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ORIGINAL ARTICLE

The Effect of Rocking Bed on Mood and Attention

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Objective: The current study aims to explore the effects of sleep in the rocking bed on mood and attention. **Methods:** Thirty-nine young adults (14 with insomnia and 25 without insomnia) slept in the Sway Bed under three different conditions; 1) motionless condition, 2) continuously rocking condition, and 3) before-sleep rocking condition. In the motionless condition, participants slept without rocking for all night. In the continuously rocking condition, rocking started when lights out and stopped at wake-up time. In the before-sleep rocking condition, rocking started when lights out, but stopped after sleep onset. The Profile of Mood States and the computerized Comprehensive Attention Test were conducted before and after experimental sleep. **Results:** Under continuously rocking, depression, tension, anger, fatigue, confusion, and standard deviation of reaction time in divided attention were reduced. Under after-sleep bed condition, depression, tension, fatigue, confusion and omission errors in divided attention were reduced. There were no significant differences in after-sleep mood or attention changes between bed conditions. However, within those with insomnia, after-sleep improvement of depression and divided reduction were larger under continuously rocking conditions than under motionless conditions. **Conclusion:** Sleeping in the rocking bed improved negative affects and divided attention. The effects of rocking bed on depression and divided attention were prominent especially in those with insomnia. The current findings suggest that the sleep in the rocking bed may improve the depressive mood and the impaired attention of insomnia patients.

Keywords: Rocking bed; Sleep; Mood; Attention

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INTRODUCTION

For centuries, rocking beds and hammocks have served as popular choices for sleep across various cultures and generations. Nevertheless, the connection between this oscillating environment and sleep remains unclear. It has been argued that providing electrical stimulation to the vestibular nervous system, akin to the sensation experienced in a swaying environment, may be effective for promoting sleep. Previous reports have indicated that stimulating the vestibular nerves reduces the duration of sleep spent in the N2 stage [1]. Experimental findings also suggest that individuals experiencing transient insomnia, particularly those with delayed onset of sleep, could achieve earlier sleep onset by stimulating the vestibular nerves [2]. In an experiment involving the direct use of a rocking bed, it was observed that the rocking motion enhanced sleep in individuals with neuro-muscular breathing issues [3]. A recent study concluded that the utilization of a rocking bed led to increased instances of napping [4]. These investigations postulated that the rocking motion diminished the N1 sleep stage and shortened the sleep onset latency, while augmenting the N2 sleep stage and spindle density. These findings suggest that the rocking environment promotes sleep and enhances sleep quality by stimulating slow-wave and spindle activities.

Furthermore, given the close relationship between sleep, emotions, concentration, and attention, it is also pertinent to consider the impact of rocking beds on these factors [5]. The vestibular organ, which is stimulated through shaking, and its corresponding sensory pathways are anatomically linked to the amygdala, a brain structure closely associated with emotions [6]. The amygdala plays a role in regulating both sleep and wakefulness, and it is also implicated in the sensation of comfort associated with shaking [7]. Additionally, there is study demonstrating that the stimulation of vestibular organs is associated with the regulation of anxiety itself [8]. The shaking stimuli that engage the thalamo-cortical network influence the synchronicity of neural activity. This perspective aligns with research indicating that slow rhythmic transcranial

magnetic stimulation enhances EEG slow oscillations and spindles, hallmark features of deep sleep [9]. Furthermore, this stimulation promotes memory consolidation both before and after sleep [10].

Despite the anticipated effects of the rocking bed as outlined above, it remains unclear what specific characteristics, such as improvements in sleep, emotions, and attention, may manifest in individuals. Therefore, the current study aims to investigate the following hypotheses by providing an environment utilizing a rocking bed: First, there would be improvement of mood and attention after sleeping in rocking bed. Second, there would be differences in the improvement of mood and attention between sleeping in rocking bed and sleeping in motionless bed. Third, there would be differences in the improvement of mood and attention between sleeping in bed rocking throughout night and sleeping in bed rocking only before initiation of sleep. Finally, the improvement of mood and attention after sleeping in rocking bed would be prominent in those with insomnia.

METHODS

Participants

The participants were recruited from Samsung Medical Center, between December 6, 2021, and October 15, 2023. The study participants were recruited through both online and offline advertisement. The inclusion criteria were young and healthy adults aged 20 to 39. The exclusion criteria were 1) an inability to complete the questionnaires by intellectual disability, major neurocognitive disorder, severely impaired schizophrenia, 2) current severe episode of major depressive disorders or manic episode, 3) substance or alcohol abuse history within 1 years, 4) medication or medical illness affecting sleep or arousal, 5) shift-work, 6) smoking more than 6 months including last month, and 7) severe sleep disorders (e.g., apnea-hypopnea index score ≥30 or periodic limb movement during sleep index score ≥50).

Initially, 50 agreed to participate in the current study. Eleven did not complete the study, since they withdrew the consent. Finally, 39 (23.74±2.87 years old, 19 males and 20 females) completed the whole study procedures. Among them, 14 (25.00±2.94 years old, 7 males and 7 females) reported the presence of significant insomnia, while 25 (23.04±2.64 years old, 12 males and 13 females) did not. There were no significant differences in age or sex between those with and without insomnia.

All study procedures were carried out following the 1964 Declaration of Helsinki as revised in 2013. This study protocol was approved by the Institutional Review Board of Samsung Medical Center (protocol code 2021-09-126). All participants provided informed consent.

Assessments

The Insomnia Severity Index (ISI) [11,12] was used to assess the severity of insomnia and screen the presence of insomnia. ISI is a 7-item self-report questionnaire used to assess for initial/maintenance/terminal insomnia, satisfaction with sleep, daytime function impairment, noticeability of insomnia, and worries about sleep. Each item is rated from 0 to 4. Total scores ≥8 indicate presence of significant insomnia in the current study.

The Profile of Mood States (POMS) is a 65-itme self-report questionnaire to measure transient state of various moods [13,14]. The POMS consists of 6 factors representing different moods (tension, depression, anger, vigor, fatigue, and confusion). Each item is rated from 0 to 5. Since it is designed to measure short-term change of mood status, it is appropriate to measure the short-term effect of the intervention on mood. In the current study, POMS was used to compare the emotional state before and that after sleep.

Attention was assessed by the computerized Comprehensive Attention Test (CAT). The CAT is a modified continuous performance test. The reliability and validity of the CAT have been reported to be acceptable [15]. The CAT has been used to study attention deficit in individuals with psychotic symptoms, sleep disturbances, or suicidal ideation [16-18]. Among 6 subsets in the battery of CAT, the sustained attention and the divided attention task were selected for the current study. The sustained attention can be defined as the ability to focus on a specific task for continuing time. Various shapes are presented in the computer screen every 2 seconds for 10 minutes. Participants are requested to respond to all shape stimuli but the X-shape. The task measures the capacity to inhibit responses to the specific stimuli under conditions of sustained attention. The divided attention is the multitasking ability to focus on multiple tasks or multiple task demands simultaneously. Auditory and visual stimuli are presented simultaneously every 2 seconds for 3 minutes 20 seconds in the divided attention task. Participants are requested to respond when auditory or visual stimulus is the same one with preceding stimuli. The numbers of omission errors (OEs) and commission errors (CEs) were calculated for both attention tasks. OEs, representing attention, are defined as failures to respond to the target. CEs, representing impulsivity, are defined as incongruous responses to the non-target. Additionally, the reaction times (RT), and the corresponding standard deviation of the RT for correct responses were calculated.

Study protocol

The bed used in the current study was Mongata Sway Bed (Mongata Inc., Seoul, Korea). The Mongata Sway Bed is an electric bed that moves once every 4 seconds in the head-to-foot direction. It moves up and down to 10 cm, and the angle is inclined by about 3 degrees. Movement of the Mongata Sway Bed can be controlled with the remote control.

The participants were asked to sleep 3 nights in the Mongata Sway Bed with different modes for each night. Nocturnal polysomnography were also done during sleeping in the Mongata Sway Bed. The three different modes of sleeping bed were 1) motionless bed condition, 2) continuously rocking bed condition, and 3) before-sleep rocking bed condition. In the motionless bed condition, participants slept without rocking function for all

night. In the continuously rocking bed condition, rocking started when the lights was off and stopped when the participants waked up in the morning. In the before-sleep rocking bed condition, rocking also started when the light was off, but rocking was stopped when sleep onset was found in the polysomnographic findings.

The order of the sleeping bed conditions was randomly assigned. Interval from the first experimental night to the next experimental night for each participant was more than 1 week. Interval from the first experimental night to the last (third) experimental night for each participant was less than 8 weeks.

Trip to large jet lag areas was prohibited 1 week before experimental sleep. Napping more than 60 minutes, drinking alcohol, drinking coffee or other caffeine drinks more than 5 cups a day, and sleep deprivation more than 3 hours compared to usual sleep duration were prohibited 3 days before experimental sleep. When participants failed to keep the above precautions, the participant were excluded or experimental sleeps were postponed or excluded. POMS for mood change and CAT for attention change were conducted in the evening before sleep in each experimental night. POMS and CAT were conducted again after waking up in each morning.

Statistical analyses

Paired t-test was used to compare mood and attention before and after sleep in rocking bed (for both continuously rocking and before-sleep rocking condition). Repeated measured analysis of variance was performed to compare three conditions (continuously rocking, before-sleep rocking, and motionless conditions) in mood and attention changes after sleep in bed. In order to explore the effect of rocking bed in those with insomnia, those whose ISI score was high were selected. The same statistical analysis was repeated for this subgroup with insomnia. The analysis was conducted using SPSS version 27.0 software (IBM Corp., Armonk, NY, USA). A p-value ≤0.05 was considered significant.

RESULTS

Change of mood and attention after sleeping in continuously rocking bed condition

No participants reported any critical adverse effects due to sleeping in continuously rocking bed. After sleeping in the continuously rocking bed condition, depression (t=2.48, p<0.05), tension (t=3.90, p<0.001), anger (t=2.18, p<0.05), fatigue (t=2.66, p<0.05), and confusion (t=3.77, p<0.001) in POMS were significantly reduced (Table 1). Vigor did not change after sleeping in the continuously rocking bed condition. After sleeping in the continuously rocking bed condition, RT (t=2.49, p<0.05) and SD of RT (t=2.06, p<0.05) in the sustained attention tasks were increased, and SD of RT (t=8.82, p<0.001) in the divided attention tasks were decreased (Table 2).

Change of mood and attention after sleeping in before-sleep rocking bed condition

No participants reported any critical adverse effects due to sleeping in before-sleep rocking bed. After sleeping in the before-sleep rocking bed condition, depression (t=2.76, p<0.01), tension (t=3.14, p<0.01), fatigue (t=2.23, p<0.05), and confusion (t=2.82, p<0.01) were significantly reduced (Table 3). Anger and vigor did not change after sleeping in the before-sleep rocking bed condition. After sleeping in the before-sleep rocking bed condition, OEs (t=2.14, p<0.05) in the divided attention tasks was reduced (Table 4).

Table 1. Change of mood after sleeping in continuously rocking bed condition (n=33)

POMS factor	Before sleep	After sleep	t	p
Depression	4.14±6.70	2.48±3.94	2.48	<0.05
Tension	5.02±4.31	3.44±3.20	3.90	<0.001
Anger	2.54±4.75	1.32±2.59	2.18	<0.05
Vigor	11.88±8.50	11.32±9.06	0.94	ns
Fatigue	5.84±5.89	4.28±5.08	2.66	<0.05
Confusion	5.29±4.73	4.02±3.54	3.77	<0.001

Values are presented as mean±standard deviation. POMS, Profile of Mood States; ns, nonsignificant

Table 2. Change of attention after sleeping in continuously rocking bed condition (n=33)

CAT subset	Before sleep	After sleep	t	p
Sustained attention				
CE	6.83±7.02	6.58±6.57	0.36	ns
OE	7.37±34.44	6.58±34.18	0.91	ns
RT (s)	429.81±96.53	445.73±102.83	2.49	<0.05
SD of RT (s)	90.52±40.91	100.46±43.09	2.06	<0.05
Divided attention				
CE	2.19±2.01	2.23±2.31	-0.12	ns
OE	8.09±13.65	7.30±12.29	1.15	ns
RT (s)	772.48±250.49	769.77±215.24	0.13	ns
SD of RT (s)	199.49±81.54	100.46±43.09	8.82	<0.001

Values are presented as mean±standard deviation. CAT, Comprehensive Attention Test; CE, commission error; OE, omission error; RT, mean reaction time to correct responses; SD of RT, standard deviation of reaction time to correct responses; ns, nonsignificant

Table 3. Change of mood after sleeping in before-sleep rocking bed condition (n=33)

POMS factor	Before sleep	After sleep	t	p
Depression	4.40±7.93	3.4±6.72	2.76	<0.01
Tension	5.22±5.47	4.10±4.74	3.14	<0.01
Anger	2.86±5.76	1.84±3.74	1.90	ns
Vigor	11.12±8.52	10.08±7.98	1.74	ns
Fatigue	5.28±6.35	4.14±5.27	2.23	<0.05
Confusion	5.10±5.12	4.04±4.17	2.82	<0.01

Values are presented as mean±standard deviation. POMS, Profile of Mood States; ns, nonsignificant

Comparison of mood and attention change after sleep between bed conditions

There were no significant differences in after-sleep mood changes in any subcategories in POMS between three different bed conditions, i.e., motionless bed condition, continuously rocking bed condition, and before-sleep rocking bed condition (Table 5). In addition, there were no significant differences in after-sleep attention changes measured by CAT between three different bed conditions (Table 6).

However, in the subgroups with insomnia, there were differences in after-sleep mood and attention changes between three different bed conditions. There were significant differences in after-sleep improvements of depression between bed conditions. The improvement of depression after sleep were larger when participants with insomnia slept in continuously rocking bed or before-sleep rocking bed compared to when they slept in motionless bed (Table 7). In addition, there were significant differences in after-sleep improvements of divided attention between bed conditions. Reductions of RT in divided attention after sleep were larger when participants with insomnia slept in continuously rocking bed compared to when they slept in before-sleep rocking bed (Table 8). Reductions of SD of RT in divided attention after sleep were larger when participants with insomnia slept in continuously rocking bed compared to when they slept in motionless bed or before-sleep rocking bed (Table 8).

Table 4. Change of attention after sleeping in before-sleep rocking bed condition (n=33)

CAT subset	Before sleep	After sleep	t	p
Sustained attention				
CE	9.10±13.17	7.48±6.86	1.04	ns
OE	20.62±56.10	20.10±52.66	0.51	ns
RT (s)	442.16±124.04	454.35±123.08	-0.61	ns
SD of RT (s)	102.57±73.80	112.01±68.85	-1.40	ns
Divided attention				
CE	3.63±4.34	2.71±2.04	1.42	ns
OE	7.29±870	5.49±8.23	2.14	<0.05
RT (s)	806.68±137.02	822.35±138.88	-1.43	ns
SD of RT (s)	207.30±80.83	210.55±58.93	-0.28	ns

Values are presented as mean±standard deviation. CAT, Comprehensive Attention Test; CE, commission error; OE, omission error; RT, mean reaction time to correct responses; SD of RT, standard deviation of reaction time to correct responses; ns, nonsignificant

DISCUSSION

The current study reports the effects of sleep in the rocking bed on the mood and attention. One night sleep in the rocking bed improved various kinds of negative mood, and enhanced the divided attention. Although there were no significant differences in mood or attention improvement after sleep between motionless bed and rocking bed in those without insomnia, those with insomnia showed larger reduction of depressive mood and greater improvement of divided attention in continuously rocking bed than in motionless bed.

Table 5. Comparison of mood change after sleep between motionless, continuously rocking, and before-sleep rocking bed conditions in all participants (n=39)

POMS factor	Motionless	Continuously rocking	Before-sleep rocking	F	p
Depression	0.82±2.61	1.33±2.80	1.49±4.03	1.40	ns
Tension	0.95±2.44	1.18±2.72	1.31±2.26	2.38	ns
Anger	1.26±2.71	1.31±4.27	0.82±3.36	0.75	ns
Vigor	1.11±3.66	0.72±4.19	0.64±4.46	0.10	ns
Fatigue	1.82±3.59	1.31±3.74	1.51±3.79	0.32	ns
Confusion	1.29±2.00	1.10±2.86	1.31±2.26	0.25	ns

Values are presented as mean±standard deviation. POMS, Profile of Mood States; ns, nonsignificant

Table 6. Comparison of attention change after sleep between motionless, continuously rocking, and before-sleep rocking bed conditions in all participants (n=39)

CAT subset	Motionless	Continuously rocking	Before-sleep rocking	F	p
Sustained attention					
CE	2.64±16.13	1.51±10.47	0.11±4.89	0.50	ns
OE	12.59±88.22	1.67±68.85	0.66±5.62	0.39	ns
RT (s)	-33.54±178.93	-7.27±129.93	-16.97±41.33	0.54	ns
SD of RT (s)	-8.83±48.30	-10.28±45.35	-9.05±31.53	0.03	ns
Divided attention					
CE	-0.21±1.64	0.95±4.34	0.11±2.56	0.30	ns
OE	0.46±12.06	1.95±5.45	0.74±4.71	1.10	ns
RT (s)	-1.78±200.15	-13.03±69.55	1.18±142.49	0.07	ns
SD of RT (s)	-2.99±61.52	-2.26±77.51	8.17±57.05	0.37	ns

Values are presented as mean±standard deviation. CAT, Comprehensive Attention Test; CE, commission error; OE, omission error; RT, mean reaction time to correct responses; SD of RT, standard deviation of reaction time to correct responses; ns, nonsignificant

Table 7. Comparison of mood change after sleep between motionless, continuously rocking, and before-sleep rocking bed conditions in participants with significant insomnia (n=14)

POMS factor	Motionless (a)	Continuously rocking (b)	Before-sleep rocking (c)	F	p	Post-hoc
Depression	0.46±1.94	2.86±2.98	3.93±5.82	3.12	<0.05	b=c>a
Tension	0.92±3.45	2.36±3.52	2.5±2.79	1.18	ns	
Anger	2.69±3.99	3.29±6.11	1.5±5.10	0.88	ns	
Vigor	2.00±3.44	1.00±3.80	0.36±3.73	0.78	ns	
Fatigue	1.15±3.18	3.29±3.83	2.57±3.92	1.29	ns	
Confusion	1.47±1.93	2.15±3.78	1.42±3.04	0.23	ns	

Values are presented as mean±standard deviation. POMS, Profile of Mood States; ns, nonsignificant

Table 8. Comparison of attention change after sleep between motionless, continuously rocking, and before-sleep rocking bed conditions in participants with significant insomnia (n=14)

CAT subset	Motionless (a)	Continuously rocking (b)	Before-sleep rocking (c)	F	p	Post-hoc
Sustained attention						
CE	54.86±126.73	4.5±14.84	1.21±5.03	0.61	ns	
OE	8.43±26.03	-1.5±75.85	-0.57±3.23	1.89	ns	
RT (s)	-100.24±255.95	14.94±119.52	-21.02±42.04	1.91	ns	
SD of RT (s)	-25.33±54.10	-3.49±39.57	-11.21±41.72	0.95	ns	
Divided attention						
CE	-0.29±1.33	1.21±3.85	0.15±1.51	1.03	ns	
OE	0.86±1.70	1.43±7.00	0.21±2.49	0.26	ns	
RT (s)	30.86±68.65	-21.95±72.94	46.42±77.99	4.99	<0.05	b>c
SD of RT (s)	-13.3±41.15	-25.38±65.65	42.49±47.17	9.45	<0.01	b>a=c

Values are presented as mean±standard deviation. CAT, Comprehensive Attention Test; CE, commission error; OE, omission error; RT, mean reaction time to correct responses; SD of RT, standard deviation of reaction time to correct responses; ns, nonsignificant

The negative affect such as depression, tension, fatigue, and confusion were reduced after sleeping in rocking bed, while positive affect such as vigor did not change after sleeping in rocking bed. These effects may be associated with emotional processing of negative affect during sleep [19]. As mood improving effects of sleep were similar between rocking and motionless bed condition, the current findings suggest that the emotional processing during sleep may be similar between sleeping in rocking bed and sleeping in motionless bed.

However, depression-relieving effects of sleep were more prominent when sleeping in rocking bed in people with insomnia. This finding suggests that sleeping in rocking bed may boost the emotional processing of depressive mood in those suffering from poor sleep quality and insomnia. As insomnia disturbs sleep and sleep-related emotional processing [20], rocking bed may recover emotional processing interfered by insomnia. On the contrary, those without insomnia or sleep disturbance may have little room to improve the emotional processing of sleep. As insomnia has been closely related to depression [21], rocking bed may help reducing depression of insomnia patients.

The attention, especially divided attention, was improved after sleeping in rocking bed. These effects may be associated with improvement of cognitive performances such as attention or working memory during sleep [22]. As improvement of attention after sleep were similar between rocking and motionless bed condition, the current findings suggest that the fostering cognitive function by sleep may be similar between sleeping in rocking bed and sleeping in motionless bed.

However, improvement of divided attention was more prominent when sleeping in continuously rocking bed in people with insomnia. This finding suggests that sleeping in rocking bed may prevent attention deficits in those suffering from poor sleep quality and insomnia. Rocking bed may improve the attention which is commonly impaired in insomnia [23]. In the current study, continuously rocking bed condition showed more effect in the divided attention of patients with insomnia compared to before-sleep rocking bed condition. This finding may suggests that improvement of attention by sleeping in rocking bed in insomnia would occur throughout the sleeping night.

The current study had some limitations. This study was limited by single-center enrollment and a small sample size, especially for insomnia patients. In addition, the current study investigated only short-term effects of rocking bed, but not its long-term effects. Future study with long-term use of rocking bed might help to discover more beneficial effects of rocking bed. Since other biological markers connecting rocking bed and mood or attention were not evaluated, the current study could not suggest the neuroscientific mechanism how sleep in rocking bed could improve the mood and the attention in insomnia.

In conclusion, the current study showed that sleeping in the rocking bed relieved depression and improved divided attention. In those with insomnia, the effects of sleeping in rocking bed on mood and attention were larger than the effects of sleeping in motionless bed. The current findings suggest that the sleep in the

rocking bed may relieve the depressive mood and the impaired divided attention of insomnia patients.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

Availability of Data and Material

The datasets generated or analyzed during the study are available from the corresponding author on reasonable request.

Author Contributions

Conceptualization: Seog Ju Kim. Data curation: Hyerin Gu. Formal analysis: Hyerin Gu. Funding acquisition: Seog Ju Kim. Investigation: Hyerin Gu, Jinyoung Jung. Methodology: Hyerin Gu, Jinyoung Jung. Project administration: Seog Ju Kim. Resources: Seog Ju Kim. Software: Seog Ju Kim. Supervision: Seog Ju Kim. Validation: Jinyoung Jung. Visualization: Hyerin Gu. Writing—original draft: Hyerin Gu, Jinyoung Jung. Writing—review & editing: Seog Ju Kim.

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