The Effects of Background Music on Quality of Sleep in Elementary School Children

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The purpose of this randomized controlled trial was to examine the effects of background music on quality of sleep in elementary school children. Convenience sampling was used to recruit a total of 86 fifth graders (43 boys and 43 girls) from an elementary school in a city in Taiwan. Subjects were randomly assigned to the experimental groups (n = 45) and the control group (n = 41). Subjects in the experimental group were given a 45-minute CD of music at naptime everyday and bedtime each night for 3 consecutive weeks. Sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI) at pretest and 3 weekly posttests. Repeated measures MANOVA was used to examine group differences across time. Results showed that subjects who received background music at naptime everyday and bedtime each night for 3 consecutive weeks had significant improvement in global sleep quality over time. Improvements were also observed in all 6 components of the PSQI although significant improvements were only observed in sleep duration and sleep efficiency. Some shortcomings of this study include the use of convenience sample, possibility of a Hawthorne effect, lack of objective measurements, and the use of non-subject's preferred music.

Many studies have shown the positive effects of music in therapy on children in a variety of setting including hospitals, schools and day care centers, but very few studies have been conducted on its effects on sleep in children, especially elementary school age children. Most of the studies related to sleep in children focused on the effects of sleep either on behavior or learning, and sleep disorder.

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Most of the studies have implied the positive effects of music on sleep in a variety of settings and populations. Several studies conducted in clinical settings have suggested that sedative music may have positive effects in enhancing sleep via muscle relaxation and distraction from thoughts. Sedative music has been utilized in hospitals to enhance relaxation of postoperative patients (Good et al., 1999). Although Good’s study was not to enhance sleep in postoperative patients, studies have shown that sedative music enhances relaxation of the body (Kaempf & Amodei, 1989; Steelman, 1990; Updike, 1990; White, 1992), which in turn reduced the circulation of norepinephrine (Gerra et al., 1998), that is associated with sleep (Irwin, Thompson, Miller, Gillin, & Ziegler, 1999). Research studies have shown that norepinephrine, which is one of the indices in the sympathetic nervous system, is associated with sleep onset as well as the amount of night time wakefulness (Prinz, Halter, Benedetti, & Raskind, 1979). Basically, music may be used to promote relaxation (Campbell, 1983), which in turn reduced neuroendocrine activity that leads to a reduction in corticotropic and cortisol, the stress response. In other words, music promotes relaxation, and when the body is relaxed, circulation of norepinephrine, which is associated with sleep onset, is also reduced. Thus, a sleep response can be expected through the responses of relaxation, distraction, and a reduction in norepinephrine (Lai, 2001).

The amount of research studies focusing on the effects of music on sleep is very limited. Five studies were found which focused directly on the effects of music on sleep (Lai, 2001; Levin, 1998; Mornhinweg & Voignnier, 1995; Zimmerman, Nieveen, Barnason, & Schamderer, 1996) with only one having children as subjects (Field, 1999). All of the aforementioned studies showed statistically significant effects of music for sleep. In other words, music does have beneficial effects on sleep. In the Levin study, the author examined the effects of “Brain Music” in the treatment of 58 patients with insomnia. “Brain Music” is basically the transformation of spontaneous bioelectrical activity of each person’s EEG into music via a special algorithm on the computer before it is recorded on an audiocassette. Subjects in the experiment group of the study listened to their own brain music before going to sleep. Results showed that subjects who received treatment improved their sleep quality significantly. Total sleep duration as well as duration of both delta and REM sleep were also increased significantly.
Zimmerman et al. (1996) studied the effects of soothing music on sleep and pain of 96 postoperative subjects who had undergone coronary artery bypass graft (CABG) surgery. Subjects in the treatment group received music on the second and third day following surgery. Music was given either in the afternoon or every evening instead of before bedtime. Sleep was measured on the third day after surgery by using the Richard-Campbell Sleep Questionnaire. Results showed that subjects in the treatment group, who received 30 minutes of music listening, had significantly better sleep scores than subjects in the control group. This study seemed to imply that music listening in the afternoon contributed to better sleep at night since music was not given at bedtime.

Mornhinweg and Voignnier (1995) and Lai (2001) examined the effects of music on sleep in the elderly population. Mornhinweg and Voignnier focused on sleep disturbance whereas Lai focused on sleep quality of the elderly population. In the Mornhinweg and Voignnier study, subjects were given a choice of New Age or Baroque music. Both types of music had a similar tempo, around 68–72 beats-per-minute. Subjects were given their choice of music at bedtime. Results indicated that of the 25 subjects, 24 of them maintained that their sleep problems were reduced with the use of music at bedtime. In Lai’s study, subjects in the treatment group were also given a choice of music, but they had more choices than subjects in the Mornhinweg and Voignnier's study. The choices in Lai’s study included four types of Western music: synthesizer, harp, orchestra, and slow jazz, as well as Chinese orchestral music. Subjects in the treatment group listened to their choice of music every night at bedtime for 3 consecutive weeks, and sleep quality was measured weekly by using the Pittsburgh Sleep Quality Index (PSQI). Results showed that subjects who received music at bedtime had significantly better sleep quality, longer sleep duration, greater sleep efficiency, shorter sleep latency, less sleep disturbance, and less daytime dysfunction.

Field's (1999) study is the only one that examined the effects of music on sleep in young children, particularly at preschool naptime. Twenty-four children (12 toddlers & 12 preschoolers) were observed at their afternoon naptime for a total of 4 days; 2 days where classical guitar music played and 2 days without music. Results showed that sleep latency was significantly shorter in the music condition. In addition, results indicated that toddlers seemed to fall asleep faster with the use of music as compared to preschoolers.
Sleep is not only important for health and quality of life, it affects behavior and learning as well, especially in children. It has been suggested that a reduction in cognitive efficiency in many children can be accounted for by sleep deprivation (Mitru, Millrood, & Mateika, 2002). In another study on sleep and behavior of children, results indicated that children with sleep problems also showed more emotional problems (Paavonen et al., 2002). Sleep deprivation often leads to increased irritability and less tolerance for situations associated with negative emotions (Dahl, 1996, 1999). Other studies have also shown that students who slept less were more likely to have aggressive behavior (Wolfson et al., 1995). Conflict between students and teachers are more likely to happen due to tardiness or sleepiness in class, and this can further affect students' emotional state that leads to hostility and resentment (Mitru et al., 2002).

Sleep-deprived students also tend to experience conflict in relationships with parents and other members of the family over sleep-related issues such as wake-up time, bedtime, and morning routines (Black, 2000). According to Dahl (1996), the prefrontal cortex of the brain deals with anticipating, preparing, or delaying a behavioral reaction based on behaviors that are socially acceptable. However, an inadequate amount of sleep can cause dysfunction of the prefrontal cortex, which consequently leads to various neurophysiological disorders. In other words, deficiency in prefrontal cortex may impair the regulation of complex tasks, creative thinking, and goal-oriented behaviors. This may explain why erratic, impulsive, aggressive, and to a certain extent, violent behaviors have been observed in school. The prefrontal cortex continues to develop from childhood to adolescence with important neurobiological changes starting during puberty. Thus, puberty is an important period where sleep has its greatest impact on behavior and cognitive processes.

Studies have shown that sleep deprivation can also exacerbate existing emotional problems (Black, 2000). Children with existing emotional problems often experience more anxiety and inner turmoil with increased sleep deprivation. Children in this state are also at a higher risk of mental depression, which can cause them to be dissatisfied with themselves and school. In a study conducted in China on the correlation of sleep, anxiety, and depression, results showed that students with poor sleep quality were more likely to have anxiety or depression (Liu, Tang, Hu, Wang, & Li, 1997).
It has also been suggested that sleep deprived children and children with attention deficit hyperactivity disorder (ADHD) manifest similar symptoms such as, inability to control impulses and to concentrate for extended periods of time (Dahl, 1996). Other studies have shown that children with sleep disorders are more likely to be diagnosed with ADHD as compared to those children without sleep disorders (Dahl, 1999). Although this correlation is not well understood, it increases the possibility for children to be diagnosed with ADHD when they are actually short of sleep. It has also been noted that some children who are labeled as ADHD are actually not ADHD but are having sleep problems, like apnea (Keller, 2001).

Since various studies suggested that sleep and academic performance and behavior seemed to be correlated, and music seemed to have beneficial effects on sleep, these studies appeared to imply that good quality sleep in children would be quite important. Due to the limited amount of studies done on the effects of music on sleep in children, the purpose of this study was to examine the effects of background music on sleep quality of elementary school children.

Method

Convenience sampling was used to recruit a total of 86 fifth graders, 43 boys and 43 girls, from an elementary school in a city in Taiwan. Subjects were, however, randomly assigned to either the control group (n = 41) or the experimental group (n = 45). Participation in the study was completely voluntary. All subjects and their parents were informed about the study protocol and agreed with the procedures. Subjects in the experimental group were given a 45-minute CD of music at naptime everyday and bedtime each night for 3 consecutive weeks.

The music chosen for this study was basically a collection of various classical adagios and Enya with tempi starting at 78 beats-per-minute and gradually dropping to 48 beats-per-minute. The tempo selection of music chosen for the study was based on Gaston’s definition of sedative music. According to him, the tempo should be somewhere around 60 to 80 beats-per-minute (Gaston, 1951). In addition, the general characteristics of sedative music should contain no accented beats nor syncopation, and certainly be nonpercussive (see Gaston, 1968). The length of the CD of music for this study was based on findings from previous studies that suggested the circulation of norepinephrine, which is related to sleep onset,
is reduced with 6 minutes of sedative music listening (Mockel et al., 1994). In addition, studies have also shown that relaxation could be induced with approximately 30 minutes of sedative music listening. According to a study by Field (1999), the mean sleep onset time for children is approximately 30 minutes with music and approximately 38 minutes without music. Based on the aforementioned studies, the researcher decided to use a CD recording that was approximately 45 minutes in length, just to give a little extra time for subjects who might need slightly longer time to fall asleep.

**Instruments**

The instruments used in this study included the *Student Background Data Sheet*, created by the researcher with the intention of obtaining demographic information from the subjects; the *Bedtime Routine Questionnaire* originally developed by Johnson (1986), but the version used in this study was modified and translated by Lai (2001); the *Caffeine Consumption Questionnaire* developed and translated by Lai (2001); the *Sleep Log* developed and translated by the researcher; the *Pittsburgh Sleep Quality Index (PSQI)* developed by Buysse, Reynolds, Monk, Berman, and Kupfer (1989) was used to measure sleep quality; the *State-Trait Anxiety Inventory (STAI)* was used to measure anxiety (Speilberger, Gorsuch, Lushene, Vagg, & Jacobs, 1985).

Anxiety was measured in this study because anxiety is often a factor considered in many of the sleep studies. According to Wang (1997), anxiety is often paired with sleep disturbances and in fact, many sleep problems are often included in the diagnostic criteria for anxiety disorders. In a study conducted on 560 students in China (Liu et al., 1997), results showed that students who scored high on anxiety level reported low in sleep quality. This finding is consistent with studies conducted on older adults that suggested that anxiety was correlated with sleep problems (Bazargan, 1996; Ford & Kamerow, 1989; Gislasen, Reinsdotir, Kristbjarnarson, & Benediksdottir, 1993; Lai, 2001; Morin & Gramling, 1989). In addition, other researchers have also reported that environmental and psychological stress do have an impact on sleep patterns (Mellman, Kulick-Bell, Ashlock, & Nolan, 1995; Paulsen & Shaver, 1991; Waters, Adams, Binks, & Vernad, 1993). Thus, anxiety should be considered an important factor that needs to be controlled in any sleep study. Although subjects in the present study were elementary school age students, their anxiety levels were still tested and con-
Anxiety and suicide levels were reported high among Asian students due to academic competition (Zeng & Tendre, 1998).

**Dependent Variable: Pittsburgh Sleep Quality Index (PSQI)**

The PSQI was developed by Buysse et al. (1989). It was originally derived from four different sources: experience with patients with sleep disorders, clinical intuition, a literature review of reported sleep quality questionnaires, and 18 months of clinical field testing with the instrument (Buysse et al., 1989).

The original version of the PSQI consists of 19 individual items mostly on a 4-point Likert-type scale. The 19 items are grouped into seven main components: 1 item for perceived sleep quality, 2 items for sleep latency, 3 items for sleep efficiency, 9 items for sleep disturbance, 1 item for use of sleep medication, and 2 items for daytime dysfunction. There were also an additional five items that were initially designed to be rated by the subject's bed partner or roommate. However, these items were not tabulated in the scoring of PSQI as they were only intended for clinical information. These items were therefore not used in this study.

The seven components of PSQI can be defined as follow: (1) sleep latency refers to the time the person attempts to fall asleep to the actual onset of sleep, and it is measured by the number of minutes needed to fall asleep and number of times the person encountered difficulty falling asleep during the past week; (2) sleep duration refers to the actual sleeping time at night and it is measured by the number of hours a person sleeps per night; (3) perceived sleep quality refers to how the person perceives his/her own sleep as good or bad, and it is measured by having the person rates his/her own sleep quality over the last week on a 4-point scale; (4) sleep efficiency is defined as the ratio of total sleeping time to the total nocturnal time, and it is measured by taking the number of hours slept divided by the number of hours spent in bed and then multiplied by 100; (5) sleep disturbance refers to the difficulty the person has falling asleep and awakening earlier and later than desired, and it is measured by adding the sum of the nine different ways of awakenings; (6) use of medication refers to the use of pharmacological intervention in aiding sleep, and it is measured by how often the person takes medicine in aiding sleep; (7) lastly, daytime dysfunction basically refers to the person not feeling well pasted during the day and it is measured by adding the score of number of
times the person stays awake to the score on how much the problem was for the person to maintain enthusiasm during the day (Buysse et al., 1989; Lai, 2001). The global score for PSQI range from 0 to 21 and higher scores mean worse sleep quality. According to Buysse et al. (1989), a global score of 5 points and above means that the person is suffering from poor sleep quality.

Using Cronbach's alpha, Buysse and colleagues (1989) reported the instrument has a internal consistency of .83 for all seven components. Internal consistency refers to the degree of homogeneity in the scores and a Cronbach's alpha of .83 indicated that the instrument has a high degree of internal consistency. In addition, Pearson product-moment correlations also showed significant relationships between the global score and scores from each of the seven components. Test-retest reliability also indicated that the global score (Time 1 & Time 2: r = .85, p < .001) and the seven component (r = .84 to .65, p < .001) scores were stable over time.

To better fit the purpose of this study, a modified version of the PSQI was used. The modified version was done by Lai (2001) for the purpose of assessing sleep quality based on the previous week rather than its original version, which was the previous month.

The Chinese version of the PSQI was translated by Wang (1997) for a study examining the effect of acupressure on sleep disturbances of Taiwanese elderly people. According to Wang, the Chinese version of the global PSQI has a Cronbach's alpha reliability of .72 and a split half reliability of .84. The modified version by Lai (2001), which is also the version chosen for this study, has an overall Cronbach's reliability of .74 and a split half reliability of .79 for the six components of the PSQI.

Procedure

All subjects were asked to complete a set of four questionnaires: PSQI, STAI, bedtime routine questionnaire, and caffeine consumption questionnaire before random assignment was conducted. Subjects were asked to bring a copy of the Student background data sheet in an envelope home for their parents to complete. All subjects were also given a weekly sleep log to fill in daily and turn in to the researcher in exchange for a fresh sheet log and the purpose was to help them be more aware of their sleep pattern.

A typical school day for elementary school children in Taiwan normally includes four periods of classes in the morning followed
by lunch break, naptime period, and four periods of classes in the afternoon (You, personal communication, December 20, 2002). Naptime has been a traditional practice since the Japanese ruling. Nowadays it is up to individual school to decide if naptime is compulsory. Some schools use it as a free-time period whereas some schools use it for remedial classes. However, naptime is considered compulsory at the school where the study was conducted. Thus, background music was implemented for subjects in the experimental group during naptime in school. Subjects in the experimental group were also given a copy of the CD to bring home to use during their bedtime. The instructions that the subjects were given on the use of the CD at bedtime were: (1) lie in bed at your usual bedtime, wearing your usual comfortable pajamas, with lights out or leave night light on if that is your usual habit, and close your eyes; (2) play the CD at a comfortable volume. If the music affects your roommate(s), earphones or ear jack may be used; (3) listen to the music and become aware of your own breathing, (4) breathe in deeply and slowly through your nose, and gently breathe out through your mouth. Feel the pulse of the music as you breathe; (5) relax your shoulders, neck, throat, arms and legs as your breathe; (6) don’t worry about turning the music off, just let it play until you fall asleep. The instructions given for school naptime were basically the same as the aforementioned except for the first two points. In Taiwan, students do not have their own bed for school naptime. The usual position for school naptime is basically in a sitting position, with arms folded on their desk, and then place their head on the desk and nap. Since subjects in the experimental group were all napping in a same classroom, earphones were not necessary.

Subjects in the control group were instructed to nap and sleep as usual without music. All subjects were asked to complete the PSQI again at the end of second, third and fourth week of the study.

Data Analysis

Data were entered into the SPSS-WINDOWS software statistical package version 10.0. The effect of background music on sleep quality over time controlling for identified covariates was examined using repeated measures MANOVA. Since variables such as age, gender, caffeine consumption, and STAI showed no significant correlation with the dependent variable, none of the aforementioned variables were selected to be the covariate in data analysis.
Results

Sleep quality was the dependent variable for this study and was measured using the PSQI. A total of four time points were collected, one pretest and three posttests. The PSQI consists of seven components: perceived sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, daytime dysfunction, and use of sleep medication. Data from subjects taking any medication were excluded from analysis. The PSQI global score has a range of 0 to 18 with scores of each of the six components ranging from 0 to 3. Higher scores indicate poorer sleep quality.

Figure 1 shows that both the experimental and control groups showed a decrease in the global PSQI mean score over time, the overall mean scores were statistically significantly lower for the experimental group than for the control group, $F = 4.07$, $p = .047$. In other words, results indicate that background music did improve subjects' global sleep quality over time compared to those who did not receive any music.

**Results of Six Components of PSQI**

In the perceived sleep quality component (see Figure 2), the experimental group had a slightly higher mean ($M = .93, SD = .39$) at Time 1 compared to the control group ($M = .83, SD = .67$). Both groups generally had decreased mean scores over time. However, the experimental group had lower mean scores from Time 2 to Time 4 as compared to the control group. There were no statistically significant group differences in this component, $F = .938, p = .33$. In other words, the use of background music did not significantly improve subjects' perceived sleep quality over time. However, the experimental group had lower mean values across three posttests even though its baseline was slightly higher than the control group.

In the sleep duration component (see Figure 3), the experimental group had lower mean scores at all time points as compared to the control group. There were also statistically significant group differences in this component, $F = 6.68$, $p = .011$. In other words, the experimental group had significantly better sleep duration.

In the sleep efficiency component (see Figure 4), the experimental group also had lower mean scores at all time points compared to the control group. Despite the erratic change in the experimental group, its overall mean scores were still lower than the
FIGURE 1.
Global PSQI mean score between groups.

FIGURE 2.
Perceived sleep quality mean score between groups.
Sleep duration mean score between groups.

Figure 3.

Sleep efficiency mean score between groups.

Figure 4.
FIGURE 5.
Sleep disturbance mean score between groups.

FIGURE 6.
Daytime dysfunction mean score between groups.
In the sleep latency component, the experimental group had a decrease in mean scores over time, but the trend in the control group was rather erratic (see Figure 7). There were no statistically significant group differences in this component, $F = 0.877, p = 0.350$.

In the sleep disturbance component (see Figure 5), the control group had a lower mean score at all time points as compared to the experimental group. Although mean scores were higher for the experimental group, the overall trend showed a decrease in mean over time whereas the trend in the control group is a little erratic. There were no statistically significant group differences in this component, $F = 3.79, p = 0.055$.

In the daytime dysfunction component (see Figure 6), both groups showed a decrease in mean scores over time but the experimental group seemed to have a greater decrease over time as compared to the control group albeit it started off with a slightly higher mean score. There were no statistically significant group differences in this component, $F = 0.192, p = 0.662$. In other words, background music did not statistically improve daytime dysfunction over time despite the overall decrease in the mean score.

In the sleep latency mean score between groups.
Discussion and Recommendations

The purpose of this randomized trial was to examine the effectiveness of background music as a treatment to improve sleep quality of Taiwanese elementary school children from Nankang district of Taipei City, Taiwan. Two hypotheses were tested in this study: (1) Students who receive background music at naptime everyday and at bedtime each night for 5 weeks have better sleep quality over time compared to those who did not receive any background music; (2) Students who receive background music at naptime everyday and bedtime each night for 3 weeks have better scores in the components of sleep quality. The findings were tested using repeated measures MANOVA. Results showed that students who received background music at naptime everyday and at bedtime each night for 3 consecutive weeks had significantly better global sleep quality over time than those who did not.

Results of the six components of the PSQI showed that subjects who received background music had greater sleep efficiency and sleep duration than did those in the control group. However, no significant group differences were observed for perceived sleep quality, sleep disturbance, daytime dysfunction, and sleep latency.

In addition, the number of poor sleepers in the experimental group decreased over time. In the pretest, 68.9% were poor sleepers, which declined to 6.7% by the end of the experiment. Although 6.7% of the subjects were still poor sleepers at Time 4, their global sleep quality scores showed an improvement over time. In other words, results suggested that the use of background music had a dose effect on the global sleep quality.

There are several explanations for the differences between the experimental group and the control group. First, the significant improvement in sleep quality may be due to the playing time of the music used. Field (1999) found that the mean sleep onset time for children is approximately 30 minutes with music. In addition, it has also been suggested that 30 minutes of sedative music listening can lead to a decrease in the circulation of norepinephrine (Gerra et al., 1998), which is related to sleep onset (Irwin et al., 1999). In this study, subjects were given a 45-minute CD of music during naptime in school and bedtime at home. The increased exposure time may account for subjects' significant improvement in sleep quality.

Another explanation for the significant experimental effect
could be attributed to a Hawthorne effect. In other words, there is a possibility that subjects might be responding to the treatment due to their awareness of participation. This might also be the explanation for why subjects in the control group also showed improvement in their sleep quality. In addition, the significant experimental effect and presence of improvement in the control group may be partially due to the high compliance with the study from the subjects, as evident from the complete data for all subjects in this experiment, which was an unusual occurrence for a longitudinal study. All subjects were introduced to the researcher by their class form teachers, and they knew that the researcher was a foreigner conducting a study in their school. Thus, the subjects may have succumbed to social desirability to give a good impression of themselves by responding to the treatment in the way they thought would please the researcher.

The design of this study may have contributed to the significant effects of background music on sleep quality. The subjects were randomly assigned to the experimental group and the control group. The fact that this study was a completely randomized trial means that all possible confounding variables were theoretically controlled for by the nature of the study design. Thus, the results obtained were further strengthened by the design of the study.

Since no experimental study has been conducted on the effects of background music on sleep quality in elementary school age children, the findings of this study provide beneficial information on the effects of music on sleep in elementary school age children.

Effects of Background Music on Six Components of Sleep Quality

Not all the results observed in the present study on the effects of background music on six components of sleep quality were significant. Although improvements were observed in all components, significant improvements were observed in only sleep duration and sleep efficiency. A review of literature found no similar studies with which the results could be compared. Although Lai’s (2001) study is similar in design and the instruments used, the subjects in her study were elderly. In addition, her subjects were given their choice of music. Thus, it would not be appropriate to compare results of this study with Lai’s study.

The first component of the PSQI to be discussed is the perceived sleep quality component. Perceived sleep quality refers to how the
person perceives his/her own sleep as good or bad. It is measured by having the person use a 4-point scale to rate his/her own sleep quality over the last week. Previous studies have suggested that subjective measures of sleep quality mainly involved if the person felt refreshed after sleep (Akerstedt, Hume, Minors, & Waterhouse, 1994). In this study, results showed that the use of background music did not significantly improve subjects' perceived sleep quality over time albeit results from the experimental group did show lower mean values across time points.

There are various possible explanations for the nonsignificant improvements in the perceived sleep quality component. First of all, the experimental group showed improvement with lower mean scores over time than the control group, subjects in the control group also showed improvement over time. It is highly likely that subjects in both groups were responding due to their awareness of participation. Secondly, the length of time between each measurement point could be a factor. Although Hoch and Reynolds (1986) suggested that 3 weeks were needed for observing a new intervention on sleep quality, no relevant literature was found that would suggest the length of time between measurement points required for finding the effects of background music on sleep quality in elementary school age children. Perhaps a change in the length of the study and increase the number of time points might yield different results.

In the sleep duration component, results showed that subjects who received background music had significant improvement in sleep duration over time. During the pretest, 66.7% of the subjects in the experimental group indicated that they had more than 7 hours of sleep per night. At Time 4, 82.2% of the subjects indicated they had more than 7 hours of sleep per night. In other words, results implied the use of background music was effective in improving sleep duration over time. No previous studies have examined the effects of background music on sleep duration in children. Therefore this study cannot be compared to previous work. However, results from the present study would be informative to future researchers and provide a basis for future comparison of the effect of background music on sleep duration in children.

In the sleep efficiency component, results showed that subjects who received background music had a significantly lower mean score than subjects in the control group. In other words, results implied that the use of background music was effective in improving
sleep efficiency over time. The findings also suggested that the number of nighttime awakenings and sleep fragmentation decreased over time with the use of background music.

For sleep disturbance, results showed that there were no significant differences between groups. Although the mean scores were higher in the experimental group, the overall trend showed decreased mean over time. One explanation for the nonsignificant outcome was environmental temperature. Practically every subject indicated that their difficulty in falling asleep was due to the cold temperature. Since this study was conducted during the winter months (December to January) in Taiwan and none of the subjects had a heater at home, difficulty falling asleep on cold nights can be expected. Thus, the effect of environmental temperature may have obscured any experimental effect.

In the daytime dysfunction component, findings showed both groups had a decrease in mean scores over time. However, the experimental group had a greater decrease albeit the differences were not statistically significant. The greater decrease in mean scores in the experimental group suggests that those subjects who received background music had fewer problems staying awake and maintaining enthusiasm during the day. Although the results were not significant, the fact that the use of background music improved subjects, daytime dysfunction is important because it is crucial that school age children feel refreshed during the day so as to concentrate better during class time in school.

Lastly, results for sleep latency indicated that those who received background music had a decrease in mean scores over time whereas mean scores of those who did not have any music were rather erratic. Differences between groups were not statistically significant. The fact that results from the experimental group showed a gradual improvement over time supported the theory that a reduction in circulating norepinephrine, which is related to sleep onset, can be induced by the use of sedative music (Gerra et al., 1998; Irwin et al., 1999). However, the lack of significance could be due to a variety of reasons, such as increasing familiarity with the music, increasing ability to relax. In addition, the results could have been affected by environmental temperature since sleep latency is also measured by the number of times the person encountered difficulty falling asleep. Subjects in the current study attributed their difficulty in falling asleep to the cold temperature.
Several limitations to this study must be noted. Firstly, generalization of results from this study is limited due to the use of a convenience sample. All subjects in this study were fifth graders from an elementary school in a city in Taiwan. Thus, generalization of results is limited to fifth graders who are healthy, not on any medication, of normal intelligence, and without any sleep disorders, and residing in that particular city in Taiwan. Secondly, in a non double-blinded experimental study, a Hawthorne effect is often an issue of concern. It is possible that results of this study were affected by subjects' awareness of participation. Thirdly, the measurement of sleep quality is limited because PSQI is essentially a subjective measure and without any verification from an objective measure, biases from results obtained could be expected. In addition, although the PSQI was written in a language that can easily be understood by any fifth graders, it might not be the most ideal or appropriate measurement tool in conducting a sleep study with children. The validity and reliability of the instrument used on children has yet to be verified. Fourthly, results from this study may have been affected by the environmental temperature. This study was conducted during the winter months in Taiwan and none of the subjects had a heater at home. In fact all subjects indicated that the cold temperature was the main factor they had difficulty falling asleep. In other words, there may be seasonal effects that confound study results. Lastly, since this study was conducted by a single researcher, it is difficult to eliminate the possibility that the researcher may have been biased in the process. Thus, one should interpret the data obtained in this study with caution.

There are several issues that can be addressed in future studies on sleep quality in children. The results of this study showed that the use of background music over a period of 3 weeks improved sleep quality. However, its effectiveness over a longer period of time has yet to be established. Since sleep is a lifetime activity, a longer period of intervention and observation in examining its effectiveness would be beneficial in the long run. In this study, the number of poor sleepers decreased from 68.9% to 6.7% at the end of the experiment. It would be interesting to find out if the number of poor sleepers would reduce to zero if a longer period of intervention was used. Thus, more research utilizing a longitudinal design in studying the effects of background music on sleep quality in children over a longer period of time would be worthwhile.
The use of a convenience sample in this study has limited its generalizability. For better generalization of results, random selection from a larger pool and a double-blinded design are suggested for future studies. In addition, this study is limited to those with normal intelligence, without any disabilities and thus, results cannot be generalized to children with special needs. In other words, studies on the effects of music on sleep quality in special population would be worth exploring for future researchers.

The measurement tool used in this study is essentially a subjective measure. Subjective measures are generally reliable and valid in measuring various aspects of sleep such as restfulness, feeling refreshed, and disturbances caused by nightmares and environmental factors. However, they may not provide accurate information on other aspects of sleep such as sleep duration, sleep latency, and number of nocturnal awakening. Thus, a combination of subjective and objective measurements, such as wrist activity recorders, dream detectors, polysomnography, static charge-sensitive beds, and critical bedside monitors would provide a broader range of valuable and reliable information on sleep quality. In other words, it is recommended that both kinds of measurements should be used in future studies. In addition, other physiological factors related to sleep such as body temperature would be worth exploring as well.

Although the use of background music was found to be effective in improving sleep quality in this study, the subjects in the experimental group were not given music of their choice. The music used in the study was selected by the researcher based on criteria set by the school's officials. The use of non-subjects' preferred music may have led to the nonsignificant results in some of the components of sleep quality since previous research has shown that perceived relaxation, which is related to sleep onset, increases with subject-selected music (Davis & Thaut, 1989). In other words, it is possible that more significant results could have been obtained if subjects were given their choice of music. Thus, future researchers might want to take this factor into consideration.

The subjects' degree of liking for the music used in the intervention must be considered. Previous researchers have found significant correlations between liking for music and relaxation (Stratton & Zalanowski, 1984). Since relaxation is related to the circulation of norepinephrine (Kaempf & Amodei, 1989; Steelman, 1990; Updike, 1990; White, 1992), which in turn is related to sleep
onset (Irwin et al., 1999), it is recommended that future researchers measure subjects' linking for the music used in sleep study. In this study, subjects' liking for the music used was not measured. Thus, it would not be possible to study how much of the results obtained was actually affected by subjects' disliking to the music used.

Lastly, it would be interesting for future researchers to find out if there is any difference in sleep quality between naptime and bedtime. Since this study did not use separate measurement for naptime and bedtime, it would not be possible to distinguish if music had different effects on sleep quality during naptime and bedtime.

References


