Sleep architecture, emotional reactivity, and emotion regulation

Note: This registration document is created based on the "Prereg Challenge" registration form on Open Science Framework.

Study Information

Our goal is to examine the relationship of sleep architecture as a trait-like measure with emotional reactivity and emotion regulation. Sleep architecture is measured by polysomnography (PSG) for one-night sleep. Emotional reactivity and emotion regulation are measured in a laboratory Emotion Regulation Task with EEG (Electroencephalography) and EMG (Electromyography) recordings.

Research questions

The overarching goal of the current study is to understand the relationship between sleep architecture, emotional reactivity, and emotion regulation. Based on previous research, the current study focuses on how rapid eye movement (REM) sleep and slow wave sleep (SWS) relate to emotional reactivity and emotion regulation. The research questions are:

1. Is REM sleep or SWS related to emotional reactivity?
2. Which sleep stage is more strongly related to emotional reactivity?
3. Is REM sleep or SWS related to emotion regulation?
4. Which sleep stage is more strongly related to emotion regulation?
5. Is sleep architecture related to emotion regulation while controlling for emotional reactivity?

Hypotheses

1. Both REM sleep and SWS are related to emotional reactivity. We do not have a directional prediction about the relationship between REM sleep and emotional reactivity. We predict a negative relationship between SWS and emotional reactivity.
2. REM sleep is more strongly related to emotional reactivity than SWS.

3. Both REM sleep and SWS are related to emotion regulation. We do not have a directional prediction about the relationship between REM sleep and emotion regulation. We predict a positive relationship between SWS and emotion regulation.
4. We have no directional hypothesis about which sleep stage (REM or SWS) is more strongly related to emotion regulation.
5. Sleep architecture (REM and SWS) is still related to emotion regulation while controlling for emotional reactivity.

Sampling Plan

Existing data

Registration following analysis of the data.

Explanation of existing data

The data collection has been completed. We have calculated the descriptive statistics of the measures of emotional reactivity and emotion regulation for another research study using the same dataset. We have not accessed any data of sleep architecture nor conducted any analyses related to the research questions of the current study.

Data collection procedures

PSG recording night: A team of two research assistants went to the participant's home and brought the equipment with them. They equipped the participant with the PSG electrodes and sensors, tested that the data recording was working appropriately and performed a set of biocalibrations. They instructed the participant on how to appropriately handle the equipment, including carrying the amplifier purse during the evening and if getting up at night and how to remove the equipment in the morning. Research assistants then left the equipment with the participant overnight for recording. They came back to the participant's home the next morning at an agreed upon time after the participant's wake time and pick up the equipment. Approximately 2 weeks after the PSG night, participants came to the laboratory to complete a task for assessing emotional reactivity and emotion regulation.

In-lab testing: Two weeks after the PSG night, participants went to our laboratory for testing emotional reactivity and emotion regulation. Participants were equipped with psychophysiological electrodes and sensors for data collection, which included sensors for ECG, ICG, respiratory bands, EEG, temperature,

EMG, GSR. At first, they performed in a simple baseline task (to count the times a bouncing ball turns red). Later, they were instructed on the emotion regulation (ER) task and performed the ER task while their psychophysiological responses were collected. Participants subsequently were detached from recording equipment, debriefed, paid, and thanked for their study participation.

The details of the ER task are as follows:

1 Description of Study Experimental Manipulation

This study uses a highly controlled, standardized, and well-validated laboratory-based experimental task that presents emotional pictures with cues to either respond naturally or decrease negative emotion in response to them to probe ER. The study intervention is an experimental task that tests ER. It does so by presenting emotionally charged neutral or negative pictures as an emotion induction, instructs on the use of natural or regulated responding, and measures ER using several different response measures.

2 Administration of Experimental Manipulation

The experimental manipulation consists of a 2 within (emotion: neutral, negative) x 3 within (regulation: WATCH, RETHINK, DISTRACT) x 5 between (block order: 1, 2, 3, 4, 5) mixed factorial design (the first factor may alternatively be conceptualized as a 4-level (negative intensity: neutral, low, medium, high) factor). For emotion manipulation, participants view negative and neutral emotional picture stimuli on a computer screen that have been normed for the appropriate emotional valence. For regulation manipulation, prior to each picture, participants are instructed either to WATCH (e.g., “simply pay attention to the depicted situation and allow any thoughts and feelings to arise as they naturally would”), RETHINK (e.g., “think about what is going on in the depicted situation in a way that helps you feel less negative”), or DISTRACT (e.g., "think about something that is completely unrelated to the depicted situation and helps you feel less negative").

Each trial sequence will be as follows: Initially, the cue to WATCH, RETHINK, or DISTRACT appears (2 s). An emotionally negative or neutral picture is presented on the screen, during which participants are asked to implement ER instructions (6 s). Participants then rate strength of their current negative affect (4 s; e.g., “How NEGATIVE did you feel by the time the picture left the screen?”) and emotional arousal (4 s; e.g., "How emotionally CHARGED or ACTIVATED did you feel by the time the picture left the screen?"). Picture stimuli and trial order are counterbalanced to control for potential confounds. Participants are presented with a pseudo-random order of 180 trials (16 s each; including 45 RETHINK

negative*, 45 DISTRACT negative*, 45 WATCH negative*, and 45 WATCH neutral trials) across 5 blocks each lasting approximately 12 min.

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[*including 15 low negative, 15 medium negative, and 15 high negative]

3 Assessment of Subject Compliance with Study Intervention or Experimental Manipulation

Before performing the ER task, participants practice implementing instructions when cued and rating their current negative affect via keyboard presses. Instructions for the ER task are presented in standardized fashion as a slide show on the computer. A written protocol for training research staff for how to administer the ER task details to experimenters how to respond depending on participant performance and how to classify participant responses. Participants must demonstrate evidence of (1) clear understanding of rethinking via saying back what it is and (2) clear ability to implement rethinking via talk aloud of a successful rethinking. Anyone who is not able to achieve this criterion will be excused from participation (< 1% in previous studies).

After each block, participants are asked to rate the following items on a scale from 1 to 5:

- Fatigue: How TIRED do you feel right now? (from “not at all tired” to “very tired”)
- Attention: How FOCUSED were you on the task during the block you just finished? (from “not at all focused” to “very focused”)
- Successful performance of WATCH trials: In what percentage of WATCH trials did you pay attention and respond naturally? (from “0-20%” to “81-100%” of trials in steps of 20%)
- Successful performance of RETHINK trials: In what percentage of RETHINK trials did you think differently about the situation? (from “0-20%” to “81-100%” of trials in steps of 20%)
- Successful performance of DISTRACT trials: In what percentage of DISTRACT trials did you think about something that is completely unrelated to the depicted situation? (from “0-20%” to “81-100%” of trials in steps of 20%)

Sample size

Our target sample size for analyses is 84 participants. To account for possible drop-outs and missing data, we plan to recruit 100 participants.

Sample size rationale

We used the software program G*Power to conduct a power analysis. In order to detect a medium-sized correlation (r = .3) with 80% power at the standard .05 alpha rate, 84 participants are needed.

Stopping rule

The data collection has stopped for the purpose of another bigger research study. We stopped recruiting new participants once at least 35 participants who are sleep bruxism positive and 35 participants who are sleep bruxism negative had been included. We ended up having 104 participants included regardless of their state of sleep bruxism (positive, negative, or uncertain).

Variables

Manipulated variables

In the Emotion Regulation Task, there are three trial conditions (i.e., *watch, rethink, distract*), where we manipulated the strategy that participants use while viewing picture stimuli.

Measured variables

Polysomnography (PSG) - Polysomnography will be recorded for one whole night's sleep. The PSG data will be scored by an external registered polysomnography technician.

Emotion Regulation Task - In each trial, a neutral or a low/medium/high negative emotional picture is presented. We will measure (a) subjective valence and arousal ratings, (b) corrugator EMG reactivity, and (c) EEG late positive potential (LPP) amplitudes at P3, Pz, and P4 (referenced to linked mastoids).

Indices

Sleep stages - REM sleep will be quantified as the total duration of REM sleep and the percentage of REM sleep in total sleep duration of the PSG night. SWS will be quantified as the total duration of SWS and the percentage of SWS in total sleep duration of the PSG night.

Emotional reactivity - There are three conditions in the emotion regulation task, that is, *watch, rethink, and distract*. Emotional reactivity will be measured as the average (a) subjective valence and arousal ratings, (b) corrugator EMG reactivity, and (c) EEG late positive potential (LPP) amplitudes at the parietal region (the average of P3, Pz, and P4) across the *watch* trials of low/medium/high negative emotional pictures.

Emotion regulation - Emotion regulation will be quantified as the reduction in emotional reactivity as measured by subjective ratings, corrugator EMG reactivity, and LPP amplitudes from the *watch* condition to the *rethink* or *distract* condition during trials of low/medium/high negative emotional pictures.

Design Plan

Study type

Observational Study - Data is collected from study subjects that are not randomly assigned to a treatment. This includes surveys, "natural experiments," and regression discontinuity designs.

Blinding

No blinding is involved in this study.

Study design

This study follows a cross-sectional design.

Randomization

In the Emotion Regulation task, a total of 180 trials is presented in a pseudo-random order across 5 blocks.

Analysis Plan

Statistical models

1. Zero-order Pearson correlations will be obtained among all indices of REM sleep, SWS, emotional reactivity, and emotion regulation.
2. Linear regressions in prediction of emotional reactivity* will be conducted with REM sleep duration and SWS duration as the predictors.
3. Linear regressions in prediction of emotional reactivity* will be conducted with REM sleep percentage and SWS percentage as the predictors.
4. Linear regressions in prediction of emotion regulation* will be conducted with REM sleep duration and SWS duration as the predictors.
5. Linear regressions in prediction of emotion regulation* will be conducted with REM sleep percentage and SWS percentage as the predictors.
6. Linear regressions in prediction of emotion regulation* will be conducted with REM sleep duration and SWS duration as the predictors while controlling emotional reactivity.
7. Linear regressions in prediction of emotion regulation* will be conducted with REM sleep percentage and SWS percentage as the predictors while controlling emotional reactivity.

All analyses above will also be conducted in a Bayesian approach to get a Bayes factor (BF).

*subjective rating, EMG, and EEG indices of emotional reactivity/emotion regulation will be tested in separate linear regression models.

Transformations

NA

Follow-up analyses

NA

Inference criteria

We will use the standard $p < .05$ criteria for determining if the relationships between IV and DV are significant. We will use the BF < 1/3 criteria for supporting the null hypotheses.

Data exclusion

Participants without any PSG data or any Emotion Regulation Task data will be excluded listwise.

Missing data in clinical research is to be expected, yet the importance of dealing with missing data and its impact on the research results have often been overlooked (Wood, White, & Thompson, 2004). In order to increase the statistical power, while determining possible biases, a Missing-Value Analysis (MVA) will used to classify the missing values to further understand their impact on the results (Sterne, et al., 2009). If the type of missing data is determined as MCAR (Missing Completely at Random) and the percentage of participants with missing data in the sample is over 5%, multiple imputations will be used to limit the negative impact of missing data (Sterne, et al., 2009).

PSG data - PSG data will be labelled as missing if the total sleep duration is less than 3 hours. PSG data will be also labelled as missing if there is insufficient number of properly functioning PSG channels for the sleep technician to score the sleep architecture.

Emotion Regulation Task data - Out of a total of 180 trials, if there are valid data (rating, EMG, or EEG) of less than 90 trials for a participant, the data of this participant will be excluded from further analyses. For EMG and EEG, data of malfunctioning channels will be excluded across all trials. For EEG data, trials will be excluded if it is contaminated with artifacts. For calculating LPP, a participant has to have at least 2 properly functioning channels with at least 90 valid trials.

Outliers - Outliers are identified as more than 3 standard deviations above or below the mean. Outliers will be excluded from analyses.

Missing data

See Data exclusion. Missing data will be excluded analysis-wise.

Exploratory analysis

While the main goal of this study is to determine the general impact of sleep-architecture as a trait-variable on emotion-regulation as well as emotion reactivity, we aim to further test in exploratory analysis, if the hypothesized relationships still can be found after controlling for different covariates. The possible covariates are: bruxism state, habitual sleep quality, habitual sleep duration, sleep quality during the PSG night, sleep duration during the PSG night, self-reported depression, anxiety, and stress. We will also explore quantifying REM sleep and SWS in EEG power spectral density (e.g., delta, theta, alpha, beta, and gamma waves) and relating the power densities in a certain sleep stage with the outcome variables. These exploratory testing might be subject to changes in later stages during the preregistration.

Reference

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