Continuous White Noise to Reduce Sleep Latency and Night Wakings in College Students

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White noise (sound covering the entire range of human hearing from 20-20,000 hertz) was investigated to promote sleep in college students. Four college students were provided white noise generators and instructed to use them all night between 60 and 75 decibels (dB) for one month. A multiple baseline design across participants design measured sleep latency and night wakings during each night at baseline, treatment, and follow-up. All students showed a decrease in both sleep latency and night wakings during treatment; however one's night wakings returned after white noise was discontinued at a one month follow-up and three of the four returned at a second follow-up the next semester. All were comfortable with white noise and would recommend it to other students with sleep problems. White noise reduced sleep problems in college students which supports its use as a non-pharmacological alternative to promote sleep. Like medication it appears to only be effective when administered. **(Sleep and Hypnosis 2007;9(2):60-66)**

Key words: college students, white noise, night wakings, insomnia, sleep problems, sleep latency

INTRODUCTION

Sleep deprivation is when people either chronically or occasionally deny themselves an adequate amount of sleep (1). Adolescents, including college students, appear to be one of the most deprived groups in the United States (2). Research has shown that over 49% of college students report short sleep time (3). These sleep difficulties adversely effect driving: 55% of sleep-related traffic accidents involve individuals less than 25 years of age (2). A study at Brown University showed that 27% of males and 16% of females have fallen asleep at the wheel and 3% have had a sleep-related accident (2). Research also has shown relationships between sleepiness and academic performance (4). Sleep difficulties are the third largest impediment to academic performance, just behind stress and illness (5).

One possible strategy for improving sleep is the presentation of continuous white noise, that is sound that covers the entire range of

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Accepted June 17, 2007

human hearing (20-20 000 Hertz). Continuous sound helped patients recover from heart bypass surgery in the hospital (6). Twenty minutes of 88 dB classical music or simulated white noise increased drowsiness and light sleep (7). All night exposure to 75 dB continuous white noise improved sleep of infants in their own home (8).

Previous studies were conducted in laboratories or hospitals where sleep is often different. Therefore, we studied the effects of white noise on both sleep and cognitive performance when used in the students' own bedroom.

METHOD

Participants

Participants were four college students who met the following criteria: 1) waking up more than once per night and/or sleep latencies longer than 30 minutes, 2) not already using an approximation of white noise (e.g., a fan or humidifier) or use was not at an effective volume, and 3) did not have a precipitating medical condition that was responsible for the sleep problem. Mean age for participants was 19 years and three were female. Participants were paid $50 and earned five points extra credit in a course for their participation.

Apparatus

A Tranquil Moments Plus white noise generator (Brookstone model #348516) set between 60 and 75 dB sound pressure level (SPL) at the individual's ear. These levels were marked and individuals chose their most comfortable volume within this range. Levels were chosen for efficacy, while minimizing disturbances to others. The university's Institutional Review Board approved these levels (Forquer & Johnson, 2005). Individuals were to use the 60-75 dB range and play sound continuously from bedtime to wake time.

Measures

Sleep diaries kept by participants measured number and length of daytime naps, bedtimes, sleep latency, number and length of night wakings, wake times, and any unusual circumstances (e.g., illness, out of town). Students visited the psychology department to complete a sleep survey and free association tasks at baseline, treatment, and follow-up. The sleep survey included questions from the Pittsburgh Sleep Quality Index (9), the Sleep Hygiene Self-test (10) and the Sleep Hygiene Test (11). The free association task involved recognition of 20 high to moderate frequency words chosen randomly from a pool of 30,000 words (12). A white noise evaluation survey was completed at follow-up as a measure of social validity.

Procedure

A nonconcurrent multiple baseline across subjects design was used (13). Individuals met with the investigator, the project was explained, written consent was obtained, physician approval was recommended, and seven nights of sleep diaries were distributed. Students also completed the sleep survey and memory task.

The free association task involved recognition of 20 high to moderate frequency words from twelve lists. These were paired with associated words as determined from an unrelated study. Participants had 1 minute to examine the target and associated word pairs. Following this examination, participants had 5 minutes to write three words they would associate with each target word. After this free association, participants had to recognize the target words from a list. This included the 20 target words and 60 distracters. Distracters were chosen from the same pool and have the same frequency levels.

Four lists were completed during baseline. One student began using white noise each week for the next four weeks as sleep patterns appeared to stabilize (13). Starting on the fifteenth day, one list was completed each week for four weeks to examine changes in performance. Finally, four more lists were completed at follow-up. The order of the tests was randomized for each participant.

After seven nights of sleep diaries, another meeting was scheduled where participants received more sleep diaries to either continue baseline or start white noise. One student began treatment each of the next three weeks. Participants were instructed to place the generators in their room approximately 2 feet from their bed at head height. White noise generators played continuously every night. Every seven days during treatment participants visited the psychology department and completed one of the word lists. At the last weekly meeting participants completed the sleep survey and the fading procedure was explained.

Fading involved one week of decreasing volume each night until white noise was no longer present. After fading students returned to the psychology department and white noise generators were collected. One month later, a follow-up began which consisted of one week of sleep diaries, the sleep survey, four lists of the free association task, and a survey measuring social validity. Participants received 5 points extra credit, were paid $50, and were allowed to keep white noise generators if sleep problems returned. A second follow-up, one month after the first, involved an emailed sleep survey.

Data Analysis

Means and standard deviations were calculated for sleep latency, number of night wakings, and number correct on free association tasks for all participants during each phase of the experiment. Means and standard deviations were calculated for the social validity survey.

RESULTS

Ten students met with researchers to consider participating, however 4 did not volunteer because of concerns that white noise would disturb roommates and two withdrew during baseline because they started sleeping better. Four participants completed the entire study. Number of night wakings and sleep latency across successive nights are displayed in Figures 1 and 2.

Danielle was a twenty-year-old sophomore with both trouble falling to sleep and night wakings. Danielle had three roommates, but her own bedroom. Danielle's night wakings decreased from 3 per night during baseline to 1.6 during intervention to 1.2 at follow-up. Danielle's time to fall asleep also decreased from 46 minutes during baseline to 31 during intervention and follow-up. At the second follow-up, Danielle reported further improvements by taking 20 minutes to fall asleep and waking only once a night.

Michael was a nineteen-year-old freshman with both trouble falling to sleep and night wakings. Michael had three roommates and shared a room. Michael's night wakings decreased from 1.3 per night during baseline to .5 during intervention then returned to 1.1 at follow-up; while his time to fall asleep decreased from 34 minutes during baseline to 19 during intervention then increased to 22 at follow-up. At the second follow-up, Michael reported taking 45 minutes to fall asleep and waking twice a night.

Lauren was an eighteen-year-old freshman with trouble falling to sleep. Lauren had three roommates and shared a bedroom. Lauren's time to fall asleep decreased from 34 minutes in baseline to 23 during intervention and 25 at follow-up. Although Lauren did not qualify as having a night waking problem, her night wakings did

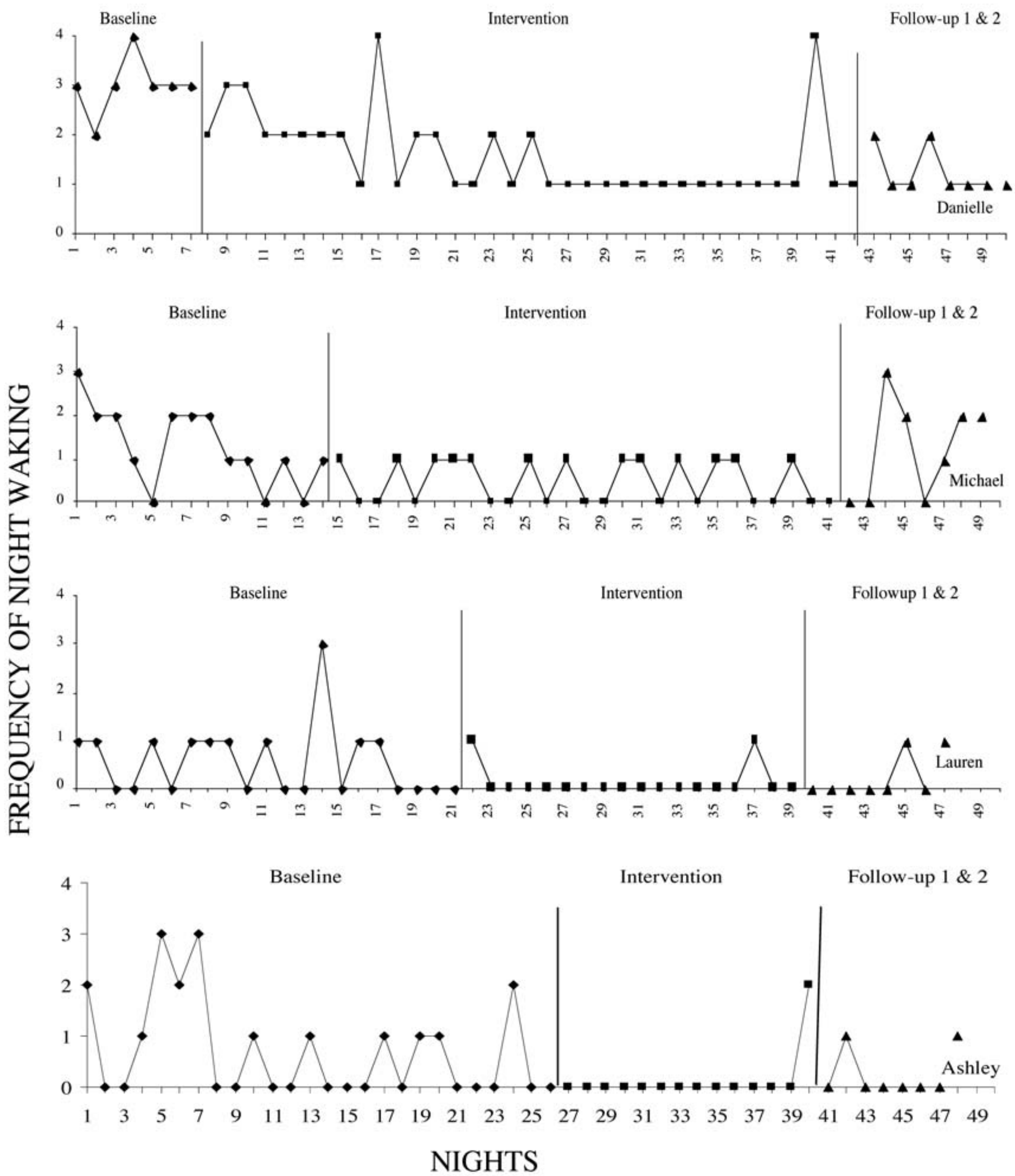

Figure 1. Number of night wakings for each student during each phase of the experiment.

decrease from .6 per night during baseline to .1 during intervention and follow-up. At the second follow-up, Lauren reported a return to baseline by taking 30 minutes to fall asleep and waking once a night.

Ashley was an eighteen-year-old freshman who had trouble falling asleep. Ashley had three roommates and shared a room. Ashley averaged 69 minutes to fall asleep during baseline, this decreased to 37 during intervention, and 6 at follow-up. Although Ashley did not qualify as having a night waking problem, her night wakings decreased from .7 per night during baseline to .1 during intervention and follow-up. At the second follow-up, Ashley reported taking 30 minutes to fall asleep and wakings once each night.

Overall, night wakings decreased from 1.4 per night during baseline to 0.6 during

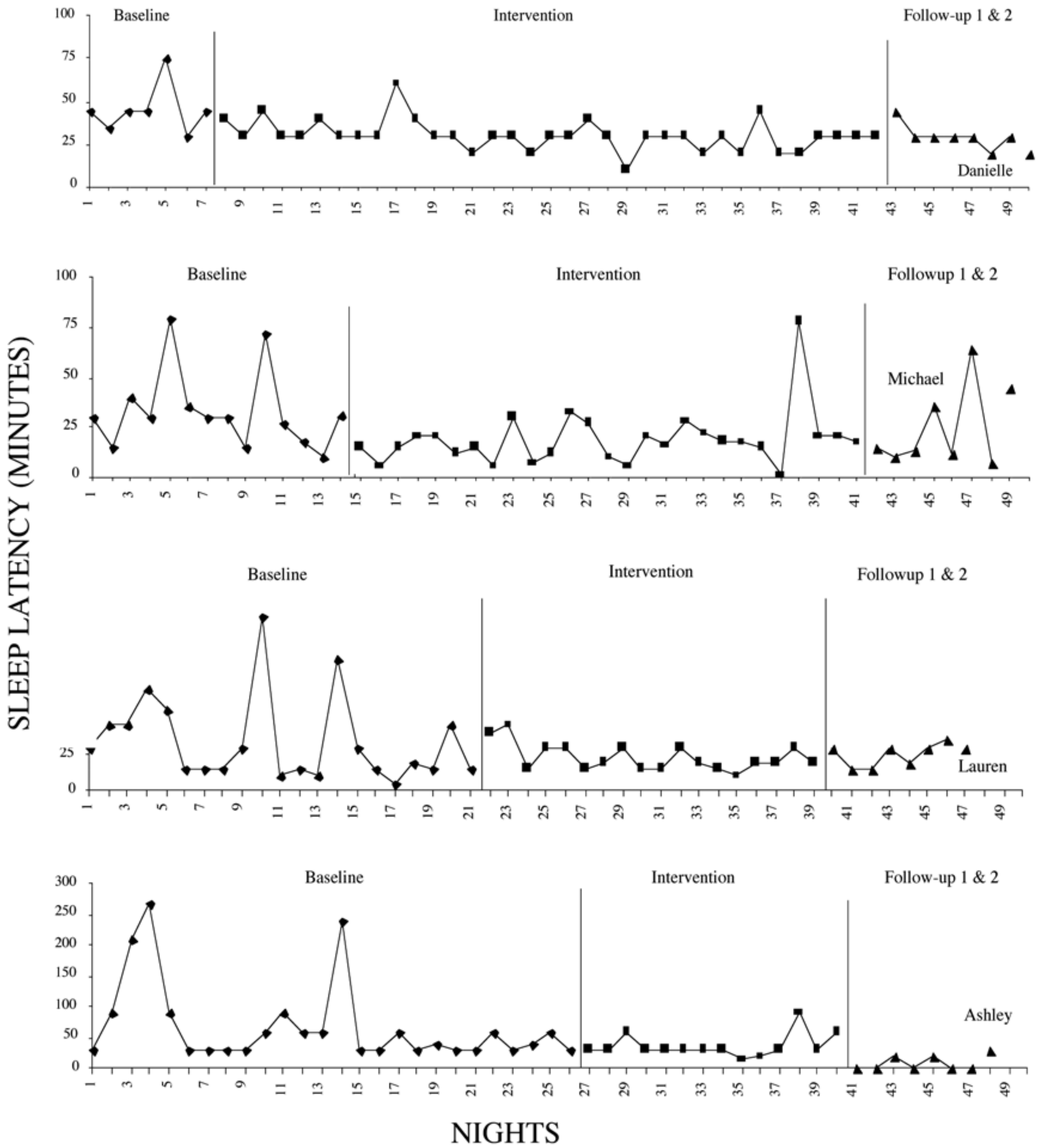

Figure 2. Sleep latency in minutes for each student during each phase of the experiment.

intervention and follow-up. Time to fall asleep also decreased from 45.5 minutes during baseline to 27.3 during intervention to 20.9 at follow-up. Both night waking (M=1.25) and time to fall asleep (M=31 minutes) increased at the second follow-up, but not to baseline levels. Cognitive performance increased slightly during the study from a mean of 18.2 correct during baseline to 18.4 during intervention and 19.2 at follow-up. All students were comfortable using white noise and would recommend it to others. The social validity mean of satisfaction with white noise was 2.1 (SD=.4) on a five-point likert scale from strongly agree (1) to strongly disagree (5).

DISCUSSION

Results demonstrated the efficacy of white noise for reducing sleep latency and night wakings in college students. All four students exhibited improvements during white noise; however Michael's night wakings returned at follow-up when white noise was discontinued. Three reported using some approximation to white noise such as fans at the second follow-up.

There are several possible explanations for the effectiveness of white noise. First, studies indicate decreases in arousal during continuous stimulation in infants (14). Decreased arousal may result from habituation following repeated exposure to a stimulus (15). Second, white noise may induce and maintain sleep by masking noises that awaken students living in residence halls or apartments, similar to noises in hospitals (6). Also, continuous auditory stimulation may function as stimulus control (15). White noise might function as a discriminative stimulus in the presence of which decreased arousal is reinforced by sleep; therefore, sleep occurs more frequently during white noise. A final explanation includes circadian rhythm management, resetting the person's biological clock to establish a 24-hour cycle without long sleep latencies and night wakings (16).

Although students were instructed on the volume and location for the white noise generators, there is no way to verify compliance. Students were to take generators with them if they went home on weekends, none reported failure to adhere. Compliance on completing sleep diaries was high, students only missed one or two nights during the entire experiment.

This study used an approximation to white noise; true white noise (20-20 000 Hz) may be more effective. Comparing various sounds to true white noise should be researched. Students chose the intensity most comfortable, as long as it was between 60 and 75 dB. Most employed 60 dB; however Danielle reported increasing intensity on nights when her neighbors were loud. A comparison between the intensity chosen (60 dB) and the loudness used in previous research (75 to 90 dB) would be helpful. However, five days of 24 hour continuous moderate-intensity (70 dB) auditory stimulation was shown to impair hearing in newborn rat pups (17); however the effects of such stimulation on human auditory development have not been examined. This suggests that sound should be limited in duration and intensity, at least for developing organisms.

All students had roommates and three had roommates in the same bedroom. None reported adverse effects from roommates or improved sleep; however this was not specifically addressed. This is important because four others declined to participate because they did not want to disturb roommates. Future studies should examine effects on roommates or spouses.

A problem in this study was a falling baseline in one dependent variable while the other appeared stable. Collecting data once a week because of scheduling constraints resulted in a few falling baselines and should be controlled in future studies. A replication with a group design (within or between) that employs parametric analyses of different decibel levels would be useful.

The memory task used in this experiment appeared to have ceiling effects. Students obtained high scores before treatment, leaving little opportunity for improvement. Future studies should employ a more difficult cognitive task. Although there were no noticeable improvements on the free association task, note that white noise produced no declines either. Finally, all students seemed comfortable with white noise and would recommend it to others. None requested reinstitution at follow-up; however all except Michael reported using some other form of sound to help them sleep (i.e., fans or humidifiers). In conclusion, white noise appears promising in reducing sleep problems in college students, however like medication disturbances may return when discontinued.

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