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The Effects of Incrementally Increasing and Decreasing Music Intensity on the Loudness Preference and Behaviors of College Students Performing Either Gross or Fine Motor Activity

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THE EFFECTS OF INCREMENTALLY INCREASING AND DECREASING MUSIC INTENSITY ON THE LOUDNESS PREFERENCE AND BEHAVIORS OF COLLEGE STUDENTS PERFORMING EITHER GROSS OR FINE MOTOR ACTIVITY

By

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Music Styles and Motor Activity
Music Performance in Physical Rehabilitation

Purposes of the Present Study

METHOD

Subjects
Design
Motor Tasks
Music
Measurement of Music Loudness Preference
Behavioral Observation
Heart Rate
Procedures
Reliability Calculation

RESULTS

Loudness Ratings

Gross versus Fine Motor Groups
Increasing versus Decreasing Mode
First versus Second Judgment
Males versus Females
Musicians versus Non-Musicians

Heart Rate

Behavioral Analysis
In-Tempo (Synchronized) Movement
Movement Levels
Facial Expressions and Behaviors Exposed to Music at High Intensity Levels
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DISCUSSION

Loudness Perception
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ABSTRACT

This study examined the preference of music loudness that incrementally increased and decreased while subjects performed a gross or fine motor task. A total of 64 college students listened to recorded popular music in the 9-minute individual experiment. In the gross motor group, subjects were asked to move up and down in small steps. In the fine motor group, subjects were observed tapping the fingers of one hand while sitting in a chair. Music loudness was the independent variable that incrementally increased from 65 to 85 dB and then decreased from 85 to 65 dB with a 5-dB change per minute. Subjects rated loudness preference every 30 seconds using a 5-point scale, thus, subjects rated loudness 2 times per minute. The dependent variables were loudness preference, behavioral responses, and heart rate. Heart rate was measured before, after the experiment, and after subjects completed a questionnaire. Ratings of loudness preference and heart rate were analyzed by the two-way analysis of variance (ANOVA) concerning gross versus fine motor groups, males versus females, and musicians versus non-musicians. Loudness preference ratings were also compared in loudness increasing versus decreasing mode and first versus second ratings at each dB level. The changes in subjects' synchronous movement and movement levels were observed and analyzed by the Friedman two-way analysis of variance by ranks. Observation reliability was 98.7%. Facial expressions and associated behaviors were also observed when music intensity increased.

Results indicated that throughout the session the fine motor group perceived music significantly louder than the gross motor group. Females perceived music significantly louder than males when the music intensity reached 80 dB. Significant interactions were found between loudness preference and 2 ratings at the same intensity levels. Subjects in both gross and fine motor groups increased comfort levels in the second rating regardless of whether they perceived music as soft or loud in the first rating. Significant interaction was also observed between music experiences and 2 ratings. Musicians quickly became accustomed to music at high intensity levels, and non-musicians quickly became used to music at low intensity levels. Subjects perceived decreasing sounds significantly softer than increasing sounds. Heart rate significantly increased after the experiment and significantly decreased after completing a questionnaire in both gross and fine motor groups. Movement levels significantly changed throughout the session. Music intensity changes correlated with movement levels. Synchronous movement and
movement levels significantly changed during the first 2 minutes. Subjects who perceived the music to be loud exhibited more facial expressions and associated behaviors of discomfort when music reached high intensity levels. The following were also discussed: the effects of body movement on loudness preference, auditory functions associated with loudness habituation, methodological issues to measure preference of loudness that changes over time, and implications for therapeutic applications.
INTRODUCTION

Music has been widely utilized in rehabilitation and exercise programs in our society. Research has reported an effective musical use to enhance motor skills in diverse population, e.g., patients with gait disorders (Staum, 1983), children with gross motor dysfunction (Thaut, 1985), patients receiving treatment of bone marrow transplant (Boldt, 1996), patients with head trauma (Lucia, 1987), and older adults with osteoarthritis (Zelazny, 2001). Improvement of motor abilities by musical interventions has also been reported in children with autistic characteristics (Hallander & Juhrs, 1974; Thaut, 1999, p. 171), patients with Alzheimer's disease (Cevasco & Grant, 2003), elderly individuals (Johnson, Otto, & Clair, 2001), individuals with cerebral palsy (Wolfe, 1979), and people with mental retardation (James, Weaver, Clemens, & Plaster, 1985).

Musical effects on gross and fine motor skills have been examined in laboratory settings. Regarding gross motor skills, research has indicated an increase of distance traveled (Beckett, 1990; Elliott, Carr, & Savage, 2004), heart rate recovery (Beckett, 1990), muscular control (Thaut, 1985; Thaut, Schleiffers, & Davis, 1991), and walking abilities (Staum, 1983). To enhance fine motor skills, practice of music instruments has been reported as an effective motivational tool in rehabilitation (Cofrancesco, 1985; Thaut, 1999, p. 158; Zelany, 2001). According to results from Cassity and Cassity's (1994) interviews about musical services in psychiatric facilities, music therapy has been provided to enhance children's fine motor skills, i.e., finger dexterity, independent finger movement, and grasp function.

Along with the widespread use of music in rehabilitation and exercise, research has examined how music functions in motor activities. Previous studies identified that music motivates individuals and gives cues to structure motor activities (Gfeller, 1988; Thaut, 1999). A strong correlation between enjoyment of exercise and participants' satisfaction to music was also reported (Wininger & Pargman, 2003).

Research has investigated what music characteristics would influence participants' successful participation in exercise programs. Wininger et al. (2003) found that participants identified tempo or beat as the most important music characteristic associated with enjoyment in aerobic activities. In Gfeller's (1988) research, music style, tempo, rhythm, and extra-musical associations were recognized as the most important musical components, followed by lyrics and sound intensity. Rock, pop, and new wave music were selected as the most preferred exercise...
music styles. Regarding effects of musical tempo, Hayakawa, Miki, Takada, and Tanaka (2000) reported that participants who were exposed to synchronous music experienced more vigorous feelings than participants with asynchronous music. Elliott et al. (2004) examined appropriate music selections for exercise through rating rhythm, familiarity, and cultural appropriateness. No significant difference was reported between the highest ranked music selections and lowest ranked selections on distance traveled and subjects' affect. Rhythmic auditory stimuli have been reported as effective techniques to improve gross motor abilities (Staum, 1983; Thaut, 1985; Thaut et al., 1991).

Although music intensity was recognized as a music component that influences exercise performance, the effects of intensity did not appear to be well investigated. An individual use of portable CD players for music listening during exercise seems to be widely accepted. This increased concerns about the effects of exposure to loud music on auditory functions. Engdahl (1996) reported that exercise conditions increased more noise-induced temporary threshold than non-exercise conditions.

Temporary threshold shift demonstrates changes in loudness perception when exposed to loud sounds. Hellström, Axelsson, and Costa (1998) observed that temporary threshold shift occurred when listeners were exposed to loud sound regardless of the sound types, i.e., noise and music stimuli. However, the degree of music-induced temporary threshold shift was comparatively small. As Hellström et al. discussed, the result might be associated with the listening condition where subjects were asked to adjust music intensity as "loud but still comfortable" levels. Hellström et al. also reported that different music listening habits appeared to influence temporary threshold shift at different frequencies.

Considering the effects of loudness perception on heart rate, no significant effects were reported (Staum & Brotons, 2000). Mukhamedrakhimov (1993) observed that heart rate tended to increase when listeners did not prefer the sound loudness, and heart rate tended to decrease when exposed to sounds with preferred loudness.

Comfortable loudness levels notably vary by individuals (Mukhamedrakhimov, 1993). Patients in a psychiatric hospital preferred lower music loudness levels than their employees (Bonny, 1968). Regarding differences in sound types, the most comfortable loudness level for musical sounds was higher than the one for pure tones (Riegler, 1980). These studies demonstrated that loudness preference changes depended on individuals, health conditions, and
sound types. The most comfortable loudness levels, however, are generally considered approximately at 70 dB (Stevens, 1986), which is within the range of the intensity levels in normal conversation.

As loudness preference is highly individualized, decades of loudness research demonstrated that loudness perception also varies according to numerous factors. Equal loudness curves, often called Fletcher-Munson curves, show that loudness perception changes depending on sounds' frequency (Radocy & Boyle, 2003, p.123). Cullari and Semanchick (1989) reported that loudness perception and music preference were negatively correlated, which indicated that the more the listeners favored the music, the less loud they perceived it to be. Loudness preference, on the other hand, positively correlated with music selections. Listeners increased the sound intensity levels when they listened to their favorite music selections. Regarding loudness discrimination, listeners more accurately discriminated music loudness levels when they were familiar with the music selections. Kageyama (1999) reported that young subjects listened to rock music at the highest intensity level and classical music at the lowest levels. Concerning loudness changes in music compositions, listeners perceived music dynamics in classical music as more musical expressions, while music dynamics in rock music were not related to its musical expressions (Geringer, 1975).

Regarding differences in males and females, loudness research has demonstrated various results. Males and females had no significant difference with respect to most comfortable loudness levels (Riegler, 1980) and discrimination of musical components when exposed to sounds at different intensity levels (Haack, 1975). Concerning loudness preference, Bonny (1968) found no significant difference, whereas Staum et al. (2000) observed that males preferred higher intensity sounds. Kageyama (1999) reported that males were exposed to higher intensity levels in their daily life. Hellström et al. (1998) revealed that females had significantly more noise-induced temporary threshold shifts than males.

Research has shown that differences in music experiences also influenced loudness perception. Musicians exhibited less variability or smaller dynamics in loudness perception than did non-musicians (Geringer, 1995; Hoover, 1992). Staum et al. (2000) found that musicians preferred softer music for relaxation as compared to non-musicians. In Geringer's (1993) research, musicians perceived flat sounds at high intensity levels as louder than non-musicians. In addition to numerous variables on loudness perception, considerable effects of sound intensity
changes on loudness perception has been examined. Loudness perception declines after a 3- or 4-minute sound exposure, which is called loudness adaptation. Listeners will gradually perceive sounds as softer when continuously listening to sounds at the same sound intensity levels (Dange, Warm, Weiler, & Dember, 1993). The perceived loudness of decreasing sounds diminished more rapidly than that of increasing sounds (Canévet & Scharf, 1990; Jones et al., 2003; Schlauch, 1992).

The results from research of music dynamics appear to be associated with the findings of studies concerning loudness adaptation. Geringer (1995) revealed that listeners perceived greater loudness in increasing sounds than decreasing sounds. Musicians performed a larger range of crescendo than decrescendo (Geringer, 1992). Listeners accurately discriminate loudness decrease sooner than loudness increase (Genringer, 1991).

Loudness adaptation phenomenon and perception of music dynamics seem to be related to loudness adjustment auditory functions. Schlauch (1992) found that a competing cognitive task interrupted a rapid decline of loudness perception with a decreasing sound. Active listeners performing no competing task perceived tones as softer than listeners performing the cognitive task. In research of background music, Madsen (1987) demonstrated that a competing cognitive task greatly diminished music perception. These results indicated that the central nervous system plays an important role in the loudness perception processing. At the same time, Schlauch also reported that loudness adaptation occurred only in the tested ear, not in the contralateral ear. This suggested that the peripheral nervous system may be involved in loudness adaptation processing. Thus, both peripheral and central nervous systems are considered to influence changes in loudness perception.
LITERATURE REVIEW

Loudness Phenomenon

Pure Tones, Noise, and Musical Sounds

The three types of sounds, pure tones, noise, and musical sounds, are differentiated because of their physical characteristics as well as the meanings in social and cultural contexts.

A pure tone is characterized by a sound consisting of the simplest kind of vibration called a *simple harmonic motion*. A pure tone has a fixed frequency and is generated with an electronic oscillator. The flute, however, especially in the upper register, can perform a sound of which the quality is close to a pure tone (Roederer, 1995, p.21).

Noise and musical sounds, when compared to pure tones, are more complex. Noise is a complex sound which does not contain fixed frequency and harmonic overtones. White noise is a specific type of noise that consists of all pitches at equal amplitude. Sounds which have similar qualities of white noise can be experienced when listening to a radio where there is no program on the air (Wagner, 1994, p.19-20).

Musical sounds have three essential components, *pitch*, *timbre*, and *loudness* (Roederer, 1995, p.3). Music is distinguished from pure tones and noise because of its organized, structured, and rhythmic sequences. In addition, music is a cultural phenomenon (Miller & Cockrell, 1991, p.1), which brings people aesthetic feelings and emotional responses (Roederer, p.13).

Loudness, Amplitude, Intensity, and Volume

*Loudness* is defined as “our perception of *amplitude*”. Amplitude is “the distance through which a vibrating body moves” (Wagner, 1994, p.4). Thus, loudness is a sound’s strength that is subjectively judged, whereas amplitude is an objective physical portion of sound. *Intensity* is a result of amplitude, and is an objectively measurable “amount of power” that the sound carries. *Volume* is often used to express a sound’s strength; however, it is differentiated from loudness. Volume is the size of sounds and related to *density*, “the compactness of sounds.” For example,
the sound of a tuba is probably perceived with much more volume than that of a piccolo (Radocy et al., 2003, p.118-119).

Loudness is difficult to measure since it is subjectively perceived while intensity levels can be measured using the unit of decibel (Wagner, 1994, p.6-7). Decibel (abbreviated as dB) is a measure for intensity ratios, not the intensity itself. A 10 dB difference between two sounds indicates that the intensity of one sound is 10 times higher than that of the other sound. For instance, the intensity of a 70 dB sound is ten times higher than that of a 60 dB sound. A 20 dB difference means that the intensity of one sound is 100 times higher than the other sound, e.g., an intensity of a 80 dB sound has 100 times as high as that of a 60 dB sound (Radocy et al., 2003, p.120).

In addition to using decibels, sound intensity levels are sometimes expressed with subjective terms in loudness research articles. For example, 50, 70, and 90 dB levels may be labeled as soft, medium, and loud sounds. However, power ratios are still physiological objective measures, not subjective. Therefore, when people listen to one sound at 60 dB and another sound at 70 dB, the intensity of a 70 dB sound is ten times higher than that of a 60 dB sound but people will not perceive the 70 dB sound to be ten times as “loud” as the 60 dB sound (Roederer, 1995, p.91).

**Comfortable Loudness Level**

According to Stevens’ (1986) decibel scale, the sound environment of a subway is at 90 to 100 dB levels and heavy traffic is at 80 dB. As for speech sounds, normal conversation is carried between 60 and 70 dB levels and whisper is at around 30 dB. The loudness levels at which people feel the most comfortable are considered approximately at 70 dB which is within the range of the intensity levels in normal conversation. However, comfortable loudness levels will be influenced by numerous factors such as frequency and individual differences (p.34).

Notable individual variability of comfortable loudness levels was reported by Mukhamedrakhimov (1993). The preference estimation toward a 1 kHz tone ranged from 10 to 70 dB although the variability was much smaller with the tone presented at higher intensity levels. Riegler (1980) discovered that the most comfortable loudness level for musical sounds was significantly higher (67.6 dB) than for pure tones (58.8 dB) in residents of a group home and
a nursing home with the average age of 78.7 years. Bonny (1968) found that patients in a psychiatric hospital preferred lower music loudness levels than their employees. The most comfortable loudness level for both patients and employees was around 60 to 70 dB.

People do not always choose to listen to music at their most comfortable dB level. Kageyama (1999) researched loudness levels that people are usually exposed to and their most comfortable loudness level. In 46 young adults, the usual listening levels of music loudness were significantly higher (1.2 to 2.3 dB) than their most comfortable loudness level. Kageyama emphasizes the importance of investigation toward usual listening levels since people are exposed to sounds at the usual listening levels rather than their comfortable loudness levels.

**Threshold of Hearing and Pain Threshold**

Human auditory perception has a limited range. The lower limit of hearing is defined as the *threshold of hearing* where the sound’s intensity is too small to hear. The upper limit is called the *pain threshold*. Discomfort will be experienced at above 120 dB for common sounds (Barthlomew, 1964, p.211 as cited by Wagner, 1994, p.7). However, threshold of hearing and pain threshold vary depending on the sound’s frequency.

Exposed to loud noise, auditory perception will be temporarily damaged toward sounds at low intensity levels which is called *temporary threshold shift* (abbreviated as TTS). High frequent tones are especially difficult to perceive compared to low frequency tones when temporary threshold shift occurs (Wagner, 1994, p.74).

When temporary threshold shift was intentionally induced in an experimental condition, a 10-minute exposure to a third octave band with 2 kHz frequency at around 105 dB was used (Hellström et al., 1998; Hutchison, Alessio, Spadafore, & Adair, 1991).

Axelsson, Vertes, and Miller (1980), as cited in Hutchison et al. (1991), reported that temporary threshold shift is caused due to neural fatigue in the central auditory pathways and a reduction of the afferent neural activations, oxygen tension, and vasoconstriction. Temporary threshold shift usually does not lead to permanent hearing loss and recovery of these physiological changes was reported. In the experiment by Hutchison et al., temporary threshold shift subsided within 48 hours. However, it is unknown if frequent temporary threshold shifts would eventually result in permanent hearing threshold shift.
A relationship between temporary threshold shift and body movement has been suggested by Engdahl (1996). Exercise significantly increased noise-induced temporary threshold in 8 subjects with the mean age of 28 years. Lindgren and Axelsson (1988) and Colletti, Fiorino, Verlato, and Montresor (1991), as cited Engdahl, also detected that exercise enhanced temporary threshold shift when paired with noise exposure.

**Loudness Adaptation**

Changes in auditory perception are reported not only when people are exposed to loud noise but also continuous sounds within the normal intensity range. *Loudness adaptation* is defined as “a decline in the perceived loudness of a tone over time” (Dange et al., 1993). The loudness of a sound will be perceived as softer after the sound exposure for 3 or 4 minutes.

Scharf (1983), as cited by Jones et al. (2003) and Dange et al. (1993), demonstrated that loudness adaptation happened in sounds only below 30 dB. However, Jones et al. detected loudness adaptation at higher intensity levels (50 and 70 dB). Dange et al. discovered that loudness adaptation occurred over a wide range of intensity levels (35 to 85 dB) but the loudness decline was more notable at low intensity levels (35 and 45 dB).

Loudness adaptation was observed not only with steady tones at the same intensity level but also tones in which the loudness continuously increases or decreases, or alternatively increases and decreases (Jones, Weiler, Warm, Joel, Dember, & Sandman, 2003). The perceived loudness of decreasing sounds diminished more rapidly than that of increasing sounds. This loudness adaptation in a decreasing sound is called “decruiitment” (Canévet et al., 1990).

Perception of the rapid loudness decline is usually measured by subjects’ frequent loudness judgments while listening to the sustained sound. Canévet et al. (1990) demonstrated that decruitment occurred even when subjects estimated the loudness magnitude only at the beginning and the end of 3-minutes of listening. Canévet et al. and Schlauch (1992) examined that decruitment in a continuous sound took place more markedly than that in an intermittent sound. Considering sound types, Canévet et al observed that loudness adaptation and decruitment with noise occurred in a similar manner to those in pure tones.

In the study of Canévet et al. (1990), the loudness of decreasing sounds declined exceptionally below 40 dB. Schlauch’s (1992) research showed decruitment with a decrease of
loudness from 90 to 50 dB although the degree of decruitment at 70 to 30 dB was more notable than that at 90 to 50 dB.

Schlauch (1992) studied if loudness adaptation occurs only in a tested ear or in both ears. The results showed that only the tested ear, not the contralateral ear, exhibited decruitment. This suggests the peripheral nervous system may be involved in loudness adaptation processing. However, Schlauch also found that a cognitive task competing with a listening task influenced the subjects’ loudness estimates. Thus, the central nervous system may also be considered to be a part of the processing.

**Continuous Loudness Change and Dynamics**

The impact of sounds, which continuously change in level, on our auditory perception has been detected throughout the studies of loudness adaptation and decruitment mentioned above. Geringer’s (1993) research suggested a greater variability of loudness estimation in all the three tested sound types, noise, synthesizer, and music excerpts, in a modulated condition (dynamics presented) than in a fixed condition (no dynamics presented).

Differences between perception of an increase of loudness and that of a decrease of loudness have been examined. Geringer (1992) analyzed dynamic changes in 60 recorded choral, orchestral, and piano compositions and revealed that an increase of loudness (expressed by dynamics notations of *piano* to *forte* on the score) were performed with larger dynamics ranges than a decrease of loudness (expressed by *forte* to *piano*) in all the three music styles. In 1995, Geringer examined subjects’ continuous loudness estimations of an increase and a decrease of loudness in a variety of musical contexts, including instrumental jazz, popular vocal, solo and orchestral classical music, and synthesizer examples. The subjects judged an increase of loudness as greater changes than a decrease of loudness. Geringer (1991) also found that subjects accurately discriminate a decrease of loudness with less time than an increase of loudness.
Variables on Loudness Perception

The following studies examined how our loudness perception of pure tones, noise, and/or musical sounds differs depending on various factors such as sound types, sound components, music types, subjects’ preference, individual attributes, and situations.

Loudness and Sound Types

Differences and similarities of loudness perception in pure tones, noise, musical sounds have been examined. In Geringer’s (1993) research, intensity of noise-band stimuli was perceived louder than that of recorded synthesizer music and commercial music. As to the most comfortable loudness, Riegler (1980) found that listeners preferred listening to pure tones at significantly lower intensity levels than musical sounds. Considering perception of sounds accompanied with dynamics changes, Marshall (1980) detected that the slopes of musical sounds were judged in a similar way for those of pure tones and noise stimuli.

Hellström et al. (1998) observed that temporary threshold shift occurred when listeners were exposed to loud sound regardless of the sound types, i.e., noise and music stimuli. However, the noise-induced temporary threshold shift was induced by 10-minute noise exposure at 105 dB whereas music-induced temporary threshold shift was examined with a one-hour exposure at above 90 dB. In music exposure, 9 out of 21 subjects exhibited less than the average of 3 dB temporary threshold shift in the range of 2 to 8 kHz frequency. The subjects who listened to the music at the lowest intensity levels (78.4 to 88.7 dB) had 0.96 dB temporary threshold shift whereas the subjects who were exposed to music at an average level of 97.2 dB exhibited more than 10 dB temporary threshold shift. Hellström et al. concluded that the degree of music-induced temporary threshold shift was comparatively small in spite of the long exposure of sounds at high intensity levels. No correlation was found between subjects’ susceptibility to noise-induced temporary threshold shift and that to music-induced temporary threshold shift.

In the loudness adaptation research by Canévet et al. (1990), differences between pure tones and noise were detected in the loudness estimations. Subjects perceived noise softer than pure tones below 50 dB and louder at 50 dB and above.
Relationship between Loudness and Frequency

Equal loudness curves, often called Fletcher-Munson curves, show that loudness perception of pure tones changes depending on sounds’ frequency in a systematic way (Radocy et al., 2003, p.123). The curves demonstrate that the ear is not equally sensitive to every sound. For instance, our ear is the most sensitive to sounds in the frequency of around 2000 Hz.

In order to investigate relationship between loudness and frequency in musical contexts, Smith (1989) examined preferences of music intensity levels for four frequency bands (110, 330, 1000, and 3000 Hz) in 180 subjects. The research did not recognize a systematic relationship between loudness preference and frequency in musical sounds.

Loudness and Music Selections, Music Types, and Music Features

Cullari et al. (1989) investigated how loudness perception and loudness preference are influenced by subjects’ preference of music selections. They found that the more subjects favored the music, the less loud they perceived the music. In addition, a significant positive correlation between preferred loudness levels and subjects’ preference of music selections was observed. In the experiment, the subjects were allowed to adjust the music intensity levels. They increased the music intensity levels when they listened to their favorite music selections. Bonny (1968), however, reported that subjects did not necessarily play their most preferred selections in the higher intensity levels when their choice of listening intensity levels was either 75 dB or 90 dB.

Hoover and Cullari (1992) studied the differences of listeners’ perception of loudness depending on music types. Subjects’ loudness perception in 10 different types of music was examined as measured by loudness matching to a neutral stimulus. The musician group displayed greater accuracy on classical music than the non-musician group whereas the non-musician group demonstrated the most accurate loudness discrimination on the music selection that was popular around that time.

Kageyama (1999) investigated loudness levels that are usually listened to by 46 young people with the average age of 18 years. The usual listening loudness levels varied depending on
music types. Subjects listened to rock music at the highest intensity level and classical music at the lowest level.

Geringer (1975) revealed that musical dynamics were perceived in a different way depending on music types. In classical music, more musical expressions were perceived with greater dynamic change, while in rock music, musical expressions was not related to dynamic changes.

The relationship between loudness perception and music features, i.e., instrumentation and sound duration, was discussed (Geringer, 1995, 1991). Geringer (1995) found inconsistency between subjects’ perception of loudness dynamics and the recorded sound intensity changes in 3 out of 10 excerpts. The changes of instrumentation were noted as potential factors that influence subjects’ perception of dynamics in one example. In the loudness discrimination experiment by Geringer (1991), frequent long silence in the Bach chorale composition and instrumentation changes in the Persichetti example were considered to be possible components that effected subjects’ loudness discrimination of the music dynamics.

Intra-Subject Variables; Age, Sex, Music Experience, and Music Habits

Age. Riegler (1980) researched comfortable loudness levels in subjects who were in residential facilities with the age range from 63 to 90 years. The investigation showed that age difference did not influence their most comfortable loudness level which was the average of 67.6 dB for music and the average of 58.8 dB for pure tones. Bonny (1968), however, found a positive correlation between preferred loudness levels and age in patients and employees in a psychiatric hospital. The subjects’ ages varied under 20 years to above 60 years. However, the loudness levels were limited either 75 or 90 dB. On the other hand, Smith (1989) discovered that younger subjects of 18 to 53 years of age preferred louder intensity levels than the oldest subjects of 78 to 90 years old. Mean scores of preferred music intensity levels exhibited a trend that the older the subjects were, the lower the intensity level they preferred.

Sex. Riegler (1980) detected no significant difference for most comfortable loudness levels between males and females of 63 to 90 years old. Bonny (1968) also found no significant difference for preferred loudness levels with respect to gender differences in patients and
employees in a psychiatric hospital. Staum et al. (2000), however, observed that males preferred higher intensity levels than females for relaxation when exposed to three different music intensity levels, 60 to 70 dB, 70 to 80 dB, and 80 to 90 dB.

Haack (1975) researched loudness effects on discrimination abilities. Three sound intensity levels, 45 to 50 dB, 75 to 80 dB, and 105 to 110 dB, were examined on discrimination tasks of musical components, i.e., pitch, rhythm, duration, loudness, timber, and tonal memory. No significant difference was shown between males and females on any of the discrimination tasks.

When considering loudness levels that subjects are usually exposed in their daily life, significantly higher intensity levels (5.0 to 8.9 dB) were found in men than in women (Kageyama, 1999). Hellström et al. (1998) reported no statistically significant differences between males and females with music-induced temporary threshold shift; however, a significant difference with noise exposure was detected. The females had significantly more temporary threshold shifts than the males after noise-exposure in high frequencies between 2 kHz to 8 kHz. This suggests that females may have more discomfort than males when listening to loud, high frequency noise.

**Music Experience.** Musicians and non musicians are often compared in music research since their music experiences and training may influence their music perception. Regarding loudness influence on discrimination of music sounds, Haack (1975) found that music and non-music majors responded similarly but music majors were slightly more influenced by loudness variables when they judged timbre and loudness characteristics while non-music majors were more influenced by loudness exposure with pitch discrimination.

Geringer (1991) examined discrimination of dynamics between musician and non-musicians in synthesizer music excerpts and in electronic tones in a modulated condition. No significant difference was detected between the two groups as measured by the number of correct discriminations and response time.

Hoover et al. (1992) observed that non-musicians showed greater accuracy on overall music loudness matching tasks than musicians using various types of music, e.g., rock, pop, dance, and country music. However, the musician group more accurately discriminated the loudness in classical music selections. Musicians showed much less variability than non
musicians in loudness matching scores. Geringer (1995) also found that musicians estimated loudness magnitude as smaller change than did non-musicians.

As to loudness preference, Riegler (1980) observed that subjects with more music experience preferred higher sound intensity levels for pure tones but no significant difference was found with respect to music experience for musical sounds. Geringer (1993) found that music majors perceived sounds louder than did non-majors when exposed to 90 dB flat sounds stimuli. In Bonny’s (1968) research, no correlation between music experience and preferred sound intensity levels was identified in music excerpts. On the other hand, Staum et al. (2000) found that music majors preferred lower intensity levels than non-music majors for relaxation.

**Music Listening Habits.** Hellström et al. (1998) investigated whether noise- and music-induced temporary threshold shifts differ depending on individual music listening habits. Noise-induced temporary threshold was examined for frequency ranged from 0.8 to 8 kHz and music-induced temporary threshold was taken for frequency ranged from 2 to 8 kHz. Subjects were divided into one of three groups depending on their musical listening habits. The first group consisted of the subjects who usually use portable cassette players for daily music listening. The second group was for loud speaker users, and the subjects in the third group were those who do not frequently listen to music.

Considering noise exposure, the maximal temporary threshold shift was detected at 2.5 to 3 kHz in all the three groups, and all the groups showed similar temporary threshold shift patterns.

For music exposure, the subjects brought their own pop music selections and were instructed to listen to the music at “a loud but still comfortable” level. In the experiment, the loud speaker users listened to music at a significantly higher level (average of 97.1 dBA) than both subjects in the portable cassette players’ group (91.4 dBA) and in the infrequent music listeners’ group (91.9 dBA).

Although the subjects in the loud speaker group exhibited the greatest amount of temporary threshold shift, no statistically significant difference of temporary threshold shift was found between the three groups except for at 2 to 2.5 kHz. However, each group exhibited a different tendency of the temporary threshold shift toward various frequencies. Temporary threshold shift in the portable cassette players’ group was the most notable at 3.5 to 4 kHz. In the
loud speaker group, temporary threshold shift evenly occurred between 2 to 5 kHz. The infrequent music listeners’ group had the most temporary threshold shift at 4 to 5 kHz.

**Background Music and Music Loudness**

In our society, music is widely used in the background at many places, e.g., shopping centers, gyms, and dental clinics. Music also plays an important role as an expression when combined with other art forms, such as movies and theatre plays. The following research examined how people perceive music when they pay attention to non-musical tasks and in what ways music could be presented to efficiently help achieve the goals of the primary activities.

**Background Music for Cognitive Tasks**

The effects of music loudness on math test performance were investigated by Wolf (1983). No significant difference was detected in the math test scores among four different loudness conditions, i.e., no music, 60 to 70 dB background music, 70 to 80 dB, and 80 to 90 dB. However, subjects in the group with music at 80 to 90 dB reported that the music distracted their focus on the task. Madsen (1987) also found that reading test scores were not influenced whether background music was provided or not, nonetheless, some subjects stated that music was distracting. Subjects who usually studied with background music obtained better test scores than the subjects who never studied with background music.

Results from the questionnaire indicated that changes in volume were recognized as the most distracting (Madsen, 1987). Changes in tempo and instrumentation followed as distracting factors. This may explain why the test scores were not influenced by background music in Madsen’s and Wolf’s (1983) studies. Though the music loudness was high during Wolf’s study, subjects may have been able to adjust to the loudness and avoid its influence because the loudness level was consistent throughout the session.

Madsen (1987) also identified that subjects could not concentrate simultaneously on two different tasks which consisted of a reading test and a music test. When subjects simultaneously performed the two tests, their scores dramatically dropped compared to the groups who performed either the reading test or the music test independently. However, a majority of the
subjects recognized some of the music selections that were played during the cognitive tests (Madsen 1987; Wolf, 1983). Through these studies, momentary attention to background music was observed when subjects performed a cognitive task rather than active listening.

Effects of cognitive tasks on perception of sound loudness were also examined in loudness adaptation research (Schlauch, 1992). Subjects were exposed to a 3-minute sustained sound that continuously decreased from 90 dB to 50 dB. Subjects in one group actively listened to the sound and estimated the loudness 9 times. The other group judged the loudness only at the beginning and at the end of the 3-minute sound, and they played a video word-matching game between the two judgments while exposed to the sound. The results showed that the videogame group exhibited less decruitment indicating that the rapid perceived loudness decrease was not remarkable when compared to the group with active listening. This suggested that the central nervous system may play a role in the loudness adaptation processing.

**Loudness of Background Music on Vocalization**

Cunningham (1986) studied the effects of loudness in background music to increase the vocalization of individuals with mental retardation. The amount of vocalization in 17 to 20 subjects who were non-ambulatory with severe mental retardation was observed during their free time. Four instrumental jazz-rock music selections were used as background music. When comparing the amount of vocalization at the beginning and at the end of observation sessions, subjects’ vocalization increased at 69.5% with music at a lower intensity level (approximately 60 dB). On the contrast, a 37.5% decrease was observed in a higher music intensity level (90 dB).

**Music Types, Loudness, and Physiological Responses**

Standley (1986) reviewed research on the effects of music on physiological responses and reported that relatively slow and quiet music, often labeled “sedative,” tends to decrease physiological activities whereas exciting, fast-tempo music, labeled “stimulus” tends to increase physiological responses. However, the research results were inconsistent and did not show a systematic relationship between music types and physiological responses. Because of the
considerable variations of individual physiological responses, Standley proposed specific music treatment techniques to specific populations.

Not only music types but the effects of music loudness on physiological measures also vary (Copeland & Frank, 1991; Staum et al., 2000). Staum et al. observed no significant changes of heart rate during three contrasting music intensity levels in relaxation sessions. The subjects listened to music at high (80 to 90 dB), medium (70 to 80 dB), and low (60 to 70 dB) intensity levels for 3 minutes per level. The sound intensity changes occurred 9 times in a randomized order.

Copeland et al. (1991) examined heart rate changes in exercise paired with slow (100 beats per minute) easy-listening music at a low intensity level (60 to 70 dB), with fast-tempo (140 beats per minute) pop music at a higher intensity (75 to 85 dB), and with no music. The subjects who perceived slow, easy-listening music with low sound intensity had lower heart rate at some points of the exercise time than the no music group and the group with faster-tempo higher-intensity music. However, the peak heart rate and the heart rate preceding maximum workout in the group with slow, low-intensity music were higher than those in the high-intensity group and in the no music condition.

**Loudness Preference and Physiological Responses**

Mukhamedrakhimov (1993) demonstrated interactions between loudness preference and autonomic responses, i.e., heart rate and the amplitude of skin electric potential changes. A 1 kHz tone at 10, 50, and 90 dB levels was used as a sound source. Subjects were divided into three groups depending on the patterns of their heart rate changes and skin electric potential changes to the sound at the three intensity levels; thus, the subject number in each group was uneven. The two physiological measures were analyzed separately which indicates that the same subject could be pooled into Group 1 in the heart rate analysis and Group 2 in the analysis of skin electric potential changes.

In the heart rate analysis, subjects’ heart rate in Group 1 decreased after they experienced 10 dB sounds and increased at 90 dB. Group 3 was defined by a heart rate increase at 10 dB and a decrease at 90 dB. Subjects who did not show these specific heart rate responses fell into Group 2. Subjects in Group 1 showed a significantly higher preference of 10 dB sounds than
Group 2 and 3. Group 2 displayed a higher preference for the 10 dB sound than Group 3. On the other hand, the preference for a 90 dB sound in Group 1 was lower than the other groups. Group 2 had a lower preference for the 90 dB tone than Group 3. The averages of the most preferable intensities were 39.4 dB in Group 1, 50.7 dB in Group 2, and 63.8 dB in Group 3.

In the analysis of skin electric potential changes (SEG), Group 1 subjects presented SEG at 10 dB and decreased SEG at 50 dB. Group 3 was characterized by a lack of change in SEG at 10 dB and a presence of maximal SEG at 90 dB. The subjects who did not present the SEG patterns of Group 1 and Group 3 fell into Group 2. Group 1 exhibited loudness preference for 10 dB more than Group 2 and 3, while preference for a 90 dB tone in Group 1 was lower than that in Groups 2 and 3. Groups 2 and 3 were not significantly different in any SEG responses. Through the investigation of heart rate and skin electric potential changes, Mukhamedrakhimov (1993) demonstrated an influence of loudness preference on autonomic responses.

Davis and Thaut (1989) suggested unique intra-subject physiological responses to music stimuli. Davis et al. examined individual psycho-physiological response patterns in relaxation sessions. The subjects chose their preferred music selections for relaxation and controlled loudness levels of the music at their comfortable level throughout the session. The subjects reported that their anxiety decreased and relaxation increased. On the other hand, their autonomic and muscular activities were aroused by music listening. In the research of temporary threshold shift by Hellström et al. (1998), subjects had relatively small temporary threshold shift when they listened to music of their choice at a loud but still comfortable level.

Music in Motor Activities

Musical Effects in Rehabilitation for Diverse Population

In the course of a meta-analysis of 30 studies implemented in actual clinical treatment, Standley (1986) detected an effective musical use in a rehabilitation treatment process to reduce pain from physical movement, reduce muscle tension, and increase strength and coordination of motor activities.

Rhythmic stimuli successfully improved motor abilities in patients with gait disorders (Staum, 1983) and children with gross motor dysfunction (Thaut, 1985). Lucia (1987) developed
a music therapy intervention model for patients with head trauma through reviewing related research. Lucia concluded that patients’ speech and motor skills, as well as self-image and psychological challenges, were positively supported by music-based rehabilitation. In Boldt’s (1996) experiment, effects of relaxation and physical exercise using live and recorded music were examined on 6 patients receiving treatment of bone marrow transplant. In a short-term treatment, the patients increased relaxation and physical comfort levels. In a long-term treatment, more endurance, more cooperative behavior, and greater participation were observed in the music condition as compared with a non-music condition.

Music effects on improving body image and motor coordination were reported for children with autistic characteristics (Thaut, 1999, p.171). The Orff-Schulwerk music method, which emphasizes rhythm in speech and body movement, has been practiced for children with autism to increase their gross and fine motor abilities (Hallander et al., 1974). Cassity et al. (1994) investigated psychiatric music therapy assessment and treatment from 65 psychiatric training facilities. Motor problems were especially identified with children. Various strategies of music therapy interventions were proposed to enhance children’s motor skills. Treatment for gross motor skills included imitating or leading movements and activities using songs with lyrics to direct specific movements, i.e., walking, skipping, and marching. When regarding fine motor activities, the keyboard, autoharp, guitar, and percussive instruments are utilized to enhance finger dexterity, independent finger movement, and grasp function.

Considering musical intervention for adults with mental disorders, Tracy, Chambliss, and Tyson (1996) observed that listening to stimulating music influenced their fine motor skills. Patients with Alzheimer’s disease significantly increased their participation in physical exercise when music was paired with effective verbal cues (Cevasco et al., 2003). Significant music effects in rehabilitation exercise were also reported in elderly individuals (Johnson et al., 2001). Four older adults with osteoarthritis improved their fine motor abilities through music keyboard playing (Zelazny, 2001).

Wolfe (1979) investigated the music effects as a contingency to improve head posturing in individuals with cerebral palsy. The study reported that 4 out of 20 subjects improved their head control during the treatment sessions. James et al. (1985) also observed significant motor improvement when music was paired with vestibular stimulation in individuals with mental
retardation. The subjects who were categorized in a high-needs group improved their motor abilities more than the subjects in a low-need group.

**Music Functions and Effects in Exercise**

Gfeller (1988) provided an excellent review of music research in motor activities. Three music functions were identified; music 1) provides cues to structure motor activities, 2) increases motivation, or distracts undesirable stimulus, and 3) enhances group cohesiveness. After interviewing 70 college students, Gfeller found that 97% of the subjects thought that music improved their mood toward the activity while 79% of the subjects stated that music helped with pacing, strength, and endurance. The subjects’ insight is consistent with the research findings that music motivates individuals and gives structure to motor activities (Thaut, 1999).

Wininger et al. (2003) recognized a strong correlation between enjoyment of exercise and participants’ satisfaction to music. Gfeller’s (1988) research discovered that appropriate mental attitude was recognized as the most important component to successfully participate in aerobic exercise. The amount of energy or effort was recognized as the secondary important component. On the other hand, 17% of the subjects recognized timing and precision of movement, and 10% of the subjects chose correct positioning of muscles, e.g., flexibility and balance as important factors for successful participation in exercise.

Music effects on exercise are measured by distances traveled (Beckett, 1990; Elliott et al., 2004), heart rate or recovery heart rate (Beckett, 1990; Copeland et al., 1991; Hayakawa et al., 2000; White & Potteiger, 1996), and ratings of perceived exertion, abbreviated as RPE (Copeland et al., 1991; Elliott et. al., 2004; Hayakawa et. al., 2000; White et al., 1996).

Distance traveled was significantly greater when paired with music than no music condition in the 30-minute walking exercise (Beckett, 1990) and in the cycling exercise (Elliott et al., 2004).

Heart rate data were inconsistent in the research of exercise with music stimuli. Significantly better heart rate recovery was observed in the waking exercise with music compared to the non-music condition (Beckett, 1990). A significant difference of heart rate between males and females was also observed. Copeland et al. (1991) found a significant difference in heart rate between the group with slow, easy-listening music at a low intensity level.
and the group with fast, stimulating music at a high intensity level during treadmill exercise. In the study of Hayakawa, et al. (2000), subjects with aerobic dance music maintained higher heart rate than the traditional folk music group and the no music group.

On the other hand, White et al. (1996) reported no significant difference in heart rate between groups with different types of stimulus and between stimulus and non-stimulus groups during moderate intensity exercise.

Ratings of perceived exertion were significantly lower with slow, easy-listening popular music at a low intensity level than no music, but the exertion lasted longer than that in the no music condition (Copeland et al., 1991). Hayakawa et al. (2000) found that the ratings of perceived exertion were higher in a group with aerobic music than in a non-music group.

In the investigation by White et al. (1996), peripheral and central ratings of perceived exertions were examined in addition to overall ratings of perceived exertion. Peripheral ratings of perceived exertion were defined as the perceived exertion from the joints and muscles of the legs. Central ratings were determined as sensations from cardiovascular and pulmonary systems. The three ratings of perceived exertion were measured in the exercise where music, visual, and combination of music and visual stimuli were presented. Significantly higher peripheral and overall ratings of perceived exertion were reported in the group with visual stimuli than with music stimuli and the combination of music and visual stimuli. Central ratings of perceived exertion were higher in the visual group than in the combination group, the music group, and the non-music group.

**Music Components and Motor Activities**

In the investigation of Wininger et al. (2003), tempo or beat was identified as the most important music characteristic associated with enjoyment in aerobic activity. Intensity or volume was recognized as the secondary important factor. By interviewing 70 female college students, Gfeller (1988) revealed that the following four music components were recognized as the most important factors in aerobic exercises: music style (96%), tempo (96%), rhythm (94%), and extra-musical associations (93%). Subjects also found lyrics (77%) and volume/intensity (66%) as influential components.
**Rhythmic auditory stimuli in rehabilitation.** Auditory cues have been used as an effective tool to improve gross motor abilities in a rehabilitation setting (Staum, 1983; Thaut, 1985; Thaut et al, 1991). Thaut et al. (1991) examined electromyographic patterns of biceps and triceps muscles when subjects were swinging their arms and hitting a pad matched with rhythmic drum sounds at 80 dB. Prior to the experiment, an individualized tempo was determined by matching the tempo with subject’s ability to hit the pad. For the pad striking task, auditory stimuli matched with their internal tempo were given in one group, and the auditory stimuli slower than their internal tempo were given to the subjects in another group. Uniformed starts and endings of triceps muscle activities were found when the matched rhythmic auditory stimuli were provided.

In the investigation by Thaut (1985), children with gross motor dysfunction improved their muscular control through learning motor movements with auditory rhythmic cues and rhythmic speech. A variety of percussion instruments in high and low pitches was used as rhythmic cues in the gross motor activities including side steps and arm movements. The rhythmic speech pattern had the words, “step, close, up, down.” The children who learned the movement with rhythmic stimuli and rhythmic speech significantly increased accuracy of the rhythmic movement more than the children who were instructed with visual modeling only. However, once the rhythmic auditory stimuli were removed, no significant difference was detected between the groups.

Staum (1983) examined the effects of rhythmic stimuli combined with marching music in 25 subjects with gait disorders on recovery of their walking abilities through 3-week rehabilitation sessions. Abilities in even walking were measured by their timed deviations between footfalls of the right and left legs. Consistent walking speed was measured by the changes in a number of steps taken every 10 seconds. Behavioral observation was also used to assess subjects’ walking abilities.

The music was recorded in eight different tempi so that the subjects could choose the music that matched their own walking speed. The subjects listened to music, tapped and vocalized to the beat to learn the rhythmic pattern before they started the gait training. Fading of music and rhythmic pulse was gradually introduced and was dependent on the progress of the individual’s walking abilities.
A significant improvement was observed in their walking abilities using rhythmic stimuli and music. The subjects successfully maintained their walking abilities after the music and auditory stimulus were eliminated. Staum’s (1983) systematic, individualized music treatment effectively improved subjects’ gait control abilities.

**Music Styles and Motor Activity**

Hayakawa et al. (2000) examined the effects of synchronous and asynchronous music during bench stepping exercises. Subjects were instructed to exercise at 120 beat per minute (30 cycles per minute). The aerobic dance music was synchronous to the tempo, whereas the Japanese traditional folk song was asynchronous. In a control group, only metronome pulse was given. Heart rate in the synchronous aerobic music group stayed at a high level and the rated perceived exertion was higher than the non-music group. Significantly less fatigue was perceived in both of the music groups than in the non-music group. The subjects in the synchronous aerobic music reported “vigor” feelings significantly more than the other two groups.

Gfeller’s (1988) research reported that music style was recognized as the most important music component for aerobic exercise in college students. A correlation between subjects’ music preference and preferred exercise music (rock, pop, and new wave music) was also noted.

Elliott et al. (2004) examined what types of music are effective for exercise by music evaluations through the Brunel Music Rating Inventory created by Karageorghis, Terry, and Lane (1999). Music selections which were evaluated with the highest score in the inventory were defined as “motivational music” and music selections with the lowest score were labeled as “oudereterous music.” The motivational music included a consistent electronic bass beat with 130 beats per minute and was culturally appropriate and familiar to participants. The effects of music were measured by distance traveled, ratings of perceived exertion, and affect ratings. Distance traveled was significantly greater when the participants were exposed to the motivational music when compared to a non-music group. However, no significant difference was detected between the highly motivational music and the least motivational music with respect to the effects on distance traveled and subjects’ affect. A significant increase in affect responses was observed in both of the music conditions.
In Beckett’s (1990) research, subjects’ preferred music selections from a radio station were used to examine musical effects on distance traveled and recovery heart rates. In one group, music was continuously played throughout the 30-minute exercise session. In the other group, music was alternately played and stopped every 5 minutes. Distance traveled was significantly greater in the intermittent music condition than in the continuous music condition.

Tracy et al. (1996) examined the effects of stimulating and sedative music on fine motor movements in patients with schizophrenia as measured by a pegboard task and finger tapping. The mean peg number and the number of finger tapping were significantly higher after an exposure of frenetic music than white noise. No significant effects were detected with respect to sedative music on the motor tasks.

Cevasco et al. (2003) investigated effects of vocal music and instrumental music through an 8-month exercise program for clients with Alzheimer’s disease. Two different verbal cues (continuous or single) and responses (easy or difficult) were also introduced. The exercise consisted of hand, arm, foot, and leg movements. Continuous verbal instructions and easy responses effectively elicited clients’ participation. Significantly greater participation was observed with instrumental music than vocal music while subjects were given verbal instructions.

Johnson et al. (2001) demonstrated that verbal and instrumental music were both effective but on different exercise tasks. In the experiment, 19 individuals in the age range of 65 to 90 years participated in a physical rehabilitation program. Country, pop, and spiritual music selections familiar to the subjects were paired with motor movement tasks. Instrumental music significantly facilitated their repetition frequencies on hand flex exercise and marching exercise than no music whereas vocal music, i.e., “Row, row, row your boat,” was significantly more effective in an arm rowing exercise than no music condition.

**Music Performance in Physical Rehabilitation**

Musical instrument performance has been employed as an effective rehabilitation exercise because it requires a variety of gross and fine motor skills and it is highly motivational. Instrument practice improves range of motion, muscle strength, respiratory functions, motor coordination, and manual dexterity (Thaut, 1999, p.158). Zelazny (2001) conducted four case studies of older adults with hand osteoarthritis, a disease of joints causing immobility and pain.
The 4 patients successfully increased their finger pinch meter and range of motion through 4-week keyboard practice. Two participants decreased their physical discomfort. Cofrancesco (1985) utilized percussion instruments and autoharp in hand rehabilitation for 3 stroke patients. All the 3 patients greatly reduced the time to complete hand grasp tasks using their right hand.

**Purposes of the Present Study**

Decades of loudness research demonstrate that loudness perception varies depending on numerous factors such as sound types, sound components, and individual characteristics. Research of temporary threshold shift exhibits the physiological impacts of continuous sound intensities. Investigation of individual preference of auditory stimuli reveals its considerable physiological and psychological effects. Studies of loudness adaptation and music dynamics demonstrate unique perceptions of loudness changes.

Music has been widely utilized in rehabilitation and exercise programs because music motivates participants and gives rhythmic cues to movements. Background music effects in motor activities benefit a wide variety of populations, i.e., participants in exercise programs, individuals in psychiatric hospitals and assisted living facilities, patients with head trauma, individuals in gait training, children with autistic characteristics, and individuals with mental retardation.

Because of the diverse populations in exercise and rehabilitation, as well as the numerous variables affecting loudness perception, investigation of music loudness when engaging in gross and fine motor activities was intriguing.

The present study was designed with the following questions:

1. Does preference of music loudness that incrementally increases and decreases differ in motor activities, i.e., a gross motor activity and a fine motor activity? If so, how is the loudness preference different between the gross and the fine motor activities?
2. Is a loudness decrease perceived more rapidly in decreasing sounds than in increasing sounds in music listening? If so, how much difference is detected in perceptions between increasing and decreasing sounds by a 5-point scale?
3. Does loudness perception decrease or increase to the musical sounds at the same intensity level in 1-minute intervals during a gross or fine motor activity?
4. How do subjects rate the loudness in the range of 65 dB to 85 dB using a 5-point preference scale?

5. Do individual music experiences influence the loudness preference in motor activities? If so, how much difference will be observed between music majors and non-music majors?

6. Do males and females differ in loudness preference in motor activities? If so, how do males and females perceive loudness changes during the motor activities?

7. Is there any correlation between movement levels and loudness preference? If so, how do the movement levels interact with the loudness preference?

8. In a gross motor activity, is there any correlation between body movements and loudness changes?

9. In a fine motor activity, is there any correlation between finger tapping and loudness changes?

10. Do synchronization and asynchronization influence loudness preference? If so, how do the rhythmic and non-rhythmic activities influence the loudness preference?

11. Does vocalization influence the loudness preference? If so, how will the vocalization influence the loudness preference?

12. How will subjects react when the loudness reaches high intensity levels, i.e., 80 or 85 dB? If the high sound intensity levels are recognized with discomfort, what kind of reactions, i.e., facial expressions, will be observed when the sound intensity becomes too loud?
METHOD

Subjects

A total of 64 college students, who were enrolled in a large university in the southeastern region of the United States, were employed. Their ages ranged from 18 to 40 years and their mean age was 25. Music majors (n = 32) were enrolled in the music degree program, studying music-related fields, e.g., music performance, music education, or music therapy. Non-music majors (n = 32) were not enrolled in any music degree program. They did not have any music-related degrees and had fewer than 2 years of music lessons or ensemble experiences, e.g., high school bands or private piano lessons. Each group was comprised of 16 males and 16 females.

From the results of the pre-intervention interview, 8% (n = 5) of the subjects reported that they had hearing loss (mild = 4 subjects, moderate = 1 subjects) and 6% (n = 4) of the subjects reported that they might have hearing loss. A total of 14% of the subjects reported that they had or might have hearing loss. The subjects who were assigned to a gross motor activity were screened by a short health history form (Appendix C). Subjects filled out the history form after they received an explanation of the gross motor task. Those who checked two or more items on the form or expressed any health concerns were excluded from the gross motor group.

Design

The two groups used in this study were differentiated by those who completed gross motor tasks and those who completed fine motor tasks. Both groups had an equal number of males and females and an equal number of musicians and non-musicians. The independent variable was incrementally increasing and decreasing music intensity. The dependent variables were loudness preference, behavioral responses, and heart rate.

Motor Tasks

Subjects individually performed either a gross or fine motor activity for 9 minutes while listening to music. They reported loudness preferences throughout the session. The gross motor
task consisted of going up and down a 4-inch step (using The Original STEP by The STEP Company). The subjects could remove their shoes if they preferred. The fine motor task was tapping the fingers on a table. Subjects sat in a chair at a table, on which a small piece of black paper was placed on a large piece of red paper. Subjects rested an arm on the table and tapped their fingers on the black paper. Colored papers were used to provide a contrast for videography purposes and to specify the locus of tapping to the subjects.

Subjects were not required to synchronize either their gross or fine motor activity to the musical beat. They were instructed to perform the task in the way they felt the most comfortable.

**Music**

Three music selections were chosen from a CD entitled “ESPN presents Jock Jams volume 2” (Tommy Boy Music, CD# TB1163): “Everybody Everybody” by Black Box, “We Got a Love Thang” by Ce Ce Peniston, and “Hey, Hey You.” All three selections had strong, consistent base beats with female vocals. The first two songs featured a main single female vocal, but the last song included several female voices. The tempi of the three selections were approximately 118, 123, and 130 beats per minute, respectively.

The three selections were chosen because they were stimulating, upbeat dance music with an appropriate speed for the stepping exercise. The experimenter was aware of the standard practice of using a single 9-minute instrumental composition to minimize the variables presented by a vocal selection. However, a pilot study which the experimenter held prior to the present study revealed that an exposure of a single instrumental music for the 9-minute stepping exercise resulted in subjects experiencing excessive exhaustion and boredom. Thus, the three songs cited above were chosen to prevent the negative sensations that might possibly lower subjects’ participation.

“Everybody Everybody” was recorded for the first 4 minutes, followed by “We Got a Love Thang” for 4 minutes. “Hey, Hey You” was recorded for the remaining one minute. Each song was recorded from its beginning, and the song sequence was continuously recorded without silence between the selections. Using the audio-editing software Peak 4 (BIAS), a 5-dB increase for 4 times was induced at one-minute intervals, followed by a 5-dB decrease for 4 times at one-minute intervals. The maximum of 20-dB difference was produced between lowest and highest
sound intensities. The music was played on the RGA portable CD radio cassette recorder (RP-7968), and the minimum intensity was adjusted to 65 dBA, measured by a decibel meter.

A beep was recorded over the music every 30 seconds to give subjects a cue to indicate their loudness preference. The first beep was heard 15 seconds after the music started; therefore the beep was heard after 15- and 45-second exposure to each intensity level. A total of 18 beeps were presented throughout the 9-minute music listening period. The beep was recorded louder than the music to offer a clear prompt.

**Measurement of Music Loudness Preference**

While engaging in motor activities, music was played throughout the 9-minute experiment and a beep was heard every 30 seconds. When subjects heard the beep, they indicated their loudness preference using a scale of 1 to 5: 1 too soft; 2 a little soft; 3 comfortable; 4 a little loud; 5 too loud. A poster, using large fonts, showed the scale. It was exhibited on a wall in front of the subjects. Subjects were instructed to express their loudness preference ratings by showing the number of 1 to 5 on their fingers, and by saying the number or their equivalent words. The experimenter sat at an angle behind the subject and recorded each loudness preference response on the observation form (Appendix D and E).

**Behavioral Observation**

Behaviors were observed at the time each subject’s loudness preference was recorded. Using the behavioral observation form (Appendix D and E), vocalization, tempo, and movement levels, as well as facial expressions associated with discomfort at high sound intensity levels were recorded.

Vocalization was marked if subjects presented humming, giggling, singing, whistling, or other vocal sounds. Tempo was marked when subjects synchronized stepping or finger tapping to the musical beat. Movements twice as slow as the expected tempo were considered as in-tempo movements.

Movement levels were categorized into three levels. For the gross motor task, level 1 (minimum) consisted of leg motions or half steps; level 2 (medium) had leg motions with full
steps; level 3 (maximum) contained leg motions with full steps, accompanied with either arm motion or bounce. Half steps indicated that both heels were not placed on the step but in the air, and the subject’s body was not lifted fully when going up the step. Full steps indicated that at least one entire sole was completely on the step. Arm movement was marked when both arms voluntarily moved parallel to leg motions, i.e., bending elbows or clenching fists. Bounce was recorded when either heel did not touch the floor or the bounce was observable by leg or upper body motions.

For the fine motor task, level 1 (minimum) had finger tapping only; level 2 (medium) was marked when one additional motion was observed, e.g., tapping a foot, shaking shoulders or the upper body, or nodding the head; level 3 (maximum) had two or more additional motions.

Facial expressions and behaviors were observed when sound intensity increased. Characteristics of expressions included smiling wryly, leaning away from the sound source, facial grimacing or clenched teeth, lifting eyebrows, closed eyes, and gesturing their discomfort, i.e. covering their ears by hands and/or looking at the experimenter. The number of subjects for each behavior at each sound intensity change was calculated. Subjects who reacted to high intensity sounds were compared between gross and fine motor groups, males and females, and musicians and non-musicians.

**Heart Rate**

Heart rate was measured before the experiment, immediately after the experiment, and after subjects answered the questionnaire. Through measuring the heart rate, the experimenter monitored the subjects’ health condition and also observed effects of the music stimuli and the motor task on heart rates. The experimenter took pulse rates from the wrist for 6 seconds, and the number was multiplied by 10 to record the heart rate per minute (Appendix D and E).

**Procedures**

The individual experiment sessions were held in a classroom where the temperature was consistent and all the lights were turned on. Entering the room, subjects completed an informed consent form (Appendix A) and answered questions about their hearing abilities. Subjects were
randomly assigned either a gross or fine motor task. Those who were assigned to the gross motor task filled out a health history form (Appendix C) for subject screening.

The subject received the aural and written instructions of the motor task and instructions for rating the music loudness. Brief music segments at the minimum sound intensity level (65 dBA) and the maximum level (85 dBA) were demonstrated to inform the subject how much loudness would be experienced during the experiment. After the heart rate was measured, the subject was asked to briefly practice the motor task. When all questions from subjects were answered and subjects properly demonstrated the motor task, the experiment started.

Subjects engaged in the 9-minute gross or fine motor task with an exposure of music of which the loudness incrementally increased and then decreased. After the experiment, the heart rate was recorded and subjects answered a one-page questionnaire (Appendix F). When they completed the questionnaire, their heart rates were measured. The experimenter answered any questions about the data of subjects’ loudness responses and behaviors when asked. At the end, a copy of the informed consent and incentives were given to subjects.

Reliability Calculation

Each session was videotaped for review of data collection and reliability calculation. The experimenter collected the data during the experimental sessions and reviewed the data through the videotape. To obtain reliability of the data, another observer was trained to record subjects’ loudness ratings, vocalization, synchronization, movement levels, and facial expressions. After the training, the observer recorded subjects’ loudness ratings and behaviors for 7 sessions (11% of the experiment), which were randomly selected. Loudness preference ratings were not recorded on a few occasions because the videotape did not clearly show and/or record the number of loudness ratings. Therefore, reliability was calculated by the number of agreements divided by a total number of the data collection possible for the observer; Reliability was 98.7%.
RESULTS

The present study was designed to examine the preference of music loudness that incrementally increases and decreases when performing a gross or fine motor task. The effects of gender differences and music experiences on loudness preference were investigated. The relationship between loudness preference ratings and changes in sound intensity levels was also a primary interest of this study. In addition, subjects’ behaviors corresponding to the loudness changes were examined.

Ratings of loudness preference were statistically analyzed by the two-way analysis of variance (ANOVA) concerning gross versus fine motor groups, males versus females, and musicians versus non-musicians. The Friedman two-way analysis of variance by ranks was employed to analyze two behaviors, i.e., in-tempo (synchronized) movements and movement levels (minimum, medium, and maximum). The effect of vocalization was not analyzed because vocalization was rarely observed in the experiment. Facial expressions and associated behaviors accompanying exposure to high intensity sounds were analyzed by calculating a number of subjects for each facial expression and behavior. Subjects who reacted to high intensity sounds were compared, i.e., between gross and fine motor groups, males and females, and musicians and non-musicians. A questionnaire reported problems performing experimental tasks.

Loudness Preference Ratings

Gross versus Fine Motor Groups

The within-subjects effect of loudness preference ratings was significant, $F(8, 496) = 242.533, p < .001$. This indicated that the subjects’ loudness preference changed throughout the session (Table 1). The effects were significant except for the change from 80 to 85 dB, when the music intensity reached the highest level. This showed that the change from 80 to 85 dB was not statistically expressed by subjects’ loudness ratings.
Table 1
ANOVA: Within-Subjects Effects of Loudness Preference Ratings

<table>
<thead>
<tr>
<th>Phase</th>
<th>dB</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 9</td>
<td>65 to 85, back to 65</td>
<td>8.00</td>
<td>115.50</td>
<td>242.53</td>
<td>0.00</td>
</tr>
<tr>
<td>1 vs. 2</td>
<td>65 vs. 70</td>
<td>1.00</td>
<td>94.53</td>
<td>134.93</td>
<td>0.00</td>
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<tr>
<td>2 vs. 3</td>
<td>70 vs. 75</td>
<td>1.00</td>
<td>45.13</td>
<td>90.62</td>
<td>0.00</td>
</tr>
<tr>
<td>3 vs. 4</td>
<td>75 vs. 80</td>
<td>1.00</td>
<td>43.95</td>
<td>111.85</td>
<td>0.00</td>
</tr>
<tr>
<td>4 vs. 5</td>
<td>80 vs. 85</td>
<td>1.00</td>
<td>1.32</td>
<td>2.23</td>
<td>0.14</td>
</tr>
<tr>
<td>5 vs. 6</td>
<td>85 vs. 80</td>
<td>1.00</td>
<td>197.51</td>
<td>231.12</td>
<td>0.00</td>
</tr>
<tr>
<td>6 vs. 7</td>
<td>80 vs. 75</td>
<td>1.00</td>
<td>66.13</td>
<td>117.98</td>
<td>0.00</td>
</tr>
<tr>
<td>7 vs. 8</td>
<td>75 vs. 70</td>
<td>1.00</td>
<td>42.78</td>
<td>85.74</td>
<td>0.00</td>
</tr>
<tr>
<td>8 vs. 9</td>
<td>70 vs. 65</td>
<td>1.00</td>
<td>5.28</td>
<td>11.06</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Note: Phases represent the time line in minutes (phase 1 is the first minute; phase 2, second; phase 3, third, and so forth).

The between-subjects effect was significant, $F(1, 62) = 5.422, p = .023$, regarding the effect of motor tasks on the loudness preference ratings. This indicated that the loudness preference ratings were significantly different between the two motor groups (Figure 1). The loudness preference of the fine motor group was consistently higher than that of the gross motor group at all dB levels.
Figure 1
Loudness Preference Ratings in Gross versus Fine Motor Groups

Note: Ratings; 1, too soft; 2, a little soft; 3, comfortable; 4, a little loud; 5, too loud.
Increasing versus Decreasing Mode

The difference between loudness preference ratings of increasing sounds and ratings of decreasing sounds was detected through a comparison of ratings in increasing and decreasing modes at the same dB level. The 85 dB level was not analyzed because it was the highest and there was no comparable phase. A significant difference was found at all the 65, 70, 75, and 80 dB levels (Table 2). The mean difference at each dB level showed that subjects perceived loudness softer at all dB levels in the decreasing mode after the 5-minute exposure of increasing sounds (Table 3).

Table 2
ANOVA: Within-Subjects Effects of Increasing versus Decreasing Sound Intensity

<table>
<thead>
<tr>
<th>dB</th>
<th>Phase</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>1 vs. 9</td>
<td>1.00</td>
<td>2.44</td>
<td>4.86</td>
<td>0.03</td>
</tr>
<tr>
<td>70</td>
<td>2 vs. 8</td>
<td>1.00</td>
<td>101.25</td>
<td>194.33</td>
<td>0.00</td>
</tr>
<tr>
<td>75</td>
<td>3 vs. 7</td>
<td>1.00</td>
<td>103.79</td>
<td>227.34</td>
<td>0.00</td>
</tr>
<tr>
<td>80</td>
<td>4 vs. 6</td>
<td>1.00</td>
<td>83.27</td>
<td>187.09</td>
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</tbody>
</table>

Table 3
Mean Loudness Preference Ratings in Combination of Groups

<table>
<thead>
<tr>
<th>Sound Intensity Mode</th>
<th>Increasing</th>
<th>Std. Deviation</th>
<th>Decreasing</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>dB</td>
<td>Phase</td>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Phase</td>
</tr>
<tr>
<td>65</td>
<td>1</td>
<td>2.02</td>
<td>0.60</td>
<td>9</td>
</tr>
<tr>
<td>70</td>
<td>2</td>
<td>2.88</td>
<td>0.46</td>
<td>8</td>
</tr>
<tr>
<td>75</td>
<td>3</td>
<td>3.48</td>
<td>0.60</td>
<td>7</td>
</tr>
<tr>
<td>80</td>
<td>4</td>
<td>4.06</td>
<td>0.68</td>
<td>6</td>
</tr>
<tr>
<td>85</td>
<td>5</td>
<td>4.16</td>
<td>0.65</td>
<td></td>
</tr>
</tbody>
</table>
First versus Second Judgment

Concerning the effects of loudness ratings between first 15-second and second 45-second judgment at each dB level, there was a significant effect in an interaction between loudness preference ratings and the time difference, $F(8, 496) = 4.561, p = <.001$. Loudness preference ratings on second hearing increased for lower dB levels while preference decreased for higher dB levels except for the final 85 dB level (Figure 2). This indicated that loudness preference ratings shifted toward comfortable in the second judgment regardless of whether they were perceived as soft or loud in the first judgment.

![Graph showing loudness preference ratings in first versus second judgment](image)

Figure 2
Loudness Preference Ratings in First versus Second Judgment

Note: Time 1 in a solid line represents the first judgment after a 15-second exposure at each intensity level; Time 2 in a dotted line represents the second judgment after a 45-second exposure.
Males versus Females

Regarding differences in sex on loudness preference ratings, there was no significant between-subjects effect, $F(1, 62) = 0.217, p = 0.643$; however, a significant within-subjects effect was found, $F(8, 496) = 2.169, p = .028$. Detailed analysis shows that the interaction was significant when the sound intensity levels changed from 75 to 80 dB and from 80 to the highest 85 dB (Table 4). A notable difference of loudness preference ratings was observed between males and females at 80 dB (Figure 3). Females had higher values in preference ratings for high dB in increasing mode and lower values for lower dB in decreasing mode.

These results indicated that when exposed to soft or comfortable loudness sounds, music loudness preference between males and females were not significantly different; however, females perceived high intensity sounds as louder than males. Inversely, after exposure to high intensity sounds, females perceived decreasing sounds as softer than males.

<table>
<thead>
<tr>
<th>Phase</th>
<th>dB</th>
<th>df</th>
<th>Mean Square</th>
<th>$F$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 9</td>
<td>65 to 85, back to 65</td>
<td>8.00</td>
<td>1.01</td>
<td>2.17</td>
<td>0.03</td>
</tr>
<tr>
<td>1 vs. 2</td>
<td>65 vs. 70</td>
<td>1.00</td>
<td>0.78</td>
<td>1.14</td>
<td>0.29</td>
</tr>
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<td>2 vs. 3</td>
<td>70 vs. 75</td>
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<td>0.50</td>
<td>1.02</td>
<td>0.32</td>
</tr>
<tr>
<td>3 vs. 4</td>
<td>75 vs. 80</td>
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<td>3.45</td>
<td>10.12</td>
<td>0.00</td>
</tr>
<tr>
<td>4 vs. 5</td>
<td>80 vs. 85</td>
<td>1.00</td>
<td>4.88</td>
<td>9.37</td>
<td>0.00</td>
</tr>
<tr>
<td>5 vs. 6</td>
<td>85 vs. 80</td>
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<td>0.63</td>
<td>0.75</td>
<td>0.39</td>
</tr>
<tr>
<td>6 vs. 7</td>
<td>80 vs. 75</td>
<td>1.00</td>
<td>0.13</td>
<td>0.22</td>
<td>0.64</td>
</tr>
<tr>
<td>7 vs. 8</td>
<td>75 vs. 70</td>
<td>1.00</td>
<td>0.13</td>
<td>0.25</td>
<td>0.62</td>
</tr>
<tr>
<td>8 vs. 9</td>
<td>70 vs. 65</td>
<td>1.00</td>
<td>1.13</td>
<td>2.44</td>
<td>0.12</td>
</tr>
</tbody>
</table>
Figure 3
Loudness Preference Ratings in Males versus Females
Musicians versus Non-Musicians

No significant between-subjects effect was detected regarding music background, $F(1, 62) = 0.657, p = .421$; however, there was a significant interaction effect between music experience and judgment phases, $F(1, 62) = 7.005, p = .010$. In the musician group, the average loudness ratings became lower for the second judgment at the same intensity level, but in the non-musician group, the ratings became higher for the second judgment (Figure 4).

Figure 4
Mean Loudness Preference Ratings in First and Second Judgment
In Musicians versus Non-Musicians
The difference in loudness preference between musicians and non-musicians enabled a further analysis of the interaction between loudness preference ratings and 30-second judgment intervals in all subjects. In the second hearing, loudness perception of the whole group was lower at high intensity levels and higher at low intensity levels (Figure 2). Decrease of loudness perception at high intensity levels was notable in the musician group (Figure 5), and increase at low intensity levels was demonstrated in the non-musician group (Figure 6).

Musicians notably decreased loudness preference ratings on the second hearing for high dB levels. In decreasing mode, the difference in loudness preference ratings between the two judgments at low intensity levels was negligible. This indicated that musicians quickly became used to high intensity sounds but not to low intensity sounds.

Figure 5
Loudness Preference Ratings in Musicians in First versus Second Judgment
Non-musicians, on the other hand, did not become used to high intensity sounds (Figure 6). In fact, in the highest intensity at 85 dB, the loudness preference ratings became even higher on second hearing than that on first hearing. On the contrary, non-musicians increased their loudness preference ratings in their second judgment at lower dB levels. This suggested that non-musicians immediately became used to low intensity sounds.

![Graph showing loudness preference ratings in non-musicians in first versus second judgment.](image)

**Figure 6**

Loudness Preference Ratings in Non-Musicians in First versus Second Judgment
Heart Rate

As it was expected, an analysis of heart rate showed a significant difference between gross and fine motor groups, $F(1, 62) = 9.491, p = .003$ (Figure 7). A significant within-subject contrast was also demonstrated in the gross and fine motor groups (Table 5). This indicated that in each group the heart rate significantly increased after the 9-minute music exposure, and heart rate became significantly lower after approximately 5 minutes during which subjects quietly sat in a chair and answered a questionnaire. The increase of heart rate in both exercise and non-exercise conditions after exposure to music demonstrated that a 4-minute decrease of sound intensity did not lower heart rate. There was no significant difference between males and females and musicians and non-musicians with respect to heart rate.

![Figure 7](image_url)

Mean Heart Rate in Gross versus Fine Motor Groups Before, After the Experiment, and After Completing a Questionnaire

Note: Heart rate per minute was measured by heart rate per 6 seconds multiplied by 10. Heart rate 1 was taken before the experiment; 2, after the experiment; 3, after completing a questionnaire.
Table 5
ANOVA: Heart Rate Before, After the Experiment, and After Completing a Questionnaire

<table>
<thead>
<tr>
<th>Measurements</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.00</td>
<td>1566.84</td>
<td>9.49</td>
<td>0.00</td>
</tr>
<tr>
<td>Within subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross motor group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 vs. 2</td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>1 vs. 2</td>
<td>1.00</td>
<td>903.13</td>
<td>4.83</td>
<td>0.04</td>
</tr>
<tr>
<td>2 vs. 3</td>
<td>1.00</td>
<td>1128.13</td>
<td>9.79</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Note: It took approximately 5 minutes to complete a questionnaire. Heart rate 1 was taken before the experiment; 2, after the experiment; 3, after completing a questionnaire.
Behavioral Analysis

In-Tempo (Synchronized) Movement

There was no significant effect of the movement changes with respect to synchronized (rated as 1.00) and asynchronized (rated as 2.00) movements throughout the session when combined with the effects from the two motor groups, $\chi^2(8, N = 64) = 10.195, p = .252$; however, a significant change was found at the beginning of the session between the first minute and the second minute, $\chi^2(1, N = 64) = 4.500, p = .034$. This indicated that asynchronized movement decreased, and synchronized movement increased in the second minute (Figure 8).

After the second minute, asynchronization movement tended to increase and decrease corresponding to music loudness changes except at the end of the experiment. This trend was detected especially in the fine motor group (Figure 9), although there was no statistical effect, $\chi^2(8, N = 32) = 6.293, p = .614$.

![Image of Mean Amount of In-Tempo Movement](image.png)

Figure 8
In-Tempo (Synchronized) Movement in Combination of Groups

Note: 1, In-tempo (synchronized) movement; 2, Not-in-tempo (asynchronized) movement. Therefore, the lower the amount, the more synchronized the movement.
On the other hand, the gross motor group exhibited a significant effect throughout the session $\chi^2(8, N = 32) = 17.785, p = .023$. A significant difference in the amount of synchronization movement was also found between the first and second minutes, $\chi^2(1, N = 32) = 4.000, p = .046$.

The difference between the two motor groups was observed through comparing changes of mean in each group (Figure 9). The fine motor group demonstrated more synchronization movement than the gross motor task. However, once movement tempo was established, the gross motor group appeared to increase its synchronization movement as time progressed, while the finger tapping became increasingly complex and switched to asynchrozation movement as loudness increased.

![Figure 9](image)

In-Tempo (Synchronized) Movement in Gross and Fine Motor Groups

Note: The lower the amount, the more synchronized the movement.
Concerning interactions between synchronization and each gender group, females showed a significant difference regarding synchronization movements between the first and second minutes, $\chi^2(1, N = 32) = 5.000, p = .025$. Synchronized movement significantly increased in the second minute (Figure 10). A comparison of mean scores in each gender group showed that females exhibited more synchronization movement than males throughout the session.

Figure 10
In-Tempo (Synchronized) Movement in Males and Females

Note: The lower the amount, the more synchronized the movement.
There was no statistically significant effect regarding music experiences, $\chi^2(8, N = 32) = 12.536, p = .129$ (musicians), $\chi^2(8, N = 32) = 9.353, p = .313$ (non-musicians). Mean changes in each group showed that musicians consistently demonstrated more synchronization movement than non-musicians.

![Figure 11](image)

In summary, the significant differences concerning synchronization versus asynchronization between the first and second minutes were observed, especially in the gross motor group and in females. The mean ratings between the first and second minutes were all decreased, which demonstrated that asynchronization movement greatly switched to synchronized movement in the first two minutes.
**Movement Levels**

Concerning movement levels, a significant effect was found throughout the session in a combination of gross and fine motor groups, $\chi^2(8, N = 64) = 17.563, p = .025$. The amount of movement levels of gross and fine motor tasks increased and decreased corresponding to the changes in sound intensity levels (Figure 12). In the gross motor group, subjects performed more actively as sound intensity levels became higher, while subjects reduced their movement levels when intensity levels became lower. In the fine motor group, additional movement of other body parts besides finger tapping was observed when sound intensity increased, while additional body parts gradually subsided when sound intensity decreased. Sound intensity changes became a cue for subjects to adjust their movement levels.

The significant difference of movement levels was detected between the first and second minutes, $\chi^2(1, N = 64) = 5.400, p = .020$, which revealed that not only the synchronization movement but also the amount of movement levels significantly increased within the first two minutes.

![Mean Movement Levels](image)

**Figure 12**
Movement Levels in Combination of Groups

Note: 1, Minimum movement; 2, Medium movement; 3, Maximum movement.
Regarding effects in each motor group, a significant effect of movement levels was found in gross motor group, $\chi^2(8, \, N = 32) = 15.761, \, p = .046$. A significant difference was also detected between the first and second minutes, $\chi^2(1, \, N = 32) = 4.000, \, p = .046$. After a notable increase of movement levels from the first minute to the second minute, movement levels decreased toward the end of an experimental session (Figure 13). This indicated that subjects started engaging more actively in the stepping task, i.e., increasing arm, full step, and bouncing movements, from the second minute, and gradually lowered their movement levels along the time line. Changes of movement levels in the gross motor group were similar to its pattern in synchronization movement, except for the beginning and the end of the session (Figure 9). Decrease of synchronization movement and reduced movement levels were demonstrated during most of the experimental time in the gross motor group.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean Movement Levels</th>
</tr>
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<tbody>
<tr>
<td>M1</td>
<td>2.2</td>
</tr>
<tr>
<td>M2</td>
<td>2.0</td>
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<tr>
<td>M3</td>
<td>1.8</td>
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<tr>
<td>M4</td>
<td>1.6</td>
</tr>
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</tr>
<tr>
<td>M7</td>
<td>1.0</td>
</tr>
<tr>
<td>M8</td>
<td>0.8</td>
</tr>
<tr>
<td>M9</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Figure 13
Movement Levels in Gross and Fine Motor Groups

The changes of movement levels in the fine motor group differed from that in the gross motor group. In the fine motor group, increase and decrease in movement levels corresponded to
changes in sound intensity and were similar to changes in synchronization movement (Figure 9). When music intensity increased, more complex finger tapping and additional body movements were observed. When the intensity decreased, synchronized movement increased, while accompanying body movements decreased.

Mean movement levels in the gross motor group fell under 1.4 to 1.6. This indicated that average subjects performed the gross motor task with half or full steps without arm movements or bounce. In the fine motor group, mean movement levels were between 1.0 and 1.2. This suggested that average subjects performed only the requested finger tapping with almost no additional body movement.

Regarding movement levels in males and females, a significant effect was found in males, $\chi^2(8, N = 32) = 15.659, p = .048$. Movement levels in males increased and decreased correlating to changes in sound intensity levels (Figure 14). Comparing males and females, females consistently demonstrated higher movement levels throughout the session than did males, but the effect of changes in sound intensity was not influential compared with that in males.

![Figure 14: Movement Levels in Males and Females](image_url)
No significant effect of movement levels was found in the musician group and in the non-musician group. However, changes in mean movement levels demonstrated that loudness preference ratings in non-musicians corresponded to changes in sound intensity levels. Musicians’ movement levels were consistently higher than non-musicians’ movement levels throughout the session.

![Figure 15](image-url)

*Figure 15*
Movement Levels in Musicians and Non-Musicians
Facial Expressions and Behaviors Exposed to Music at High Intensity Levels

Analysis of facial expressions and behaviors when exposed to music at high intensity levels revealed that subjects’ responses appeared to be associated with their loudness preference ratings.

Smiling wryly was the most frequently observed expression followed by leaning away from the sound source and facial grimaces. In addition, some subjects lifted their eyebrows, gestured discomfort, and closed their eyes.

A total of 20 subjects (31%) reacted to changes of music sound intensity. The more the sound intensity increased, the more facial expressions and behaviors were observed (Table 6). No observation was made in the change from 65 to 70 dB. Only one facial expression was observed from 70 to 75 dB. When the intensity changed from 75 to 80 dB, 10 behaviors were expressed. In the final intensity change from 80 to 85 dB, 26 facial expressions or behaviors were demonstrated.

Table 6
Facial Expressions and Behaviors Exposed to Music at High Intensity Levels

<table>
<thead>
<tr>
<th>dB change</th>
<th>Smile</th>
<th>Leaning</th>
<th>Grimace</th>
<th>Eyebrows</th>
<th>Gesture</th>
<th>Closed eyes</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>65 to 70</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>70 to 75</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>75 to 80</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>80 to 85</td>
<td>10</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>37</td>
</tr>
</tbody>
</table>

Definitions
a. Smile: Smiling wryly
b. Leaning: leaning away from the sound source
c. Grimace: grimace, clenched teeth
d. Eyebrows: lifting eyebrows, making a surprised face
e. Gesture: gesturing discomfort, i.e., covering ears by hands, looking at the experimenter
f. Closed eyes: closing eyes

Concerning differences between gross versus fine motor tasks, 14 subjects (44%) in the fine motor group demonstrated behavioral or facial changes to the high sound intensity whereas 6 subjects (19%) in the gross motor group reacted to high intensity sounds. Regarding
differences in sex, 15 females (47%) exhibited expressions whereas 5 males (16%) responded to high intensity sounds. There was no difference between musicians (31%) and non-musicians (31%).

**Problems Performing Experimental Tasks**

Results from the questionnaire (Appendix F) demonstrated that some subjects had problems rating their loudness preference and/or performing the motor task: 14 subjects (22%) commented regarding the music task, whereas 5 subjects (8%) reported problems with the motor task.

Regarding music loudness ratings, the most frequent comment (4 subjects) was trouble with ratings because subjects perceived music to be “loud” at the beginning of music exposure but the loudness quickly became “comfortable.” Two subjects reported they felt high intensity sounds as “distorting” or “disturbing” rather than “too loud.” Two subjects mentioned that their loudness preference varied depending on whether they like the music or not. One subject suggested that with slow-tempo music, it is “comfortable” listening to it when it is “soft.” Another subject answered that some sound intensity levels were perceived to be the same. Other comments included trouble deciding, and brief confusion and anxiety.

Concerning problems in motor tasks, brief confusion at the beginning and trouble deciding how fast they performed were reported. One subject reported difficulty performing the motor task when music was too loud. Another subject stated that beeps used as a cue to answer loudness preference disrupted the movement. One subject reported physical discomfort from engaging in finger tapping for 9 minutes.
DISCUSSION

Loudness Preference Ratings

Gross versus Fine Motor Groups

The main finding of the present study was that subjects engaging in the fine motor task perceived music louder than subjects engaging in the gross motor task. Physiological and/or psychological factors may influence the difference in loudness perception between the exercise and non-exercise conditions.

Regarding physiological effects, exercise may physiologically affect the auditory system and increase temporary threshold as Engdahl (1996) suggested. Physiological changes caused by exercising may diminish the degree of loudness perception. Engdahl's study, however, employed noise stimuli, whereas the present study used musical sounds. Research has shown similarities and differences between loudness perception of noise and that of music. Marshall (1980) observed a similar perception of loudness changes in pure tones, noise, and musical sounds. On the other hand, listeners seem to perceive music softer than noise (Geringer, 1993) or pure tones (Riegler 1980). Because music is widely utilized in exercise programs, it is important to investigate how gross motor movement will cause physiological changes which possibly result in changes of loudness perception.

Considering psychological effects, the amount of attention to music stimuli may have affected the difference in loudness perception between the two motor groups. Since the fine motor task was easier to accomplish than the gross motor task, subjects in the fine motor group may have received less physical disturbances. Therefore, they may have been able to listen to the music more actively. Subjects in the fine motor group who paid more attention to music seemed to become more susceptible to music loudness changes, which may be a reason why they exhibited more facial expressions of discomfort and behaviors when exposed to music at high intensity levels.

Madsen (1987) demonstrated that a competing cognitive task greatly diminished music perception. Schlauch (1992) found that a competing cognitive task interrupted a rapid decline of loudness perception with a decreasing sound, which indicated that active listeners perceived
tones as softer than listeners performing the cognitive task. In the present study, listeners in the fine motor group perceived music louder than subjects in the gross motor group. Therefore, with respect to the amount of loudness perception, the present study appears to contradict Schlauch's results; however, Schlauch's research and the present study may both suggest interactions between a mental set and susceptibility of loudness changes. Active listeners seem to perceive auditory stimuli louder than listeners who engage in additional tasks. At the same time, active listeners are more susceptible to auditory sounds. Thus, they perceive greater changes in sound intensity as Schlauch's study demonstrated. In clinical fields, therapists need to be cautioned when they change music loudness because participants may perceive the changes greater than those in healthier conditions and possibly experience greater discomfort or pain. Further research is needed to investigate the perception of loudness changes in active listeners and in listeners engaging in an additional task.

**Increasing versus Decreasing Mode**

The present study demonstrated a significant difference between loudness perceptions in increasing mode as compared to decreasing mode. Listeners perceived music softer after a 5-minute music exposure. They rapidly decreased their loudness perception, especially in the first minute of decreasing mode. This finding seems to support the conclusions of investigations in sound dynamics and loudness adaptation.

A rapid decline of loudness perception in decreasing mode appears to be associated with the findings of Geringer's (1991) research, according to which the listeners accurately discriminate loudness decrease sooner than loudness increase. Geringer (1995) also found that listeners perceived greater loudness in increasing sounds than decreasing sounds. Musicians performed a larger range of crescendo than decrescendo (Geringer, 1992). These previous findings and the present study showed that listeners may perceive loudness greater in increasing mode than in decreasing mode, which results in more rapid loudness decrease in decreasing mode than in increasing mode.

Music intensity levels in the present study ranged from 65 to 85 dB, where subjects showed a rapid decline of loudness perception. This result is consistent with the findings of Dange et al. (1993) and Jones et al. (2003), demonstrating a rapid decrease of loudness.
perception at high intensity levels. The previous studies used simple tones or noise, while the present study used music. Hence, a rapid decline of loudness perception in decreasing sounds may occur at high intensity levels not only in pure tones or noise but also in musical stimuli.

Perception of sounds that successively increases and then decreases in level over time may be different from that of sounds with loudness changes in one direction. A rapid loudness decline in females in the present study might demonstrate an effect of loudness perception in increasing mode upon their loudness perception in decreasing mode. Females perceived music slightly louder than males in increasing mode at the low intensity levels, but they perceived it significantly louder at the high intensity levels. When sound intensity decreased, females perceived music as softer than males. Greater loudness perception at the high dB levels might cause smaller loudness perception in decreasing mode. This phenomenon suggested some correlation between sensitivity to loudness perception and auditory adaptation function. More research is needed to find out the difference between loudness perception of increasing sounds and that of decreasing sounds using musical and non-musical sounds.

First versus Second Judgment: Musicians and Non-Musicians

The present study revealed a significant interaction between loudness preference ratings and judgment time. Loudness preference in the first judgment differed from that in the second judgment. Subjects became accustomed to music loudness and started to perceive loudness to be comfortable during the 30-second intervals, a very short period of time. Loudness perception shifted toward comfortable levels in the second judgment regardless of whether it was perceived as soft or loud in the first judgment.

Some subjects reported that they had trouble with ratings because they perceived music to be "loud" at the beginning but the loudness quickly became "comfortable." This was the most frequently reported problem regarding loudness preference ratings. The comment suggested that the loudness preference change might occur in less than 30 seconds. The subjects' descriptions and the experimental data suggested quick auditory habituation and rapid increase of loudness preference. Much more research is needed to study hearing adjustment functions of loudness perception.
Further analysis of the loudness adjustment revealed a significant interaction between the time difference and music experience. Musicians notably decreased loudness preference ratings on the second hearing for high dB levels. Non-musicians, on the contrary, did not become used to high intensity sounds. Their loudness preference rating, at 85 dB, became even higher on second hearing. Musicians quickly became used to the high intensity sounds, whereas non-musicians were annoyed by the exposure to loud sounds.

The notable adjustment to high dB sounds in musicians may be related to the findings of the studies by Hoover (1992) and Geringer (1995). They found that musicians exhibited less variability or smaller dynamics in loudness perception than did non-musicians. Musicians' quick loudness adjustment might influence their loudness estimation. Musicians might be exposed to louder sounds through music training compared to non-musicians. This might cause physiological changes in their auditory perception and/or increase familiarity to high intensity sounds. These factors may influence musicians' loudness perception and adjustment.

Although musicians quickly became accustomed to high intensity sounds, it did not demonstrate that they preferred music at high intensity levels. Staum et al. (2000) found that in comparison to non-musicians, musicians preferred softer music for relaxation. In Geringer's (1993) research, musicians perceived flat sounds at high intensity levels as louder than non-musicians. In the present study, musicians may have actively listened to sounds at lower intensity levels, since they become used to focusing on the details of musical features. Therefore, musicians did not become used to sounds at low intensity levels. This result may be related to the findings of Schlauch's (1992) study demonstrating greater loudness perception changes at low dB levels in active listeners. Future research considering effects of music experience on loudness perception and loudness adjustment is extremely necessary.

**Increase of Loudness Preference Ratings in Final Minute**

In the final minute of the 9-minute experiment, a notable increase of loudness preference ratings was observed, although sound intensity continuously decreased. Changes in music might influence the unexpected increase. The final music selection started at the beginning of the last minute. Moreover, musical features of the last song were different from those of the first two songs; the last song had a slightly faster tempo than that of the other songs. The last song also
included several vocals, while the other two songs had only one main vocal. In previous studies, changes in instrumentation were considered as a possible effect on perception of dynamics (Geringer, 1995, 1991). Further research regarding effects of musical features, i.e., instrumentation and tempo, on loudness perception was requisite.

In the present study, the three songs used did not have an even time length. The first song lasted for 4 minutes; the second, 4 minutes; and the last, 1 minute. This made it difficult to differentiate the effects of musical changes from the effects of sound intensity changes. In order to observe the interaction between loudness preference ratings and the effects of musical changes, the length of music selections need to be the same in any future study.

Familiarity to music loudness might be related to the increase in loudness perception at the end of the experiment. As a subject reported, "soft" music can be perceived "comfortable." After exposed to music for 8 minutes, subjects might increase comfort to the given musical stimuli. Subjects also might become able to expect how much sound intensity they would perceive. Madsen (1987) found that subjects recognized changes in sound intensities as the most distracting. Increase in familiarities to music loudness might develop their comfort to music loudness and result in a growth of loudness preference ratings in the final minute despite decrease of sound intensity levels.

**Males versus Females**

Music loudness preference ratings were not different between males and females when exposed to soft or comfortable loudness sounds; however, females perceived music significantly louder at high intensity levels.

This finding (the similar preference ratings between males and females at soft or comfortable levels) is consistent with the results of previous studies, in which no significant difference was detected between males and females with respect to loudness preference (Bonny, 1968), most comfortable loudness levels (Riegler, 1980), and discrimination of musical components exposed to sounds at different intensity levels (Haack, 1975).

Females' significantly greater value in loudness preference ratings at high intensity levels was an important finding in the present study. This finding seems to be related to the results of previous studies, which reported that males preferred higher intensity sounds (Staum et al. 2000)
and were exposed to higher intensity levels in their daily life (Kageyama, 1999). Behavioral observation of facial expressions and behaviors in the present study revealed that females perceived more discomfort to high intensity sounds than males. Some subjects reported that they perceived high intensity sounds not as loud but as disturbing. Listeners might perceive 80 or 85 dB sounds not as loud music but as irritable, noisy sounds. If this is the case, physiological effects might be considered since Hellström et al. (1998) reported significantly more noise-induced temporary threshold shifts in females.

Surprisingly, females perceived music as less loud at 85 dB, the highest intensity level, than at 80 dB levels; on the other hand, males' loudness preference ratings corresponded to sound intensity levels. Thus, psychological effects might play an essential role in females' loudness perception. The results of discomfort to high intensity sounds and quick adjustment to high intensity levels in females demonstrated need for further research with respect to loudness susceptibility and auditory processing in the central nervous system.

**Heart Rate**

Heart rate significantly increased after music exposure in both gross and fine motor groups. Intensity of the music increased from 65 to 85 dB in the first 4 and a half minutes and then decreased from 85 to 65 dB in the latter half. The 20-dB decrease in the middle to high intensity range did not lower heart rate, but rather increased heart rate. Music selections included fast-tempo, up-beat, popular dance music with strong base beat. The stimulus music increased heart rate of subjects in exercise and non-exercise conditions regardless of changes in intensity. The result was consistent with a general agreement of previous studies in which stimulus music heightened physiological responses (Standley, 1986).

Considering the effect of sound intensity on heart rate, previous research detected no significant effect (Staum et al., 2000) or different effects in different times (Copeland et al., 1991). However, Mukhamedrakhimov (1993) reported that heart rate tended to increase when listeners did not prefer the sound loudness, and heart rate tended to decrease when exposed to sounds with preferred loudness. Thus, measuring heart rate and loudness preference simultaneously is recommended in future research.
The method for measuring heart rate in the present study exhibited some problems. Heart rate per minute was calculated by heart rate per 6 seconds multiplied by 10. This method was effective to monitor subjects' physical conditions and to safely implement the experiment; however, more close measurement is necessary to examine changes in heart rate. Calculating heart rate at least per 15 seconds multiplied by 6 or continuous recording with electrocardiogram is suggested.

**Synchronized Movement and Movement Levels**

**Combination of Groups**

Subjects exhibited a significant increase of in-tempo movement and movement levels at the beginning of the session between the first and second minutes. This result showed that subjects adjusted their stepping or finger-tapping speed to the musical beat and started to perform tasks more actively during the first 2 minutes; however, this observation is based on the responses of college students with no serious health problems. In a clinical setting, individuals with physical or mental challenges may need longer time to process music tempo and may need extra efforts to adjust their movement to the beat.

Subjects tended to maintain their movement once they established their movement pattern. Synchronized movement and movement levels did not extremely decrease in the middle of the sessions. Gfeller (1988) reported that participants recognized appropriate mental attitude and the amount of energy or effort as the two most important components to successfully participate in exercise. Therefore, if therapists carefully structure the beginning part of movement activities and support participants to coordinate their movement with musical beats, participants may be able to maintain their rhythmic motor movement.

Movement levels significantly changed across the session along with music intensity changes. The more the music sound intensity increased, the more actively the subjects performed. Although sound intensity effects in exercise or rehabilitation have not been well researched, previous studies demonstrated that music improved gross motor abilities (Beckett, 1990; Elliott et al., 2004; Staum, 1983; Thaut, 1985) and fine motor abilities (Cofrancesco, 1985; Thaut, 1999,
Much more research is needed to investigate effects of music loudness perception and sound intensity levels to increase the amount of gross and fine motor movements.

In the final minute of the 9-minute experiment, notable decrease of synchronized movement and of movement levels was observed. Subjects slowed their movement at the end of the sessions, which implies that subjects might have been aware that the experiment was approaching the end, and the awareness might have heightened their perceived exertion and lowered their motivation to perform.

Changes in music selections at the beginning of the last minute might become a cue for the movement reduction. Since the first two music selections were played for 8 minutes, subjects might assume that the end of the second song would be the end of the experiment. Thus, when the third song started, subjects greatly diminished their movement because they might have been disappointed by the unexpected extension.

Decrease of sound intensity might also prompt subjects toward the end of performance. Subjects could estimate how much sound intensity would decrease since they already experienced the dynamic range in increasing mode and were informed that the sound intensity would diminish until the beginning intensity level.

Previous research revealed that motivating individuals and distracting undesirable stimulus were one of the main music functions (Gfeller, 1988; Thaut, 1999). Effects of music loudness changes and effects of music selection changes need to be further investigated to prevent perceived exertions and to increase motivation. Interestingly, Beckett's (1990) study showed that intermittent music condition significantly increased the amount of exercise than the continuous music condition. Much more studies are necessary to investigate the effective amount of music exposure. Therapists may be able to manipulate sound intensity and music selections, as well as structure music and non-music activities to cue participants in changing motor activities and changing the amount of motor movement.

**Gross and Fine Motor Groups**

The patterns of changes in synchronized movement in gross and fine motor groups appeared to be almost opposite. Synchronized gross motor movement increased as time progressed except for the final minute. Synchronized fine motor movement, on the other hand,
decreased when music intensity became higher, and synchronized movement increased when intensity became lower except for the beginning and end of the sessions. However, the reduction of synchronized finger tapping did not indicate that subjects lost their sense of rhythm, because some subjects exhibited foot tapping in tempo when synchronized finger tapping subsided. Some subjects demonstrated faster finger tapping and more tapping variation when sound intensity increased. In this case, the experimenter was no longer able to detect whether finger tapping was in-tempo or not. Fast complex finger tapping at high sound intensity was recorded as asynchronization. Thus, the data showed the amount of synchronized finger tapping, but did not indicate subjects' entire rhythmic motor coordination.

In the fine motor group, the higher the sound intensity displayed, the more additional body movements were observed, i.e., tapping their foot, nodding the head, and shaking the upper body. Mean movement levels, however, ranged from 1.5 to 1.7, which indicated that average subjects performed one or less additional body movement. Subjects might hesitate about behaving naturally because of the experimental setting and might try to perform consistently. This subjects' mental set might result in reduction of non-requisite body movements. In clinical settings, participants may have nervousness or physical challenges, which prevent their natural body movements. Therapists can adjust music intensity to elicit fine motor movements in participants. Previous research reported that rehabilitation including practice of music instruments successfully improved fine motor abilities (Cofrancesco, 1985; Thaut, 1999, p.158; Zelany, 2001). Music has been widely utilized to enhance children's fine motor abilities (Cassity et al., 1974; Hallander et al., 1974). Further research is necessary to expand musical interventions to improve fine motor abilities in a variety of individuals.

The gross motor group exhibited more movement changes than the fine motor group. Synchronized movement and movement levels in the gross motor group significantly changed throughout the sessions, whereas the fine motor group showed no significant changes. The gross motor group gradually decreased movement levels as time progressed. Fatigue or tiredness was considered a main reason for the decrease of movement levels in the exercise group.

At the beginning of the sessions, the gross motor group significantly increased synchronization and movement levels, while no statistically significant increase was observed in the fine motor task. Subjects in the exercise group needed more time to adjust their movement to the musical beat at the beginning of the sessions than subjects performing finger tapping.
The mean amount of synchronized movement showed less synchronized movement in the exercise group than in the finger tapping group throughout the experiments. The gross motor task required more efforts by the subjects to maintain synchronized movement.

Although the gross motor performance gradually decreased movement levels, synchronized movement slightly increased as time progressed except for the final minute. Movement levels did not notably decrease in the middle of the sessions. Subjects maintained their exercising speed and completed the exercise task once they established their movement tempo and movement levels. Therefore, in clinical settings, therapists need to encourage participants to actively exercise, especially at the beginning of treatment sessions. In music treatment, remaining treatment effects after removing musical stimuli is an essential technique. Thaut (1985) reported that music-induced effects on gross motor skills subsided when rhythmic auditory stimuli were removed. In long-term rehabilitation, Staum (1983) systematically faded music, which resulted in successful improvement of gait control abilities.

In the present study, changes in sound intensity and changes in loudness perception did not appear to affect synchronized movement and movement levels in the exercise tasks. Methodological issues might influence the results. Movement levels were defined by observing types of steps, arm movement, and bounce. The definitions seemed effective to differentiate active performers from others. However, exercise tempo appeared to be an appropriate measurement for the amount of workout in the majority of subjects. Stepping speed was recorded as either synchronization or asynchronization. Asynchronized stepping speeds varied; some performed extremely slowly and some exercised nearly in tempo. In this case, the amount of movement in slow speed and the amount of movement in fast speed were noticeably different, yet their movements were both categorized as asynchronous and their differences in exercise speed did not reflect their scores of movement levels. In the future studies, experimenters need to consider effects of exercise speed to define movement levels when exercise speed varies by individuals.

In spite of the methodological problems, mean values of synchronized movement and movement levels detected trends of changes in each group; fine and gross motor groups, males and females, and musicians and non-musicians. Detailed definitions of behaviors might lead to the favorable results. Precise measurement of the amount of movement and detailed behavioral observations may enable examining behavioral changes. Quantifying movement change is a
prerequisite to investigate effects of music intensity and loudness perception on gross motor abilities. Further research is desired to study music intensity effects in exercise conditions.

**Males and Females**

Females demonstrated more synchronized movement and marked higher movement levels. Statistically significant increase of synchronized movement in females was observed at the beginning of the experiments. Females performed motor tasks more rhythmically and actively than males.

Males, on the other hand, demonstrated significant changes in movement levels throughout the sessions. Males' movement levels increased and decreased corresponding to the changes of music intensity. Sound intensity changes might influence their movement levels. Males showed gradual increase of loudness preference ratings corresponding to increase of sound intensity, whereas females marked highest values at 80 dB before it reached the highest 85 dB level. Males expressed less discomfort when exposed to music at high dB levels as compared to females. For male subjects, sound intensity changes might become a cue for the amount of workout. Males' higher comfort levels to high intensity sounds might be associated with the greater changes in males' movement levels corresponding to sound intensity.

**Musicians and Non-Musicians**

No statistically significant differences were observed in musicians versus non-musicians. The frequencies of expressing discomfort when exposed to high intensity sounds were even in the two groups.

Mean movement values, however, showed that musicians demonstrated more synchronized movement and higher values of movement levels than non-musicians throughout the session. Musicians tended to actively perform their motor tasks with synchronized movement in comparison to non-musicians. Musicians increased their asynchronous movement as sound intensity grew. Some musicians exhibited rhythmic, complex improvisation of finger tapping when sound intensity increased, which might result in the increase of asynchronization in musicians.
Non-musicians, on the other hand, tended to change movement levels corresponding to the changes in music intensity. Non-musicians might be influenced by sound intensity changes as compared to musicians.

**Music Selections**

The music selections used in the present study seemed to be appropriate for both activities. All subjects completed motor tasks, and 85% of subjects answered that they enjoyed the music. Two subjects mentioned that their loudness preference varied depending on whether they liked the music or not. This answer supported the results of the study by Cullari et al. (1989) which revealed a positive correlation between preferred loudness levels and preference of music selections. In Beckett's (1990) study, the amount of exercise increased when subjects were exposed to their preferred music selections.

Regarding the effects of different types of music on motor movement, Hayamawa et al. (2000) examined the effects of synchronous and asynchronous music selections on exercise. Both music selections decreased fatigue in subjects, but more vigorous feelings were perceived in subjects who were exposed to synchronous music. Tracy et al. (1996) reported that stimulating music increased fine motor movements in individuals with schizophrenia.

In the present study, popular music in moderate tempo with consistent strong base beat was played throughout the sessions. The synchronous up-beat music might enhance subjects' synchronized movement. Further research is desired to investigate the effects of loudness preference with preference of music selections and with types of music.

**Methodological Issues**

A main methodological problem in the present study was difficulties to differentiate the three effects: sound intensity, the amount of music exposure, and subjects' physical conditions. When sound intensity increased, the amount of music exposure also increased as time progressed; therefore, it is difficult to interpret if movement changes were influenced by changes in music intensity or in the amount of music exposure. When sound intensity decreased in the latter half of the sessions, subjects possibly perceived more exertion and became tired. Thus, decrease of
synchronized movement and movement levels might have been affected by either loudness perception or physical sensations, or both. In replications of this study, it is suggested to design additional groups in the following four conditions: no sound intensity change, increasing sound intensity change, decreasing sound intensity change, and no music.

In the present study, synchronous movement was greatly related to the amount of movement levels. Synchronous movement possibly has physiological and psychological impacts on loudness preference and loudness perception. It is recommended to design a group engaging in synchronous movement and a group engaging in asynchronous movement to examine interactions between loudness preference and synchronous movement.

The loudness rating scale from 1 to 5, used in the present study, seemed to adequately function to express loudness preference in each sound intensity level. However, the scale including both numbers and adjectives, e.g., 1 too soft, 2 a little soft, may have caused problems. Some subjects expressed their loudness preference by numbers, some used adjectives. Some subjects stated both or switched from one to the other during the experiments. Stevens (1986, p.137) introduced that subjects marked greater values of loudness perception when they used ratings by number than ratings by adjective. Even though subjects meant to express the same loudness perception, the scores of ratings depend when they use adjectives instead of numbers, or vice versa. Using either a number scale or a category scale will avoid possible errors.

The most essential methodological issue in the present study was the way to interpret values of loudness preference ratings. Subjects rated their perceived loudness using the scale from 1 to 5: the number 1 represented too soft; 2, a little soft; 3, comfortable; 4, a little loud; 5, too loud. Smaller numbers showed smaller amount of loudness perception and higher numbers exhibited greater loudness perception. However, considering loudness preference, the scale defined the greatest loudness preference as the middle value of 3, comfortable. The number 5, too loud, expressed discomfort toward the loudness perception, thus representing smaller loudness preference. Therefore, higher values of the scale did not demonstrate greater loudness preference. For instance, when scores decreased from 5 or 4 to 3, the comfortable levels actually increased. The score values of loudness preference ratings corresponded to the amount of loudness perception, not loudness preference. Still, subjects were not instructed to accurately judge sound intensity levels, but to rate their subjective comfort levels. Thus, the ratings...
demonstrated loudness preference, in other words, comfort levels, rather than loudness perception.

The scale of loudness preference ratings including the aspects of loudness perception possibly confused subjects when they rated their loudness preference. The number 1, too soft and 5, too loud represented the loudness perception in a negative direction. When subjects rated loudness as too soft, they might have been unable to hear the music well and might have preferred higher sound intensity. When subjects scored loudness as too loud, they probably perceived discomfort or pain and preferred lower intensity levels. However, the number 2, a little soft and 4, a little loud might include positive and negative aspects. Subjects were not supposed to feel comfortable when they rated loudness as a little soft or a little loud, but some subjects who used 2 or 4 may have still felt comfortable. In fact, the results from a questionnaire reported that a subject was confused because "it is sometimes 'comfortable' listening to music when it is 'soft.'"

Generally speaking, experimental conditions psychologically influence on subjects responses. For example, some subjects might feel that they were expected to change their ratings corresponding to sound intensity changes. Some may not have changed their ratings when they felt that the sound intensity did not change even though their loudness preference actually changed.

To solve the methodological problems mentioned above, subjects must be clearly instructed to choose categories corresponding to their loudness preference, not loudness perception. However, it may be difficult to fix the boundary between comfortable and uncomfortable levels. It is important to consider how the range of scales will influence subjects' ratings of loudness preference. Subjects may rate loudness preference differently depending on numbers of categories, adjectives that label loudness levels, or other factors. For instance, although subjects rate loudness preference as "comfortable" when they choose either "comfortable" or "not comfortable," they may rate the same loudness preference as "a little loud," not "comfortable," when more categories are given. Thus, a range of loudness preference which is rated as "comfortable" may broaden or become narrow depending on measurement of loudness preference ratings. Developing reliable and valuable measurement for preference of music loudness that changes over time is mandatory.
Facial Expressions and Behaviors of Discomfort

Over 30% of subjects demonstrated facial expressions or associated behaviors indicating discomfort when exposed to musical sounds at high intensity levels. Frequencies of facial expressions and behaviors in each group, i.e., gross versus fine motor groups, male versus female groups, and musician versus non-musician groups, surprisingly appeared to correlate with each group's loudness preference ratings: The fine motor group perceiving music significantly louder than the gross motor group exhibited more facial expressions and behaviors. Females, who expressed significantly greater loudness perception when sound intensity reached 80 dB, reacted to high dB levels more than males. Musicians and non-musicians demonstrated no significant difference in loudness preference ratings and no difference in frequencies of facial expressions. Because of these correlations between loudness preference ratings and behavioral responses, the facial expressions and behaviors is considered to indicate subjects’ discomfort, annoyance, or irritation toward high dB sounds.

Iezzi, Adams, Bugg, and Stokes (1991) reported that patients with muscle-contraction headache demonstrated common characteristics of facial expressions in the headache state. Iezzi et al.'s research and the present study commonly observed facial grimacing and closed eyes. Wry smiles were the most frequently observed characteristics in this study. Most subjects might not directly express their discomfort because their behaviors were videotaped and observed by the experimenter. More facial expressions or associated behaviors indicating discomfort may appear in a non-experimental setting.

Most facial expressions and behaviors appeared when sound intensity reached 80 and 85 dB, which were noticeably below the average auditory pain threshold, approximately 120 dB. Subjects listened to the highest sound intensity before the experiment so that they were able to expect how much intensity they would be exposed to during the experiment. Therefore, subjects' discomfort and anxiety were assumed to be lower than the case in which subjects had not previously listened to the sounds. Nevertheless, subjects expressed discomfort at 80 to 85 dB, which are considered to be approximately equal with loudness levels experienced in heavy traffic (Stevens, 1986). In clinical settings, individual with physiological and mental challenges may be more susceptible to loud sounds and experience more discomfort than individuals in healthier conditions. More research is needed to investigate discomfort or annoyance when exposed to
music at high intensity levels. Music therapists need to develop assessment of discomfort caused by music loudness exposure and techniques to reduce risks of negative effects from the exposure.

Mukhamedrakhimov's (1993) research revealed notable individual variability of comfortable loudness levels. In the present study, the average subject rated the preference of loudness at 80 and at 85 dB as “a little loud.” Still, 1 out of 3 subjects in healthy conditions expressed their negative feelings or sensations, such as discomfort, annoyance, irritation, nervousness, or pain, when exposed to music at the high intensity levels. In a clinical setting, individuals who participate in rehabilitation or treatment programs may perceive music as loud or too loud even below 80 dB levels.

Interactions between loudness preference and physiological responses, i.e., heart rate and skin electric potential changes, were reported by Mukhamedrakhimov (1993). The research employed a 1 kHz tone, not musical sounds. Although numerous studies have examined music effects on physiological measurements, a relationship between loudness preference and physiological reactions has not been well understood. More studies are needed to investigate the effects of music loudness preference on physiological and psychological responses to provide safe and effective musical interventions.
CONCLUSION

This study demonstrated that subjects engaging in the exercise perceived music softer than subjects who did not participate. This finding is important because anyone who participates in exercise with background music possibly experiences changes in loudness perception. College students in healthy conditions performed a relatively easy exercise task at their own pace for a short period time. Nevertheless, their loudness perception significantly changed. Thus, more intensive and longer workouts, in a real exercise setting, may yield greater changes in tolerance for loudness. Further research is needed to suggest appropriate loudness levels for participants and instructors.

In both the gross and fine motor groups, loudness perception was quickly adjusted when music intensity changed. Subjects rapidly became accustomed to the music loudness levels. This loudness adjustment is important because people cannot change sound loudness in most occasions, e.g., traffic noise, background music in restaurant, or shopping malls.

Changes in the loudness perception during body movement and our high adaptable sense of hearing may have an interesting relationship. Examining if a small amount of body movement causes changes in loudness perception is necessary. If changes in loudness perception occur, this may explain why people shake their heads while playing or listening to loud sounds in rock concert. People may naturally use body movement to adjust loudness perception. In this case, individuals synchronize their body movement to the music beat not only to count beats and keep rhythm, but also to adjust their auditory perception.

A rapid decline of loudness perception in decreasing sounds exhibited notable differences between loudness perception in increasing and decreasing sounds. Frequent facial expressions of discomfort were observed when loudness increased. Increasing and decreasing loudness creates the image of an object approaching and passing. Approaching sounds naturally arouse fear and anxiety when the sound source is unknown. In clinical fields, therapists need to recognize that loudness changes can cause significant psychological impact on an individual. Much more loudness research on physiological and psychological effects of loudness changes will benefit individuals who provide and receive music-related services.
APPENDIX A

INFORMED CONSENT FORM
Informed Consent Form

I am Yuri Kimura, a graduate student of the department of music therapy in the School of Music at Florida State University. I am conducting this research to study how people prefer music loudness while engaging in motor activities. People’s behaviors responding to music will also be investigated.

Your participation will involve engaging in a nine-minute individual motor activity while listening to music and filling out a survey. In the survey, you will be asked about general individual information such as age, music background, and daily exercise habits. All your answers to the questions will be kept confidential and identified by a subject code number. During the nine-minute activity, you will be asked to either 1) repeat going up and down a four-inch step or 2) sit in a chair and tap your fingers on the table.

The total time commitment would be about twenty minutes. If you participate in the experiment, you will receive a drink and some snacks. If you choose to withdraw from the study, you will still be eligible to receive the compensation.

The session will be videotaped to study how music affects people’s behaviors. I will keep these videotapes in a locked filing cabinet. Only I will have access to these tapes and I will destroy these tapes by December 1, 2004.

The results of the research may be published, but your name will not be used and any information obtained during the course of the study will remain confidential, to the extent allowed by law. Any identifying information will be destroyed after all data has been analyzed.

There is a minimal level of risk involved if you agree to participate in this study. You might experience discomfort by listening to specific music in a loud level. Subjects in the gross motor activity group will complete health history screening. Those who indicate any health concern in the screening will be excluded from the gross motor activity group. You might feel physical fatigue, out of breath, and/or physical discomfort during the gross motor activity. I will assist you throughout the session and you will be able to stop your participation at any time you wish.

You will not receive any physical benefits for participation in this project. Your participation will provide the data necessary to further study preference of music loudness during motor activities and contribute to the development of music therapy and the related fields.

Your participation in this study is totally voluntary. You may stop participation at any time without prejudice or penalty of benefits. You have been given the right to inquire about any parts of this research. Please contact me at yyk6454@garnet.acns.fsu.edu or Dr. Jayne Standley for the office of the music therapy department at 850-644-4565 if you have any questions. If you have any questions about your rights as a participant in this research, or if you feel you have been placed at risk, you may contact the Chair of the Human Subjects Committee, Institutional Review Board, through the Vice President for the Office of Research at 850-644-8633.

I, _______________________ (please write your name clearly) have read and understand this consent form and give my consent to participate in the above study.

Signature: ______________________________ Date: _______________
APPENDIX B

FSU HUMAN SUBJECTS COMMITTEE APPROVAL LETTER
APPROVAL MEMORANDUM

Date: 7/29/2004

To: Yuri Kimura  
1327 High Road X-2  
tallahassee FL 32304

Dept.: MUSIC SCHOOL

From: John Tomkowiak, Chair

Re: Use of Human Subjects in Research
The effects of music loudness preference and behaviors of college students performing a gross motor activity versus college students performing a fine motor activity

The forms that you submitted to this office in regard to the use of human subjects in the proposal referenced above have been reviewed by the Human Subjects Committee at its meeting on 7/21/2004. Your project was approved by the Committee.

The Human Subjects Committee has not evaluated your proposal for scientific merit, except to weigh the risk to the human participants and the aspects of the proposal related to potential risk and benefit. This approval does not replace any departmental or other approvals which may be required.

If the project has not been completed by 7/20/2005 you must request renewed approval for continuation of the project.

You are advised that any change in protocol in this project must be approved by resubmission of the project to the Committee for approval. Also, the principal investigator must promptly report, in writing, any unexpected problems causing risks to research subjects or others.

By copy of this memorandum, the chairman of your department and/or your major professor is reminded that he/she is responsible for being informed concerning research projects involving human subjects in the department, and should review protocols of such investigations as often as needed to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

This institution has an Assurance on file with the Office for Protection from Research Risks. The Assurance Number is IRB00000446.

cc: Jayne Standley  
HSC No. 2004 458
APPENDIX C

PRE-INTERVENTION QUESTIONNAIRE AND HEALTH HISTORY FORM
Pre-intervention Questionnaire

Subject code: _______

Have you ever been tested for hearing loss?  □ Yes  □ No

If yes, under which category do you fall?  □ None  □ Mild  □ Moderate  □ Severe

If you have not been tested, do you think you could have hearing loss?  □ Yes  □ No

Health History Form  (For Subjects in Gross Motor Activity Group)

Please indicate whether any of the following apply to you. If so, please place a check in the blank beside the appropriate item. Thank you.

□ Hypertension or high blood pressure
□ A personal OR family history of heart problems or heart disease
□ Diabetes
□ Orthopedic problems
□ Cigarette smoking or other regular use of tobacco products
□ Asthma or other chronic respiratory problems
□ Recent illness, fever or Gastrointestinal Disturbances (diarrhea, nausea, vomiting)
□ Any other medical or health problems not listed above. (Provide details below.)

________________________________________________________________________
________________________________________________________________________

List any prescription medications, vitamin/nutritional supplements or over-the-counter medicines you routinely take or have taken in the last five days (including dietary/nutritional supplements, herbal remedies, cold or allergy medications, antibiotics, migraine/headache medicines, aspirin, ibuprofen, birth control pills, etc.)

________________________________________________________________________
________________________________________________________________________

I certify that my responses to the foregoing questionnaire are true, accurate, and complete.

Date: _____________________  Signature: __________________________

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APPENDIX D

OBSERVATION FORM FOR GROSS MOTOR ACTIVITY GROUP
### MUSIC LOUDNESS PREFERENCE DATA

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<th>Soft</th>
<th>Time in second</th>
<th>Loud</th>
<th>Soft</th>
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<td>525 sec</td>
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#### The Scale of Music Loudness Preference

- 1 = too soft
- 2 = a little soft
- 3 = comfortable
- 4 = a little loud
- 5 = too loud

### BEHAVIORAL OBSERVATION FORM (Gross motor activity)

#### Definitions of Behavioral Observation

- **V** = vocalization
- **T** = tempo
- **M** = motor movement
- **R** = reaction when music intensity increased
- **G** = grimaces, clenched teeth
- **S** = smile
- **N** = closed eyes
- **B** = leaning back
- **E** = surprised face with lifting eyebrows
- **I** = indicating, gesturing
- **C** = none

<table>
<thead>
<tr>
<th>dB</th>
<th>65</th>
<th>70</th>
<th>75</th>
<th>80</th>
<th>85</th>
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<td>135</td>
<td>165</td>
<td>195</td>
<td>225</td>
<td>255</td>
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</tbody>
</table>

#### Motor movement

- **Gross motor activity (going up and down a small step)**
  - 0 (minimum level): leg motion only (the required activity with no additional motion) with half step
  - 1 (medium level): leg motion only with full step
  - 2 (maximum level): leg with arm motions (voluntarily swinging arms corresponding to leg motion)
    - or leg with bounce (toes not touched the ground or entire body bounced)
  - Exception: between 0 and 2 = 1 (leg motion with half step but with arm motions or bounce)

- **HALF STEP:** both heels stick out from the step edge (thickness of shoes is not included).
- **FULL STEP:** at least one heel is completely placed on the step.

#### HEART RATE

1. Before the experiment (after quietly sitting for five minutes): ___/6 sec (___/min)
2. Immediately after the experiment: ___/6 sec (___/min)
3. After the experiment (after quietly sitting for five minutes): ___/6 sec (___/min)
APPENDIX E

OBSERVATION FORM FOR FINE MOTOR ACTIVITY GROUP
MUSIC LOUDNESS PREFERENCE DATA

| Subject code: _______________ Date of experiment: ___________ Time: Start _______ End _______ |

| *time in second | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| loud            | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| soft            | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| time (min.)     | 15| 45| 75| 105| 135| 165| 195| 225| 255| 285| 315| 345| 375| 405| 435| 465| 495| 525|   |
| dB              | 65| 70| 75| 80 | 85 | 80 | 75 | 80 | 75 | 70 | 65 |   |   |   |   |   |   |   |   |   |

The Scale of Music Loudness Preference
1 = too soft  2 = a little soft  3 = comfortable  4 = a little loud  5 = too loud

BEHAVIORAL OBSERVATION FORM (Fine motor activity)

<table>
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<th>75</th>
<th>80</th>
<th>85</th>
<th>80</th>
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<td>BEGSICN</td>
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</tr>
</tbody>
</table>

Definitions of Behavioral Observation

Target behavior
V = vocalization  / = occurred  humming, giggling, singing, whistling, making other noise
T = tempo  N = not occurred
M = motor movement  0 = minimum level  Tempo
1 = medium level  performing tasks to the beat of the selected music
2 = maximum level

Motor movement
Fine motor activity (finger tapping)
0 (minimum level): the required fine motor activity only
1 (medium level): the required fine motor activity and an additional motion,
                          e.g., nodding head, tapping a foot, shaking shoulders or body
2 (maximum level): the required fine motor activity and two or more additional motions

R = reaction when music intensity increased
B=leaning back  E=surprised face with lifting eyebrows  I=indicating, gesturing
G=grimaces, clenched teeth  S=smile  C=closed eyes  N=none

HEART RATE
1. Before the experiment (after quietly sitting for five minutes): ______/6 sec (_____/min)
2. Immediately after the experiment: ______/6 sec (_____/min)
3. After the experiment (after quietly sitting for five minutes): ______/6 sec (_____/min)
APPENDIX F

QUESTIONNAIRE
Questionnaire

Subject code: ______  Date: _____  Age: ____  Major: ________________  Sex: □ Male  □ Female
Classification: □ Freshman  □ Sophomore  □ Junior  □ Senior  □ Master  □ Doctor
Music background: □ Yes (Please describe: ____________________________________________
Duration: _______ [months/years])  □ No
1. How many hours ago did you get up today? ______ hour(s)
2. How many hours ago did you eat before the experiment? ______ hour(s)
3. Have you ever heard the music you listened to in the experiment? □ Yes  □ No
4. Did you enjoy the music you listened to in the experiment? □ Yes  □ No
5. To what extent did you enjoy the motor activity? (1: Not at all, 5: A lot) □1 □ 2 □ 3 □ 4 □ 5
6. Did the motor task physically challenge you? (1: Not at all, 5: A lot) □1 □ 2 □ 3 □ 4 □ 5
7. Did the music help you to continue to perform the motor movement task? □ Yes  □ No
8. Did you have any problems indicating your loudness preference in the experiment?
   □ Yes (If so, please describe: ____________________________________________ ) □ No
9. Did you have any problems performing the motor movement task in the experiment?
   □ Yes (If so, please describe: ____________________________________________ ) □ No
10. Do you like music? □ Yes  □ No
10a. If yes, what type of music do you prefer? (Check any items that apply.)
   □ Rock  □ Classical  □ Country  □ Jazz  □ Pop  □ Rap  □ R&B  □ Other: ________
11. Do you choose to listen to music on a regular basis? □ Yes  □ No
11a. If yes, what type of activities do you engage in while listening to music?
   (Check any items that apply.)
   □ Cleaning  □ Cooking/eating  □ Studying  □ Driving  □ Relaxation  □ Other: __________
11b. If yes, how often do you usually listen to music?
   □ Every day (Choose one: □ Less than one hour  □ Two to five hours □ Six or more hours)
   □ Three or four days a week  □ One or two days a week  □ Other: __________
12. Do you adjust the volume of music depending on the situation? □ Yes  □ No
13. If yes, in what situations/emotional states do you prefer louder/softer music volume?
   Describe: I prefer louder volume when (e.g., driving, angry) ________________
   I prefer softer volume when (e.g., relaxing, sad) _______________________
14. Do you exercise/play any sports regularly? □ Yes  □ No
14a. If yes, how often do you exercise?  Duration: _______ (minutes/hours) per (day/week/month)
15. Do you listen to music while exercising? □ Yes  □ No
15a. If yes, what type of music do you listen to while exercising? (Check any items that apply.)
   □ Rock  □ Classical  □ Country  □ Jazz  □ Pop  □ Rap  □ R&B  □ Other: ______
15b. If yes, which music volume level do you prefer while exercising? □ Loud  □ Middle  □ Soft
REFERENCES


BIOGRAPHICAL SKETCH

Yuri Kimura

Year of Birth
1976

Place of Birth
Chiba Prefecture, Japan

Education
Florida State University, Tallahassee, FL
August 2000 – Present
M.M. Candidate, Music Therapy, degree expected April, 2005

University of the Air, Japan
April 1999 – August 2000
Non-matriculated student
Specialization: Psychology

Tokyo Gakugei University, Japan
April 1995 – March 1999
B.A., Music Education with emphasis in Piano Performance, March 22, 1999

Achievements
Candidate, Music Therapist Board Certificate, expected to be certified, December 8, 2004
A teacher’s certificate of music for junior high school and high school in Japan, 1999

Awards and Honors
Recipient, Tuition Exemption, Florida-Japan Institute, University of South Florida, Tampa, FL,
Spring, Summer, Fall 2004
Japanese Teaching Assistantship, Department of Modern Languages, Florida State University,
2001 – 2003

Professional Experiences
Orff-Schulwerk Level I Certification Courses
July 5 – 16, 2004
Florida State University, Tallahassee, FL

Music Therapy Internship
August 1, 2003 – January 30, 2004
Southwestern State Hospital, Thomasville, GA