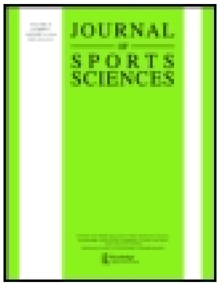

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Influence of a conservative sleep management strategy during a solo Pacific Ocean crossing on anxiety and perceived fatigue: A case study

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Influence of a conservative sleep management strategy during a solo Pacific Ocean crossing on anxiety and perceived fatigue: A case study

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Abstract

The aim of this case study was to determine whether a sailor's deliberate choice of a conservative strategy to manage sleep deprivation would allow him to cross the Pacific Ocean and to minimize his state of anxiety and perceived fatigue. The participant, who had more than 10 years' sailing experience in severe conditions, was tested on a small catamaran without any living quarters during a solo Pacific Ocean crossing. Estimations of sleep hours, state anxiety, and perceived fatigue were self-reported by the sailor on a daily basis using a specific questionnaire. The most important finding is that the sailor's deliberate sleep strategy, 5.4 h sleep per day (24% less than on-shore), was enough to keep his anxiety and perceived fatigue within acceptable limits and enabled him to achieve his goal, which was the first crossing of the Pacific Ocean on a catamaran of less than 6 m. In conclusion, our results suggest that the sailor observed in the present case study was able to minimize anxiety and perceived fatigue with adequate sleep to optimize his performance, security, and to achieve his goal.

Keywords: *Sailing, extreme environment, anxiety, sleep deprivation, modelling*

Introduction

Lewis and colleagues (Lewis, Harries, Lewis, & De Monchaux, 1964) were the first to study a sailor's behaviour during an Atlantic crossing in 1960. They decrypted the sailor's behaviour in an ecological situation and one of their suggestions was that the sailor's personality might play a major role in his behaviour rather than the environment itself (i.e. wind and sea conditions). However, Bennet (1973) was the first to report that sailors were not performing to their best ability. He suggested those impaired performances were due to a time relationship and a connection between impaired performance and adverse environmental conditions, as well as calms experienced by sailors during the 1972 solitary transatlantic sailing race. Since then, sleep patterns have been evaluated (Léger et al., 2008; Lewis et al., 1964; Stampi, 1989). It has been shown that to adapt to extreme sailing conditions and improve performance, sailors replace continuous sleep with polyphasic sleep lasting between 20 min and 2 h for a total of 4.5–5.5 h of sleep per day (Stampi, 1989). Léger et al. (2008) have reported the use of sleep management strategies before as well as during racing. Moreover, they showed that sailors who managed to get enough sleep before the race believed their sailing performance and total sleep on board to be influenced in a positive way.

Banks and Dinges (2007) established that a chronic restriction of sleep, starting at less than 7 h, can lead to neurobehavioural and physiological disorders as severe as those encountered during total sleep deprivation for between 1 and 3 nights. One of the main effects of sleep deprivation is on the performance of psychomotor tasks requiring vigilant attention (Balkin et al., 2004; Dorrian, Rogers, & Dinges, 2005), which are important for single-handed sailing.

In other models, taken from the merchant navy, seamen work in shifts of 4 h on/8 h off. Rutenfranz et al. (1988) showed that all watch-keepers displayed fragmented sleep patterns, indicating difficulties in adapting to the sleep/wakefulness cycle. Sanquist and colleagues (Sanquist, Raby, Forsythe, & Carvalhais, 1997) also showed a reduction in alertness during the second half of the day. Moreover, in a laboratory

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study with a different model (6 h on/6 h off), Eriksen and colleagues (Eriksen, Gillberg, & Vestergren, 2006) observed perturbations in sleep patterns and an increase in sleepiness during the night and early morning watch. Belenky et al. (2003) have observed that this decrease in performance can be either completely restored through a full night's sleep or partially restored with shorter periods of sleep. Van Dongen and colleagues (Van Dongen, Maislin, Mullington, & Dinges, 2003) labelled this phenomenon the ''dose–response effect''.

A reduction in total hours of sleep also has consequences for the perception of anxiety and fatigue. To date, this relationship has been less well studied in ecological contexts compared with in the laboratory. One study reported a strong relationship between sleep deprivation and perceived fatigue during long-haul flights for crews, who had increased response times, eventually leading to small mistakes in tasks such as interpretation and calculation (Bourgeois-Bougrine, Carbon, Gounelle, Mollard, & Coblenz, 2003). In a study conducted under sailing conditions during the Atlantic crossing in 2002, Groslambert and colleagues (Groslambert, Candau, & Millet, 2008) reported that anxiety and perceived fatigue are affected by wind force and, to a lesser extent, the cumulative effects of sleep deprivation. Most studies conducted in laboratory conditions support the notion that partial sleep or total sleep deprivation increases one's state of anxiety (Chambers & Kim, 1993; Kahn-Greene, Killgore, Kamimori, Balkin, & Killgore, 2007; Peeke, Callaway, Jones, Stones, & Doyle, 1980; Vardar et al., 2007; Vein, Dallakyan, Levin, & Skakun, 1983). However, Bonnet and Arand (1998) reported no significant effect of a lack of sleep on anxiety. For Kulas (2001), the experience of the sport itself reduces feelings of anxiety, but sailors' state of anxiety is likely higher than in any other sport. Sleep deprivation and its influence on the perception of fatigue and anxiety during performance is a well studied field but, to the best of our knowledge, only Groslambert et al. (2008) have modelled sleep deprivation, anxiety, and environmental factors such as wind force in ecological conditions. We found it highly challenging to follow the recommendation of these authors to conduct a methodological replication of the Atlantic crossing in 2002, but with a larger observation sample. In addition, we thought it interesting to study the impact of those factors on the anxiety and perceived fatigue of sailors faced with extreme conditions, such as those experienced during an ocean crossing.

Thus, the purpose of this study was to determine whether a sailor's deliberate choice of a conservative strategy to manage sleep deprivation and to minimize his state of anxiety and perceived fatigue would help him to cross the Pacific Ocean. The strategy was for the sailor to try to sleep at least 6 cumulative hours per day. It was hypothesized that this conservative management of sleep deprivation would influence psychological variables important for the safety of the sailor. A marked increase in anxiety and/or perceived fatigue might decrease the cognitive and the physical capacities required for sailing. In addition, wind force was considered in the present study as a potential covariate in the relationship between sleep, fatigue, and state of anxiety.

Methods

Participant

The participant in the present study was an experienced male sailor (age 35 years, training background of over 10 years of regular solo practice). The sailor provided written consent to participate in the investigation. The case study and the protocol received approval from the local ethics committee of the University of Franche-Comté. The sailor's challenge was to establish the first unassisted world record for crossing the Pacific Ocean in a solo sports catamaran. After his experience of the Atlantic crossing (Groslambert et al., 2008), he decided to use a 6 h per day sleep management strategy for this Pacific challenge. Before the start, the sailor was subjected to a medical check-up. During the crossing, he only suffered from sea sickness at the end of the first day and in the middle of the trip, and due to the bad weather conditions he was unable to have regular bowel movements and suffered from some dizziness. A couple of weeks before the end of his crossing, the sailor suffered from a sore throat (treated with antibiotics, for which we do not know if there are any side-effects related to sleep) and some skin problems on his face and shoulders (treated with skin cream).

Boat

The boat was a non-submersible self-built wood-epoxy construction catamaran (5.97 m long, 2.5 m wide) with an integrated self-recovery system. This class (<20 feet) is recognized officially by the World Sailing Speed Record Council and has the accreditation of the International Sailing Association Federation. The boat weighed 480 kg, plus 250 kg of food (e.g. lyophilized food, lemon, cookies, condensed milk, honey) and water. The boat was also equipped with a freshwater producer, a fishing line, a reflecting radar (detectable by big vessels), an SOS distress beacon (emergency position indicating radio beacon), a global positioning system, an autopilot (which was lost on day 27 and replaced with a self-made one), and a cell phone. The boat was rigged with a mast (9 m) and boom, both made of aluminium, a main sail (20 m^2), two jibs (9 and 5 m^2 respectively), a storm jib, and three gennakers (18 m^2). The boat did not have any living quarters, which made navigation extremely difficult. Because the sailor was exposed continuously to the sun, wind, and sea spray even while sleeping or resting, he was equipped with a dry suit for his protection. To sleep, the sailor used an inflatable mattress and a polyvinyl chloride cloth as protection.

Itinerary

The chosen route was 4482 nautical miles, starting in Yokohama, Japan on 10 June 2006, sailing eastwards through the Pacific Ocean, and arriving in San Francisco, California on 11 August 2006.

Data collection

On a daily basis, at noon while the boat was steered by the autopilot, the sailor was asked to read standardized instructions and to complete by hand a specific questionnaire (Questionnaire for Evaluation of Fatigue and Anxiety, QEFA; Millet, Groslambert, Barbier, Rouillon, & Candau, 2005) (see Table I). The QEFA contains 19 items measuring anxiety, perceived fatigue, sleep quality, and appetite. Only three days of data (days 37, 47 and 48) were lost during the 62 days of the crossing.

The participant responded to each questionnaire item by rating himself on a 4-point Likert scale (1 = "not at all"; 2 = "somewhat"; 3 = "moderately so"; 4 = "very much"). For items on which a high rating indicates low anxiety, the scoring weight is reversed.

Evaluation of anxiety

Level of anxiety is evaluated by eight items (items 1–8 in Table I). Items 1, 3, 5, and 7 indicated a high level of anxiety when the sailor's response was "not at all". Items 2, 4, 6, and 8 indicated a high level of anxiety when the sailor's response was "very much". The range in anxiety scores is from a minimum of 8 to a maximum of 32.

Evaluation of perceived fatigue

Perceived fatigue is evaluated by items 9–17. Items 9, 13, 14, and 15 indicated a low perceived fatigue when the sailor's response was "not at all". Items 10, 11, 12, 16, and 17 indicated a low perceived fatigue when the response was "very much". The range in perceived fatigue scores is from a minimum score of 9 to a maximum of 36.

Evaluation of appetite

Item 18 evaluates appetite. A score of "very much" indicated the desire to eat. The score range was from 1 to 4.

Sleep evaluation

Some variables investigated are redundant, especially perceived fatigue (estimated by items 9–17), and item 19, which logged the sailor's sleep quality.

Table I. Questionnaire for Evaluation of Fatigue and Anxiety Instructions: "We would like to know how you feel at the present time".

Items	Not at all	Somewhat	Moderately so	Very much
1. I feel self-confident				
2. I feel depressed				
3. I feel relaxed				
4. I feel nervous				
5. I feel happy				
6. I feel anxious				
7. I feel peaceful				
8. I feel irritable				
9. I feel tired				
10. I feel able to think				
11. I feel on form				
12. I feel energetic				
13. I am somnolent				
14. I feel awkward				
15. I have muscular pains				
16. I have a strong will				
17. I have the desire to succeed				
18. I have a good appetite				
19. I feel sleepy				

The sleep quality score ranged from 1 to a maximum of 4, and a high score indicated a low quality of sleep. In addition, the sailor was asked to estimate his total number of effective sleep hours during the last 24 h. Total sleep hours were evaluated during the entire crossing by filling in a sleep diary after each sleep session. However, many sleep-deprived people have "micro sleeps" of a few seconds to a few minutes. This variable was not reported in the questionnaire because, by definition, micro sleeps were very difficult to self-record. Nevertheless, one may assume that during his crossing, our participant had micro sleeps that noticeably decreased his actual sleep deficit.

Evaluation of environmental conditions

The sailor measured some complementary data, which were logged on a daily basis. Data were recorded for wind intensity (in knots) measured with an anemometer, and the distance covered during the last 24 h (nautical miles) measured using a global positioning system. Finally, the sailor had the opportunity to make some comments in his sailing diary that have been used to better understand his behaviour.

Modelling the effects of sleep deprivation on anxiety and perceived fatigue

To determine baseline values, the sailor began to fill in the questionnaire 49 days before embarking from Yokohama, Japan, and he completed it for another 11 days after arriving in San Francisco, California. As a linear regression analysis does not take into account the cumulative effect in a relationship, we chose to use a nearly equivalent method with transfer functions. This method allowed us to describe and take into account the time relationship between sleep deprivation, anxiety or perceived fatigue by using a system where the input was sleep deprivation SP(t) and the outputs were the level of state anxiety, SA(t), and perceived fatigue, PF(t), as a function of time t. The impulse first-order system retained had the following mathematical form:

$$g(t) = k \cdot e^{-t/\tau}$$

where τ is the decay time constant expressed in days, and k is a positive or negative factor (dimensionless) inducing an increase or a decrease in state anxiety and perceived fatigue, respectively.

The modelling procedure in the present study was similar to that used to describe the relationship between sleep deprivation, anxiety, and perceived fatigue during the Atlantic crossing in 2002 (see Groslambert et al., 2008). To reveal subtle relations between sleep deprivation, state anxiety, and perceived fatigue, anxiety and fatigue variability due to wind force was removed from the system. A variance analysis was used to test whether the addition of a second transfer function, which could introduce an elevation in anxiety, significantly increased the variance of the model by considering the supplementary degrees of freedom introduced in the model (Busso, Candau, & Lacour, 1994). An auto-correlation function was applied to the series of state anxiety and perceived fatigue data of the participant to assess the stability of the results.

Analysis

Means and standard deviations were calculated for all variables. To compare the results from the Atlantic crossing with those from the Pacific Ocean crossing, effect sizes (ES) were calculated using the following formula, where μ_1 is the mean of an Atlantic crossing variable and μ_2 the mean of a Pacific crossing variable, and $S^2{}_P$ is the pooled standard deviation (Hedges, 1982):

The definitions of Cohen (1988) for small, medium, and large effect sizes (ES = 0.20, 0.50, and 0.80, respectively) were used.

The normality of the distribution was tested with a Kolmogorov-Smirnov test and only the distance per day (miles) was accepted as a normal distributed variable during the crossing. To compare a variable before and during the crossing, a Mann-Whitney U-test was used and Pearson's correlation was used as a model of prediction between the different parameters. SPSS v.17.0 (Chicago, IL) statistical software was used for the statistical analysis. In all analyses, statistical significance was fixed at $P < 0.05$.

Results

Sailing performance

The World Sailing Speed Record Council and the International Sailing Association Federation have ratified this record as the first official transpacific single-handed Pacific Ocean crossing on a catamaran of less than 20 feet in length. The passage took 62 days, 17 hours, 51 minutes, and 55 seconds at an average speed of 2.97 knots.

Total sleep per day

Total sleep duration per day estimated by the sailor during the crossing (mean = 5.4 h, s = 2.1 h) was significantly lower than that on-shore (mean = 7.19 h, s = 2.4 h) (–24%; $P < 0.001$). There was no established protocol but the sailor tried to sleep at dawn and during the day for periods of 20 min to 2 h providing that the wind was light. In addition, we identified several other factors that played an important role in his sleep deprivation: (1) the loss of the auto-pilot on day 27 resulted in the sailor, who was alone onboard, spending long periods at the helm; (2) the configuration of the catamaran meant that there was no proper protection for the sailor from wind spray during storms and depressions while sleeping, since the boat had no cabin to protect him. The total number of sleep hours per day off-shore had a significant influence on perceived fatigue ($r = -0.34$, $P < 0.01$). Furthermore, a large effect size (ES = 1.54) was observed for the total number of sleep hours between his first crossing of the Atlantic and this Pacific crossing (see Table II).

Effect of sleep deprivation on state of anxiety

Pearson's correlation was used to show the state of anxiety in relation to the number of sleep hours estimated per day ($r = -0.32$, $P < 0.05$). Furthermore, when the cumulative effect of sleep deprivation was taken into account by using a mono-exponential transfer function, a significant relationship was observed ($r = 0.35$, $P < 0.01$). A more complex modelling, including two exponential functions, was tested without success. Moreover, the time constant of 0.65 indicates that the negative cumulative effect of sleep deprivation had disappeared after 2–3 days (4–5 times the time constant).

Table II. Comparison of the mean and standard deviation (s) of the different variables recorded during the Pacific and Atlantic crossings.

	Pacific		Atlantic*		
	mean	s	mean	s	*ES*
Wind (knots)	13.8	9.3	16.8	7.1	−0.35
Estimation of sleep duration (h)	5.4	2.1	2.8	1.0	1.54
Distance covered per 24 h (nautical miles)	81.6	39.6	95.4	35.4	−0.36
State of anxiety score (max. 32)	12.5	4.3	11.6	3.0	0.23
Perceived fatigue score (max. 36)	14.3	3.8	14.7	4.9	−0.14
Desire to sleep score (max. 4)	2.4	1.1	1.7	0.8	0.69

*Groslambert et al. (2008).

Sleep quality and perceived fatigue

Sleep quality was significantly higher off-shore (mean = 2.4, $s = 1.1$) than on-shore (+36%; $P < 0.001$) and it was significantly related to perceived fatigue on-shore ($r = 0.57$; $P < 0.01$). However, we observed no significant difference ($P > 0.05$) in perceived fatigue between off-shore and on-shore conditions. Furthermore, sleep quality was significantly related to the number of sleep hours per day ($r = -0.31$, $P < 0.05$) and perceived fatigue off-shore ($r = 0.82$, $P < 0.01$). The effect size of sleep quality shows a medium difference (ES = 0.69) compared with the Atlantic crossing, whereas perceived fatigue (ES = −0.14) shows only a small effect (see Table II).

Influence of wind

The mean of the wind force during the Pacific crossing was 13.8 knots ($s = 9.3$). As expected, wind force had a significant influence on the sailor's level of anxiety ($r = 0.62$, $P < 0.01$; see Figure 1), sleep behaviour ($r = -0.31$, $P < 0.05$; see Figure 1), perceived fatigue ($r = 0.51$, $P < 0.01$), the perception of his sleep quality ($r = 0.51$, $P < 0.01$), and appetite ($r = -0.46$, $P < 0.01$). A more complex model with

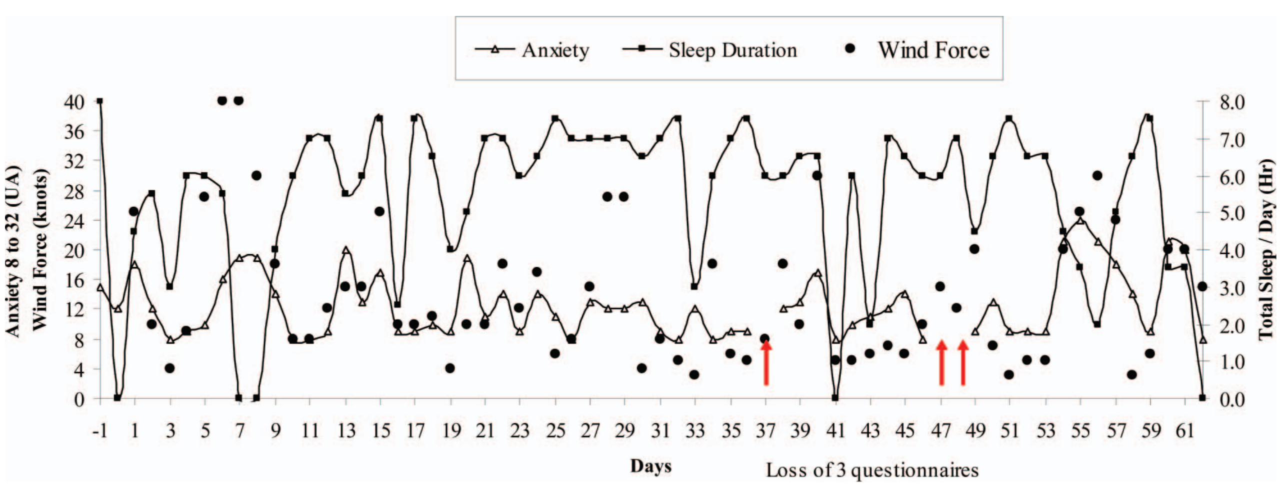

Figure 1. Relationship between wind force, sleep duration, and anxiety from day 1 to the finishing line on day 62. *Note*: Three days of data were lost on days 37, 47, and 48.

one transfer function was tested on anxiety without success. Moreover, the wind force and the related sea conditions had a negative role on his sleep, and made it difficult or even impossible. During this crossing, the sailor reported three periods of total sleep deprivation (previous night from day 7 to 8, 41 and 62 as shown in Figure 1). Otherwise, the sailor was able to manage his sleep well during the crossing. Finally, the difference in the effect size found between the Atlantic crossing and the Pacific crossing shows a small effect ($ES = -0.35$).

State of anxiety and other variables

The comparison of anxiety on-shore with that off-shore shows a non-significant relationship (4%, $P = 0.058$). This borderline value shows a tendency for significant differences in level of anxiety before and during the crossing. However, appetite was significantly lower on the boat compared with on-shore (–4%, $P < 0.05$). A strong relationship was also found between anxiety and perceived fatigue ($r = 0.79$, $P < 0.01$). The addition of one or two transfer functions did not determine a significant increase in the relationship. Furthermore, anxiety is related to appetite ($r = -0.46$, $P < 0.01$) and sleep desire ($r = 0.74$, $P < 0.01$). Finally, the effect size of 0.23 indicates a small difference in anxiety from that of the Atlantic crossing (see Table II).

Discussion

The most important finding in the present study is that the sailor's deliberate sleep strategy of 5.4 h sleep per day (24% less compared with on-shore) was enough to keep his anxiety within acceptable limits and enabled him to achieve his goal of the first solo crossing of the Pacific Ocean on a catamaran of less than 20 feet in length.

This study, which replicates the one done during the Atlantic crossing in 2002, confirmed that an adapted sleep pattern is a determinant during solo sailing and helps the achievement of extreme sailing performance. Other studies have shown sleep management strategies or polyphasic sleep to be the best way for solo, double-handed sailor, and team sailors to perform well and adapt to extreme sailing conditions (Léger et al., 2008; Stampi, 1989).

In this study, we also observed that the period of sleep was almost twice as long as that during the Atlantic crossing. This was a deliberate choice made based on the sailor's previous experience. Hurdiel and colleagues (Hurdiel, Monaca, & Theunynck, 2008) also observed this phenomenon during the longest (27 days) stage of an Atlantic race compared with the shortest stage (7 days). The large effect size (1.54) between the Atlantic and Pacific confirms the hypothesis that sleep requirements are higher for longer crossings than for shorter ones.

Furthermore, sailors have to find a balance between performances, security, and sleep. It is obvious that steering in stormy weather, strong winds, or due to the lost of his auto-pilot, that this was the only way for the sailor to complete his challenge, while maintaining a good command of his boat, avoiding accidents, and taking continuous advantage of the wind direction.

The positive correlation between wind force and anxiety, as identified Groslambert et al. (2008), was not supported by a more complex model that uses one or more transfer function. This reveals that the wind had only a short lasting effect on anxiety. Moreover, sleep deprivation influenced the level of anxiety negatively. This relationship is reinforced by a model using one transfer function. This was also identified by Groslambert et al. (2008) during the Atlantic crossing in 2002, but apparently contradicts Bonnet and Arand (1998), who reported that sleep deprivation had no effect on anxiety. This apparent difference could be explained by the linear relationship investigated in that study, whereas in the present study we characterized the long-lasting effect of sleep deprivation using non-linear transfer functions. Sleep deprivation has a minor effect the next day following deprivation but its real effect becomes apparent several days later when such deprivation has been repeated. Our results are in line with a number of previous studies (Chambers & Kim, 1993; Kahn-Greene et al., 2007; Peeke et al., 1980; Vadar et al., 2007; Vein et al., 1983), who observed an increase in anxiety after total or partial sleep deprivation. The short time constant of 0.65 found in the present study indicates a capacity of recovery from anxiety of 2–3 days (4–5 times the time constant). This is in contrast with the Atlantic crossing when Groslambert et al. (2008) observed a much longer decrease time (16 days) in anxiety, and will be considered as an important result in the context of solo sailing. This difference highlights the importance of the sleep strategy retained. The total number of sleep hours per day appears to be of particular importance. Further studies are required to confirm this during the round-the-world challenge solo challenge and during other solo sailing. Hence the key issues are: (1) How does a solo sailor self-perceive anxiety? (2) Is it reasonable to think that a sailor being able to recover sleep lost during a windy stage by sleeping during calmer periods is a positive thing?

Finally, this does not explain why there is only a tendency for anxiety to decrease between on-shore and off-shore periods (–4%, $P = 0.058$) and why the level of anxiety showed a relatively low score (12 out of 32) during the crossing. One hypothesis could be that the sailor's experience (Kulas, 2001) of those challenges in the past helped him to manage his anxiety well during the crossing. The low effect size (0.23) for anxiety between the Pacific and the Atlantic crossings combined with the effect of more sleep suggests a positive effect on anxiety management. Furthermore, the higher anxiety values before the crossing could be due to the fact that the navigator estimated that the pre-crossing period could play a major part in the success of the crossing. During this period, the sailor was still able to check or test his boat and could make modifications as needed. However, after the start, these operations were no longer possible. Such behaviour has previously been reported by other explorers preparing for extreme expeditions (Maniguet, 1988).

If we assume that the total number of sleep hours per day is directly influenced by wind force, it is also important to understand any other factors that may influence sleep deprivation. Sleep quality was worse off-shore and during periods with lots of wind, and this could also have been affected by conditions on the boat, for example, no cabin and just a polyvinyl chloride cloth as protection. Thus, the perception of the sailor's sleep quality on board was 36% lower than that on-shore, which means that the sailor considered the conditions to be worse on-board.

Other arguments include the medium effect size in sleep quality compared with the Atlantic crossing, which shows that the Pacific is perceived as being harder to cross and could explain why sailors' sleep requirements could be higher. Put into context, the fact that the sailor perceived his sleep quality as better after a longer sleep, which is supported by the negative significant relationship with the number of sleep hours off-shore, demonstrates that environmental conditions play an important role. There is logic behind this statement as for the confirmation of other correlations. For example, the negative relationship between wind force and the total number of sleep hours. The sailor slept more and had better quality sleep during low wind conditions. Finally, the observation that wind force had an impact on other variables such as appetite, perceived fatigue, and sleep quality appears to confirm that wind plays an important role in the behaviour of the sailor.

The fact that we did not find any significant difference in the average wind force and distance covered between the Atlantic and the Pacific ($ES = -0.35$) indicates that the Pacific crossing was also tougher due to other factors. Those factors could be the length of the crossing, which is twice as long as that of an Atlantic crossing, the cold and how the sailor approached the challenge. This factor prompted us to create a new questionnaire, which will be used during the round-the-world solo challenge. The results of this around-the-world campaign should provide us with an even better understanding of solo sailors and their behaviour.

Limitations

This study had a number of limitations. Sailing on a small catamaran does not allow for the use of much technology, which influences standardization. A limitation was the difficulty in ensuring the objective measurement of sleep duration. For example, micro sleeps have not been taken into account and there was a lack of physiological variables (e.g. heart rate hormonal responses for anxiety). In future, researchers should use wrist actimetry and a heart rate recorder to accurately determine the sleep and consciousness periods, and anxiety as well as arousal. The mathematical model we used does not allow us to calculate reverse influences such as the influence of anxiety on sleep and vice versa. Finally, it is possible that fatigue played a role in how well the sailor filled in the questionnaire and this may have influenced his scores.

In conclusion, the conservative sleep strategy used by the sailor in the present case study allowed him to establish the world record for a one-man Pacific Ocean crossing in 2006. The management of his sleep allowed him to minimize sleep deprivation, his state of anxiety, and perceived fatigue. However, the wind force played a role in increasing the sailor's anxiety and sleep deprivation.

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