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Effects of multiple consecutive nights of rocking stimulation on sleep and memory in young healthy adults

Submission date	Recruitment status	[_] Prospectively registered
08/03/2023	No longer recruiting	[_] Protocol
Registration date	**Overall study status**	[_] Statistical analysis plan
17/03/2023	Completed	[_] Results
Last Edited	**Condition category**	[_] Individual participant data
16/12/2025	Other	[X] Record updated in last year

Plain English summary of protocol

Background and study aims

Recently, improvements in technology and developments in scientific understanding have begun to uncover new potential methods for improving memory and sleep. Using a rocking bed, a team in Geneva (Switzerland) revealed that, compared to a stationary night, continuous gentle lateral rocking during a whole night of sleep has beneficial consequences on the sleep of healthy young adults. Indeed, compared to a stationary condition, a rocking motion not only facilitated entrance into sleep but also prolonged time spent in deep sleep and reduced nighttime awakenings with benefits on declarative memory performance. Thus, by specifically targeting sleep entrance and maintenance - which are the two main complaints in ageing sleep in general – sleeping in a rocking bed could improve sleep in this population as well as memory. However, so far, rocking stimulation has only been conducted over a single-night study but its persistent beneficial effects have never been investigated.

The aim of this study is to test whether the effect of rocking stimulation on sleep and memory is constant and can persist over three consecutive nights compared to two nights in a stationary position in young healthy sleepers. A bed based on the design from the initial studies conducted in Geneva, Switzerland will be rocking gently from side to side during the rocking nights while remaining in a stationary position during the control stationary nights. The study will use subjective (i.e., self-reported questionnaire) and objective (i.e., polysomnographic recordings) measures of sleep as well as cognitive tasks assessing overnight memory improvement in procedural (i.e., sequence finger tapping task) and declarative (i.e., word paired-associate learning task) memory to assess the difference between sleep in a rocking and a stationary position.

Who can participate?

Young (18-35-year-old) healthy individuals without any sleep complaints

What does the study involve?

Three consecutive nights sleeping in a bed rocking laterally slowly and three nights of sleep in a

stationary position (i.e., screening night + 2 consecutive stationary nights). Sleep measures are assessed with polysomnographic recordings every night. Participants are also asked to perform computerized memory tasks and to fill out questionnaires.

What are the possible benefits and risks of participating?
The researchers do not expect any major benefits or risks, only minor inconveniences like skin irritation due to electrode placement.

Where is the study run from?
Centre de recherche de l'institut universitaire de gériatrie de Montréal (CRIUGM), affiliated with the Sleep, Cognition and Neuroimaging Laboratory (SCNLab) (Canada)

When is the study starting and how long is it expected to run for?
November 2018 to December 2023

Who is funding the study?
1. Fonds de recherche du Québec (Canada)
2. Quebec Network for Research on Aging (RQRV) (Canada)

Who is the main contact?
1. Dr Aurore Perrault, aurore.perrault@gmail.com
2. Dr Thien Thanh Dang-Vu, tt.dangvu@concordia.ca

Contact information

Type(s)
Principal investigator

Contact name
Dr Aurore A. Perrault

ORCID ID
https://orcid.org/0000-0003-2839-610X

Contact details
Concordia University, HKAP department
7141 Rue Sherbrooke O
Montréal
Canada
QC H4B 1R6
+1 (0)514 848 2424
aurore.perrault@gmail.com

Type(s)
Principal investigator

Contact name
Prof Thien Thanh Dang Vu

Contact details

Concordia University, HKAP department
7141 Rue Sherbrooke O
Montreal
Canada
QC H4B 1R6
+1 (0)514 848 2424
tt.dangvu@concordia.ca

Additional identifiers

Clinical Trials Information System (CTIS)
Nil known

ClinicalTrials.gov (NCT)
Nil known

Protocol serial number
Nil known

Study information

Scientific Title
Effects of multiple consecutive nights of rocking stimulation on subjective sleep quality, sleep brain oscillations and sleep architecture as well as procedural and declarative memory consolidation in young healthy adults

Acronym
ROCK-Y

Study objectives
Concerning the first night of each condition: compared to the first night of stationary sleep, the first night in the rocking condition will be associated with a beneficial improvement in sleep and memory (see outcomes below).
Within each condition (i.e., 2 nights in a stationary position, 3 nights rocked), we expect no change from the first night to the last night in both conditions, suggesting that the beneficial effect of rocking will persist during multiple consecutive nights.

Primary outcome:
Using polysomnographic (PSG) recording, participants will exhibit a change in sleep architecture, including reduced sleep onset latency (SOL) and an increased proportion of time spent in deep sleep (NREM 3), with decreased time spent in lighter sleep stages (NREM1 +NREM2), as well as a reduction in sleep fragmentation and arousals, when rocked compared to a stationary position. Moreover, rocking stimulation will beneficially affect NREM brain oscillations activity including the density of sleep spindles while also entraining the generation of spindles and slow oscillations into a rhythmic appearance. No other characteristics of spindles and slow oscillations will be affected (i.e., frequency, duration, amplitude, coupling). REM characteristics (i.e., phasic and tonic REM sleep, eye movement) will not be affected by the stimulation.
Self-reported measures of sleep will be associated with improved subjective sleep quality (five-point scale) and a better perception of sleep (e.g., level of mismatch between objective

recording and the subjective report of sleep duration) during rocking nights compared to stationary nights.
Such beneficial effects will appear on the first night and remain stable across the 3 days of rocking sleep, compared to the 2 days of stationary sleep.

Secondary outcomes:
When compared to the stationary condition, the rocking condition will be associated with improved mood and daytime functioning, as assessed with self-report questionnaires (i.e., fatigue levels, positive and negative affect).
When compared to the stationary condition, the rocking condition will be associated with enhanced overnight improvement in declarative memory, as assessed with the accuracy difference between delayed (i.e., morning) and immediate (i.e., evening) recalls for a word-pair associate learning task (46 pairs of words). We expect the improvement on Day 2 to be greater after the second rocking night compared to the second stationary night.
When compared to the first night of stationary sleep, the first night of rocking sleep will be associated with enhanced overnight improvement in procedural memory, as assessed with the accuracy and speed differences between delayed (i.e., morning) and immediate (i.e., evening) performances for a finger-tapping task (five-digit sequences).
The enhanced memory performance improvements found in the rocking condition (i.e., declarative and procedural) will be positively associated with enhanced spindle activity (e.g., sigma spectral power).

Exploratory analyses will be performed in order to understand the effects of rocking during REM sleep, and on markers of physiological arousal, such as heart rate variability (HRV) measured using the electrocardiogram leads during the PSG recording at every visit.

Ethics approval required
Old ethics approval format

Ethics approval(s)
Approved 16/12/2021, Comité d'éthique de la recherche vieillissement – neuroimagerie du centre intégré universitaire de santé et de services sociaux (CIUSS) du Centre-Sud-de-l'Île-de-Montréal [Aging – Neuroimagery Research Ethics Committee of the Centre-Sud-de-l'Île-de-Montréal Integrated University Health and Social Services Centres] (1001 boulevard de Maisonneuve Est, Montreal, H2L 4P9, Canada; +1 (0)514 809 3929; karima.bekhiti.ccsmtl@ssss.gouv.qc.ca), ref: 21-22-26

Study design
Single-centre within-subjects interventional randomized cross-over trial

Primary study design
Interventional

Study type(s)
Quality of life

Health condition(s) or problem(s) studied
Sleep quality and memory in healthy young adults

Interventions

This study is composed of two blocks of two consecutive “stationary” nights and three consecutive “rocking” nights, a week apart. The order in which participants experience the blocks is randomized and counterbalanced (1:1 allocation ratio). At the pre-intervention baseline (part of the screening process), participants complete self-report measures on insomnia severity, depression and anxiety, as well as overnight polysomnography to screen for sleep disorders. Randomization is then conducted.

Participants sleep on the same bed for all 6 nights (i.e., screening night, 2 stationary nights and 3 rocking nights) and their sleep is recorded with polysomnography. During the rocking nights, the stimulation is generated by an electric motor and a rails system with wheels, placed on a commercially available bedframe. A mattress is placed on top of the rocking apparatus and is displaced 10.5 cm laterally (i.e., side-to-side, with no vertical element) at 0.25 Hz during the entire night. The stimulation can be activated and stopped with a remote control by the participant. During the screening and stationary nights, the bed remains in a stationary position.

Questionnaires on mood and subjective sleep quality are completed after every night spent at the laboratory. Concerning declarative and procedural memory tasks, encoding and immediate recall tests are performed on the first night of both rocking and stationary blocks. The delayed recall for the procedural memory task is only done on the first morning of each block, while the recall of declarative memory task is performed on each subsequent morning of each block (i.e., the second and third night of the rocking block, and the second night of the stationary block).

Intervention Type
Other

Primary outcome(s)
1. Objective sleep architecture and brain oscillations will be investigated with polysomnography (PSG) recordings at every visit. Sleep measures include total sleep time, sleep onset latency, sleep efficiency (i.e., the ratio of total sleep time over time over the time spent in bed), time spent in each sleep stage and awake, sleep fragmentation (i.e., sleep stage changes), number of arousals, spindles and slow oscillations activity (count, density, timing, amplitude, frequency), spectral activity, eye movement.
2. Subjective sleep measures will be extracted from a sleep questionnaire answered in the morning after each visit. Subjective sleep measures include estimated total sleep time, sleep quality, wake duration and sleep onset latency. The sleep perception index will be calculated by dividing subjective sleep measures by objective sleep measures.

Key secondary outcome(s))
1. Mood measured using the Profile of Mood States (POMS) questionnaire filled before and after sleep at every visit
2. Fatigue and daytime functioning measured with homemade self-report questionnaires on the mornings of each visit
3. Declarative memory overnight improvement, measured with the difference in accuracy (i.e., the ratio of correct answers over wrong answers) between immediate (i.e., evening) and delayed (i.e., morning) recall tests. The memory encoding tests are performed on the first stationary and rocking night in the evening and the recall tests are performed immediately after the encoding tests on the first night of each condition and repeated every morning.
4. Procedural memory overnight improvement, measured with the difference in speed (i.e., number of correct sequences performed per 30-second blocks) and accuracy (i.e., the ratio of correct sequences over total sequences tapped) between delayed (i.e., morning) and immediate (i.e., evening) recall tests. The memory recall tests are only performed on the first stationary and

rocking condition evening and morning.
5. Heart rate variability measured with the electrocardiogram lead from the PSG at every visit

Completion date
01/12/2023

Eligibility

Key inclusion criteria
1. Self-report as a good sleeper, with no sleep complaints
2. 18 to 35 years old

Participant type(s)
Healthy volunteer

Healthy volunteers allowed
Yes

Age group
Adult

Lower age limit
18 years

Upper age limit
35 years

Sex
All

Total final enrolment
19

Key exclusion criteria
1. Out of the age range
2. Medical conditions likely to affect sleep; in particular:
2.1. Current neurological disorder (e.g., epilepsy with any seizure in the past year, concussion in the past 3 months, multiple sclerosis, Parkinson's disease)
2.2. Brain lesion history (e.g., brain hemorrhage, brain tumor, any condition having required brain surgery)
2.3. Major surgery (i.e., requiring general anesthesia) in the past 3 months
2.4. Untreated thyroid disorder
2.5. Chronic pain syndrome self-reported as interfering with sleep (e.g., migraine, fibromyalgia, rheumatoid arthritis)
2.6. Recent and severe infection in the past 3 months (e.g., pneumonia, kidney infection)
2.7. Active cancer or treated cancer with post-cancer treatment for less than 2 years
2.8. Severe mental disorder (psychotic disorders, anxiety disorder, major depression)
2.9. Current psychotherapy or use of medication for depression or anxiety
2.10. Pregnant or breastfeeding women
2.11. Impaired cognitive function (diagnosed dementia)

2.12. Other cardiac, breathing or sleep-related anomalies detected at the polysomnography screening
3. Major cardiovascular events or interventions; in particular:
3.1. Stroke
3.2. Myocardial infarction
3.3. Arterial bypass or angioplasty (coronary, carotid, femoral, etc)
3.4. Pacemaker
3.5. Heart failure causing limitation of ordinary physical activity
4. Sleep-related conditions:
4.1. Sleep complaints
4.2. Sleep apnea with an apnea-hypopnea index (AHI) >5/h
4.3. Restless legs syndrome with symptoms 3 days or more per week
4.4. Periodic limb movements during sleep with index >15/h
4.5. REM-sleep behavior disorder with > 1 episode/month
4.6. Narcolepsy with cataplexy
4.7. Unable to stop hypno-sedative medications for at least 2 weeks prior to the first assessment and during the whole study protocol
5. Substance consumption, in particular:
5.1. Frequent alcohol consumption (>10 glasses/week) or use of cannabis (more than once a week) or illicit drugs (more than once a month)
5.2. Smoking more than 10 cigarettes/day
6. Having worked on night shifts or rotating shifts for more than 2 weeks in the last 3 months
7. Any vestibular disorders or a score >19 on the Motion Sickness Susceptibility Questionnaire (MSSQ)
8. Motor impairment

Date of first enrolment
01/07/2022

Date of final enrolment
01/11/2023

Locations

Countries of recruitment
Canada

Study participating centre
Centre de recherche de l'institut universitaire de gériatrie de Montréal (CRIUGM)
4565 Queen Mary Road
Montreal
Canada
H3W 1W5

Sponsor information

Organisation
Centre de Recherche de l'Institut Universitaire de Geriatrie de Montreal (CR-IUGM)

Funder(s)

Funder type
Research organisation

Funder Name
Fonds de recherche du Québec - intersectorial program AUDACE

Alternative Name(s)
Quebec Research Fund, FRQ

Funding Body Type
Government organisation

Funding Body Subtype
Local government

Location
Canada

Funder Name
Réseau québécois de recherche sur le vieillissement

Alternative Name(s)
Quebec Network for Research on Aging, RQRV

Funding Body Type
Private sector organisation

Funding Body Subtype
Research institutes and centers

Location
Canada

Results and Publications

Individual participant data (IPD) sharing plan
The dataset generated during and/or analysed during the current study will be available upon request from Dr Thien Thanh Dang Vu (tt.dangvu@concordia.ca) and Dr Aurore Perrault (aurore.

perrault@gmail.com). Data (including PSG recording) will be available upon request once published - consent was obtained and anonymization was performed.

IPD sharing plan summary

Available on request

Study outputs

Output type	Details	Date created	Date added	Peer reviewed?	Patient-facing?
Participant information sheet	Participant information sheet	11/11/2025	11/11/2025	No	Yes