THE EFFECTS OF PRIOR EXPOSURE TO MUSIC ON A SUBSEQUENT MEMORY TASK

by

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B.Ed., Nara University of Education, Japan, 1989

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

in

THE FACULTY OF GRADUATE STUDIES

(Department of Visual and Performing Arts in Education)

We accept this thesis as conforming

to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

AUGUST 1992

ABSTRACT

This study investigated the effects of prior exposure to music on subsequent brain hemispheric arousal levels. Forty Japanese subjects performed a one-digit-number memorizing task using a dichotic listening method. The task consisted of: (1) a free report condition --- in which the subjects reported as many numbers as they remembered with both ears, and (2) a directed report condition --- in which they were to attend to an assigned ear in memorizing numbers. Then the subjects were randomly assigned to listen to either music played by western musical instruments or to the same music but played with Japanese musical instruments. This procedure was conducted to activate either the right hemisphere or the left hemisphere of the brain. After the exposure to the assigned music, the subjects worked on the same one-digit-number memorizing task.

A 2x2x2 ANOVA revealed that in both the free report and the directed report conditions, there was a main effect for test (pretest, posttest), and for ear (left ear, right ear). However, there was no main effect for the kind of music.

The results indicate that prior activation of either the left or the right hemisphere through music listening further induces cerebral arousal levels. The finding implies a

potential use of music listening in educational and therapeutic situations.

Supervisor Approval

Dr. Allen E. Clingman

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"The man who thinks he knows something does not yet know as he ought to know." (1 Corinthians 8:2)

Special thanks are expressed to the subjects who participated in this study, for their time and effort. To Yoshi, Steve H. and other friends who helped me find these subjects, I wish to express my sincere appreciation for their co-operation.

To my family in Japan, who have kept encouraging me, I also say thank you.

I am indebted to Dr. Allen Clingman, Dr. Harold Ratzlaff, and Dr. Rita Watson, for their constant support and valuable advice.

My deep appreciation is also expressed to Sujatha and Randy for proof-reading the manuscript.

To all my friends, especially, Akosua, Sandy and Steve E., I say thank you for sharing both exciting and laborious times throughout the conduct of the research.

I also express my deep gratitude to Tomo for mental support.

CHAPTER 1. PROBLEM

1.1 LISTENING ACTIVITY IN MUSIC

> *It came to pass, when the evil spirit from God was upon Saul, that David took an harp, and played with his hand; so Saul was refreshed, and was well, and the evil spirit departed from him.* (I Samuel, 16:23)

Music listening has become a major part of the lifestyle of a very large number of people due to the wide-spread use of equipment for the recording and reproduction of music (Konecni, 1982). People listen to music while eating, walking, or even while engaging in cognitive activities, such as studying. Bloom (1987) stated "though students do not have books, they most emphatically do have music. Nothing is more singular about this generation than its addiction to music" (p. 68). They choose certain kinds of music to listen to depending on where they are, what they are doing, whom they are with, and what kind of mood they are in. According to Konecni (1979), people listen to music in order to optimize their mood; when people were asked to listen to different kinds of music and an aversive tone, they chose to listen to the aversive tone earlier and the favorable music later in order to offset the impact of the aversive stimulation. People also listen to different kinds of music depending on a slight mood change during the process of stress management in every day life (Yokota, 1992). In addition, Konecni and Sargent-Pollock (1976) reported that people who were made to engage in work which involved a considerable amount of information processing showed a strong tendency to avoid listening to a complicated melody when given the choice of listening to either a simple or a complicated melody. They noted that the subjects opted for the less demanding additional stimulus, the simple melody, since the complicated melody is more difficult to process than the simple melody.

These studies indicate that listening to music is a part of everyday life, and people know from their experiences how music changes their mood and affects the cognitive activity in which they are concurrently engaged.

Applications of music listening are reported in therapeutic settings as well. However, studies have not yet provided us sufficient proof of the efficacy of music listening in therapy. For example, studies have demonstrated the facilitative effects of background music on the accuracy of a performance task in psychotic children (Burleson, Center & Reeves, 1989), in retarded adults (Sterlight, Deutsch & Siegel, 1967), and on work oriented behavior in mentally handicapped adults (Groeneweg & Stan, 1989). Those studies clearly report how background music affects one's performance of the tasks, however, they did not discuss what caused these effects. Music was also successfully used as a contingent positive reinforcement for emotionally and/or behaviorally disturbed children in order to correct their undesirable behaviors (McCarty, McElfresh, Rice & Wilson, 1978: Wilson, 1976). However, in those studies, music listening was simply used as one of positive reinforcements, and thus the stimulus did not necessarily have to be music as long as the stimulus was pleasant to a subject. Other studies have reported that music listening helps neurotic patients release anxiety and recover from depression (Murai, 1987, 1988; Taniguchi & Ohara 1991). However, it is not known how long the effects were maintained in those two studies. Moreover, in Murai's studies (1987, 1988), the criteria in determining whether there was an effect or not was vague.

Thus, in those studies, the investigations described only how music affects us, but not why. In other words, they imply, but do not prove the efficacy of music listening in clinical settings. Research which would explain the causes of the effects is necessary, since the author believes that an idea which is based on mere empirical knowledge is limited in its applicability. In order to develop the applicability of an idea, the support of solid theory is crucial.

1.2. NECESSITY OF BASIC RESEARCH ON MUSIC LISTENING

In a practical setting, a practitioner seeks information for understanding phenomenon, solving problems, allocating sources to meet changing conditions and/or needs in other settings and developing and/or planning a new program. There are many sources for the practitioner to rely on: personal experience, tradition, and advice and/or opinion from an expert. However, those sources are not necessarily stable in all situations, thus limited in their applicability to new settings. The most reliable information to which the practitioner should refer is, probably, a theory which is related to the problem. According to McMillan and Schumacher (1989), a theory is " a set of interrelated constructs and propositions that specify relations among variables to explain and predict phenomena (Kerlinger, 1986)" (p. 7). A theory is abstract, general, and explanatory, since it is a principle which is applicable to explain various phenomenon.

A theory is established based on findings from research. "Research is a systematic process of collecting information (data) for some purposes" (McMillan & Schumacher, 1989, p. 8), which provides valid information and knowledge. Research is conducted in order to advance knowledge and to improve a practice. Concerning educational problems, McMillan and Schumacher (1989) have said "If one plans to improve education, the first step is to have valid information and knowledge about education...Information derived from authority, philosophy, tradition, or personal experience is less likely to be objective and realitybased... Research-based information is most likely to define the problem carefully and to reflect the complexity of educational process" (p. 24). Thus, a practice is dependent on research in its validity and reliability of application.

There are three types of research: basic, applied, and evaluation research. According to McMillan and Schumacher (1989), the purposes of basic research is " to add to our knowledge of basic principles and scientific laws," and " to advance further scientific inquiry and methodology and indirectly, the methodology of applied science" (p. 18). Applied research is aimed at "testing the usefulness of scientific theories and determining empirical and analytical relationship within a given field. ... and adding to the research-based knowledge in the given field" (p. 19). Evaluation research is conducted in order to " assess the merit and worth of a particular in terms of the values operating at the sites" (p. 20). Those three types of research interact and complement each other in order to develop a stronger relationship between a theory and a practice.

The level of applicability of finding, that is generalizability, of basic research is abstract; in other words, the finding from basic research is more general and thus more applicable than the other two types of research. In an applied research, generalizability is less than that of basic research and thus only applicable in a related field. The generalizability of evaluation research is least general of these three types of research; a finding is applicable only to a concrete and a specific practical situation. Thus, the more practical a research becomes (from basic to evaluative), the less applicable the research becomes. Therefore, a valid and reliable theory which is applicable in various settings cannot be established without basic research.

This discussion may be applied to the previous studies on the efficacy of music listening in practical settings.

Even though many studies have examined this topic, as reviewed in the previous section of this chapter, the findings from those studies were insufficient to induce a generalized theory about the efficacy of musical listening in clinical settings. As has been indicated, those studies lack reliable evidence about the causes of the effects. In addition, all of those studies are applied research; thus, generalizability of findings are more limited in a related field. Particularly, some of the studies were case studies using only one patient (e.g., Murai, 1987, 1988), therefore, the external validity of the findings are limited.

Sometimes a lack of basic research causes other problems, such as misunderstanding, or misuses of practice.

For example, in Japan, the lack of basic research on the effects of music causes serious problems with the use of music in clinical settings. In Japan, "music therapy" itself has not yet been recognized by any official institute, and inevitably, there are no registered music therapists. Nevertheless, some music educators, psychologists, and psychiatrists use music in the treatment of their patients, and label such treatment "music therapy." They call themselves "music therapist," even though they have neither learned systematically what music therapy is, nor trained as a therapist. Most of their practices do not originate from a solid theory about the efficacy of music in treatment but from personally induced empirical knowledge. As Gibson (1987) has suggested, scientific research is crucial in order to improve this situation. A solid theory which is based on fundamental research would make usability wider and prove its efficacy. Inevitably, the applicability of music in therapy could be recognized through issuing a certificate for "music therapy," thus, validating the title, "music therapist."

Therefore, basic research is necessary in terms of the following two purposes: (1) to establish a theory and thus to improve practice, and consequently (2) to rectify the misuse and misunderstanding of practice and consequent problems, if any exist.

In order to make a contribution to the aforementioned two purposes, basic research will be conducted on the effects of music listening on one's cognitive activities--why does music enhance or interfere with other activities? In the next chapter, literature related to this question will be reviewed.

CHAPTER 2. PURPOSE OF THE STUDY

In the present study, basic research will be conducted particularly focusing on the relationship between cognitive activities and music from an educational point of view for the following reasons. The first reason is being implied in Bloom's report, "today, a very large proportion of young people between the ages of ten and twenty live for music it is their passion; nothing else excites them as it does; they cannot take seriously anything alien to music" (p. 68). Thus, there is a necessity to examine what kinds of effect music has on children's cognitive activities. The other reason is that there seems to be a therapeutic implication of music for mentally handicapped children to enhance their learning abilities, as reviewed in the previous chapter.

In this chapter, hemispheric specialization and processing of cognitive activities and music will be discussed. Based on the discussion, the effects of concurrent exposure to music on other activities, and the effects of prior exposure to music on subsequent activities will be discussed.

2.1. OVERVIEW OF HEMISPHERIC SPECIALIZATION AND MUSIC

The early reports about the human brain's hemispheric specialization were done through clinical settings. Broca in 1861 (Boring, 1950) and Wernick in 1871 (Gardener, 1975) found that left hemisphere-damaged patients who were right-handed suffered aphasia, while right hemisphere-damaged patients did not. Kimura (1961a, b) reported that a left temporal lobotomy caused the decline of language abilities. Other studies reported the right hemisphere's superiority for visual and spatial abilities (Bogen, 1969; Levy & Trevarthen, 1972), for perception of complex visual stimuli (Levy, 1980; Nebes, 1974), for interpreting emotional stimuli and expressing emotion (Tucker, 1981; Sackheim, Gur & Saucy, 1978). It has also been demonstrated that the right hemisphere has much fewer abilities in language skills than the left hemisphere (Gazzaniga & Sperry, 1967). These studies were done through the investigation of split-brain patients who received an operation to cut the corpus callosum which connects the two hemispheres. Those findings have been confirmed by other studies involving normal people. Measuring blood flow level in the brain during various task performance, Gur et al. (1982) found that the left hemisphere is dominant for verbal task processing, while the right hemisphere is dominant for the spatial task processing. Those results were further confirmed when Phelps and Mazziotta (1985) reached the same results using Positron Emission Tomography (PET) for measuring the subjects' brain activation level during the task. Thus, the hemispheres of the brain are involved differently in processing various sorts of information.

Focusing on the processing of music in the brain, Milner (1962) found that scores on the timbre and tonal memory subtests of the Seashore Measure of Musical Talents were depressed by a right temporal lobotomy but not by a left temporal lobotomy. This finding was confirmed in normal subjects by Kimura (1964). She examined the difference between the processing of spoken digits and the processing of melodies in right-handed normal subjects using a dichotic method. The principle behind this method is the fact that the human's auditory pathway is more strongly connected to the counterlateral hemisphere than to the isolateral hemisphere; the right ear is connected more strongly to the left hemisphere than to the right hemisphere, and the left ear is connected more strongly to the right hemisphere than to the left hemisphere. In this method, two different stimuli are presented to each ear simultaneously in order to cause a competition between ears in processing information. The premise is that the counterlateral hemisphere to the ear that successfully perceives the information is dominant for processing the information. Using this method, she found that on the digit test, the score for the right ear was significantly higher than for the left ear, while on the melodies tests, the score for the left ear was significantly higher than for the right ear; that is, the left hemisphere was more dominant for the verbal tasks, and the right hemisphere was more dominant for the non-verbal task (music) in right-handed people. These results corresponded with her previous studies on brain-damaged-patients (Kimura, 1961a, b).

Some other researchers, however, reached contradictory results. According to Gordon (1975), as a person becomes comfortable with the dichotic task, left hemisphere superiority increases. Peretz, Morais and Bertelson (1987) reported the superiority shift to the left hemisphere from the right hemisphere when analytic tasks are involved in the melody recognition task. Bever and Chiarello (1974) demonstrated left hemisphere dominance for musical recognition in musically sophisticated children. Gates and Bradhsaw (1977) reported the notion of music induced involvement of both hemispheres. Hodges and Bartlett (1990) summarized these variations in the results as follows: "generally speaking, the right hemisphere appears to demonstrate an advantage in processing melodic materials; however, a shift towards left hemisphere dominance may occur as the listening task becomes more analytic or as the listener becomes more musically sophisticated (p. 10)." It may be possible to conclude that in general, music is processed in the right hemisphere as long as more holistic perception is being employed in the music processing. Whereas, when more analytical perception is being employed in such a way that one tends to pay attention to the detailed part of music, it is processed in the left hemisphere.

2.2. THE EFFECTS OF CONCURRENT EXPOSURE TO MUSIC ON COGNITIVE ACTIVITIES

Based on the discussion in the previous section, the effects of concurrent exposure to music on other activities will be reviewed.

Many studies have been done on the relationship between cognitive activities and the music which is being played in the background. Some studies reported that background music has a positive effect on non-verbal tasks such as memorizing pictures (Stainback, Stainback & Hallohan, 1973), spatial task (Miller & Schyb, 1989). On the other hand, music has negative effects on people's, particularly females', performance on tests of their verbal abilities, especially when the music is unfamiliar (Etaugh & Michaels, 1975; Etaugh & Ptasnik, 1982; Fogelson, 1973). Other studies reported that listening to familiar music has no effect on solving math problems (Wolfe, 1983). These results seem to indicate that, as Miller and Schyb (1989) have concluded, in general, the right hemisphere's activities, such as spatial orientation and math problem solving, are positively influenced by concurrent exposure to music, while the left hemisphere's activities, such as verbal tasks, are negatively influenced. A reason for unfamiliar music's negative influences on the left hemisphere's activities would be that unfamiliar music requires more analytical procedure (more left hemispheric procedure) in order to be perceived and processed than familiar music does. Since the music is new information, this requirement for left hemispheric information processing may interfere with the left hemisphere's activities.

As can be seen, there seem to be three factors which determine whether the effect of concurrent exposure to music on cognitive activity is positive or negative. The first factor is the <u>kind of task</u>--whether the task is more left hemispheric or more right hemispheric in nature. The second factor is the <u>music background</u> of people--whether they are musically naive or sophisticated; in other words, their attitude in listening to music--whether they listen to it analytically or synthetically. The third factor is the <u>kind of music</u>--whether the music is familiar or unfamiliar to the listener. The core idea which is common to these three factors is that the left hemisphere is dominant for more analytical processing, and the right hemisphere is dominant for more synthetic processing. Thus, positive and/or negative effects of concurrent exposure to music on cognitive activities could be attributed to interactions between the right and left hemispheres' specializations.

2.3. THE EFFECTS OF PRIOR EXPOSURE TO MUSIC ON SUBSEQUENT COGNITIVE ACTIVITIES

In the previous section, the effects of concurrent exposure to music on cognitive activities were reviewed, based on the relationship between hemispheric specialization and music. What follows is a discussion as to whether prior exposure to music also affects cognitive activities.

Even though many studies have been conducted on the effects of concurrent exposure to music, few studies have been done on prior exposure to music. Probably, Morton, Kershner and Siegel's (1990) is the only one which deals with that topic. They examined music's effects on memory and attention using a verbal dichotic listening task (monosyllabic digits). They reported that prior exposure to music enhanced memory capacity (number of digits reported) and reduced distractibility. They concluded that this result supports either (1) the Heilman and Van Den Abell's study (1979) which states that the right hemisphere's activation causes the arousal of both hemispheres, or (2) the notion of music induced involvement of both hemispheres (Gates & Bradsaw, 1977).

However, there seems to be a serious weakness which may have affected the validity of Morton, Kershner and Siegel's study (1990). They used the song, "The Wall" by Pink Floyd, as the musical stimulus. This stimulus contains two variables--words and melody. In listening to the song, the words are processed in the left hemisphere as verbal stimuli, while the melody is processed in the right hemisphere as a nonverbal stimulus. As Phelps and Mazziotta (1985) reported, music with words activates both the left and the right hemispheres. Thus, in Morton, Kershner and Siegel's study (1990), the musical stimulus was not sufficiently controlled to infer the conclusion which they made.

Therefore, the purpose of the present study was to examine whether Morton, Kershner and Siegel's finding (1990) is still valid in a setting in which musical stimuli are controlled. In other words, does music, which activates the right hemisphere, play a role in causing the activation of both hemispheres? If so, is the left hemisphere's activation induced by the right hemisphere's mediating role in cerebral activation comparable with the activation induced by the left hemisphere alone? Would not the left hemisphere activation cause the activation of both hemispheres?

In the present study, the right hemisphere and the left hemisphere will be activated by music respectively, and the effects will be compared. The hypotheses are as follows; priming of the right hemisphere would induce both hemispheres' activation, while priming of the left hemisphere would induce only the left hemisphere's activation.

CHAPTER 3. METHODOLOGY

3.1. Background Theory of The Methodology

In order to activate each of the right and the left hemispheres respectively, Tsunoda's findings (1987) were applied in the present study.

He examined the difference in cerebral processing mechanism for musical sounds between Japanese and non-Japanese people using the "key-tapping-method " (Tsunoda, 1987). The underlying principle of this method is the delayed auditory feedback (DAF) effect. People operate a "loop" of vocalizing sounds and hear the sounds which they make when speaking. Therefore, if there is any delay between making and hearing, they " are observed to have difficulties maintaining their normal speech performance due to a delayed auditory feedback of their voice " (Tsunoda, 1987, p. 96), and they start to stammer. Tsunoda has applied this effect to his hemispheric study. In the key-tapping method, the subjects were required "to tap an electrical key according to a prescribed rhythmic pattern and to listen intensively to the synchronous sound feedback of the key-tapping delivered in short tones to one ear. ... while the subjects are performing this requirement, a delayed feedback of the key-tapping is delivered to the opposite ear in a 0.15 to 0.4 second delay." They are still asked to " concentrate their attention to the synchronous feedback and ignore the delayed feedback" (Tsunoda, 1987, p. 96) in order to create a condition of intense auditory competition. Then, the experimenter starts to increase the loudness of the delayed feedback until the subject is no longer able to follow the synchronous sound feedback because of the interference of the delayed auditory feedback (that is, a DAF effect occurs). Next, " ... the channels are reversed and the same investigation is performed. The ear which requires a higher intensity of delayed feedback before the disturbance of accurate tapping is considered dominant over the opposite ear for the perceptual processing of that specific sound" (Tsunoda, 1987, p. 97).

A sound stimulus exposed to subjects by this method is so short (such as 0.05 second or 0.07 second) that the subjects are not able to recognize what the sound stimulus is. This short exposure to stimulus contains three benefits. First, an experimenter is able to examine the hemispheric dominance for a sound without causing subjects' bias for the sound stimulus. Second, since unlike a dichotic listening test a subject does not need to vocalize in reporting what they hear, this method is applicable to people who have problem with speaking. Third, an experimenter is able to investigate a hemispheric dominance for a sound which cannot be vocalized (for example, sound of falling rain).

Using this key-tapping-method, Tsunoda (1987) found that in the non-Japanese speaker, the nonverbal hemisphere is dominant for any kind of instrumental music. In the Japanese speaker, however, even though the nonverbal hemisphere (the right hemisphere in right handed people) is dominant for music which is played by western musical instruments, such as the violin, flute or piano, the verbal hemisphere (the left hemisphere in right-handed people) is dominant for music which is played by Japanese traditional musical instrument, such as koto, shakuhachi, or shamisen. Tsunoda attributed this phenomenon to the difference between the Japanese language and other languages. In the English language, for example, consonant sounds are more stressed than vowel sounds in articulation in order for words to be understood. On the contrary in the Japanese language, consonants are less stressed than vowels; vowel sounds are more important than consonant sounds. Therefore, when a Japanese speaker hears a vowel, the vowel is automatically switched to the verbal hemisphere to be processed, even if the sound of the vowel is too short (such as 0.05 second or 0.07 second) for a person to recognize it is a vowel. As well, when he or she hears a consonant, it is automatically switched to the nonverbal hemisphere. The results in non-Japanese speakers are the opposite of those in Japanese speakers.

This characteristic of the Japanese language causes the difference in music processing between music played with western musical instruments and music played with Japanese traditional musical instrument in a Japanese speaker. The sound structure which a Japanese traditional musical instrument makes is acoustically very similar to that of vowels in the Japanese language (Tsunoda, 1985). Therefore, when a Japanese speaker hears the sound made by a Japanese traditional musical instrument, the sound is automatically switched to the verbal hemisphere for processing. Those findings were replicated by other studies (Kikuchi and Tsunoda, 1986; Kikuchi, 1986, 1987) using the evoked potentials method.

In the present study, music which was played and recorded using two different kinds of musical instruments--Western and Japanese--will be used for Japanese speakers to activate either their left hemisphere or their right hemisphere respectively.

3.2. <u>The Population</u>

This study was designed to involve people who met both of the following criteria: (1) people whose first language is Japanese, and (2) people who are initially right-handed. People who were initially left-handed during their early childhood, and forced to switch the hand preference were excluded. The generalization of the findings from the study will be applicable to these people.

3.3. The Sample

The sample of 40 subjects (16 males and 24 females) was drawn from the population. They ranged in age from 18 to 39 years. They participated in the experiment with their consent (Appendix A).

Hearing was tested with a Beltone Model 119 Audiometer, set at 20 db, and only subjects with equivalence in hearing in both ears, 125Hz - 8000Hz range (speech range), were selected (Appendix B).

In order to control for other priming effects, the subjects had been asked not to listen to music, not to smoke or smell cigarettes, and not to put on or smell perfume, and not to drink alcohol for 180 minutes prior to the experiment. This is because hemisphere dominance in Japanese people is easily affected by smelling perfume, smoking, or drinking alcohol. After these have been experienced, the left hemisphere deals with the stimuli which are supposed to be processed in the right hemisphere; as a result, a right ear (the left hemisphere) advantage occurs for a while --- from 90 to 180 minutes (Tsunoda, 1979).

3.4. Materials and Apparatus

The task was composed of 8 trials of one-digit-numbers, which contained four bursts of two pairs of numbers per second in one cluster with an eight-second interval between trials. The numbers were recorded in the Japanese language by a female native Japanese speaker (the author) in analogue sound on a cassette tape. The tape was prepared at the Bullfrog Recording Company Ltd, Vancouver, British Columbia.

The music selected was the first four minutes of "The Fall" from Vivaldi's "The Four Seasons," Concerto No. 1 in E major, La Primavera (p. 241), f-22, Allegro, for the reason being that "The Fall" contains less staccato than other pieces in "The Four Seasons." Staccato would cause extra activation of the right hemisphere since the sound made by staccato contains inharmonic sound structures which are supposedly processed in the right hemisphere. Two versions of this music, one played with Japanese traditional music instruments and the other played with western musical instruments were prepared: the koto version, ("The Koto Vivaldi") played by the New Koto Ensemble of Tokyo, and a chamber orchestra version played by the Southwest German Chamber Orchestra. Both versions were played for approximately four minutes based on the following reasons. The first reason was that four minutes exposure to music was equivalent to the music stimulus used in the Morton, Kershner and Siegel's study (1990); even though they played the musical stimuli, Pink Floyd's "The Wall" for five minutes instead of four minutes, the instrumental part of the music is about four minutes. The second reason was that most music which people are familiar with in their daily lives is approximately four minutes long. The third reason was that four minutes of exposure to music was assumed to be a maximum length of time that most subjects could tolerate; it would be particularly so in the case of classical music, since it is assumed that classical music is not as preferred as popular music is by people who belong to the population.

Both number-memory-task and music were reproduced on a Sony CF 5-D500 tape recorder through earphones.

3.5. PROCEDURE

The subjects were randomly assigned to one of the two following groups: Japanese musical instrumental version listening group (JMV group), or western musical instruments version listening group (WMV group). Each group contained 8 males and 12 females.

The subjects in both groups first worked on a pretest of one-digit-number memory tasks using the dichotic listening method, and then listened to the assigned music. Then they performed a posttest which contained the same memory task but in a different order from the pretest. This reordering was implemented to avoid causing a practice effect.

Both pretest and posttest consisted of three conditions: (1) free report ("orally report as many digits as you remembered hearing during the interval between trials"), (2) directed right ear report ("orally report the digits you hear with the right ear during the intervals between trials"), and (3) directed left ear report ("orally report the digits you hear with the left ear during the interval between trials").

In the free report, the subjects were allowed to report the numbers which they remembered hearing in any order. They were instructed not to attend to the preferred ear, but to attend to both ears and try to catch both numbers from both ears. Moreover, they were instructed not to simply guess the answers, but to report the numbers which they were sure of hearing.

In the directed reports, the subjects were asked to completely repeat the numeric serial as dictated on the tape. For example, when the tape said "3-6-4-2," the report must be "3-6-4-2." Oral report, instead of a written report, was implemented to let the subjects engage in a less loaded verbal activity, and to avoid showing the previous answers (numbers) which might act as cues to remembering new numbers. Both in the free report and the directed report, the subjects were instructed not to orally repeat to themselves, out loud, what they were hearing while the numbers were being given. This instruction was given in order to avoid providing verbal feedback which would cause extra left hemisphere activation.

The task was administered first in a free-report condition followed by one warm-up trial. Then it was conducted in directed report conditions (Appendix C).

Half of the subjects in each group worked on the free report in the initial earphone condition (the right channel of the earphone in the right ear, and the left channel in the left ear), in both the pretest and the posttest. The other half of the subjects worked in the earphone-reversed condition (the right channel in the left ear and the left channel in the right ear) in both of those tests. This procedure was implemented for counterbalance.

Half of the subjects in each group worked on the directed left ear report first and then worked on the directed right ear report in both the pretest and the posttest. The other half of the subjects worked on the directed right ear report first and then performed the directed left ear report in both tests. For both the directed left and the directed right reports, the same channel of the earphone was used for the attending ear. For example, a subject, who worked on the directed left ear report with the left channel in the left ear and the right channel in the right ear, was asked to switch the channel of the earphone between ears on the next right ear report--the left channel in the right ear and the right channel in the left ear. This procedure was implemented to administer both directed reports under the same condition in sound.

While listening to the assigned music, the subjects were allowed to relax and enjoy the music freely. They were also instructed not to listen analytically to the assigned music, and not to do intentional logical and/or verbal activities, such as thinking about a paper, assignments, or homework. This instruction was given in order to control a disturbing effect which would cause extra activation of the left hemisphere.

The experiment lasted approximately 10 minutes. The whole procedure was administered in an individual setting in a quiet room only in the afternoon in order to control time-of-day effect. The whole instruction was given in their first language, Japanese, by a native Japanese speaker (Appendix D).

3.6 Data Collection

A subject and the experimenter sat down at a table facing each other, and the subject orally reported the digits which he or she remembered hearing. The digits reported were recorded on a sheet held by the experimenter on her lap instead of on the table, so as to prevent the subject from watching the digits as they were written and thus receiving feedback. All subjects were treated anonymously. Age, gender, hand-preference and the result from an auditory test were also recorded.

3.7. Data Analysis

In the free report condition, the correct digits reported with each of the left and the right ears were counted for each of eight trials. And then, the sum of the left ear report and the right ear report was computed for the eight trials in each subjects. The sum of the correct digits reported with the left ear and the right ear respectively throughout the eight trials were computed for each subject. Then the means and the standard deviations were calculated in order to conduct an analysis of variance on the total number of correct digits reported with each ear in the free report data.

In the directed report condition, correct digits reported in the identical order as was on the tape were counted as the correct answer. The total numbers of correct answers for each of the left ear report and the right ear report were counted, and the means and the standard deviations in the sample were calculated. Based on these data, an analysis of variance was computed.

These procedures were planned based on the results from the pilot study (Appendix E).

Chapter 4. RESULTS

4.1. Free Report Data

Means and standard deviations in the total numbers of correct digits reported are presented in Table 1. A 2x2 ANOVA was computed for the total numbers of correct digits reported in the free report condition (see Table 2). The Kind of Music (Japanese instrumental version, Western instrumental version) was the between-groups variable, while Test (pretest, posttest) was the within-groups variable that was treated as a repeated measure.

Table 1

Means (Standard Deviations) in Total Numbers of Correct Digits Reported in the Free Report Condition

		Kind of Music		
		Japanese	Western	Total
Type of Test	pretest	43.70 (6.74)	43.25 (4.72)	43.475 (5.747)
	posttest	45.90 (6.54)	45.30 (7.24)	45.600 (6.819)

Note. Maximum score = 64.00

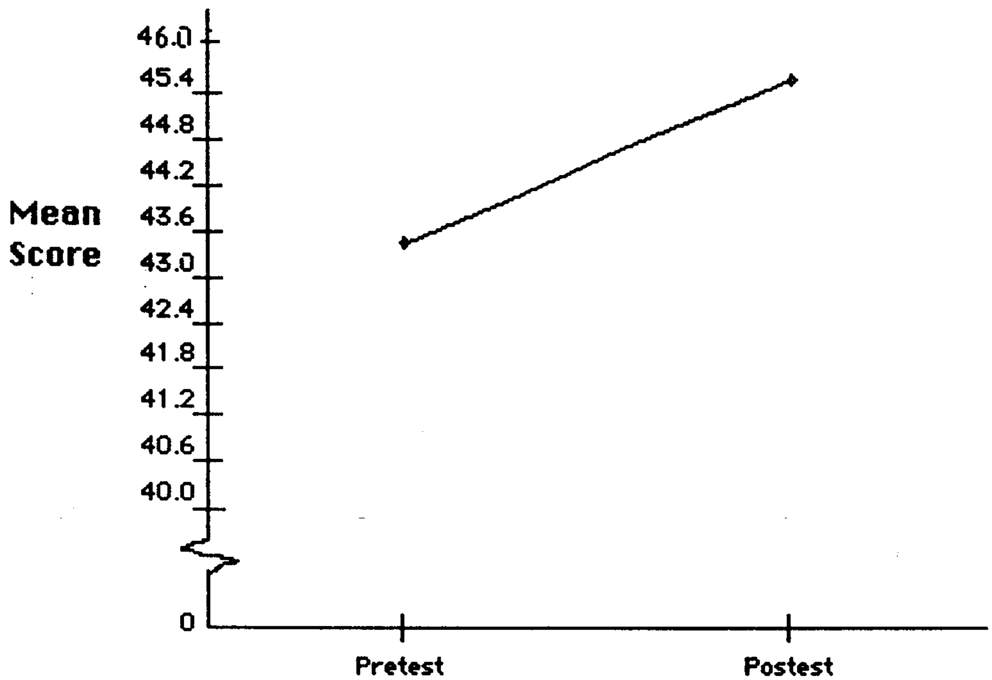
Table 2

2x2 ANOVA for Total Numbers of Correct Digits Reported in the Free Report Condition

Source	SS	df	MS	F	P
Music(M)	5.5125	1	5.51250	0.08	0.775
Test(T)	90.3125	1	90.31250	5.93	0.020
MT	0.1125	1	0.11250	0.01	0.932
Error(M)	2516.8750	38	66.23355		
Error(T)	579.0075	38	15.23882		
Total	3191.8200	79			

There was a main effect for the test which revealed a significantly higher report in the posttest than in the pretest (Figure 2). There was no main effect for Kind of Music.

Means and standard deviations in the total numbers of correct digits reported with the left ear and the right ear are shown in Table 3. A 2x2x2 ANOVA was computed for the total numbers of correct digits reported with the left ear and with the right ear in the free report condition (Table 4). Kind of Music was a between-groups variable, while Test (pretest and posttest) and Ear (the left, the right) were



Note: Maximum = 64

Figure 1. Total numbers of correct digits reported in the free report task

within-group variables. There was a main effect each for Ear and Test, which indicated that the right ear report was significantly higher than the left ear report both in the pretest and the posttest (Figure 2). There was no main effect for Kind of Music.

Table 3

Means (Standard Deviations) in Total Numbers of Correct Digits with the Left Ear and the Right Ear in the Free Report Condition

			Kind of Music		
			Japanese	Western	Total
Ear	Left ear				
	Type of Test	pretest	19.65	19.10	19.375
			(3.88)	(3.34)	(3.585)
		posttest	21.20	20.25	20.725
			(4.34)	(4.78)	(4.529)
	Rgiht ear				
	Type of Test	pretest	24.05	24.15	24.100
			(4.49)	(3.07)	(3.795)
		posttest	24.70	25.20	24.950
			(3.94)	(3.78)	(3.816)

Note. Maximum score = 32.00

Table 4

2x2x2 ANOVA for Total numbers of Correct Digits Reported with the Left Ear and the Right Ear in the Free Report Condition

Source	SS	df	S	F	P
Music(M)	2.025	1	2.02500	0.06	0.807
Ear(E)	801.025	1	801.02500	46.94	0.000
Test(T)	48.400	1	48.40000	6.34	0.016
ME	11.025	1	11.02500	0.65	0.427
MT	0.000	1	0.00000	0.00	1.000
ET	2.500	1	2.50000	0.45	0.509
MET	1.600	1	1.60000	0.28	0.507
Error(M)	1264.250	38	33.26974		
Error(E)	648.450	38	17.06447		
Error(T)	290.100	38	7.63421		
Error(MET)	213.400	38	5.61579		
Total	3282.775	159			

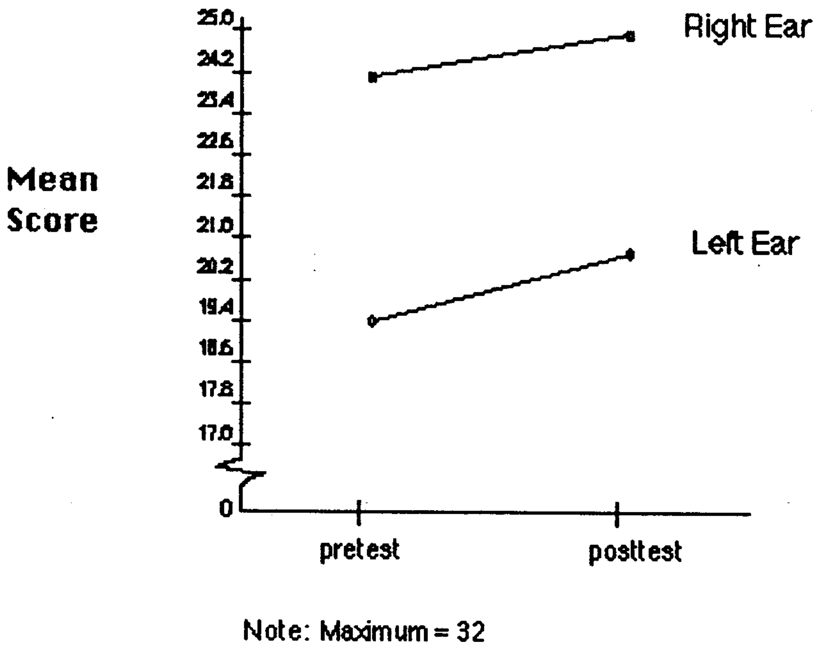


Figure 2. Total numbers of correct digits reported with the left ear and the right ear in the free report task

4.2. <u>DIRECTED REPORT DATA</u>

Correct digits reported in the correct order (e.g., when the tape said "3-6-4-2," the answer should be "3-6-4-2") were counted as the correct answer in the directed report data treatment. Means and standard deviations are presented in Table 5. A 2x2x2 ANOVA was computed on the correct answer reported (Table 6). The independent variables were Kind of Music (Japanese version, Western version), Ear (the left, the right) and Test (pretest, posttest). The variable Kind of Music was a between-groups variable, and the variables of Ear and Test were within-group variables. There was a main effect each for Ear and Test. In addition, there was an interaction between Test and Ear. There was no main effect for Kind of Music. These results indicated that there was a significant difference between the left ear report and the right ear report in the pretest, however, the difference was affected by the factor of Test (pretest, posttest); as a result, the main effect for Ear was lost in the posttest (Figure 3).

Table 5.

Means (Standard Deviations) in the Total Numbers of Correct Answers Reported with the Left Ear and the Right Ear in the Directed Report Condition

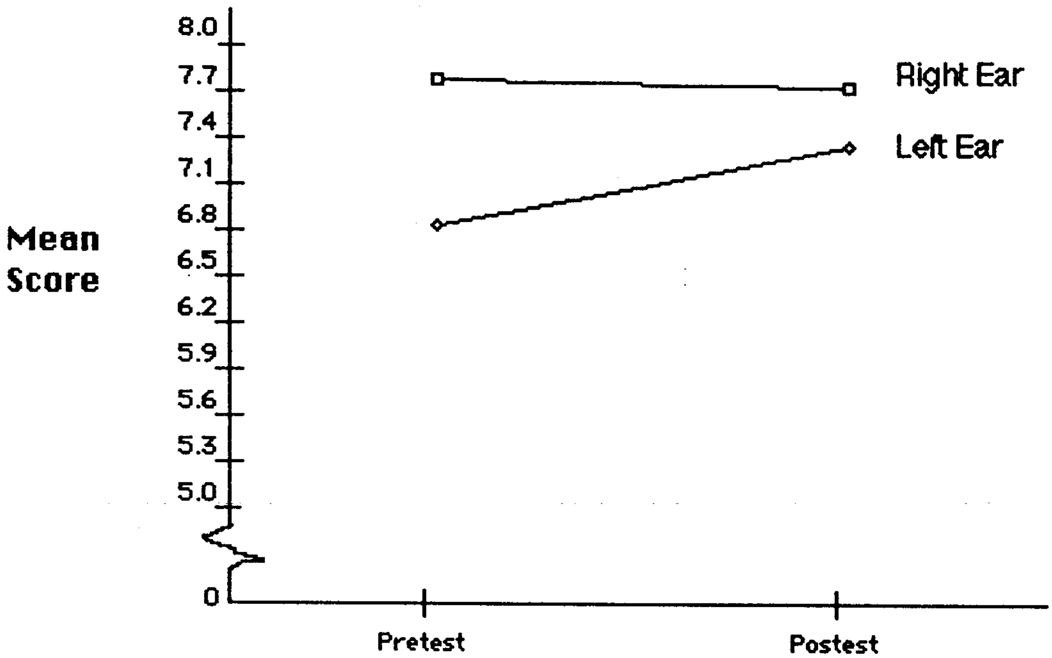
			Kind of Music		
			Japanese	Western	Total
Ear	Left ear				
	Type of Test	pretest	6.90 (1.41)	6.75 (1.59)	6.825 (1.483)
		posttest	7.50 (0.69)	7.20 (1.58)	7.350 (1.210)
	Right ear				
	Type of Test	pretest	7.75 (0.55)	7.80 (0.52)	7.775 (0.530)
		posttest	7.65 (0.81)	7.80 (0.52)	7.725 (0.079)

Note. Maximum score = 8.00

Table 6

2x2x2 ANOVA for Total Numbers of Correct Answers Reported with the Left Ear and the Right Ear in the Directed Report Condition

Source	SS	df	MS	F	P
Music(M)	0.15625	1	0.15625	0.06	0.805
Ear(E)	17.55625	1	17.55625	16.83	0.000
Test(T)	2.25625	1	2.25625	5.72	0.022
ME	1.05625	1	1.05625	1.01	0.321
MT	0.00625	1	0.00625	0.02	0.901
ET	3.30625	1	3.30625	6.35	0.016
MET	0.15625	1	0.15625	0.30	0.587
Error(M)	96.03750	38	2.52370		
Error(E)	39.63750	38	1.04309		
Error(T)	14.98750	38	0.39441		
Error(MET)	19.78750	38	0.52072		
Total	194.94375	159			



Note: Maximum = 8.00

Figure 3. Total numbers of correct answers reported with the left ear and the right ear in the directed report task

CHAPTER 5. DISCUSSION

5.1 FREE REPORT CONDITION

There was a significant difference between the pretest and the posttest in the total numbers of correct digits reported in both the JMV group and the WMV group (see Table 2). In fact, from a record of individual comments from the subjects after the experiment, most of them reported that the task performance became easier in the posttest. Only two of the subjects (one male in the JMV group and one female in the WMV group) reported that it became harder in the posttest. However, the scores in the posttest in those two subjects were still improved.

Table 4 indicates that the right ear mean recall of numbers was significantly higher than the left ear for both tests (the pretest and the posttest). This result corresponded with Kimura's studies (1961a, b) that the left hemisphere (the right ear) is dominant for processing verbal information in right-handed people. In the present study, this left hemisphere's dominance for the processing of the task was not affected by exposure to music, let alone by two kinds of music. In other words, the left hemispheres dominance was maintained even after exposure to music either Japanese musical instrumental version or Western musical instrumental version.

Concerning the factor Kind of Music, there was no significant difference. In both groups, there seems to have been a treatment effect by exposure to music--no matter which of the two kinds of music was played. However, these results may be insufficient to be attributed solely to a treatment effect. The first reason for this insufficiency is that the present study did not include a control group in which subjects received no treatment in order to examine whether the results are due to a treatment effect or not. Another reason is that the total numbers of correct digits reported (by both the left ear and the right ear) do not demonstrate the difference between the score of the left ear improvement and the score of the right ear improvement. Thus, there is a possibility that the laterality of the left ear report and the right ear report, between the pretest and the posttest, could be different between the JMV group and the WMV group. To deal with the former issue, a further study which includes a control group is required. Therefore, the discussion is limited to the latter issue, that is, the laterality in the left ear report (the right hemisphere's involvement) and the right ear report (the left hemisphere's involvement) between the pretest and the posttest in the two groups.

In the WMV group, one possible reason for the left ear score improvement in the posttest over the pretest is that the right hemisphere's activation by exposure to music, which was played with a western musical instrument, induced activation in both hemispheres. This interpretation supported Heilman and Van Den Abell's finding (1979) that the right hemisphere's activation plays a role in inducing cerebral arousal level. For further investigation, a t-Test was computed for the number of the correct digits reported with the right ear in the very first trial of the posttest in the WMV group and the JMV group. It was assumed that the very first trial in the posttest was most greatly affected by the exposure to music, since the first trial in the posttest was conducted immediately after listening to music (approximately 10 seconds after the music). In addition, after the second trial, previous trials might have influenced the subsequent trials (practice effects). The result from the t-Test shows that there was no significant difference in the right ear report between the WMV group and the JMV group ($t = 0.34$, $\underline{P} > .05$). This result indicates that the left hemisphere's activation induced by the right hemisphere's mediating role in cerebral arousal, was comparable with the arousal induced by left hemisphere's activation alone. Concerning the left ear's report, the improvement would be due to the right hemisphere's activation by exposure to music played with Western musical instruments.

In the JMV group, the exposure to music could have functioned as a priming effect on the left hemisphere, and as a result, the right ear's report would have been improved in the posttest. In order to examine whether the left ear report in the JMV group was comparable with that of the WMV group, a t-Test was computed on the number of correct digits reported with the left ear in the very first trial of the posttest in the WMV and in the JMV groups. The result indicates that there was no significant difference between those two groups ($t = 0.64$, $\underline{p} > .05$). This result seems to indicate that the left hemisphere's activation also played a mediating role in inducing cerebral arousal level; as a result, the right hemisphere's activation induced by the left hemisphere was comparable with that induced by the right hemisphere alone. This finding was also supported by a few comments made by the subjects of the JMV group after the experiment. Two subjects in this group individually stated that " ... after listening to music, I realized that it became easier to remember the numbers with my left ear. Those numbers with the left ear still stayed in a group on my mind even though I did not try to do it ... the numbers came into the ear by a cluster of four numbers, and remained. Concerning the numbers with the right ear, I still had to try to remember the four numbers one-by-one, even though the right channel sounds clearer than the left channel. " Since the comment was made by only two subjects, such a response cannot be regarded as representative of all of the subjects in the JMV group. However, the comment is still notable for the following points. First of all, both of those subjects were females, and the scores were the first and the third highest in the whole group (57 and 51 out of 64: the mean score in this group, 45.90). Moreover, none of the subjects in the WMV group made the same comment. Another noteworthy point is that this comment seems to imply that the numbers heard with the left ear were processed in a completely right hemispheric way (that is, holistically). The statement, "... the numbers came into the ear by a cluster of four numbers, and remained..." seems to indicate that the subjects perceived the numbers as a group instead of remembering the numbers one by one. These points could imply that there is a gender difference in the left hemisphere's mediating role in inducing cerebral activation. In addition, the activated right hemisphere, which is induced by the left hemisphere's mediating role in the cerebral arousal level, might work in a "more right hemispheric" way for processing information. Additional investigations are required for the further understanding of those points.

Another possible reason for the identical improvement of both ear reports in both groups is a practice effect. The subjects in both groups could have got used to dealing with the task, and as a result, the score was improved in the posttest. In addition, since the subjects performed the posttest approximately only five minutes after the pretest (in which four minutes were for exposure to music), the pretest performance itself might have induced an activation of the hemispheres. It is also likely that Type II error caused this lack of significant difference between the groups. The procedure and the materials used in the present study might have prevented a discovery of a hidden real difference. If the exposure to music was for a longer length of time, at an increased volume, and through speakers instead of earphones, a difference in effects of kind of music might have been found.

Moreover, it is also possible that the improvement of both ears' scores was due to a combination of those two effects--the effect of music and the effect of practice. In fact, ten out of forty subjects (four out of twenty in the JMV group, six out of twenty in the WMV group) stated that "... after listening to music, it became easier to catch numbers." This statement did not indicate why it became easier--whether it was due to the exposure to music, or the practice of the tests--. However, it is still interesting to note that the change was not only objectively evidenced by the score improvement, but also subjectively suggested by the subjects.

Finally, the author would like to discuss the lack of significant difference between the groups from another point of view that the procedure was appropriate but the premise itself, which was used as a part of the methodology, is invalid. In the present study, the Tsunoda finding (1987) was applied for methodological convenience so as to activate the left hemisphere and the right hemisphere by exposure to music respectively. In other words, the present study was conducted based on the notion that the Tsunoda's finding was valid, and thus it was simply presumed that the left hemisphere or the right hemisphere in Japanese speakers would be independently activated by music played with either the Japanese musical instruments or western musical instruments. Thus it was presumed that subsequent hemispheric arousal would be induced differently between the JMV group and the WMV group. In the present study, this issue of the difference in the perception of the two kinds of music was not the purpose of the investigation, rather it was applied to a part of the methodology for convenience. Therefore, it is beyond the scope of the present study to argue about the validity of the issue--whether the two kinds of music were actually processed in the different hemispheres or not. However, the result that there was no main effect for kind of music indicates a possibility that the Tsunoda's finding itself is doubtful--there might not be any difference in perception of the Japanese musical instrumental version and the Western musical instrumental version.

5.2. DIRECTED REPORT CONDITION

The significant difference between the right ear report and the left ear report in the pretest indicates the left hemisphere's dominance for the task. This result concurs with Kimura's studies (1961a, b). The difference between the ears in the pretest, however, lost its magnitude in the posttest. Table 6 and Figure 3 show that in the posttest the left ear report was improved, while the right ear report remained unchanged. This interaction between test and ear was statistically significant.

What does this interaction mean? Why was only the left ear report improved, while the right ear report was not? Why did this interaction occur both in the JMV group and the WMV group in the same way--there was no main effect for kinds of music--?

Concerning the left ear report improvement in the WMV group, the right hemisphere could have been activated by exposure to music played with western musical instruments, and as a result, the subsequent report might have been improved. While in the JMV group, the activated left hemisphere (by exposure to music played with Japanese traditional musical instruments) might have induced the other hemisphere's arousal level, as in the case of the free report condition as discussed. However, it would also be possible that a practice effect caused this improvement in both groups. As discussed in the case of the free report condition, since the present study did not include a control group it is impossible to simply attribute the left ear's improvement in both the groups to the effect of music. Again, to investigate this issue, a further study which includes a control group is required. Another possibility of inducing the left ear improvement is that a combination of these two factors--the effects of music and practice--would have caused this result.

In the case of the right ear report, there was no significant difference between the pretest and the posttest in both groups. The most likely cause for this lack of difference is a ceiling effect. The maximum score in the directed test was 8.00. In the pretest of the directed-left ear report, 19 out of 40 subjects scored 8.00. and the mean for this group was 6.825. In the posttest, 27 out of 40 subjects attained 8.00, and the mean for this was 7.350. While in the directed-right ear report 33 out of 40 subjects obtained 8.00 in both tests, and the mean score for this was 7.775 and 7.728 for the pretest and the posttest respectively. In the posttest, these results indicate that the task was too easy for the subjects; the maximum score obtained does not reflect the maximum of the subjects ability. If the task was more difficult than that of the present study, the score in the pretest and the posttest may well differ; the score in the pretest may be lower than that of the present study, and the score in the posttest may well be higher than that in the pretest. In addition, if it occurred, there may not be interaction between Ear and Test; the left ear report and the right ear report may have been improved in a parallel fashion.

Regarding the result that there was no significant difference between the two kinds of music, one possible reason is a Type II error, as pointed out in the case of the free report results. Music exposure under different conditions might cause a difference for the effects of kind of music.

However, as has been argued in the case of the free report condition, it is also possible that the different music did not activate the different hemispheres. This would be contradictory to the assumption that kind of music affects hemispheric arousal. And inevitably, the subsequent memory task was affected in an identical manner in both the JMV and the WMV groups.

In summary, the results from the free report task would be attributed to the following: the right and the left hemispheres' mediating roles in inducing cerebral activation by each kind of music, the practice effect, or a combination of those two. In the directed report task, the results would be due to the left and the right hemisphere's mediating role in inducing cerebral activation, practice effect, or a combination of all of those causes. In both the free and the directed report tasks, there could have been a Type II error. In addition, it is also possible that the two kinds of music were processed in an identical manner in both hemispheres. This would contradict Tsunoda's finding (1987), and thus result in the lack of significant difference between the JMV group and the WMV group.

CHAPTER 6. IMPLICATIONS OF THE STUDY AND SUGGESTIONS

6.1 IMPLICATIONS

Up to the previous chapter, the discussion involved the findings from the present study. What follows is a discussion of these findings in terms of practical settings. In chapter II (page 9), the two reasons for focusing on the relationship between cognitive activities and music from an educational point of view in this study were stated. These were: (1) the necessity of an investigation of the effects of music on children's cognitive activities in their everyday lives, and (2) the possibility of therapeutic implication of music.

Concerning those two issues, the findings from the present study indicate the following.

Regarding the first issue, the findings imply two possibilities. First of all, they indicate the necessity of consideration of the priming effect of music in devising a curriculum at school. When teachers make a schedule, they might have to take into account the order of the subjects of what they are going to teach. For example, they would be able to apply the priming effects induced by a prior Music class on a subsequent Math class in order for the students to work on the task more efficiently. Since prior exposure to music activates the right hemisphere and inevitably induces the other hemisphere's arousal, time schedules could positively affect the students' performances. Moreover, it could be more effective to listen to music than to work on another cognitive activity (such as reading a book of English literature simply in order to activate the left hemisphere) before performing an anxiety-producing cognitive activity. This is because a certain kind of music causes mental relaxation as we experience it in daily life as well as hemispheric activation. Listening to music might bring two benefits for a student, namely to release anxiety and to perform more effectively on the subsequent cognitive task.

As well, the findings from the study have implications for the second issue, music in therapeutic situations. Morton, Kershner, and Siegel (1990) have discussed that "... if information processing may be enhanced by music-induced arousal, then there is clearly a potential strategic role for music in education and therapeutic settings. The value of a music-induced memory capacity ... increase is obvious. Children with short-term memory difficulties, whether due to hypoarousal, anxiety, or personality, may benefit from exposure to music prior to certain tasks that require the short-term memory process. The key for facilitative music-induced effects may be prior exposure rather than concurrent exposure to music" (p. 204-205). The left hemisphere's arousal induced by the right hemisphere's activation by exposure to music might help learning disabled people to enhance their left hemispheric abilities. Since music also easily catches the attention of mentally handicapped people (Sternlight, Deutsch & Seigel, 1967) and they seem to enjoy exposure to music, it would become an efficient treatment in therapy.

However, these implications would not be regarded as practically applicable in the actual clinical setting until further investigations have been done on both the internal and external validities and the duration of the effects of the present study.

6.2. SUGGESTIONS FOR FUTURE STUDIES

There are a few suggestions for future studies concerning internal and external validities, and the duration of the effects in the present study.

In order for the internal validity of the study to become solid, a further study will be required: a study which includes a control group, and in which a directed-report task is more difficult than in the present study so as to avoid the ceiling effect. Also, a study is needed using the Solomon four-group design in order to control the possibility of the effects of a pretest's influence on the results. In addition, studies which are conducted on different samples are also needed in order to strengthen the external validity. Besides this, to examine the possibility of a Type II error in the present study, additional investigations under different conditions are necessary, such as, a study in which musical exposure is longer, louder, or in which a subject listens to music reproduced by other media, such as speakers in a room instead of earphones. Further studies which examine the duration of the effects and the external validity of the duration are also required; namely, for how long would the cerebral activation which is induced by the left or the right hemisphere's mediating role last? Would those effects last for the same duration? Would there be any differences in the duration depending on age, gender, educational background, kinds of music or the individual's musical sophistication?

These future basic studies which examine internal and external validities and duration of the effects are crucial, since such inquiries are requisite in order to establish a theory. On the other hand, development of basic research indirectly stimulates applied and evaluative research, and as a result, enhances the practical applicability of music listening.

Finally, the author would like to mention the issue of the application of another's finding to an important part of the methodology as a premise and its distractibility in interpreting the data. In the present study, one of Tsunoda's findings was applied for convenience in order to activate the left hemisphere and the right hemisphere respectively by exposure to different kinds of music. The methodology was based on the assumption that his finding was valid and applicable to the present study. Even though the findings were confirmed by some other studies (such as Kikuchi and Tsunoda, 1986; Kikuchi, 1986, 1987), it was not necessarily replicated in the sample of the present study. This uncertainty distracted the interpreting of the result that there was no significant difference between the two kinds of music, since the data obtained from the present study were insufficient to argue the internal and the external validities of Tsunoda's finding. For future research, the researcher suggests that so as to activate each hemisphere respectively, (1) a well confirmed and more theorized principle of hemispheric activation be applied, or (2) a preliminary study be conducted prior to the main investigation, which ensures the replicability of the theory on a drawn sample.

Music is associated to other mood-optimizers, such as drugs and alcohol and has been influencing social mini-movements and subculture (Konecni, 1982). Particularly, listening to rock music " ... provides premature ecstasy and in this respect, is like the drugs" (Bloom, 1987). Thus, the effects of music listening tends to be allied to those of drugs and alcohol. However, music does not cause the negative side-effects which drugs or alcohol can produce. The author hopes that the advantage of music listening will be scientifically theorized and will be used to benefit people --- in education, in therapy, and in their daily lives.

REFERENCES

Bever, T.G., & Chiarello, R.J. (1974). Cerebral dominance in musician and nonmusician. Science, 185, 537-539.

Bible, English. Authorized. (1938). The Holly Bible, containing the Old and New Testaments translated out of the original tongues; and with the former translations diligently compared and revised by His Majesty's special command. Oxford: University Press.

Bogen, E.J. (1969). The other side of the brain I: Dysgraphia and dyscopia following cerebral commissurotomy. Bulletin of the Los Angeles Neurological Society, 34, 73-105.

Bloom, A. (1987). The closing of the american mind. New York: Simon and Schuster.

Boring, G.E. (1950). A history of experimental psychology. (2nd ed.). New York: Appleton-Century-Crofts.

Burleson, S.J., Center, D.B., & Reeves, H. (1989). The effects of background music on task performance in psychotic children. Journal of Music Therapy, 26(4), 198 -205.

Etaugh, C., & Michals, D. (1975). Effects on reading comprehension of preferred music and frequency of studying to music. Perceptual and Motor Skills, 41, 553 -554.

Etaugh, M.C., & Ptasnik, P. (1982). Effects of studying to music and poststudy relaxation on reading comprehension. Perceptual and Motor Skills, 55, 141-142.

Fogelson, S. (1973). Music as a distractor on reading test performance of eighth grade students. Perceptual and Motor Skills, 36, 1265-1266.

Gardner, H. (1975). The shattered mind: The person after brain damage. New York: Knopf.

Gates, A., & Bradshaw, J.L. (1977) The role of the cerebral hemispheres in music. Brain and Language, 4, 403-431.

Gazzaniga, S.M., & Sperry, W.R. (1967). Language after section of the cerebral commissures, Brain, 90, 131-148.

Gibson, C. (1987). Music therapy in Japan: An 11-year update. Journal of Music Therapy, 24, 47-51.

Gordon, H. (1975). Hemispheric asymmetry and musical performance. Science, 189, 68-69.

Groeneweg, G., Stan, A.E., Celser, A., MacBeth, L., & Vrbancic, M.I. (1988). The effects of background music on the vocational behavior of mentally handicapped adults. Journal of Music Therapy, 25(3), 118-134.

Gur, R.C., Gur, R.E., Obrist, W.D., Hungerbuhler, J.P, Youkin, D., Rosen, A.D., Skilnick, B.E., & Reivich, M. (1982). Sex and handedness differences in cerebral blood flow during rest and cognitive activity. Science, 217, 659-661.

Heilman, K.M., & Van Den Abell, T. (1979). Right hemisphere dominance for mediating cerebral activation. Neuropsychologia, 17, 315-321.

Hodges, A. & Bartlett, D.L. (1990). The effects of music learning experience on a dichotic listening task. Texas Music Education Research, 9-15.

Kikuchi, Y. (1986). Oto to no. Gengo, 15, 119-126.

Kikuchi, Y., & Tsunoda, T. (1986). A comparative study on auditory laterality using Tsunoda's method and the evoked potential method. Folia Phoniatrica, 38, 317.

Kikuchi, Y. (1987). Higengo'on to gengo'on. Gengo, 16, 48 -57.

Kimura, D. (1961a). Some effects of temporal-lobe damage on auditory perception. Canadian Journal of Psychology, 15(3), 156-165.

Kimura, D. (1961b). Cerebral dominance and the perception of verbal stimuli. Canadian Journal of Psychology, 15(3), 166-171.

Kimura, D. (1964). Left-right differences in the perception of melodies. Quarterly Journal of Experimental Psychology, 16, 355-358.

Konecni, J.V. (1979 IIB). Determinants of aesthetic preference and effects of exposure to aesthetic stimuli: social, emotional and cognitive factors. In B.A. Maher(Ed.), Progress in experimental personality research (Vol.9). New York: Academic Press, 149-197.

Konecni, J.V. (1982). Social interaction and music preference. In D.Deutsch (Ed.), The psychology of music. New York: Academic Press, 497-516.

Konecni, J.V. & Sargent-Pollock, D. (1976). Choice between melodies differing in complexity under divided -attention condition. Journal of Experimental Psychology: Human Perception and Performance, 2, 347 -356.

Levy, J. (1980). Cerebral asymmetry and the psychology of man. In M.C. Wittrock (Ed.), The brain and psychology. New York: Academic Press.

Levy, J., Trevarthen, C., & Sperry, W.R. (1972). Perception of bilateral chimeric fugures following hemispheric deconnexion. Brain, 95, 61-78.

McMillan, J.H., & Schumacher, S. (1989). Research in education (2nd Ed.). Glenview: Scott, Foresman and Company.

McCarty, B.C., McElfresh, C.T., Rice, S.V., & Wilson, S.J. (1978). The effect of contingent background music on inappropriate bus behavior. Journal of Music Therapy, 15(3), 150-156.

Miller, K.L., & Schyb, M. (1989). Facilitation and interference by background music Journal of Music Therapy, 26(1), 42-54.

Milner, B. (1962). Laterality effects in audition, in V. Mountcastle (Ed.). Interhemispheric relations and cerebral dominance. Baltimore: John Hopkins.

Morton, L.L., Kershner, R.J., & Siegel, S.L. (1990). The potential for therapeutic applications of music on problems related to memory and attention. Journal of Music Therapy, 27(4), 195-208.

Murai, Y. (1987). Healing by music. Tokyo-Musashino Annual of Music Therapy, 17, 9-15.

Murai, Y. (1988). The use of music listening as a therapy of anxiety neurotic patient, Tokyo-Musashino Annual of Music Therapy, 18, 1-11.

Nebes, D.R. (1974). Hemispheric specialization in commissurotomized man. Psychological Bulletin, 81, 1-14.

Peretz, I., Morais, J., & Bertelson, P. (1987). Shifting ear differences in melody recognition through strategy inducement. Brain and Cognition, 6, 202-215.

Phelps, M.E., & Mazziotta, J.C. (1985). Positron emission tomography: Human brain function and biochemistry. Science, 228, 799-809.

Sackheim, H.A., Gur, R.C., & Saucy, M.C. (1978). Emotions are expressed more intensely on the left side of the face. Science, 202, 434-436.

Stainback, S., Stainback, W.C., & Hallohan, D.P. (1973). Effects of background music on reading. Exceptional Children, 40, 109-110.

Sternlight, M., Deutsch, M.R., & Siegel, L. (1967). Influence of music stimulation upon the functioning of institutionalized retardates. Psychiatric Quarterly Supp., 41, 323-329.

Taniguchi, A., & Ohara, K. (1991). Shinkeisho no ongaku ryoho. Morita Ryoho Gakkai Zasshi, 2(2), 149-155.

Tsunoda, T. (1979). Difference in the mechanism of emotion in Japanese and Westerner. Psychotherapy and Psychosomatics, 31(1-4), 367-372.

Tsunoda, T. (1985). The Japanese Brain. Tokyo: Taishukan shoten

Tsunoda, T. (1987). The difference in the cerebral processing mechanism for musical sounds between Japanese and non-Japanese and its relation to mother tongue. Contemporary Music Review, 1, 95-117.

Tucker, M.D. (1981). Lateral brain function, emotion, and conceptualization. Psychological Bulletin, 89, 19-46.

Wilson, C.V. (1976). The use of rock music as a reward in behavior therapy with children. Journal of Music Therapy, 13(1), 39-48.

Wolfe, D.E. (1983). Effects of music loudness on task performance and self-report of college-aged students. Journal of Research in Music Education, 31, 191-201.

Yokota, H. (1992). The effects of two stages of stress management process on musical preferences in extroverted and introverted students. Educational Insights (in press).

Appendix A

Consent sheet
(Original in Japanese)

Visual and Performing Arts in Education
THE UNIVERSITY OF BRITISH COLUMBIA
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MASTER OF ARTS THESIS
MUSIC IN THE BRAIN: "THE EFFECTS OF PRIOR EXPOSURE TO MUSIC ON A SUBSEQUENT MEMORY TASK"

Experimenter: Hiroko Yokota
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Our daily life is surrounded by music; we listen to music while walking, eating, or studying. How does the brain process music? How are such concurrent activities influenced by music? This study is designed to find an answer to these questions.

In this experiment, you will be assigned randomly to listen to music, or no music by the experimenter. After you have listened to the assigned music (or no music), you will hear two one-digit numbers simultaneously from the right and the left ears (e.g., "2" through the right ear, and "6" through the left ear). What I would like you to do is to report as many numbers as possible, based on the numbers that you have heard. The experiment will take approximately 15 minutes. (More detailed instructions will be given right before you begin to work on the actual task.) You will experience no discomfort.

You are allowed to ask any questions about the experimental procedure. The experimenter will answer any inquiries concerning the procedures to be followed.

This is neither an IQ test nor a personality inventory. The results will be kept confidential. Your name will not appear anywhere in the study. Your performances in this experiment will not be used in other studies.

You also have the right to refuse to participate in this experiment, and to withdraw your participation. Such refusal or withdrawal will not jeopardize further treatment of you.

If you agree to participate in the experiment under the above-mentioned conditions, please give your signature below:

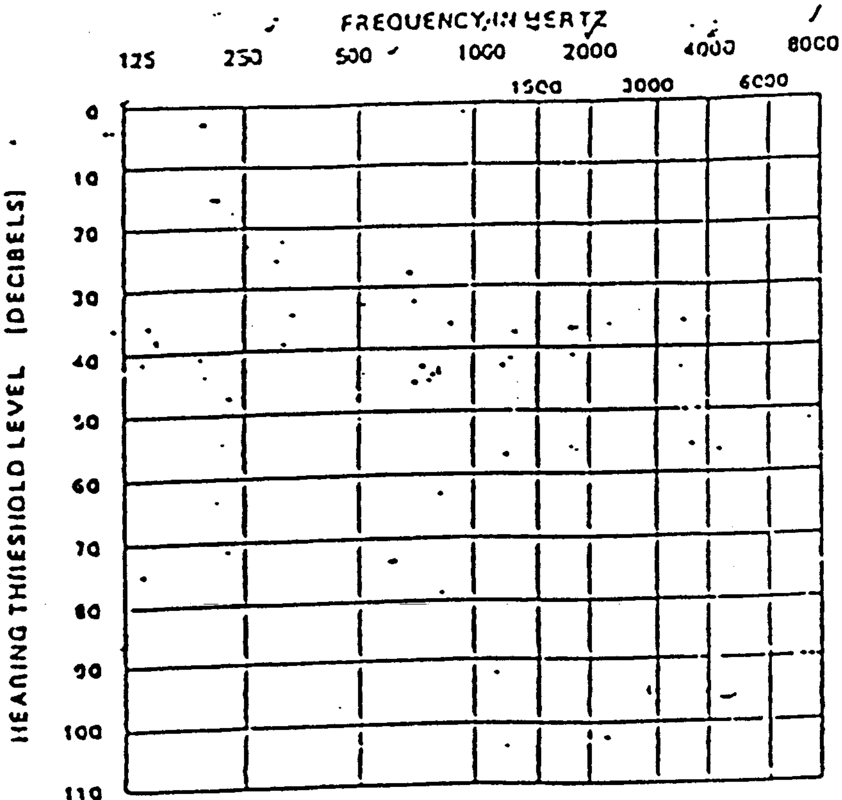
I acknowledge receipt of a copy of this form and understand the purpose and procedure of this experiment. And I agree to participate in the experiment under the above -mentioned conditions.

____
(signature by the subject)
Thank you very much for your cooperation.

Appendix B

Auditory test sheet

Name: Mr. / Miss
Address: ______
City: ______ State: ______ Zip Code: ______
Occupation: ______ Approx. Age ______



This audiogram is plotted on basis of:

AMERICAN NATIONAL STANDARD
(ANSI)

Tested by: ______ Audiometer Used: ______ Date: ______

TEST FINDINGS

Average PT loss (dB) 500-2000	Right	Left
Air		
Bone		

Test Conditions: ☐ Quiet ☐ Mod. noise ☐ Noisy

Test Reliability: ☐ Good ☐ Fair ☐ Poor

KEY TO AUDIOGRAM

EAR	AIR	BONE	NO RESPONSE AIR	NO RESPONSE BONE	MASKING EAR	MASKING AIR	MASKING BONE
Right (Red)	O	[			Right ear tested with Masking in Left		
Left (Blue)	X	]			Left ear tested with Masking in Right		

Appendix C

Number memorizing task

<WARM-UP TRIAL>

LEFT EAR	RIGHT EAR
8	5
3	7
6	9
1	2

<PRETEST>

(1) FREE REPORT TASK

LEFT	RIGHT
3	8
4	2
1	9
5	6
1	4
8	0
6	2
3	7
1	7
3	4
5	6
0	8
5	9
1	0
6	3
7	8
5	7
8	3
9	1
0	2
0	2
5	4
8	9
1	7
8	1
6	5
9	4
2	3
7	6
0	9
2	1
1	4

(2) DIRECTED REPORT TASK

LEFT	RIGHT	LEFT	RIGHT
9	5	5	9
6	1	1	6
4	3	3	4
0	8	8	0
3	8	8	3
9	1	1	9
7	0	0	7
4	5	5	4
6	2	2	6
7	0	0	7
9	1	1	9
3	5	5	3
3	2	2	3
6	7	7	6
9	5	5	9
0	1	1	0
1	6	6	1
8	0	0	8
5	9	9	5
3	7	7	3
2	0	0	2
3	7	7	3
9	1	1	9
6	5	5	6
4	0	0	4
6	5	5	6
1	7	7	1
8	9	9	8
4	5	5	4
3	2	2	3
6	7	7	6
8	0	0	8

These numbers are arbitrarily drawn from the random-number-table.

<POSTTEST>

(1) FREE REPORT TASK (2) DIRECTED REPORT TASK

LEFT/RIGHT		LEFT/RIGHT		LEFT/RIGHT	
7	6	3	8	8	3
0	9	9	1	1	9
2	1	7	0	0	7
8	4	4	5	5	4
1	7	6	2	2	6
3	4	7	0	0	7
5	6	9	1	1	9
0	8	3	5	5	3
3	8	2	0	0	2
4	2	3	7	7	3
1	9	9	1	1	9
5	6	6	5	5	6
8	1	1	6	6	1
6	5	8	0	0	8
9	4	5	9	9	5
2	3	3	7	7	3
5	7	4	0	0	4
8	3	6	5	5	6
9	1	1	7	7	1
0	2	8	9	9	8
5	9	4	5	5	4
1	0	3	2	2	3
6	3	6	7	7	6
7	8	8	0	0	8
0	2	9	5	5	9
5	4	6	1	1	6
8	9	4	3	3	4
1	7	0	8	8	0
1	4	3	2	2	3
8	0	6	7	7	6
6	2	0	5	5	0
3	7	9	1	1	9

These were arbitrarily reordered series of the pretest, using the random-number-table.

Appendix D

Instruction for the task

INSTRUCTIONS FOR THE TASK

(given in Japanese)

You will be asked to perform a one-digit-number memorizing task.

Look at the instruction figures (see the attached figure).

You will hear four pairs of two different one-digit-numbers simultaneously. That means you will hear eight one-digit-numbers in total. After those numbers, there will be an eight-second pause. What you are supposed to do is, remember as many numbers as possible, and then report the numbers which you have remembered hearing during the pause. You are allowed to report the numbers in any order.

Do you understand?

There are three points which you need to keep in mind.

First, you need to attend to <u>both</u> ears. Do not try to pick up numbers with the preferred ear, but focus equally on both sides and remember as many numbers as possible, please.

Second, you have to report only those numbers which you are sure of hearing. Please do not guess.

Third, you must not repeat the numbers out loud to yourself.

I will let you work on a warm-up trial.

<WARM-UP TRIAL>

Please get ready to start when you have heard "Let us begin," in a female's voice at the very beginning of the tape.

After a few seconds, you will hear four pairs of number. Please try to remember as many numbers as possible with both ears, and report orally what you have heard.

Do you have any questions?

Put on the earphones, please.

--- performance on the warm-up trial ---

Did you get an idea what the task is like?

<FREE REPORT: PRETEST>

Let us move to the main task.

The main task contains eight trials.

You will hear an instruction, "Let us begin." Then, you will hear four pairs of one-digit-numbers on the first trial. After each trial, there is an eight-second-pause in order for you to report the numbers which you have heard. There will be no instruction between trials, therefore, be prepared to work on the next trial after you have reported the numbers.

After the eight trials, there will be the instruction, "Take off the earphones, please. " Then you need to follow the instruction.

Do you have any questions?

--- performance of the free report task for approximately three minutes ---

<DIRECTED REPORT 1: PRETEST>

Let us move to the next task.

As the previous task, in this next task, you will hear four pairs of two different one-digit-numbers simultaneously by a second interval in the next task. This time, however, I would like you to focus on the left (or the right) ear only, and report the numbers which you have heard with the ear. You need to repeat the complete series as you have heard. For example, if the tape says "1-2-3-4," then you have to report "1-2-3-4." You are not allowed to arbitrarily reorder the series, such as "2-1-4-3."

You must not repeat the numbers to yourself out loud.

The task contains eight trials in total. After the eight trials, you will hear the instruction, "Take off the earphones." Please follow the instruction, when you hear it.

Do you have any questions?

--- performance of the directed report task: pretest with the left(right) ear ---

<DIRECTED REPORT 2: PRETEST>

Please reverse the earphones.

In the next task, you will be asked to perform the same task as the previous one. This time, however, you need to focus on the other ear, the right (left) ear. And again, you need to repeat the numbers in the exact same order as you have heard.

The task contains eight trials.

--- performance of the directed report task: pretest with the right (left) ear ---

<MUSIC LISTENING>

Thank you very much.

You are going to have a four-minute break now. You will be listening to music during the break. The music is not a part of the number-memorizing task, but simply for a break. Therefore, you can relax yourself, and enjoy it. Please do not think about something difficult or complex, such as your paper or homework. Just put yourself at ease, but be careful not to fall asleep.

After the break, you will perform the one-digit-number memorizing task in the same way as you have worked before. The first task is, again, to report the numbers which you have heard with both ears. You are allowed to report the numbers in any order.

After the music has stopped, you will hear four pairs of two different one-digit numbers in the same way as the previous tasks in this experiment. Remember as many numbers with both of your ears as possible and report the numbers during the intervals between trials.

Please do not listen to the preferred ear only but pay attention on both sides. Report the numbers which you are sure of hearing, and do not guess. You are not allowed to repeat the numbers to yourself out loud.

There will be no instruction after the music. Therefore, get prepared to perform the task immediately after the music has stopped.

Do you have any questions?

Reverse the earphones and put them on, please.

--- music listening ---

--- free report task: posttest ---

<DIRECTED REPORT 1: POSTTEST>

Let us work on the next task.

This time, you will be asked to attend with the right (left) ear and report the numbers in exactly the same order as you have heard.

Do you have any questions?

--- performance of directed report: posttest with the right (left) ear ---

<DIRECTED REPORT 2: POSTTEST>

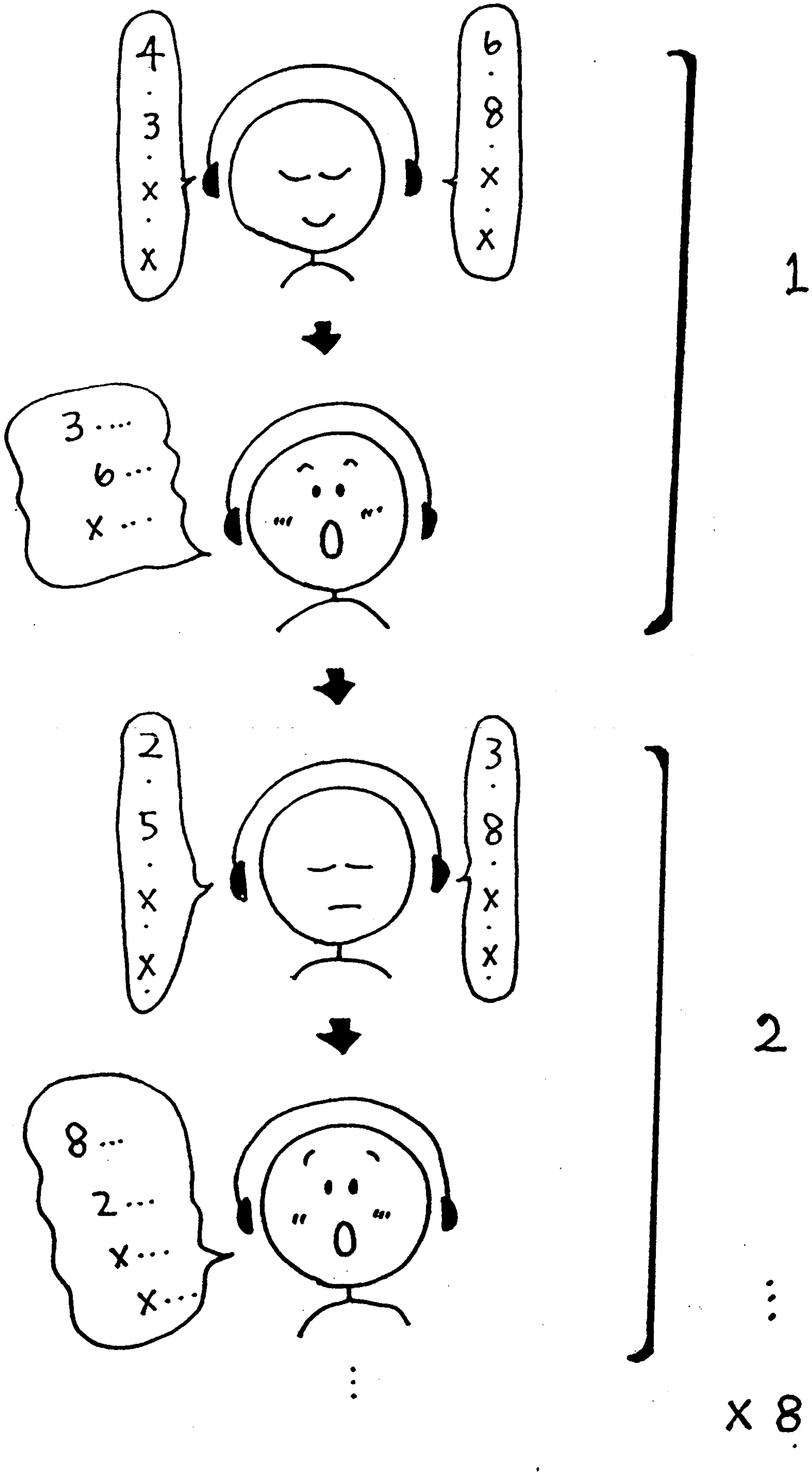
Please reverse the earphone.

Now move to the next task.

This time, you need to attend with the left (right) ear, and report the numbers you have heard with the ear.

--- performance of directed report: posttest with the left (right) ear ---

Thank you very much for your co-operation.


4 · 3 · x · x
6 · 8 · x · x
3 ....
6 ...
x ...
1
2 · 5 · x · x
3 · 8 · x · x
8 ...
2 ...
x ...
x ...
2
x 8

Appendix E

A summary of the pilot study

A SUMMARY OF THE PILOT STUDY

PURPOSE OF THE STUDY

To check the adequacy of the methodology before conducting the main investigation.

SUBJECTS

Subjects were 7 Japanese university students (2 males and 5 females), with a mean age of 21.13 years. They were right-handed in writing, throwing a ball, using chopsticks, and scissors. None of them had hearing problems.

They had been asked not to listen to music prior to the experiment on the assigned day.

PROCEDURE

The subjects were randomly assigned to the two following groups: Japanese musical instruments version listening group (JMV) group, Western musical instruments version listening group (WMV group). The subjects in all groups first worked on a pretest on a one-digit-number memory task in a dichotic listening method. They then listened to the assigned music, and performed a posttest on the same memory task.

The music selected was the first three and half minutes of Vivaldi's "The Four Seasons," Concerto No.1 in E major, La primavera (p. 241). F - 22, Allegro. For the JMV group, the koto version of this piece was played, and for the WMV group, a chamber orchestra version was played.

The task was composed of eight trials of one-digit-numbers, which contain four burst of two pairs of numbers per second in one cluster with an eight-second interval between trials.

Both the pretest and the posttest consisted of three conditions: (a) free report ("orally report as many numbers as you remembered hearing, during the interval between the trials"), (b) directed right ear report ("orally report the digits you hear with the right ear during the interval between trials"), and (c) directed left ear report ("orally report the digits you hear with the left ear during the interval between trials"). The free report was conducted to let the ears compete with each other in a number memory task in order to determine which ear is dominant over the other. The directed reports were conducted to check selective attention occurring in each ear. This would help to check other priming effects on both ears.

The task was administered first in a free report condition followed by one warm-up trial. Then it was administered in directed report condition. In the pretest and the posttest, the same trials were used in an earphone-reversed condition. Half of the subjects worked on the pretest in the initial condition (the right channel of the earphone in the right ear, and the left channel in the left ear), and the other half of the subjects worked in an earphone-reversed condition (the right ear channel in the left ear, and the left channel in the right ear). In posttest, the conditions were reversed. These procedures were implemented to offset any difference in sound between channels, and to avoid causing a practice effect. To counterbalance the directed report task, one half of the subjects in each group were instructed to attend to the right ear and to report the right ear numbers, and the other half were instructed to attend to the left ear and to report the left ear numbers. The selective listening order was reversed in each group in the pretest and the posttest.

The numbers were recorded in the Japanese language using a female voice in analogue sound. The tape was prepared at the Media Service at the University of British Columbia, using a Sony Stereo Cassette Deck TC-FX210, Technics SL-B202, and Realistic Stereo Mixing Console.

The dichotic tape was played on a Sony CF5-D500 tape recorder through earphones. The whole procedure was administered in an individual setting in a quiet room on a weekday.

RESULTS

<FREE REPORT CONDITION>

The mean number of correct digits reported and the standard deviation were calculated for the pretest and the posttest (table 1), and the Laterality Index was computed (table 2).

Table 1

Mean Number of Correct Digits Reported on the Dichotic Listening Task for the Free Report Condition

	Treatment	
	JMV group (n = 3)	WMV group (n = 4)
	pretest(s) posttest(s)	pretest(s) posttest(s)
left ear	15.63 (1.53)	21.75 (2.75)
	19.33 (2.31)	21.50 (1.73)
right ear	22.33 (2.89)	26.25 (3.86)
	22.00 (2.64)	25.00 (4.97)

Note. Maximum score = 32

Table 2

Mean and Standard Deviation for the Laterality Index for the Free Report for JMV group and WMV group

		Treatment	
		JMV group (n = 3)	WMV group (n = 4)
pretest	M	15.50	9.25
	s	10.26	3.77
posttest	M	6.33	6.75
	s	10.60	8.66

Note. The laterality Index: A score or ear advantage, computed as [(Rc - Lc) / (Rc + Lc)] x 100. In this index, Rc = right ear correct report, Lc = let ear correct report. Using this index, a positive number indicates a right ear advantage (REA) while a negative number indicates a left ear advantage (LEA).

<DIRECTED REPORT CONDITION>

The mean number of correct digits and the standard deviation were calculated for the pretest and the posttest (Table 3).

Table 3

Mean Number of Correct Digits Reported on the Dichotic Listening Task for the Directed Report

	Treatment	
	JMV group ($\underline{n}$ = 3)	WMV group ($\underline{n}$ = 4)
	pretest ($\underline{s}$) posttest ($\underline{s}$)	pretest ($\underline{s}$) posttest ($\underline{s}$)
left ear	29.33 (4.62) 31.67 (0.58)	32.00 (0.00) 32.00 (0.00)
right ear	31.00 (1.00) 32.00 (0.00)	32.00 (0.00) 32.00 (0.00)

Note. Maximum score = 32.00

In the free report task, a notable difference in means between the JMV group and the WMV group on the pretest (Table 2) implies a possibility that other uncontrolled variables may have caused the priming effects. Concerning the results from the directed report task, selective attention successfully occurred in the subjects in the WMV group, but not in the JMV group. The initial purpose of administration of the directed report was to check other priming effects. However, since a successful selective attention does not necessarily reflect the priming effects, the task for this purpose would be inappropriate.

Based on these results, the following additional procedures were implemented in the main investigation.

(1) In order to control other priming effects, the subjects will be instructed to refrain from wearing or smelling perfume, smoking cigarettes, or drinking alcohol, since hemisphere dominance in Japanese people is easily affected by such substances (Tsunoda, 1979).

(2) The subjects will be tested on their hearing ability with an audiometer prior to the experiment, and only the subjects with equivalent hearing in both ears will be selected.

(3) A more difficult directed task than that used in this pilot study will be administered in order to examine the unattended ear's distractibility by the attended ear.

(4) The same channel will be used in the pretest and the posttest in order to administer the tasks under the same condition of hearing in the pretest and the posttest for both the free report and the directed report task.

(5) In order to avoid causing a practice effect in the posttest, the same cluster of numbers will be provided as in the pretest, but in a different order.

(6) The tape will be prepared at a recording studio by professional engineers so as to ensure balance in sound level between channels and clearity of sound.

REFERENCES

Tsunoda, T (1979). Difference in the mechanism of emotion in Japanese and Westerner. Psychotherapy and Psychosomatic, 31 (1-4), 367-372.