are needed to fully understand it, which should include seasonality, psychological traits, confinement and isolation conditions, and psychosocial aspects of crew members interactions. In turn, preventive psychological countermeasures could be developed to improve adaptation to long-duration space missions [8].

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