The Effects of Distal Limb Warming on Sleep Latency

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Abstract

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The purpose of this study is to investigate the functional relationship between sleep and temperature regulation. Are these two functions so intimately linked that an externally produced change in temperature regulation will trigger sleep? One group has found that the single best predictor of sleep onset is an increase in the amount of hand and foot warming relative to more proximal areas (1). Therefore as a next step we wanted to know if an increase in sleepiness would also occur if the distal limbs were warmed through an external manipulation. Consequently, in the current study, five minutes before participants (N=11) attempted to fall asleep on a multiple sleep latency test (MSLT; 2) nap their hands and feet were immersed in water heated to either 42°C (treatment condition) or water heated to the temperature of the warmest limbs (control condition). The results showed no significant difference between the warm and control water conditions. There was a significant decrease in sleep latency in the control and warm water conditions compared to the initial (non-counterbalanced)

baseline MSLT. Of note, although the greatest amount of warming occurred in the warm water condition, there was also a significant amount of warming in the control water condition. Therefore, even mild limb warming may produce a decrease in sleep latency. Alternatively, this difference found may be due to a longer sleep latency on the first MSLT performed in the lab (this was always the baseline MSLT) or possibly immersion in water regardless of temperature caused the decrease in sleep latency between the water conditions and baseline MSLT. Further investigation is required to determine which of these hypotheses is correct.

Key words: distal limb warming; MSLT; behavioral sleep disorder treatment; heat loss; POAH

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Introduction

Sleep and thermoregulation are both functions that have periodic fluctuations in tune with the light/dark cycle and are considered to be regulated by an endogenous circadian oscillator. The close relationship between sleep and thermoregulation in humans has been well documented. For example human brain temperature (T_b) has been shown to decrease during the transition from wakefulness to non-REM sleep (NREMS) by 0.1-0.2 degrees C (3). Core body temperature (T_c) has been shown to have an even larger relative change than T_b with an average maximum temperature of 36.96 degrees C during wakefulness and an average nadir of T_c declining to 36.52 during NREMS (4). When distal regions of the body, such as the hands and feet, are investigated separately, the relative change in temperature between NREMS and wakefulness, vary on average 1 degree C at the feet and slightly less, 0.93 degrees C, at the hands (4).

This difference in temperature change between distal regions and core regions of the body in the transition from waking to sleep is thought to occur primarily because of vasomotor actions such as dilation that effect blood flow. This allows the body to dissipate heat from the core (5). Recently one

group of investigators has found that the single best predictor of sleep onset is the amount of distal vasodilation (as measured by distal-proximal temperature gradient or DPG) (1). Moreover, distal vasodilation was more predictive of sleep onset than subjective sleepiness ratings, T_c, or dim light melatonin onset.

The purpose of this study was to investigate the functional relationship between sleep and thermoregulation. Are these two functions so intimately linked that an externally produced change in thermoregulation will hasten the onset of sleep? To test this hypothesis we warmed the distal regions of the body by immersing hands and feet in water, and measured the sleep latency on the multiple sleep latency test (MSLT). If limb warming proves to be an effective method for reducing sleep latency it may be useful in patients with difficulty falling asleep.

Methods

Four male and seven female participants were recruited from the City College of New York, New York Methodist Hospital and other local community organizations in New York City by flyers and public announcements. Initially we had determined that nine participants should be

run to achieve significance on a paired t-test with a two-tailed alpha of .05 and a power level of .80 (this was based on an anticipated 5 minute difference between the means of the control and warm water conditions). Although during the study we decided to run additional participants which increased our power to .87. Mean age was 25 ± 5.6 yr (SD) range 19-34, and mean body mass index 21 ± 1.6 kg/m^2 (SD) range 19-24. Prospective participants were initially contacted by telephone and scheduled for an interview to insure that the following inclusion criteria were met.

Inclusion criteria for each participant were as follows:

1) Must be between 18 and 35 years old.

2) No history of any sleep disorder.

3) No history of major psychopathology (as measured by the Mini International Neuropsychiatric Interview version 5.0.0), major medical disorder (as measured by the Cornell Medical Index), and/or dermatological disorders.

4) Not currently using psychotropic or hypnotic medications and willing to refrain from using these medications during the course of the study.

5) Limits caffeine consumption to ≤ 2 coffee servings, or equivalent per day.

6) Limits alcohol intake to 7 drinks per week and $\leq$ 2 drinks on any one night.

7) Naps < one hour per week according to subjective report.

8) Must have a body mass index <30.

9) Shift workers were not accepted.

Prospective participants were told that for at least the two weeks prior to their first appointment at the center and throughout the study they must further restrict their habits as follows:

11) Limit caffeine consumption to one or less coffee serving or equivalent per day before noon.

12) Limits their alcohol intake to 7 drinks per week and $\leq$ 1 drink on any one night.

13) No napping.

14) Bedtime and wake time must be consistent (within two hours of the week's mean).

Once the participants fulfilled all the previously stated criteria they were then given an initial baseline MSLT using the technique developed by the Association of Sleep Disorders Centers Task Force on Daytime Sleepiness (2). The MSLT is a diagnostic test used to measure an individual's degree of sleepiness during the day (see below). Participants with a mean sleep latency score of <10 minutes were rejected from the study.

Participants were required to spend approximately three, eight-hour sessions (two treatment and one baseline) in the laboratory. Participants were required to fill out a sleep log two weeks prior to the first experimental night. A researcher contacted the participant after the first week of filling out the sleep log in order to determine the mean bedtime of the participant. This was used to help insure that the participants were maintaining consistent schedules and was also used to determine the time period for testing. In addition, the sleep log was also used to insure that participants were following all other inclusion criteria. If the participant's bedtime and wake time were not consistent within two hours of the week's mean for the week preceding the MSLT, the participant was then requested to stabilize their schedule for the next week and their schedule was reanalyzed at the end of

that week (this happened with two participants). If the participant was unable to stabilize their schedule during the second week they would have been rejected from the study (no participants needed to be removed for this reason). Participants were then asked to come to the New York Methodist Sleep/Wake Disorder Center two hours after their mean wake-up time of the previous week.

Upon arriving at the laboratory the subjects had surface electrodes placed on the scalp and face for recording EEG, and eye movements (6). In addition rectal temperature as a measure of core body temperature was measured by a thermocouple (model 491B, accuracy ± 0.2°C, Cincinnati Subzero, Cincinnati, Ohio) inserted 10cm past the anal sphincter. Skin and water temperatures were measured by thermocouples (model 409B, accuracy ± 0.1°C, YSI Inc., Yellow Springs, Ohio) fixed to the skin with porous surgical tape (one hand and the contralateral foot were measured). The foot electrode was placed on the skin above the center of the plantar surface of the Tarsus and the hand electrode was placed on the skin above the center of the dorsal surface of the Metacarpus. Water temperature of the independent variable was also measured with a thermode placed midway in the water

container of the foot during both the treatment and control conditions. All temperature data was collected in one-second intervals on a mini-logger 2000 data recorder (accuracy ± 0.1°C, Mini-Mitter Co., Inc. Sunriver, Oregon). Of note, thermodes placed on the hand and foot were not immersed in the water during the experimental conditions. Polysomnographic data was collected and analyzed on Grass-Telefactor DEEG equipment used in conjunction with Twin version 2.6 software.

During the entire testing period subjects were required to maintain a constant routine (both during and between MSLT naps). This routine required the subjects to remain in a semi-recumbent position, with isocaloric food intake hourly (237ml of Ensure was given upon arriving at the laboratory and subsequently given after each nap opportunity) and constant lighting conditions (<50 lux). Of note, between the MSLT naps the participants had dim illumination (<50 lux), these lights were turned off during the nap opportunities; therefore some fluctuation in lighting did occur. In addition all subjects were required to wear sweatpants and a short sleeve t-shirt to control for the effect different types of clothing may have had on the thermoregulatory changes under investigation in this study. Ambient

temperature was maintained and measured between 70-75 degrees Fahrenheit throughout the study.

The modified MSLT began one hour after arriving in the lab (3 hours after mean wake-up time). During the modified MSLT the participants were required to attempt to fall sleep for the first twenty minutes of each hour during five nap opportunities. Naps were separated by approximately 2 hours of wakefulness. Participants were given pre and post nap questionnaires at every nap opportunity. The pre-nap questionnaire consisted of two visual-analog scales questioning level of anxiety, sleepiness and one question requiring the participant to estimate the number of minutes it would take them to fall asleep. The pre-nap questionnaire was given after the water condition, but before the beginning of the nap opportunity. The post nap questionnaire asked the participant several questions about depth of sleep, amount of time it took them to fall asleep, level of wakefulness, and level of anxiety (see the appendix for both the pre and post nap questionnaires). The post-nap questionnaire was given immediately after each nap. Five minutes before the participant attempted to fall asleep their hands and feet were immersed in plastic disposable containers. Within this container water

heated to 42°C (treatment condition) or water heated to the temperature of the warmest limbs (control condition) were placed in approximately two liters of water for each foot and approximately one liter of water for each hand. The hands and feet remained in the water for five minutes. After each nap the participants hands and feet were toweled dry. The time period of five minutes immersion in the water was chosen because pilot data showed that the vast majority of the limb warming occurred within four and a half to five minutes of immersion. All trials were conducted on the same day of the week for each subject; therefore if the first trial was conducted on a Wednesday then all future trials for that subject were also conducted on Wednesday. A cross over design was used to control for an order effect in both the warm and control water conditions (six participants began with the warm water condition and five participants began with the control water condition). The scoring of sleep during the MSLTs and the execution of all conditions (baseline, control, and warm water) of the study were performed entirely by one of us (MRE). Therefore, the study was not performed in a double blind fashion. Moreover, three of the subjects were members of the City College of New York sleep laboratory and could have possibly known the objective of the project. Therefore, the study cannot be considered

entirely single blind either. However, these participants were not formally informed as to the objective of the study).

Statistical Analysis

All statistical tests were performed in SPSS version 9.0, except the p-value adjustment, which was performed by hand. The data was separated into the following families of analysis: sleep latency data (sleep latency was separated into two separate families of analysis with one a priori test which was control vs. warm, and two post hoc tests which were control vs. baseline and warm vs. baseline), temperature data, spectral data, and subjective questionnaire data. The error rate for each family was set at an α=0.05. Holm's sequential Bonferroni method was used to control for type I error for all paired t-test's performed within a family of comparisons. Therefore if a p-value is listed as part of the t-test result, the level of significance will be measured against an adjusted α designated as α_1-α_k where k is equal to the number in the sequence of the pairwise comparisons.

Sleep Latency Data

Sleep latency data were collected from each MSLT nap opportunity and averaged for a daily mean for each participant in each condition. Sleep latency was defined as the time from waking to the first of three consecutive

thirty-second epochs of any stage of sleep. If no sleep was present participants were assigned a sleep latency of 20 minutes for that nap.

Spectral Analysis

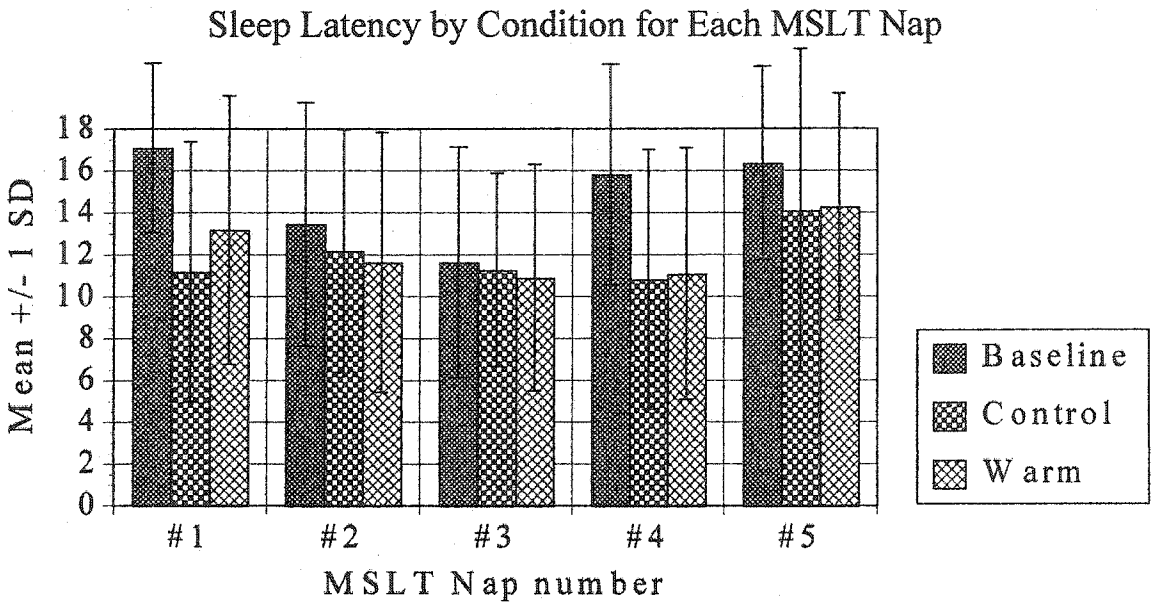
All spectral analysis was performed with the following settings: FFT block size-256, highest frequency band-35, with DC component removed. Analysis was split into periods of sleep and wake. Each of the five daily naps were averaged into a daily total for each condition. Therefore, because sleep was not present during every nap opportunity the daily average for sleep includes a range of 2-5 naps for each daily average. The wake periods were chosen from O1 referenced to an A1-A2 average. This channel was chosen for wake primarily because alpha is most pronounced from the occipital leads. Sleep segments were chosen from C4 referenced to an A1-A2 average. Conversely this channel was chosen for sleep because theta and delta bands are typically more pronounced on the central leads. In both wake and sleep, 90-second artifact free segments were chosen for analysis. This typically involved choosing the last 90-seconds of wake and the last 90-seconds of sleep, unless artifact was present, then the closest artifact free segment was chosen. One participants data was lost due to a hard drive failure, therefore we had an N=10 for all spectral analysis.

Results

The results of the paired t-tests showed no significant difference in sleep latency between the control and warm water conditions (df=10, t=-.13, p=0.897). Cohen's effect size revealed very little difference between these two groups (d=-0.03). There was a significant difference between the warm water condition vs. baseline (df=10, t=2.78, p=0.019 @ $\alpha_1 < 0.025$, d=-0.83) and the control water condition vs. baseline (df=10, t=2.48, p=0.032 @ $\alpha_2 < 0.05$, d=-0.82). See graph 1 for the mean sleep latencies in each condition for each nap. There was not a significant order effect for either variable on independent t-tests, control water first vs. control water second (df=5, t=-1.11, p=0.295), warm water first vs. warm water second (df=5, t=-0.19, p=0.854). A two-way repeated-measures MANOVA was performed to investigate the main effects and interaction between treatment conditions (Factor 1=baseline, control water, and warm water) and nap number (Factor 2=naps 1-5 on the MSLT, this could also be thought of as a time of day effect). The multivariate tests indicate a nonsignificant treatment main effect, Wilks' Λ=0.52, F (2,9) = 4.14, p=0.053, a significant nap order effect Wilks' Λ=0.25, F (4,7)= 5.14, p=0.03, and a nonsignficant treatment-by-nap interaction effect, Wilks' Λ=0.24, F (8,3)=1.22, p=0.48. Follow-up paired t-

tests revealed a significant difference between naps 1 and 3 (df=10, t=4.83, p=0.001 @ $\alpha_1 < 0.005$), and a trend between naps 3 and 5 (df=10, t=-2.95, p=0.015 @ $\alpha_2 > 0.006$).

Graph 1



Temperature Data

All temperature data were originally collected in 1-second intervals and were collapsed into 1-minute bins for all temperature data analysis. The time period of each selection was as follows: one minute before each water condition temperature for all body temperature channels were collected (core body, hand, and foot), during the water conditions water temperature was measured 2-minutes after the feet were placed into the water for a period of 1-minute (in other words, a 1-minute sample of water temperature was taken

in the middle of each water condition), all body temperature measures were taken during the last minute of each water condition, 1-minute samples of body temperatures were taken again 5-minutes after the end of each water condition (a delay of 5-minutes after the water condition was chosen primarily because this was typically when the zenith of the body temperature variables occurred). See table 1 below for the means and SD for all body temperature channels.

As expected, there was a significant difference between the water temperatures in the control and warm water conditions ($df=10$, $t=-18.85$, $p=0.0001$ @ $\alpha_1<0.005$). The mean water temperature for the control water conditions was 31.5°C (± 1.37°C). During the warm water condition it was 39.5°C (± 0.45°C). The results of the paired t-test's comparing differences in hand, foot, and core between the control and warm water conditions are listed on the right side of table 1. It is clear from table 1 that there was not a significant difference between any of the body temperature measures before the water conditions were administered. During the last minute of the water conditions and 5-minutes after the water conditions the hands and feet were significantly warmer in the warm water condition than the control water

condition. This demonstrates that the warm water condition was effective in increasing the temperature of the hands and feet. Although the feet were 1.72°C warmer in the warm water condition than in the control water condition, a paired t-test of the pre-water vs. post-water foot temperatures in the control water condition revealed that significant warming also occurred in this condition (df=10, t=-4.327, p=0.001 @ α_3<0.006). The hand temperature was not significantly different in the pre-water vs. post-water paired t-test (df=10, t=-1.576, p=0.147). The rectal body temperature did not change significantly in any of the conditions tested.

Table 1
Temperature Values for Control and Warm Water Conditions

	Control Water Condition Temperatures			Warm Water Condition Temperatures			Control vs. Warm Water Conditions t-tests		
	Pre-water	During water	Post-water	Pre-water	During water	Post-water	Pre-water	During water	Post-water
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	P-value α level	P-value α level	P-value α level
Rectal	36.99 (±0.17)	37 (±0.17)	36.99 (±0.16)	36.99 (±0.25)	36.99 (±0.27)	37.02 (±0.25)	0.995 NS	0.889 NS	0.686 NS
Hand	31.22 (±1.05)	30.7 (±0.91)	31.59 (±1.16)	31.64 (±1.24)	32.22 (±1.3)	32.83 (±1.31)	0.205 NS	0.008 α_6=0.008	0.002 α_4<0.006
Foot	30.93 (±1.37)	30.53 (±1.23)	31.49 (±1.37)	32.15 (±1.35)	32.36 (±1.23)	33.21 (±1.2)	0.14 NS	0.001 α_2<0.005	0.002 α_5<0.007

All temperatures in this table are listed in degrees Celsius. Below each p-value is listed either the adjusted alpha or NS if there is a non-significant difference.

Spectral Data

The paired t-test's did not reveal a significant difference during sleep between the control and warm water conditions in any band range, although the theta range had a slight trend towards significance (df=9, t=2.760, p=0.022 @ α_1> 0.003). All other paired comparisons both during sleep and wake were non-significant.

Subjective Questionnaire Data

None of the paired t-test's comparing the control vs. warm water conditions found any significant differences between the groups on any question on either the pre or post nap questionnaires. The pre-nap visual-analog scale on sleepiness revealed virtually no difference between the control vs. warm water condition (df=10, t=0.129, p=0.9). Similarly the results of the pre-nap visual-analog scale on anxiety also showed no significant difference between the control and warm water conditions (df=10, t=-0.365, p=0.723). The post-nap analog-visual scales revealed results similar to the pre-nap: depth of sleep control vs. warm (df=10, t=0.820, p=0.434), level of awakening control vs. warm (df=10, t=0.484, p=0.639), and level of anxiety control vs. warm (df=10, t=0.864, p=0.408). When participants were asked how long it took them to fall asleep on the MSLT nap they responded with a mean of 8.7

minutes (SD ±4.43) in the control and 11.2 minutes (SD ±5.32) in the warm water conditions (df=9, t=-1.960, p=0.082). Therefore participants did not feel a significant subjective difference between the control and warm water conditions on any of the measures in which they were tested.

Discussion

In the following sections we will describe possible reasons why no difference in sleep latency was found between the control and warm water conditions.

Time Period of the Water Immersion

As mentioned in the method section, the time period for the five minutes of water immersion was chosen because in the initial trials we found that the vast majority of limb warming during the warm water condition occurred in the first four and a half to five minutes. However, it is possible that in order to stimulate the central mechanisms responsible for sleepiness a longer immersion time may be necessary. This point is highlighted by the fact that no significant change in core body temperature occurred during the warm water condition. It is important to note that raising the core body temperature through the limb warming was not the goal of the limb warming

condition. In fact, the limb warming was intended to cause vasodilation, which was anticipated to off load core body temperature once the water was removed. We anticipated that limb warming would primarily stimulate warm senseitive neurons (WSN) through afferent connections from cuntaneous thermoreceptors in the skin. More intense or longer warming of the limbs may be necessary to stimulate the WSN's in the hypothalamus (POAH) to induce sleepiness.

Need for a Hypothalamic Set Point Modulator

In order to cause a decrease in sleepiness between the control and warm water conditions we hypothesized that it would be necessary to engage central temperature/sleepiness mechanisms. For this to occur requires modulation of temperature through the limb warming procedure. It is possible that modulation of body temperature through limb warming may require an additional hypothalamic set point adjustment to generate the thermoregulatory changes associated with sleep. One role of the hypothalamus is to maintain a relatively stable endogenous environment in light of constant fluctuations in the external world. Therefore it's reasonable to assume that simply heating the limbs of the body would not allow basic set point changes necessary to significantly off load heat.

Mel administration has been shown to induce sleepiness and decrease T_c when given during the daytime, when it is not normally secreted (5,7,8). Moreover the increase in sleepiness and decrease in T_c is also associated with a parallel increase in limb temperature. Therefore the hypothermic effect of Mel may be modulated by the WSN's in the POAH, which can control vasomotor action. In light of the many lines of evidence implicating Mel in both thermoregulatory set-point and soporific changes, Mel may be necessary as a set-point modulator allowing limb warming to both effect WSN's in the POAH and help to amplify the vasodilation, ultimately causing a reduction of sleep latency.

Causal Relationship between Limb Warming and Sleep Onset

In addition to the other previously mentioned reasons why a significant difference was not seen between our control and warm water conditions. It is also possible that our basic rationale behind limb warming was flawed. We assumed that because the increase in distal limb temperature relative to proximal areas preceded the onset of sleep that it was possible to produce sleepiness by increasing limb temperature. Within this theory was an implicit assumption that because this change in DPG occurred before

conventionally defined sleep that it also occurred before sleepiness, but this may not be the case. It may be that relative distal limb warming occurs as a result of increases in sleepiness and not as an antecedent to sleepiness (or sleep). If this is the case then externally producing limb warming would not decrease sleep latency.

Warming in the Control Condition

Another possible reason why we may not have produced a difference in sleep latency between our two experimental conditions is because of the way we determined the water temperature of the control water condition. As mentioned previously, this was done by adjusting the water temperature to the temperature of the warmest limbs. We decided on this method because we felt that if the water had a cooling effect this may produce an increase in alertness. In addition, we also felt the need to have the control condition include water as to rule out the possibility that if we did see an effect it was related to the temperature of the water and not the water itself. As a result, this control water procedure had the unintended consequence of significantly increasing the temperature of the limbs (although not nearly as much as the warm water condition). Therefore it is possible that both the control and warm water conditions produced sufficient limb warming to stimulate WSN's and thereby cause a decrease in sleep latency.

The Order Effect

Although no significant difference was found between the sleep latencies of the control vs. warm water condition, there was a significant difference between the control and warm water conditions as compared to the baseline MSLT. This may be related to the fact that the baseline MSLT was not counterbalanced because it served as a screen for sleepiness. Therefore the participants may have had a longer sleep latency on the first day in the laboratory due to their adjustment to the laboratory environment. This is a well-known phenomenon for nighttime polysomnogram studies called "the first night effect" (or "the laboratory effect"). There is some evidence that "the first night effect" does not occur in the MSLT. In a 1988 study Zwyghuizen-Doorenbos (9) investigated the test-retest reliability of the MSLT separated by 4-14 months and found a correlation of 97% between studies. An earlier study, which separated the MSLT by 3-90 weeks, found a considerably weaker correlation of 65% (10). Each of the three MSLT's in the current study was typically separated only by one week, with the longest separation between MSLT's of one month (this occurred with only two participants). Therefore it is unclear whether the first of two MSLT's

separated by only one-week would demonstrate higher sleep latencies corresponding to a "first day effect".

Limb warming in both the control and warm water conditions may have had two primary effects. First, the initial warming of the distal regions may have stimulated WSN's through afferent connections from cuntaneous thermoreceptors in the skin. In addition limb warming may also have produced a slight increase in temperature of the POAH (although we did not see a significant change in core body temperature). The combined actions of these two processes on the WSN's may have in turn caused an enhancement of sleepiness. Secondly, limb warming may have also produced vasodilation through both the direct application of heat to the skin and from the stimulation of WSN's in the POAH through the limb warming. Activation of WSN's would then cause both increases in vasodilation and decreases in vasoconstriction through the neuro-pathways described. This vasodilation could then allow off loading of core body heat, consistent with what normally occurs during the initial period of sleep in entrained individuals. The combined effects of all these mechanisms may have produced the

decrease in sleep latency between the water conditions and the baseline condition.

The Nap Order Effect

The nap order effect found in this study is remarkably similar to the findings of Carskadon and Dement (11) in the early nineties. Using the MSLT to test participants on a constant routine schedule they found what is now commonly referred to as the "afternoon dip". This dip refers to a decrease in sleep latency which occurs in the early afternoon around 2:00-3:00 pm. The significant decrease in sleep latency found in our study between the third MSLT nap compared to naps one and five is likely the same "afternoon dip".

In conclusion, in order to clearly determine the reasons for the findings in our current study several follow-up studies will be needed. The first of which should be a counterbalanced study investigating the MSLT sleep latencies of a warm water condition vs. a non-water control condition. In addition it would also be helpful to produce limb warming under fMRI monitoring in order to test the hypothesis that limb warming produces stimulation of the POAH. If it is found both that the result of the current study was caused by an order effect, and that under fMRI monitoring limb

warming stimulates the POAH, it may then be necessary to investigate the use of limb warming with a set-point modulator, namely MEL. This emphasis on limb warming as a mechanism to decrease sleep latency is not without reason. If limb warming can reliability reduce sleep latency it may be a treatment option for patients with mild sleep onset insomnia and would help this group of patients break free from the use of hypnotic medications.

Appendix A

Answer before the Nap

Date: ___/___/___ Time ___: ___ Nap#_____ Subject #_____

1. How sleepy are you right now (line is not to scale)?

Less_____More

2. How much anxiety are you feeling right now (line is not to scale)?

Less_____More

3. How many minutes do you think it will take to fall asleep? _____mins.

Appendix B

Answer After the Nap

1. Please, indicate how long it took you to fall asleep once you began trying (please answer in numbers and minutes) _____min

2. Compared to the time it usually takes you to fall asleep, it was

a. ___ longer than usual
b. ___ same as usual
c. ___ shorter than usual

3. How deep was your sleep compared to usual (line is not to scale)?

Less_____More

4. How RESTLESS was your sleep?

a. ___ more restless than usual
b. ___ as restless as usual
c. ___ less restless than usual

5. How RESTFUL was your sleep?

a. ___ more restful than usual
b. ___ as restful as usual
c. ___ less restful than usual

6. How awake do you feel immediately after awakening (line is not to scale)?

Less_____More

7. How much anxiety are you feeling right now (line is not to scale)?

Less_____More

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