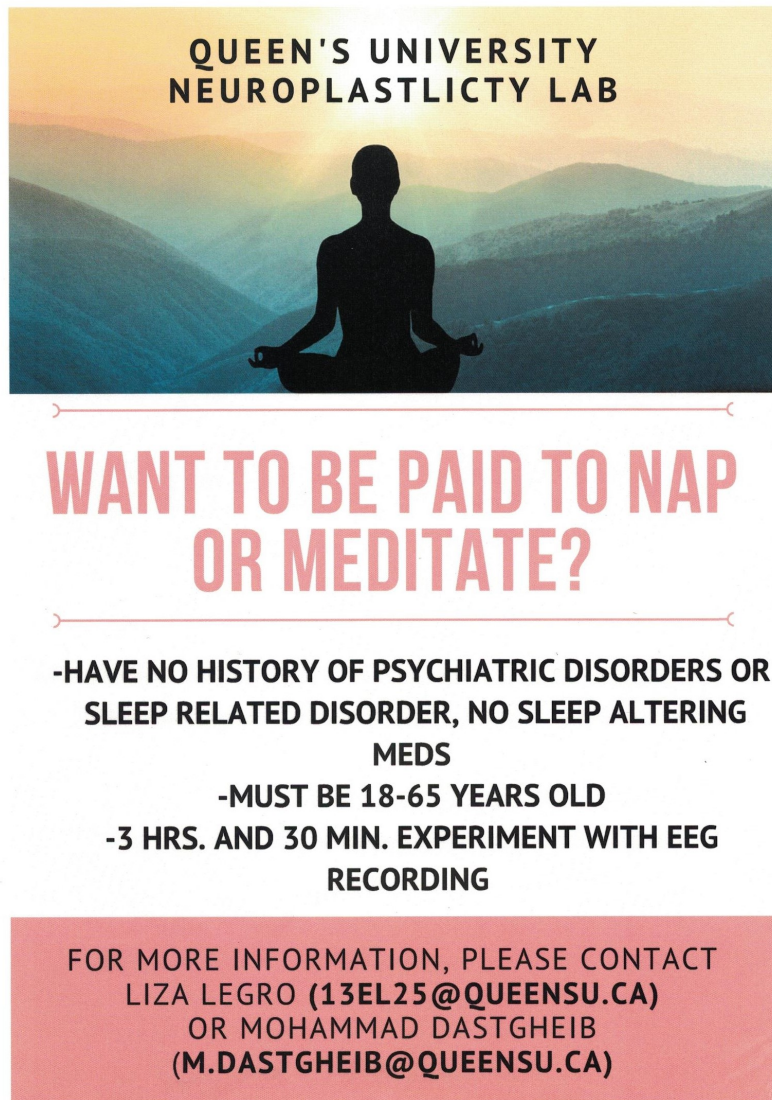# Appendix

Appendix A.

Figure 1: Poster of the study.

Appendix B.

September 14, 2018

Dr. Hans Dringenberg
Professor
Department of Psychology
Queen's University
Humphrey Hall
Kingston, ON, K7L 3N6

Dear Dr. Dringenberg:

GREB TRAQ #: 6019212
Title: "GPSYC-779-16 The role of napping, meditation, and relaxation on memory consolidation in humans"
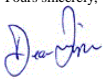
The General Research Ethics Board (GREB) has reviewed and cleared your request for renewal of ethics clearance for the above-named study. This renewal is valid for one year from September 30, 2018. Prior to the next renewal date, you will be sent a reminder memo and the link to ROMEO to renew for another year. You are reminded of your obligation to submit an Annual Renewal/Closure Form prior to the annual renewal due date (access this form at http://www.queensu.ca/traq/signon.html/; click on "Events;" under "Create New Event" click on "General Research Ethics Board Annual Renewal/Closure Form for Cleared Studies"). Please note that when your research project is completed, you need to submit an Annual Renewal/Completed Form in Romeo/traq indicating that the project is 'completed' so that the file can be closed. This should be submitted at the time of completion; there is no need to wait until the annual renewal due date.

You are reminded of your obligation to advise the GREB of any adverse event(s) that occur during this one-year period. An adverse event includes, but is not limited to, a complaint, a change or unexpected event that alters the level of risk for the researcher or participants or situation that requires a substantial change in approach to a participant(s). You are also advised that all adverse events must be reported to the GREB within 48 hours. To submit an adverse event report, access the application at http://www.queensu.ca/traq/signon.html/; click on "Events;" under "Create New Event" click on "General Research Ethics Board Adverse Event Form."

You are also reminded, that all changes that might affect human participants must be cleared by the GREB. For example, you must report changes in study procedures or implementation of new aspects into the study procedures. Your request for protocol changes will be forwarded to the appropriate GREB reviewers and/or the GREB Chair. To submit an amendment form, access the application at http://www.queensu.ca/traq/signon.html; click on "Events;" under "Create New Event" click on "General Research Ethics Board Request for the Amendment of Approved Studies."

On behalf of the General Research Ethics Board, I wish you continued success in your research.

Yours sincerely,

Dean Tripp, Ph.D.
Chair, General Research Ethics Board

c.:   Ms. Asvini Kulanayagam and Mr. Mohammad Dastgheib, Co-investigators
        Dr. Leandre Fabrigar, Chair, Unit REB

Figure 2: General Research Ethics Board approval of the study.

Appendix C.

LETTER OF INFORMATION AND CONSENT FORM
FOR DATA COLLECTION AND PROTECTION

Principal Investigator: Hans C. Dringenberg, Ph.D.
Co-Investigator: Mohammad Dastgheib

Study Title: The role of napping, meditation, and relaxation on memory consolidation in humans

I, _____, have agreed to participate in the above-mentioned study, which aims to investigate the role of different behavioural states and activities (waking, napping, meditation, yoga) in memory consolidation. I am aware that, at any time, I am encouraged to ask for further information about the study and the specific, experimental procedures that will be performed during my participation.

Study Overview:
I am aware of and agree to participate in the following aspects of the study.

1. I will complete a questionnaire to collect the following, personal information: name; age; gender; handedness; employment status; confirmation of the absence of a diagnosis of neurological, psychiatry, and sleep disorders; confirmation that I currently do not use prescription medication that is known to affect sleep quality. I will complete the *Freiburg Mindfulness Inventory* questionnaire to characterize my experience of mindfulness.

2. On the day of the experiment, I will arrive in the lab during afternoon (2:30 to 3:00 pm), where I will complete the *Epworth Sleepiness Scale* to assess my level of wakefulness.

3. Subsequently, electroencephalogram (EEG), electromyogram (EMG), and electrooculogram (EOG) electrodes are attached to measure brain activity, muscle activity, and eye movements, respectively. I agree to have the principal investigator or co-investigator connect electrodes to the skin of my head and face to monitor EEG, EMG, and EOG activity for about 60 minutes, while I will either watch a movie, nap, meditate, and do yoga. I realize that the procedure to connect the electrodes involves some level of physical contact between the experimenter and me. Also, I am aware that

this procedure requires the application of conductive pastes and medical tape to my skin.

4. I agree to complete a number of behavioural learning tasks over a period of about 45 minutes, which will include:
- study paired associates (list of two nouns presented as pairs, e.g., "milk streetcar")
- visual-motor skill (subjects play a game where they navigate a marble through a wooden maze)

5. Next, I will enter a secure, quiet lab room (adjacent to the main lab room, where the investigators will be present throughout the entire duration of the experiment) by myself, where I will either watch a movie, nap, meditate, or do yoga. EEG, EMG, and EOC activity are monitored during this time period (45 - 60 minutes; all personal belongings can be brought with me into the room during this period).

6. Subsequently, I will return to the main lab and all electrodes are removed. I will again complete the *Epworth Sleepiness Scape* to assess if the different activities changed my level sleepiness.

7. Finally, I will be tested on the same tasks again to assess memory for the information learned during earlier task exposure.

8. I will be given the choice of receiving an immediate payment of $25, or being entered into a draw for a $250 gift card (Tim Horton's; Starbuck's). Participants recruited from the Departmental Subject Pool will receive credit toward PSYC 100 and an immediate payment of $10, consistent with Departmental policies; they are offered the choice of payment or entry into the draw.

Withdrawal for Study: I understand that I may withdraw from the study at any time during the two visits to the laboratory, or refuse to participate in specific aspects of the study without explanation and without incurring a penalty. If I decide to withdraw, all data collected up to this time point will be immediately destroyed unless I give permission that the experimenter keep my partial data on file for further analysis and possible inclusion (in aggregate form) in future publications resulting form the research.

Potential risks of participation: Physical risk: some participants may experience skin irritation by the medical tape or conductive paste required to attach the electrodes to the skin, even though such reactions are extremely rare. Immediately inform the experimenter if you experience discomfort or irritation of the skin; the experimenter will immediately remove all electrodes and clean the affected skin area with warm, soapy water (this is also performed at the end of all recording procedures).

2

Appendix C. cont.

Benefits of participation: Participants have an opportunity to experience research first-hand and learn about the role of sleep and other behavioral states in memory formation and optimal cognitive functioning.

Confidentiality of information and data: Each participant is assigned a unique code and data collected during the experiment are only linked to this code. All information and data are kept in a secure space at Queen's University (locked office and lab space; password-protected computers) and are only accessible to the principal and co-investigator(s). For the purposes of any written theses, conference presentations, and scientific publications, only aggregate data are presented. Data are kept for five years following the publication of the study results in a scientific journal. Subsequently, all data and other files are deleted (from computers) or shredded.

Ethics clearance: This study has been granted clearance by the Queen's University General Research Ethics Board, according to the recommended principles of Canadian ethics guidelines, and Queen's policies.

Questions or concerns regarding this project: Questions regarding this lab can be addressed to:

> Dr. Hans C. Dringenberg
> Principal Investigator
> Phone: 613-533-6215
> E-mail: dringenb@queensu.ca

Any ethical concerns about the study may be directed to the Chair of the General Research Ethics Board at:

> E-mail: Chair.GREB@queensu.ca
> Phone: 613-533-2988, ext. 32988

I understand that my consent to participate in this study does not waive any of my legal rights as an individual residing in Canada.

Signature: _____

Date: _____

3

Figure 3: Letter of information and consent form for data collection and protection.

Appendix D.

Participant Information Survey

1. Name (First/Last): _____

2. Do you have a current, medical diagnosis of any neurological, psychiatry, or psychological conditions (circle one)?

                                                   YES   NO

3. Do you have a current diagnosis for a sleep disorder and/or are you taking any prescription medication that could affect sleep (circle one)?

                                                   YES   NO

IMPORTANT: If you answered Yes to either Question 2 or 3, please do not continue with this questionnaire and talk to the investigator.

4. Age (years): _____

5. Gender (circle one):   Male   Female   Other

6. Handedness (circle):   Right   Left   Both

7. Employment Status: _____

8. Please check if you engage in either of the following activities (at least 3 times per week on average for the last 3 months)

Napping _____ If yes, what time do you typically nap? _____

Meditation _____ If yes, describe your technique: _____

How long have you been practicing? _____

9. At what time do you typically go to sleep? _____

At what time do you typically get up? _____

1

Appendix D. cont.

10. How would you characterize your typical sleep quality (circle one)?

   A.   I have no trouble sleeping and usually feel that I get enough sleep and am well-rested
   B.   I generally sleep well, but occasionally suffer from lack of enough sleep

   C.   My sleep is quite mixed; at times I sleep well, but at other times, I suffer from sleep loss and tiredness

   D.   I am a poor sleeper and it is rare for me to get enough sleep and feel well-rested

   E.   I suffer from chronic sleep loss and feel that my daytime functioning is impaired due to the poor quality of my sleep

Participant Code (condition + subject number): _____
C = control (movie); N = nap; M = meditate

2

Figure 4: Participant Information Survey.

Appendix E.

Freiburg Mindfulness Inventory

The purpose of this inventory is to characterize your experience of mindfulness. Please use the last *30* days as the time-frame to consider each item. Provide an answer the for every statement as best you can. Please answer as honestly and spontaneously as possible. There are neither 'right' nor 'wrong' answers, nor 'good' or 'bad' responses. What is important to us is your own personal experience.

	1	2	3	4
	Rarely	Occasionally	Fairly often	Almost always

I am open to the experience of the present moment.	1 2 3 4
I sense my body, whether eating, cooking, cleaning or talking.	1 2 3 4
When I notice an absence of mind, I gently return to the experience of the here and now.	1 2 3 4
I am able to appreciate myself.	1 2 3 4
I pay attention to what's behind my actions.	1 2 3 4
I see my mistakes and difficulties without judging them.	1 2 3 4
I feel connected to my experience in the here-and-now.	1 2 3 4
I accept unpleasant experiences.	1 2 3 4
I am friendly to myself when things go wrong.	1 2 3 4
I watch my feelings without getting lost in them.	1 2 3 4
In difficult situations, I can pause without immediately reacting.	1 2 3 4
I experience moments of inner peace and ease, even when things get hectic and stressful.	1 2 3 4
I am impatient with myself and with others.	1 2 3 4
I am able to smile when I notice how I sometimes make life difficult.	1 2 3 4

sum:

subject:

Figure 5: Freiburg Mindfulness Inventory.

Appendix F.

1. Were you able to stay awake?   YES   NO

2. If not, how long do you think you were asleep?

   5 min ————————————————————————————— 60 min

Figure 6: Self-report Questionaire for the wake condition.

Appendix G.

1. Were you able to meditate?   YES   NO

2. How would you describe the quality of your meditation?

 Poor   One of the best

     1   2   3   4   5

3. How long do you think you were meditating?

 5 min — 60 min

Figure 7: Self-report Questionaire for the meditation condition.

Appendix H.

1. Were you able to sleep?   YES   NO

2. How would you describe the quality of your sleep?

 Poor   One of the best

        1   2   3   4   5

3. How long do you think you were sleeping?

 5 min — 60 min

Figure 8: Self-report Questionaire for the sleep condition.

Appendix I.

Epworth Sleepiness Scale

Your name: _____ **Today's date**: _____

Your age (yrs): _____ **Your sex (Male = M, Female = F)**: _____

Reflect on how you feel at this moment. If you were currently in each of the listed situations, rate how likely would you be able to doze off or fall asleep

Use the following scale to choose the *most appropriate number* for each situation:

0	=	would **never** doze
1	=	**slight chance** of dozing
2	=	**moderate chance** of dozing
3	=	**high chance** of dozing

It is important that you answer each question as best you can.

Situation	Chance of Dozing (0 - 3)
Sitting and reading _____	_____
Watching TV _____	_____
Sitting, inactive in a public place (e.g. a theatre or a meeting) ___	_____
As a passenger in a car for an hour without a break _____	_____
Lying down to rest in the afternoon when circumstances permit ___	_____
Sitting and talking to someone _____	_____
Sitting quietly after a lunch without alcohol _____	_____
In a car, while stopped for a few minutes in the traffic _____	_____

Figure 9: Epworth Sleepiness Scale.

Appendix J.

GPSYC-779-16 The role of napping and meditation on human memory consolidation

Sleep research has been thriving as a field and much of this excitement is due to the apparent role of sleep in enhancing memory retention. Studies show that groups who sleep following a period of learning consistently perform better on re-tests than their counterparts who stay awake. There are many opposing theories that attempt to explain how sleep produces this memory consolidating effect but an area of the brain called the hippocampus appears to be involved. Interestingly, the hippocampus also appears to be highly activated during meditation in both novices and experienced meditators. Meditation is a wakeful state that is distinct from both sleep and typical wake-control situations such as watching a movie. Despite the evidence that meditation may be involved in memory, almost no research has been published to test the effect of meditation on memory tasks.

Your participation has helped us begin to bridge the gap in the literature. This study has served to broaden the scope of sleep research by considering comparisons to other behavioural states. We are confident that scientific interest in meditation will continue to grow in the years to come. As such, the potential practical applications of meditation such as improving memory performance will attract more research.

Please feel free to talk to the experimenter for more information on the research you just participated in. If you would like further information on this area of research, these are some related references that might be of interest to you.

1. Diekelmann, S., Wilhelm, I., & Born, J. (2009). The whats and whens of sleep-dependent memory consolidation. *Sleep Medicine Reviews, 13*(5), 309-321.
2. Ellenbogen, J. M., Hulbert, J. C., Stickgold, R., Dinges, D. F., & Thompson-Schill, S. L. (2006). Interfering with Theories of Sleep and Memory: Sleep, Declarative Memory, and Associative Interference. *Current Biology, 16*(13), 1290-1294.
3. Engström, M., Pihlsgård, J., Lundberg, P., & Söderfeldt, B. (2010). Functional Magnetic Resonance Imaging of Hippocampal Activation During Silent Mantra Meditation. *The Journal of Alternative and Complementary Medicine, 16*(12), 1253-1258.

Please direct any questions about the study or your participation to *Hans Dringenberg* at *dringenb@queensu.ca*. Any ethical concerns about the study may be directed to the Chair of the General Research Ethics Board at 613-533-6081 or Chair.GREB@queensu.ca

Again, thank you. Your interest in participating in this research study is greatly appreciated.

Hans Dringenberg   Liza Legro & Mohammad Dastgheib
Professor   Undergraduate & Graduate Honours Student

Figure 10: Debriefing and explanation of the study.

Appendix K.

Frequentist report

Declarative memory

The overall model predicting GMean (`formula = GMean ~ 1 + as.factor(Condition)`) explains 7.64% of the variance of the endogen (adj. $R^2 = 4.61$). The model's intercept is at 0.80 (SE = 0.025, 95% CI [0.76, 0.85]).

Within this model: - The effect of as.factor(Condition)NAP is not significant (beta = -0.026, SE = 0.033, 95% CI [-0.093, 0.040], t = -0.79, p > .1) and can be considered as small (std. beta = -0.23, std. SE = 0.29). - The effect of as.factor(Condition)WAKE is significant (beta = -0.080, SE = 0.036, 95% CI [-0.15, -0.0078], t = -2.22, p < .05) and can be considered as medium (std. beta = -0.70, std. SE = 0.31).

Non-declarative memory

non-SWS

The overall model predicting MedianScores (`formula = MedianScores ~ Condition + (1 | Code)`) has an total explanatory power (conditional R^2) of 59.98%, in which the fixed effects explain 4.50% of the variance (marginal R2). The model's intercept is at 5.53 (SE = 0.55, 95% CI [4.46, 6.60]).

Within this model: - The effect of ConditionNAP is not significant (beta = -0.63, SE = 0.93, 95% CI [-2.42, 1.17], t(43) = -0.68, p > .1) and can be considered as small (std. beta = -0.24, std. SE = 0.35). - The effect of ConditionWAKE is not significant (beta = -1.29, SE = 0.78, 95% CI [-2.81, 0.23], t(43) = -1.65, p > .1) and can be considered as small (std. beta = -0.49, std. SE = 0.30).

SWS

The overall model predicting MedianScores (`formula = MedianScores ~ Condition + (1 | Code)`) has an total explanatory power (conditional R^2) of 67.51%, in which the fixed effects explain 6.22% of the variance (marginal R2). The model's intercept is at 5.53 (SE = 0.51, 95% CI [4.54, 6.52]).

Within this model: - The effect of ConditionNAP is not significant (beta = -1.24, SE = 0.77, 95% CI [-2.74, 0.25], t(47) = -1.61, p > .1) and can be considered as medium (std. beta = -0.52, std. SE = 0.32). - The effect of ConditionWAKE is significant (beta = -1.29, SE = 0.72, 95% CI [-2.69, 0.11], t(47) = -1.79, p = 0.08) and can be considered as medium (std. beta = -0.54, std. SE = 0.30).

Appendix L.

Central Posterior Uncertainty Intervals

Declarative memory

Declarative memory
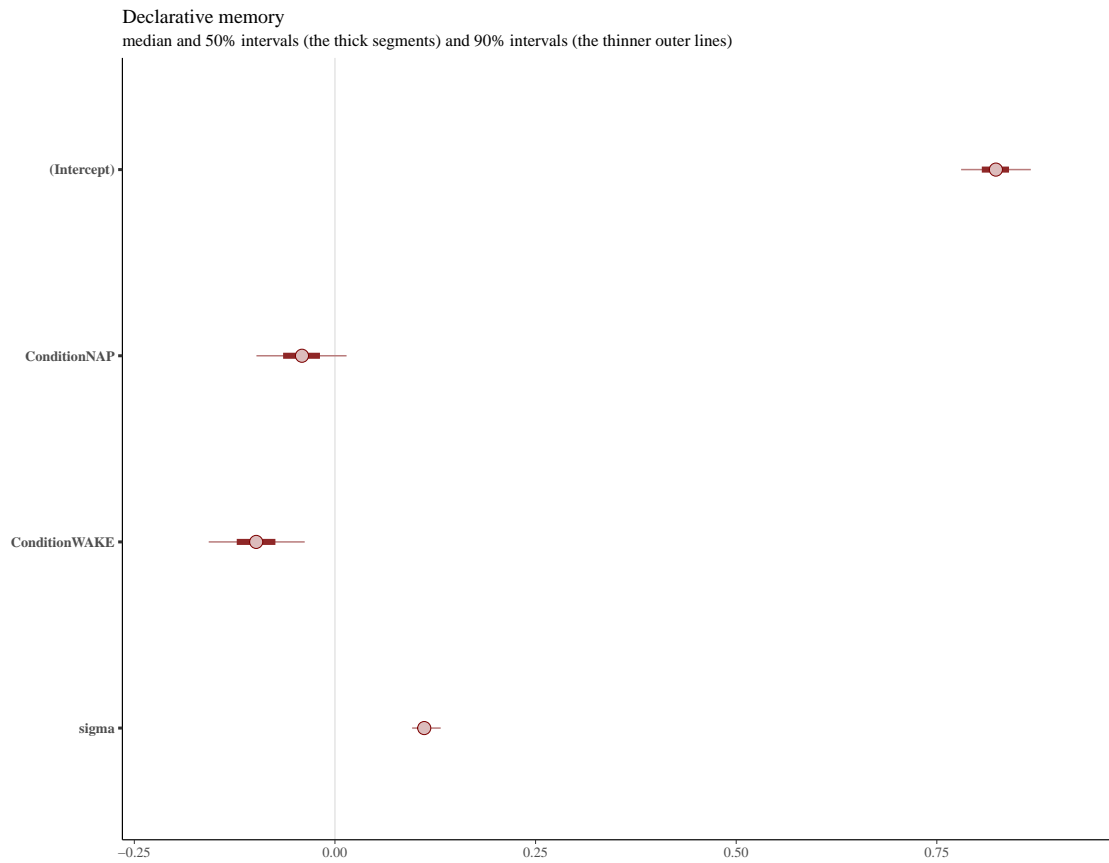median and 50% intervals (the thick segments) and 90% intervals (the thinner outer lines)

Figure 11: Central Posterior Uncertainty Intervals of the Declarative memory model.

Appendix L. cont.

Non-declarative memory
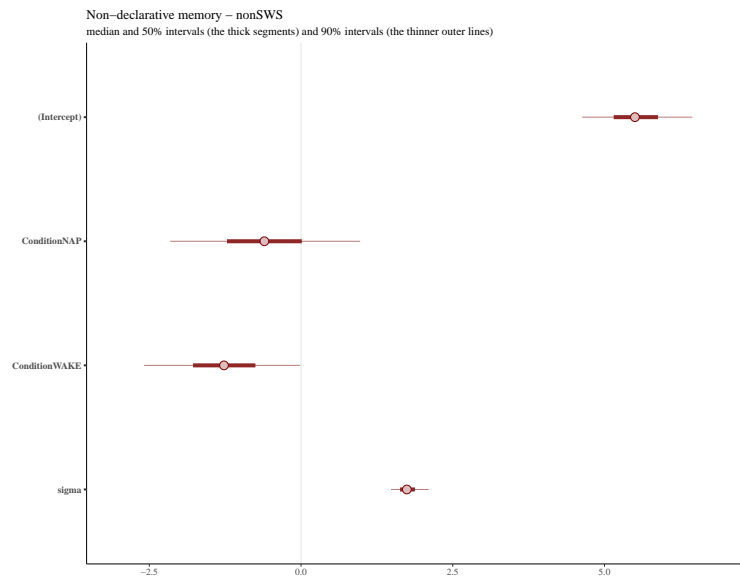
Central Posterior Uncertainty Intervals

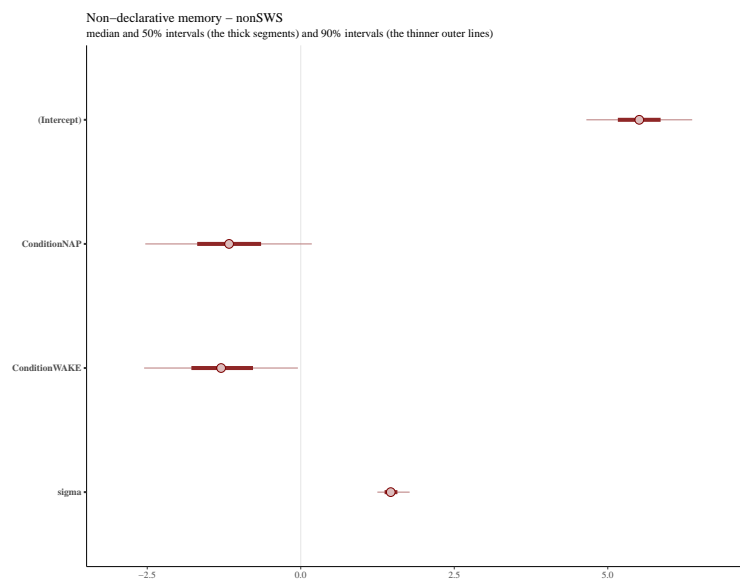Figure 12: Central Posterior Uncertainty Intervals of the Non-declarative memory model, non-SWS.

Figure 13: Central Posterior Uncertainty Intervals of the Non-declarative memory model, SWS.
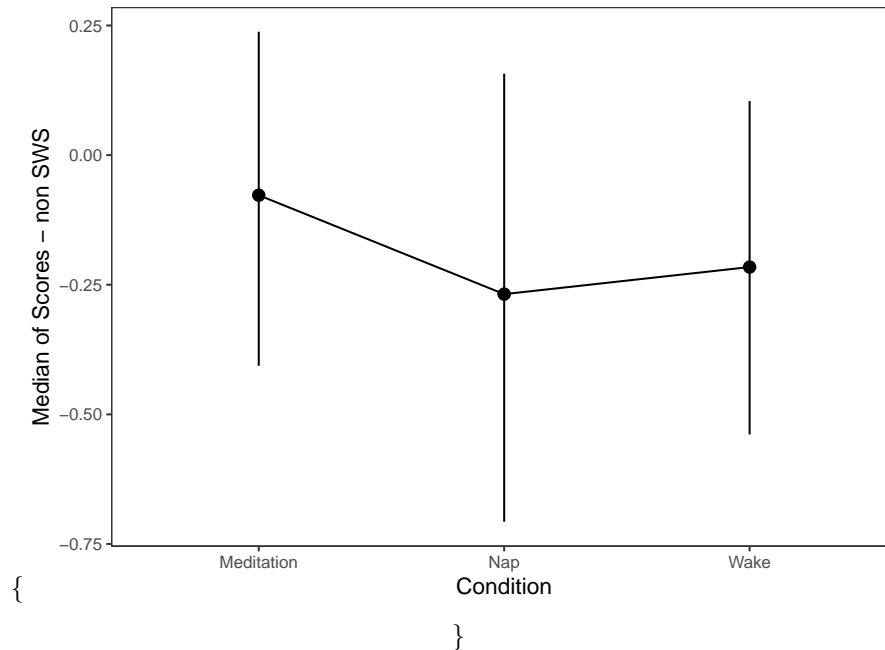
Appendix M.

The interaction of gender in non-SWS subset of nappers on non-declarative memory task

I fitted a Markov Chain Monte Carlo gaussian (link = identity) model (`4 chains, each with iter = 2000; warmup = 1000; thin = 1; post-warmup = 1000`) to predict Median Scores (`formula = scale(MedianScores) ~ Condition * Gender + (1 | Code)`). The model's priors were set as follows: ~ normal (location = (0, 0, 0, 0, 0), scale = (0.50, 0.50, 0.50, 0.50, 0.50))

The model has an explanatory power (R^2) of about 60.06% (MAD = 0.077, 90% CI [0.47, 0.72], adj. R^2 = 0.24). The intercept is at -0.086 (MAD = 0.20, 90% CI [-0.40, 0.24]). Within this model:

- The effect of stage 1 and 2 sleep has a probability of 74.98% of being negative (Median = -0.19, MAD = 0.28, 90% CI [-0.65, 0.28], Overlap = 74.61%).
- The effect of quiet wake has a probability of 70.28% of being negative (Median = -0.13, MAD = 0.25, 90% CI [-0.54, 0.28], Overlap = 78.90%).
- The effect of being Male has a probability of 99.50% of being positive (Median = 0.73, MAD = 0.28, 90% CI [0.28, 1.19], Overlap = 19.60%).
- The interaction between nap and being male has a probability of 53.97% of being negative (Median = -0.039, MAD = 0.41, 90% CI [-0.65, 0.67], Overlap = 96.14%).
- The interaction between quiet wake and being male has a probability of 78% of being negative (Median = -0.33, MAD = 0.43, 90% CI [-1.07, 0.37], Overlap = 71.10%).

\begin{figure}

{

}

\caption{The interaction of being male on the performance on the Maze task for nappers in the stage 1 and 2, meditators, and participants in the quiet wake condition. Error bars reflect 90% credible intervals.}
\end{figure}

Appendix M. cont.

The interaction of gender in SWS subset of nappers on non-declarative memory task

I fitted a Markov Chain Monte Carlo gaussian (link = identity) model (4 chains, each with iter = 2000; warmup = 1000; thin = 1; post-warmup = 1000) to predict MedianScores (formula = scale(MedianScores) ~ Condition * Gender + (1 | Code)). The model's priors were set as follows: ~ normal (location = (0, 0, 0, 0, 0), scale = (1.24, 1.24, 1.24, 1.24, 1.24)).

The model has an explanatory power (R^2) of about 65.02% (MAD = 0.062, 90% CI [0.54, 0.75], adj. R^2 = 0.47). The intercept is at 4.48 (MAD = 0.48, 90% CI [3.69, 5.25]). Within this model:

- The effect of SWS has a probability of 81.85% of being negative (Median = -0.60, MAD = 0.67, 90% CI [-1.59, 0.46], Overlap = 65.33%).
- The effect of quiet wake has a probability of 67.22% of being negative (Median = -0.27, MAD = 0.60, 90% CI [-1.20, 0.77], Overlap = 82.26%).
- The effect of being male has a probability of 99.95% of being positive (Median = 2.09, MAD = 0.65, 90% CI [1.07, 3.17], Overlap = 11.23%).
- The interaction between SWS and being male has a probability of 67.33% of being positive (Median = 0.42, MAD = 0.91, 90% CI [-1.06, 1.96], Overlap = 82.32%).
- The interaction between quiet wake and being male has a probability of 81.08% of being negative (Median = -0.96, MAD = 1.08, 90% CI [-2.74, 0.76], Overlap = 66.27%).
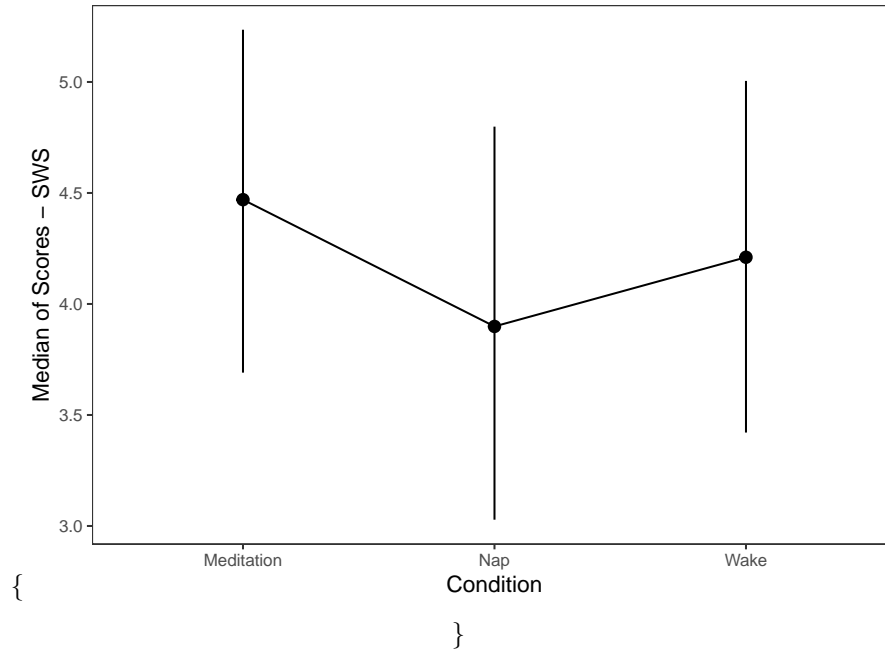
\begin{figure}

{

}

\caption{The interaction of being male on the performance on the Maze task for nappers in the SWS, meditators, and participants in the quiet wake condition. Error bars reflect 90% credible intervals.}
\end{figure}