SLEEP PATTERNS DURING AN ANTARCTIC FIELD EXPEDITION

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ABSTRACT
Extreme conditions in Antarctica pose a significant challenge to researchers in field parties. One of the key issues noted in anecdotal evidence during expeditions is the presence of sleep disturbances. It is likely these disturbances are a result of the extreme photoperiod Antarctic personnel face, both in summer and winter. In an effort to examine the validity of these claims and define the variables associated with poor sleep during trips to Antarctica, 14 volunteers traveled to Antarctica and spent several days both in base and field camps. Participants self-reported sleep onset latency, sleep/wake times, number of awakenings, sleep quality, and mood rating during daytime. There is no indication that subjective sleep disturbance measures are significantly affected by travel to Antarctica on a group level, although individual differences varied markedly. STROOP and digit recall tests, given four times at approximately 3-day intervals show significant, $t(13)=2.16$ $p<.001$, increases only on digit recall . Future analyses will employ objective data to further explore the possible effects of the environment on sleep disturbance.

ANTARCTICA is undoubtedly one of the most extreme and isolated regions of the globe. Since the 1950's, many nations have endeavored to maintain permanent or seasonal base stations spread across the continent. In addition to these base stations, field expeditions are sent out regularly for scientific or exploratory purposes. These expeditions may be as short as a few days, or as long as several months. Field researchers and support personnel endure the hardships common to the continent, including exceptionally cold temperatures, biting wind, and extreme photoperiods. These external stressors sometimes translate into various psychological issues, including "winter-over syndrome", subsyndromal seasonal affective disorder, negative affect, and cognitive impairment (Palinkas et al, 2008). During the 1989 winter season at U.S. station McMurdo, 64.1% of crew members interviewed reported some sleep issue, and 51.5% reported difficulty concentrating during the day (Palinkas, 1992). Members of polar expeditions have also reported difficulty falling asleep, difficulty staying asleep, loss of slow-wave sleep, and loss of rapid eye movement (REM) sleep (Palmai, 1963, Natani et al, 1974, Guenter et. al, 1970, Natani et al., 1970, Joern et al., 1970, Macdonald et al., 1991). In one study, two out of three people in the Antarctic summer experienced sleep issues (Gander, 1991).

The sleep issues reported by summer expeditions have roots in dysregulation of the external time cues, or *zeitgebers*, of photoperiod and temperature. The human circadian clock relies on several zeitgebers to function, one of the most important being the photoperiod. Without day/night light cues, circadian rhythms tend to free run. This has been demonstrated in Antarctic conditions (Nakagawa et. al., 1992, Kennaway et. al, 1991). The disruption of circadian rhythms is potentially a key contributor to sleep disturbances. While some studies of human circadian rhythms in

Antarctica suggest that certain effect are more dependent on the strictness of social cues than the external environment, there is good evidence that the physical conditions in Antarctica have a significant impact on the length and quality of sleep (Weitzman et al., 1975, Gander, Macdonald, Montgomery, & Paulin, 1991, Lugg, 2005). Research on the sleep patterns of scientific exploratory parties is scarce, and few interventional studies have been done as of yet. The objectives of this study were, first, to more fully describe the nature of sleep disturbances that occur in field parties and, second, to examine the interaction of some of the variables associated with poor sleep during Antarctic expeditions.

METHODS

Fourteen participants (age M=36.5 years SD=14.5; education level M=17.5 years, SD=2.2) were recruited from a post-graduate course in Antarctic studies. This course included a 12-day field trip to the Antarctica. As part of the course, the students were given training in first aid, and cold-weather conditions prior to, and again upon arrival in Antarctica. Baseline measures of bedtime and wake times, sleep onset latency, subjective quality of sleep, how they felt the following day, and total sleep times were collected for 4 days prior to Antarctic travel. The Pittsburgh Sleep Quality Index was administered 4 days prior to travel in order to assess baseline sleep patterns. Participants spent 4 nights at New Zealand's Scott Base and 7 nights in a field camp several kilometers away during the Antarctic mid-summer. Each participant spent one night in a makeshift snow shelter, and the remaining time in polar tents. Each participant was asked to keep a sleep log measuring sleep/wake times, sleep onset latency, subjective quality of sleep, how they felt the next day, and total sleep time. Participants were also given the STROOP and WEIS digit recall memory test once prior to departure, once upon arrival at Scott Base, and twice in the field. Social schedules were controlled to some degree, in that participants had to report most morning at 9 am to the main polar tent, and were typically occupied until 7 pm.

RESULTS

Climate at the field camp varied with a minimum on the 24th and another dip on the 26th, but with an average temperature of 26°F (3.3°C). Solar radiation followed a diurnal cycle, with high outgoing radiation as a result of the snow cover, similar to normal Antarctic summer conditions.

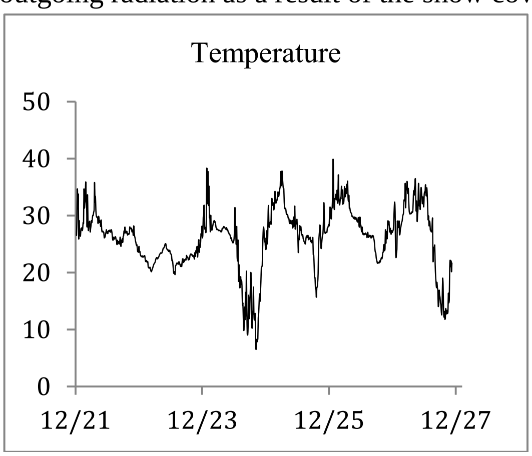

Figure 1. Temperature (F°) over the period of time spent in the field camp.

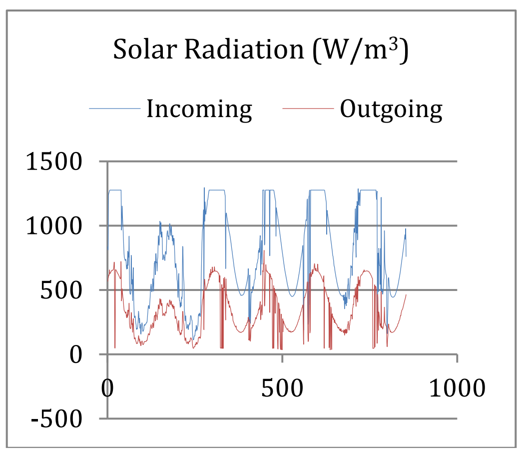

Figure 2. Solar radiation as measured in watts per square meter over the time period spent in field camp.

Participants had a mean baseline PSQI global score of 8.78, which was on the high end of the normal range. Mean self-reported sleep onset latency (Figure 3) increased dramatically on the 20th, dipped slightly on day the 21st and increased again on the 22nd, then proceeded to return to within usual levels for the rest of the expedition. Self-reported awakenings increased during the first nights in Antarctica, and this increase corresponded with a decrease in the next day's mood rating on the 19th and 20th (Figure 4). Average total hours of reported sleep (Figure 7) reached minima during the night trip to the Antarctic on the 18th, then once again on the 27th and 29th. Self-reported sleep quality (Figure 6) peaks on the night of the 25th, dropping to a minimum two nights later, and then subsequently recovering. The mean of standardized STROOP test scores (Figure 7) decreased slightly upon arrival to Antarctica, and then increased slightly with Sessions 3 and 4. There were no significant differences between baseline and expedition average mean scores. The mean of the digit recall scores (Figure 8) increased dramatically upon arrival in Antarctica. Mean expedition scores in this test showed a significant increase over baseline mean scores, $t(13)=2.16$ $p<.001$.

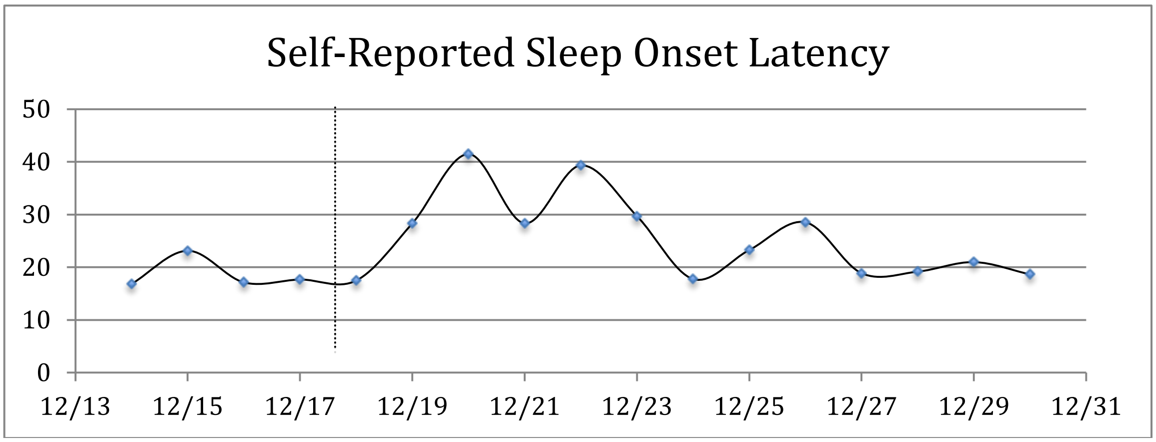

Figure 3. Self-reported sleep onset latency in minutes over time. Vertical line at 12/18 indicates travel to Antarctica.

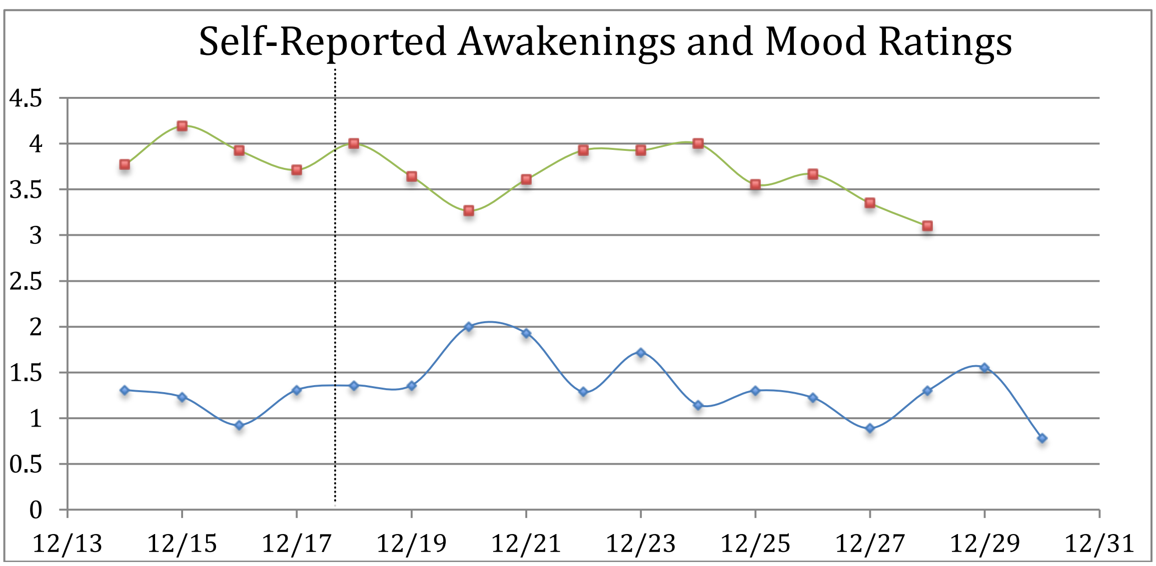

Figure 4. Self-reported number of awakenings (blue) and mood rating (green) on a scale of 1=very poor, 2=poor, 3=average, 4=good, 5=very good. Vertical line at 12/18 indicates travel to Antarctica.\

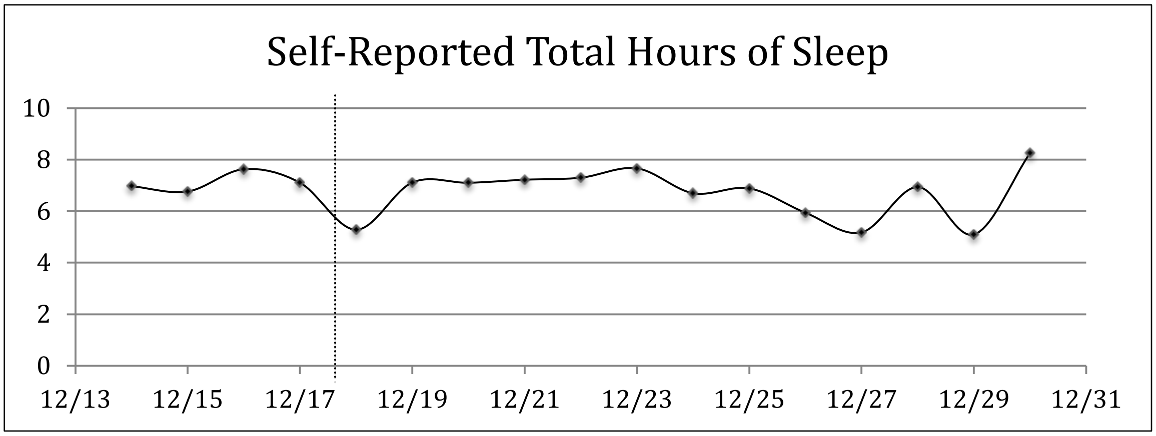

Figure 5. Self-reported total hours of sleep. Vertical line at 12/18 indicates travel to Antarctica.

Figure 6. Self-reported sleep quality on a scale of 1=very poor, 2=poor, 3=average, 4=good, 5=very good. Vertical line at 12/18 indicates travel to Antarctica.

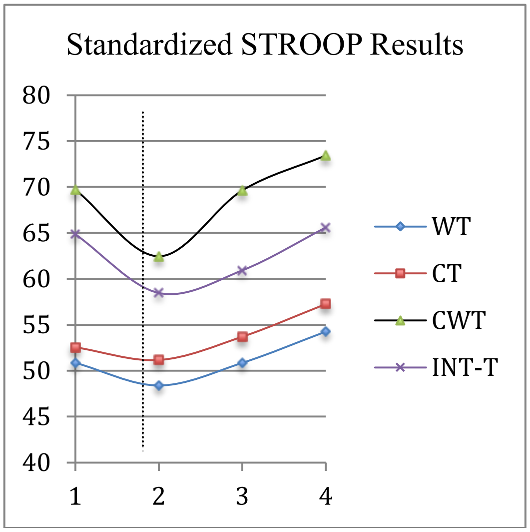

Figure 7. Average STROOP test results. WT=word test, CT=color test, CWT=color-word test, INT-T=interference score. Vertical line at 12/18 indicates travel to Antarctica

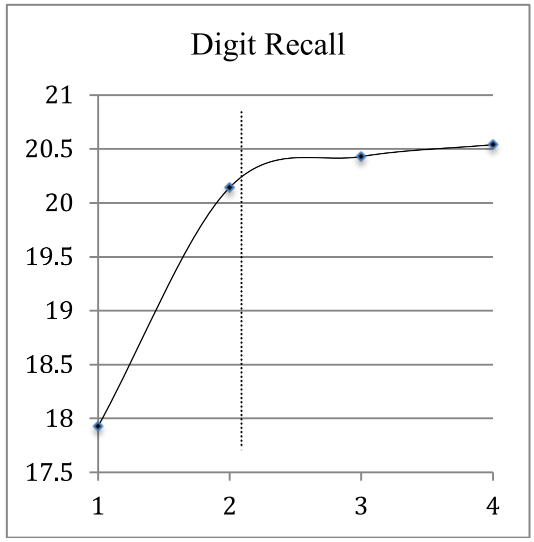

Figure 8. Average digit recall scores as sum of forward and backward scores. Vertical line at 12/18 indicates travel to Antarctica

DISCUSSION

The stressors of Antarctic continent pose challenges for any field party. During the entire student expedition, the sun did not set, and participants endured the reality of living and working in an extreme environment. The results of this study showed that mean self-reported sleep quality became highly variable towards the end of the expedition, with a sharp increase on Christmas night and on the last night of the expedition. Readers should be cautioned that some studies show self-reported sleep quality does not always accurately describe true sleep quality (Weaver, Kapur, & Yueh, 2004). Further investigations into measuring objective sleep quality are currently underway. The reasons that mean total sleep times dropped on specific nights are most likely related to travel and transition. The group traveled on two of these nights (the 18th and the 29$^{th)}$, and the night of the 27th immediately followed the return to Scott Base. The pattern of sleep onset latency could represent an adjustment period to life in Antarctica, and be related to the effect of sudden exposure to constant daylight and the lack of environmental day/night cues.

Melatonin, a key player in the regulation of sleep patterns, is entrained by several photopigments that collect light data (Brainard et al., 2001; Weaver et al., 2004). Effectively, it is suppressed by light reaching the retina, which in turn sends a message to the SCN that it is daytime. In a location like Antarctica, this entrainment system no longer functions without the setting of the sun. For this reason, these types of studies are valuable for future research as a space analogue, or for use with military personnel in submarines or capsule environments (Suedfeld et al., 2000). This study demonstrates the variability of self-reported measures examining sleep disturbances at a group level. In this particular group, it would appear that subjective measures of sleep quality, taken across the group, show no significant difference between baseline and expedition environments, although there was remarkable variability between individuals. There were also no significant differences in any measures within the group when taking into account the use of a sleep mask. With such a small group, inferential analysis of self-reported measures would be unreliable, but the results are can be taken to be indicative, nonetheless. They were able to demonstrate that self-reported measures of sleep quality can be taken from a somewhat large expedition group in extreme environments. However, it is clear that further investigation into objective sleep disturbance measures is required. While the results of this study essentially represent a case study of one particular expedition, they provide a foundation for further study into the sleep disturbances of any traveling group.

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