

Policy Brief

The winter-over syndrome is a combination of psychological and physiological conditions which can develop due to the isolating, confining, and extreme environment (ICE environments) present in Antarctica during the winter. Although most winter-over syndrome cases are not extreme, there have been incidents and reports where mission objectives, and even the lives of the group members were at stake. In an effort to ensure that such life and mission endangering conditions do not occur during space faring missions, it is imperative that the causes of the different conditions associated with the winter-over syndrome are identified. Identifying the causes of the different conditions is key to being able to plan for, to manage, and to mitigate their effects on the crew during long-duration missions.

The main causes of conditions associated with the winter-over syndrome is sleep disturbance, and lack of environmental stimulation. Sleep disturbance has been linked to lower levels of oxygen at altitude, as well as the lack of regular day-night cycles during the winter period. To counteract sleep disturbances, it is recommended that synchronised group sleeping schedules, regular sleeping and waking times, as well as artificial mood lighting be used to help keep the bodies of the crew synchronised while in space.

Despite limited options to keep the crew stimulated, it is important for crew members to keep up regular social activities, and to maintain frequent exercise. Social activities and exercise boosts the morale of isolated groups and helps to maintain good mental and physical health. Exercise is even more important for space travel, as muscles deteriorate quickly when not used in zero gravity.

It is important for the crew of any long-lasting space missions to be aware of the possible physical and mental effects that isolation and confinement can have on their wellbeing. This review provides a comprehensive and concise analysis of these effects as well as methods for management and mitigation.

PCAS 21 (2018/2019)

**Critical Literature Review
(ANTA602)**

***The Winter-Over Syndrome and the Potential Lessons
for Space Travel***

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Word count: (2504)

Abstract (ca. 200 words):

[The isolating, confining, and extreme environment of Antarctica presents a number of psychological and physiological challenges and stressors to those who choose to stay over during the winter months. The winter-over syndrome is a combination of conditions which can develop due to such challenges and stressors. This literature review looks into what may trigger certain conditions (such as insomnia and depression) associated with the winter-over syndrome and offers some possible solutions to help counteract and minimise their occurrences. Counter measures such as maintaining a synchronous group sleep schedule, good sleep hygiene, regular activities both social and otherwise, as well as frequent exercise may prove helpful for future interplanetary/stellar travellers.]

Introduction:

Due to the ongoing advancement in technology as well as the establishment of NASA in 1958, interplanetary, and even interstellar space travel has become more of a reality over the past few decades (Lambright 2014). With the recent success of multi-billion-dollar missions like NASA's Mars Curiosity rover, it is likely that more interplanetary missions will begin to line up on the global stage in the coming future. One of the more compelling visions is the Mars One project which was established in 2010 by Bas Lansdrop, an entrepreneur from the Netherlands. Mars One intends to send volunteers to Mars by 2032 (Koepsell 2017), and it has been estimated that such missions may include 300 or more days of travel through space (Cain 2013). Such isolation and confinement during space travel can place the human body under significant psychological and physiological duress. Scientists have been using terrestrial analogues for space travel in an attempt to study the effects on people in order to better select, prepare, and protect potential space travellers from the negative effects of the extreme conditions (Pagel et al. 2016). The Antarctic "winter-over syndrome" is a classic example of the effects isolation in an extreme environment during 24-hour darkness can have on the individual. Symptoms of the winter-over syndrome include depression, irritability, hostility, insomnia, and cognitive impairments such as fugue (Palinkas et al. 2000). This review aims to discuss a wide range of literature in order to better understand the Antarctic winter-over syndrome, and to consider the possible lessons learned for manned space travel.

What Is the Winter-Over Syndrome?

Known as one of the most extreme and isolated locations on Earth, over 30 countries have established research stations on the highest, driest, coldest and windiest continent of Antarctica (Suedfeld et al. 2000; Chen et al. 2016). Scientific and support personnel operate out of these research stations and can remain on the continent for varying periods of time ranging from weeks to 18 months in duration (Palinkas 1992; Sandal et al. 2006). Prolonged periods of residence in Antarctica exposes the individual to a multitude of stressors including isolation, confinement, and an extremely inhospitable environment. It has been observed that expeditioners who winter-over (stay over winter) at research stations in Antarctica may even develop psychological and physiological conditions due to these stressors (Sandal et al. 2006). This combination of psychological and physiological conditions in reaction to the extreme environment of Antarctica has come to be known as the "winter-over syndrome".

Terrestrial Proxy for Interstellar Travel

Due to the insatiable desire for knowledge and understanding of the universe we reside in, it is inevitable that the human species will reach further out into the solar system in an attempt to satisfy our curiosity (Stuster 1996). At this day and age, the technology required to accomplish such feats are beginning to become more of a reality. With the success of the lunar landing in 1969, (Adamson et al. 2007), the recent unmanned missions to Mars by NASA, and plans by Bas Lansdrop to send people to the red planet by 2032, it is imperative that we understand the effects of long term isolation and confinement in extreme environments on the human mind and body. A relatively controlled way to study the effects of long term isolation and confinement during space missions would be to use terrestrial proxies such as Antarctica. The extreme environment of Antarctica provides excellent insight into the effects of isolation and confinement on people, however does not replicate the effects of weightlessness and radiation that one would experience in space (Lugg et al. 1999; Pagel et al. 2016). Furthermore, although Antarctica is an excellent proxy for researching the isolation and confinement of space missions, the extended durations and astronomical distances required for interplanetary/interstellar travel will likely make space travel even more dangerous and difficult (Stuster 1996). One extremely important factor however is that on the ice during the severe winter, and in space, the small confined groups of people will have to be almost completely self-reliant/sustaining, with both requiring the protection of complex technology to survive (Lugg et al. 1999). Both Antarctica and space are isolating, confining, and extreme (ICE) environments, and therefore

some parallels can be drawn between the two (Golden et al. 2018). Although not perfect representatives of each other, their ICE environmental nature means that some aspects of Antarctica may be helpful in predicting what will happen in space, and vice versa.

Psychological Symptoms

The psychological symptoms that can be expected of the winter-over syndrome include, but are not limited to severe clinical depression, negative interpersonal relations such as hostility and irritability, loss of productiveness, insomnia, and other cognitive impairments such as fugue (Stuster 1996; Palinkas et al. 2000). Minor conditions such as insomnia, irritability, and absentmindedness are the more common occurrence within groups wintering over, however documentation of mission endangering behaviour has also been recorded (Gundersen 1963; Palinkas 1992).

In one example Capt. Brian Shoemaker, a former commander of Naval Support Force Antarctica, describes how during an expedition, seven of eight men developed severe clinical depression during the winter period. The mechanic was first to succumb to the depression and was found catatonic lying in a foetal position. He required days of relentless attention from the medical corpsman to persuade him to return to duty. Next, the two scientists began drinking heavily while grumbling about their workload and working conditions. The cook came after, as a comment from the scientists about the quality of food sent him into a fury. Refusing to cook for anyone, he barricaded himself in his quarters and did not emerge. After days of persuasion by the corpsman, he finally returned to his duties but remained withdrawn and uncommunicative for several weeks after. The corpsman found similar conditions afflicting each member of the crew, and noted that the conditions developed rapidly over a four week period (Stuster 1996). Although this example is an anecdotal account, it is worth noting that the results of the mission could have been disastrous if the mechanic or the cook did not recover. Such a situation in space could have had much more severe consequences, including failure to complete the mission, and potentially even loss of life. This kind of mission and life endangering behaviour must be avoided at all costs, and it is therefore imperative to understand their triggers and how best to mitigate or manage such behaviour should it occur.

What Causes the Conditions Associated with the Winter-Over Syndrome, and How Can They Be Counteracted?

Sleep disturbances- Different factors of the extreme environment generate different reactions of the human mind and body, and the most commonly reported health disturbance by personnel deployed to Antarctica is sleep disturbance (Pattyn et al. 2017). Insomnia and other sleep related conditions, are due to the lack of sunlight over the winter period which typically exposes the individual to 24-hour darkness (Lo Coco et al. 2017). As light is an important zeitgeber (external cue that helps synchronise the human biological clock to the Earth's time cycles (Grandin et al. 2006)), 24 hour darkness can cause an individuals biological clock to become desynchronized (Stuster 1996). Due to this, the circadian rhythm which regulates the body's sleep-wake rhythm can also be disrupted, thus causing conditions such as insomnia, more disturbed sleep with frequent arousals, and hypersomnia (Palinkas et al. 2008; Lo Coco et al. 2017). It has been found that increased exposure to total darkness is associated with fewer total hours of sleep, shorter durations of the longest sleep event, a later time of sleep onset, and reduced quality of sleep (Palinkas et al. 2008).

Another possible trigger for sleep related conditions is hypobaric hypoxia due to the lower partial pressure of oxygen in the air at altitude (Barkaszi et al. 2016; Pattyn et al. 2017). It has been argued that it is in fact the stress induced by hypobaric hypoxia which impacts sleep more than the disturbed photoperiod during winter (Steinach et al. 2016; Lo Coco et al. 2017). A study was conducted at Concordia and Dumont d'Urville stations which are located at elevations of 3800m and sea level respectively to investigate the effects of seasonality and altitude on sleep in

extreme Antarctic conditions (Collet et al. 2013). The study found that although both stations had similar work ethics during the “day” in winter, the personnel at Concordia station had more pronounced sleep disturbances during the “night” with reports of fragmented sleep, and shorter sleep durations. As the main variable during this study was the difference in altitude (both stations had similar photoperiods and work ethic), it shows that altitude-induced hypoxia should also be taken into account when considering sleep related conditions during the winter period in Antarctica (Collet et al. 2013; Collet et al. 2015; Pattyn et al. 2017).

In the event of space travel, the absence of normal diurnal cues of daylight and darkness, as well as hypoxia from lower oxygen levels in the ship may also lead to personnel becoming affected by sleep disturbances. To counteract this, a possible mitigation method would be to adhere to regular sleep cycles in order to facilitate group synchronisation (nobody sleeping when everyone else is awake) and maintain sleep hygiene (Stuster 1996). Another solution could be to provide zeitgebers to help regulate the crew’s circadian rhythms. An example of this could be dimming or changing the lights colour at set times everyday in order to create the illusion of day-night cycles (Stuster 1996). To counteract the effects of hypoxia, sleep chambers with higher oxygen concentrations may be of use.

Negative affect- Negative affects are negative feelings which are associated with depression, anger, irritability, anxiety, and can lead towards interpersonal tension and conflict. Although extremely common in winter-over personnel, negative affect is usually transient and self-resolving (without clinical intervention) (Palinkas et al. 2008). Negative affect is generally attributed to poor sleep and extended periods of exposure to the dark and cold conditions present during winter (Palinkas et al. 2008). It is also likely that negative affect can arise due to feelings of isolation and separation from family and loved ones (Palinkas et al. 2008).

As negative affect appears to be a cascade effect due to poor sleep, it may be possible to prevent or minimise its occurrence during space travel if the triggers of sleep disturbances are addressed (as explained previously). Furthermore, as most cases of negative affect are self-resolving and do not require clinical intervention (Palinkas et al. 2008), crew members may benefit from regular social activity and exercise to help regulate mood and behaviour (Stuster 1996; Abeln et al. 2015). Regular activity and exercise is also beneficial as it helps mitigate the effect of isolation and confinement that the crew may have, as such feelings of isolation and confinement may also contribute to negative affect (Stuster 1996).

Cognitive Impairment- Cognitive impairments such as forgetfulness, absentmindedness, productivity loss, and fugue states are described as impairments of memory and concentration (Palinkas et al. 2008). Cognitive impairments are also attributed to fatigue (lack of sleep) as well as lack of environmental stimulation and long periods of exposure to the cold (Palinkas et al. 2008). Cognitive impairments such as those mentioned above may affect the productivity and alertness of personnel and should be avoided. During space travel, lack of attention, or reduced attention may lead to disaster, especially if a member of the crew is in a fugue state and unaware of their surroundings.

Cognitive impairments are also linked to poor sleep, and therefore it is imperative that sleep disturbances are addressed. As space travel will also be lacking in environmental stimulation, it is even more important to keep up regular activities and exercise to keep the crew functioning without cognitive hinderances. Exercise and social activities will help to keep morale of the crew up, as well as help keep them mentally and physically fit during the journey (Stuster 1996). Furthermore, as space will also have the added effect of zero gravity, keeping muscle strength up should be taken even more seriously as muscle atrophy occurs rapidly with disuse (Fitts et al. 2001).

Is the Winter-Over Syndrome That Bad?

In 1996 and 1997, 104 voluntary Antarctic expeditioners from the Australian National Antarctic Research Expeditions (ANARE) were recruited as part of a study regarding the winter-over syndrome and its effects on the individual when isolated in groups (Wood et al. 2000). Each winter-over party consisted of groups 15-20 people in size and were situated at 4 different stations on the ice.

The study conducted found that although many experienced negative events/emotions, most of the winter-over staff at the four stations had a majority of positive experiences. Furthermore, the study found that participants had generated a long list of negative experiences, and a short list of positive experiences. Despite the list of negative experiences being fairly lengthy, the occurrence rate for such events was extremely low (Wood et al. 2000). This could suggest that the majority of negative experiences could be minor, transient, and self-resolving issues as discussed in the negative affect section previously. In contrast, the short list of positive experiences was fairly short, but the occurrences for these positive experiences was quite frequent (Wood et al. 2000). This may also suggest that although the winter-over members have limited ways to amuse themselves and keep themselves positive, these methods seem to work consistently and frequently enough to keep morale up and everyone happy.

Another point that should be considered is that fact that many people return to Antarctica and may end up wintering-over multiple times over the course of their Antarctic career. If the experience was truly awful, surely far fewer people would be inclined to return. If this is the case, it would indicate that the winter-over syndrome is indeed manageable, and people are fully capable of enduring the ICE like environments if they have the knowledge and means (Stuster 1996).

Conclusion

In conclusion, the winter-over syndrome can be described as a combination of psychological and physiological reactions to the isolating, confining, and extreme environment present in Antarctica. This combination of reactions seems to primarily revolve around sleep disturbances and the cascading effects of poor sleep. Although the primary cause of sleep disturbances has not been clearly identified, the two main influencers appear to be altitude induced hypoxia, and the lack of zeitgebers which ultimately disrupt the body's sleep-wake rhythm. Ways to counteract this is maintaining a group sleep schedule, keeping good sleep hygiene, and introducing artificial zeitgebers such as mood lighting. Other reactions to the ICE environment such as cognitive impairment and negative affect may be kept at bay with regular activity (social and otherwise), exercise, and good quality sleep. Overall, the winter-over syndrome seems manageable by any group of people in ICEs so long as they are aware of the condition and have the means to manage it.

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