An effect that a consonant-dissonant music therapy has on autonomic nervous system

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Abstract. This is a nonequivalent control group quasi-experimental study for grasping the effect of music therapy after making college students listen to consonant and dissonant music. Among the 38 college students enrolled in August 2, 2015 to September 7, 2015, 21 students were allocated to the experimental group to listen to consonant music, and 17 students were allocated to the control group to listen to dissonant music. Analysis of covariance was used to compare results before and after music therapy after controlling for baseline scores. Consonant music therapy had a significant positive effect on subjective stress (F=61.34, p< 0.001), parasympathetic nerve activity (F= 4.66, p= 0.038), and sympathetic nerve activity (F = 4.65, p < 0.038) compared with the control group.

Keywords: Music therapy, Stress, Autonomic nervous system, Consonance, Dissonance

1 Introduction

People who live in modern society suffer from numerous types of stress due to everyday life demands and heavy workloads. Stress occurs when an individual feels pressure with regard to one’s ability or when one thinks one's well-being is threatened by one's own limitations [1]. This definition of stress describes a specific relationship between the individual and the environment. Stress is also a phenomenon that may disturb homeostasis in the human body. When the stress level increases, the autonomic nervous system activates the sympathetic nervous system, which suppresses the parasympathetic nervous system to maintain homeostasis and in turn increases blood pressure, heart rate, respiratory rate, and blood sugar. Symptoms such as headache, muscle tension, indigestion, and changes in appetite as well as negative emotions such as depression and anxiety occur in response to stress [2]. Various intervention methods are used to relieve stress, including meditation, yoga, music and art therapy, abdominal breathing, and biofeedback. Among these methods, music therapy can be practiced anytime and anywhere without any special equipment or skills.
Many studies on the use of music as a nursing intervention in Korea have been published since 1983. And, among the cases of intervention methods, the percentage of studies simply using a listening method was 74.5%, which recorded the highest. In approximately half of these studies (51.2%), the researchers selected the music; in the remaining studies (48.8%), participants were allowed to select music based on their preferences. This lack of consistency across studies has prevented the development of standardized criteria for music therapy. The majority of studies lack a logical explanation for the method of music selection [3]. Moreover, various types of prenatal care, meditation, classical, and relaxation music are administered without validation of their effectiveness. Many researchers administer music therapy casually without a valid basis [4]. One study reported that the administration of unfavorable music may induce stress, leading to increases in blood pressure, pulse rate, blood sugar, and anxiety.

Hence, the purpose of this study was to provide a theoretical basis for the selection of music for music therapy and to understand the emotional and physiological effects of music. Music was categorized as either consonant or dissonant based on musical characteristics such as harmony, rhythm, and melody.

2 Methods

2.1 Research design

This non-equivalent control group quasi-experimental study was designed to determine the effect of consonant and dissonant music therapy on stress in college students.

2.2 Study participants

Thirty-eight students at Sahmyook University who met study criteria and consented to participate were enrolled in this study between August 2, 2015 and September 7, 2015.

2.3 Research instruments

In this study, dissonant music was defined as a piece of music that frequently uses non-harmonic pitches or harmony, irregular rhythmic activities, and sharp tempo changes. Dissonant music is also characterized by asymmetric and angular melodies with sharp changes in range, accent, and pattern (Table 1).
Table 1. Comparison of the two music types.

<table>
<thead>
<tr>
<th>Consonant Music</th>
<th>Dissonant Music</th>
</tr>
</thead>
</table>
| A. Claude Debussy  
*Suite bergamasque, third movement - Clair de lune in Db Major* | A. Brian Ferneyhough  
*Lemma-Icon-Epigram for Piano Solo* |
| B. Peter Ilyich Tchaikovsky  
*Valse Sentimentale in F Minor, Op. 51 No. 6* | B. Galina Ivanovna Ustvolskaya  
*Piano Sonata No.6* |
| C. Franz Liszt  
*Liebestraum Ab Major Notturno for Piano, S. 541 No.3* | C. George Crumb  
*Celestial Mechanics, “Makrokosmos IV,” I. Alpha Centauri* |
| D. Frederick Chopin  
*Etude Op. 10 No. 3 in E Major, Tristesse* | D. Peter Eötvös  
*Kosmos for Two Pianos* |

• **Autonomic nervous activity**

In this study, we measured two indices in the time domain, heart rate variability (HRV) and the standard deviation of the normal-to-normal intervals (SDNN), and three indices in the frequency domain, normalized low frequency power (n-LF), normalized high frequency power (n-HF), and LF/HF, using a heart rate variability analyzer (SA6000, Medicore, Korea) [5]. These indices measure and quantify temporal variations in heart beat period due to autonomic nervous activity.

• **Level of subjective stress**

The stress felt by participants after a stressful event is subjective. In this study, stress was measured via a 10-cm horizontal visual analogue scale. The leftmost score on the line was 0, indicating “no stress at all”; the rightmost score on the line was 10, indicating “very much stress.” Subjects were asked to mark their level of stress on the scale.

2.4 **Research procedure**

The co-researcher, a professor in the music department with expertise in composition, generated two types of music files in advance and saved them to an MP3 player. Only two types of piano music were selected for this study.

Stress was assessed prior to music exposure via the visual analogue scale. After this stress measurement, participants were divided into experimental and control groups. The listening duration was fixed at 20 minutes, which is suitable for producing an effect without inducing boredom [4]. Participants were instructed to lie down to listen to the music in a comfortable position. Participants were also instructed to use earphones in order to block background noise and increase concentration. Subjective stress was re-assessed after exposure to the music.

Participants were instructed to rest for 5 minutes in a supine position before the measurement of autonomic nervous activity and pulse rate. The anode lead of the analyzer was attached to the participant's right wrist, the cathode lead was attached to the participant’s left wrist, and the ground reference was attached to the left ankle.
2.5 Statistical analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 21.0. Analysis of covariance (ANCOVA) was used to analyze post-test differences in the effect of music therapy on stress between the experimental and control groups.

3 Results

3.1 Effect of music therapy on autonomic nervous system

Music therapy had a positive significant effect on parasympathetic nerve activity ($F = 4.65$, $p = .038$) and sympathetic nerve activity ($F = 4.66$, $p = .038$) compared with the control group (Table 2).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Consonant music $\bar{M} \pm SD$</th>
<th>Dissonant music $\bar{M} \pm SD$</th>
<th>$F$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SN activity (nu)</td>
<td>57.03 16.33</td>
<td>67.50 12.34</td>
<td>4.65</td>
<td>.038</td>
</tr>
<tr>
<td>PSN activity (nu)</td>
<td>42.97 16.33</td>
<td>32.48 12.35</td>
<td>4.66</td>
<td>.038</td>
</tr>
</tbody>
</table>

SN: sympathetic nerve, PSN: parasympathetic nerve.

3.2 Effect of music therapy on subjective stress

Music therapy had a positive significant effect on subjective stress ($F = 61.34$, $p < .001$) compared with the control group (Table 3).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Consonant music $\bar{M} \pm SD$</th>
<th>Dissonant music $\bar{M} \pm SD$</th>
<th>$F$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjective stress (score)</td>
<td>2.50 1.56</td>
<td>6.14 2.04</td>
<td>61.34</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

4. Discussion

The results of this study indicate that music composed with consonant elements reduces sympathetic nervous system activity, enhances parasympathetic nervous system activity, and reduces subjective stress levels.
The results of this study suggest that dissonant music provides a stressful signal that stimulates the sympathetic nerve; therefore, norepinephrine and epinephrine are released from the adrenal medulla and peripheral nerve. In contrast, soft consonant music has a calming effect and creates a comfortable atmosphere that adjusts heart and respiratory rhythms, and it relaxes stiff muscles via increases in brain alpha waves [6]. The results of this study suggest that consonant music activates the parasympathetic nervous system. Thus, consonant music acts therapeutically to activate physiological changes in harmony and balance.

Dissonant music may play a role as noise. Continuous noise is known to stimulate the reticular activating system, which stimulates the sympathetic nervous system and in turn leads to an excited state [7]. Thus, dissonant music may act as psychological stress and cause negative responses in the human body. The results of this study highlight the importance of listening to music carefully after examining the details of the musical composition, even if the music is famous or popular.

According to Girdano and Everly [8], repeated exposure to noise releases more stress hormones. Therefore, dissonant musical compositions may be exceptionally destructive or stimulating, which in turn may induce stress responses in listeners.

References