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Sleep Induction Effects of Steady 60 dB (A) Pink Noise

Abstract: The effects of 60 dB (A) steady pink noise on sleep induction were studied. Two experiments were conducted. First, 10 night-sleep polygrams of a young male subject were recorded consecutively as controls. Five night polygrams of the same subject were then recorded with exposure to steady 60 dB (A) pink noise. Second, polygrams of four students were recorded using the same noise exposure as in the first experiment. Polygrams for the control night were also recorded. Noise exposure tended to shorten sleep latency, i.e., the values were 4.2 and 9.5 min in the first and second experiment, respectively. The steady 60 dB (A) noise made sleep induction easier.

Key words: Steady pink noise—Sleep latency—Insomnia

Environmental noise is a major cause of sleep disturbance, though passengers in trains or airplanes often sleep well in noisy environments. Eberhardt *et al.*[1] made a comparison of steady and intermittent road traffic noise on sleep. They found that 45 dB (A) steady noise caused a REM sleep deficit, while 45 dB (A) intermittent noise caused sleep stage 3 and 4 deficits, and that 55 dB (A) noise led to awakening. We have already reported the sleep induction effects of steady pink noise in a case study[2]. This article focuses on the effects of the same 60 dB (A) pink noise on the shortening of sleep latency, adding four other young subjects.

Material and Methods

The first experiment was conducted on a healthy male subject 28 years of age (A)[2]. The second experiment was performed on four students, three males (B–D) and one female (E), aged 19 to 21 years. Their sleep polygrams were recorded during all-night exposure to the same sound. Polygrams on the control night were also recorded with a background level of 33 to 37 dB (A). Alcoholic beverages and drug ingestion were prohibited during the experiment. The steady 60 dB (A) pink noise used in an experimental room was produced by an SF–05 noise generator (RION Co. Ltd., Tokyo). Pink noise was defined as follows: the correction of white noise by making sound pressure level of each frequency band to be constant. Pink noise is more similar to truck and bus noise than white noise. The pink noise was delivered through a loudspeaker located 2 m from the head of the subject at the same height from the floor. The microphone of a NA–23 sound level meter (RION Co. Ltd., Tokyo) was positioned 0.3 m from the head of the subject. Electroencephalogram (EEG) leads were positioned according to the international 10-20 method (C_3–A_2). The EEG, electromyogram

(EMG), and electrooculogram (EOG) were recorded using a telemetry system (NIHON KOHDEN Co. Ltd., Tokyo). Sleep latency was defined as the time elapsed from getting into bed until the first appearance of a sleep spindle judged visually. Sleep latency on noise-exposure and non noise-exposure nights was compared. The Mann-Whitney U test and Wilcoxon matched-pair signed-rank test were used to assess significance.

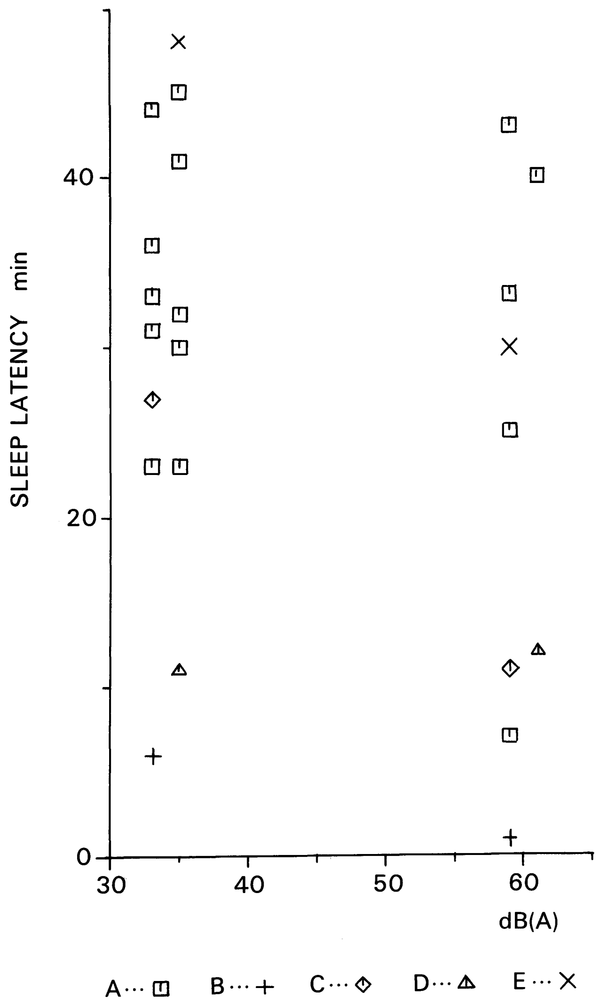

Fig. 1. Sleep latency (min) of the five subjects, A, B, C, D and E, on nights when exposed to steady 60 dB (A) pink noise and on the respective control nights.

Table 1. Sleep latency of the five subjects exposed to steady pink noise paired with control nights.

Subject	Age	Sex	Sleep latency (min.)	
			Exp. (−)	Exp. (+)
A*	28	Male	33. 8±7. 79	29. 6±14. 4
B	19	Male	6	1
C	19	Male	27	11
D	20	Male	11	12
E	21	Female	48	30

* Data are cited from the authors' experimens, ref 2). Exp. (−) is the control and Exp. (+) is all-night exposure to steady 60 dB (A) pink noise. The Wilcoxon matched-pair signed-rank test was applied to these four subjects, B to E, and P was 0. 144.

Results

No statistical differences in sleep latency between steady 60 dB (A) pink noise nights and control nights could be detected in subject A. The mean sleep latency value in the noisy environment was 29.6 minutes and the control value was 33.8 minutes. This means a 12.4% decrease or a 4.2 minute shortening of sleep latency as a result of exposure (Fig. 1). There were no statistical differences between the mean value of the sleep latency of subjects B to E on 60 dB (A) exposure and the control nights, although the sleep latency of three subjects (B, C, E) became shorter upon exposure. The mean value of sleep latency was 13.5 minutes upon exposure, while the value in the control was 23.0 minutes. This shows a 58.7% decrease or 9.5 minute shortening of sleep latency by steady pink noise (Fig. 1 and Table 1).

Discussion

Spencer *et al.*[3] reported a sleep inducing effect of white noise in neonates. The sound level was 70 dB, and they explained the phenomenon as due to masking of environmental stimuli. Scott *et al.*[4] used exposure to 93±2 dB (A) steady white noise and found no change in sleep latency compared with control nights. Thus, steady noise may not disturb sleep induction even over 90 dB (A). White noise is predominant at higher frequency bands. In general, low frequency sound causes greater behavioral disturbance than high-pitched sound. Pink noise may thus be more suppressive or disturbing than white noise at tne same sound level.

In the present study, sleep induction in four of the five subjects was accelerated by steady pink noise exposure at 60 dB (A). The author performed an additional experiment in subject A using exposure to steady 40 and 50 dB (A) pink noise. The means and standard deviations of sleep latency in response to 40 and 50 dB

(A) exposure were 45.8 ± 19.8 (n=4) and 38.6 ± 29.2 (n=5), respectively, indicating prolongation of sleep latency compared with the control[2]. Acceleration of sleep induction by steady 60 dB (A) pink noise may thus be explained not only by the masking effect of enviromental noise described by Spencer *et al.*[3], but by some positive mechanism of sleep induction which seems to exist at 60 dB (A). In contrast to sleep induction by steady 60 dP (A) pink noise, significant prolongation of sleep latency was found in response to intermittent 60 dB (A) pink noise[5].

Shift work or VDT jobs may cause a tendency forward psychophysiological insomnia This is characterized by difficulty in falling asleep and maintaining sleep[6]. In addition to sleep induction, steady pink noise has a sleep deepening effect[7], and this seems to be useful information for persons who suffer from insomnia caused by work-related stress.

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