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Music and its Effect on Late Auditory Evoked Potentials in Elementary School Aged Children

Lee Helen Weeks
University of Southern Mississippi

The University of Southern Mississippi

Music and its Effect on Late Auditory Evoked Potentials in Elementary School Aged Children

By

Lee Helen Weeks

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Approved by

Edward L. Goshorn, Ph.D.
Associate Professor

Steven Cloud, Ph.D., Chair
Department of Speech and Hearing Sciences

David R. Davies, Ph.D., Dean
Honors College

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I. Introduction

Music has long been an important aspect of human life. In the distant past, music was a means of communication; a drumbeat could warn a neighboring village of danger. In early wars, different drum beats represented different commands from a command center. Music has its religious and ritual purposes also. Today, music of some sort is popular throughout all societies. It influences culture, it conveys emotion, it can be excitatory or depressing, and it entertains (O'Donnel 1999). Some even believe that music has healing powers.

The concept of healing in music might not be as absurd as it may first seem. Music has become a highly researched topic in recent years, and studies have shown that there is, indeed, some physiological connection between the brain and music with certain rhythms or beats per minute. So, what areas of the brain are affected by a certain type of music and what are the characteristics of this music? Although research has been conducted to determine how music affects the brain (O'Donnel, 1999; Peretez & Zatorre, 2005), there is still a great deal to discover. Many of the previous studies were concerned with how music affects emotions or vocabulary retention (Janata et al., 2002.; Nilsson, 2008; Ting, n.d.). One of the newer areas of research is whether music affects auditory processing. There is some evidence that music influences auditory processing. If that is the case, could music enhance treatment strategies for individuals with auditory disorders? And if so, how might this enhancement be assessed or measured? An answer may lie in the use of auditory evoked potentials.

An auditory evoked potential (AEP) can be defined as, "A change in the neural-electrical activity in the brain in response to auditory signals" ("Auditory evoked potentials" n.d.), and may be detected at the scalp with surface electrodes. This change in neural-electrical activity is categorized into three components that are based on the time span (early, middle, and late) in which they are observed following a stimulus. The AEPs associated with auditory processing fall primarily into the middle and late category. There are several components in the late AEP that may be useful to measure or assess alterations in auditory processing. The most robust of these, and thus the most reliable to study, is the waveform known as P1 (Hall 2007). As an example of its clinical usefulness, the P1 wave is not present in people who are deaf because the auditory processing centers in the brain never receive the incoming auditory stimulus. However, P1 is present in deaf children who have received cochlear implants (CI) (Sharma et al., 2002) because with a CI in place the auditory stimulus now reaches brain centers responsible for auditory processing.

II. Significance

This project was concerned with determining whether or not auditory processing as reflected by the measure of the late auditory evoked potential is influenced by the presence of certain types of music. The influence on auditory processing was determined by measuring salient aspects (latency and amplitude) of the P1. The research design will compare P1 with no music present to P1 with music of different rhythms. If certain types of music influence P1 in a positive way (earlier latencies or larger amplitudes), then future studies could investigate if music is useful for rehabilitation purposes in individuals with auditory disorders.

III. Literary Review

a. History of Music used in Therapy

"Playing live music with people who are ill to promote optimal states of health and well being is a contemporary practice which has origins as far back as the written historical record" (Edwards 2008). Music Therapy is a field in which music is used for various rehabilitative purposes. Even though the actual term has only recently been coined, the practice itself has been performed for centuries. However, music therapy was not introduced in the United States until the late eighteenth century, and did not develop as a profession until World War One and World War Two ("History of Music Therapy" n.d.). This "ward music" was later used in general hospitals and had an enormous affect on patients. Eva Vescelius, founder of the National Therapeutic Society in New York City, stated that, "Music means so much – we cannot estimate how much – to sick folk, especially those who....are compelled to remain in hospital for long periods of time." She was able to come to such a conclusion through her direct work with the patients and through doctors' testimonials (Edwards 2008). The most widely accepted theory, at the time, as to why music had such positive effects on people in the hospitals was quite simple: the music distracted the patients from their troubles; it filled their minds with something enjoyable and positive (Nilsson 2008).

b. Effects of Music on the Brain

The theory that music acted as a distraction to the patients is an acceptable explanation. However, recent studies show that there is an actual physiological correlation between music and the brain, and music can affect the body in several ways.

One thing that has been found is that music processing is mapped onto the human brain with a certain consistency. "If there were no consistency, understanding the relations between music and its neural correlates would be impossible" (Peretez & Zatorre 2005). Music activates many regions of the brain at once: the frontal region, temporal region, parietal region, and the sub cortical region. These areas of the brain are responsible for attention, working memory, motor functions, semantic processes, syntactic processes, and emotions (Janata et al., 2002). Classical music from the baroque period, when played at a tempo marking of 60 beats per minute, has been shown to be the most influential type of music in these studies. The reason as to why it is the most influential type of music lies solely in the way it is composed. When listening to music, the brain subconsciously "looks" for differences and similarities of phrases within the composition. In baroque music, there is a starting theme. The theme will change, and then repeat itself once. If something is repeated more than once, it can cause the brain to become aggravated, and one can leave a very well played concert feeling angry. Another reason why baroque music is superior to other types of music is because it does not have any "stopped anapestic beats" like those in hard rock. A man by the name of Dr. John Diamond discovered that the symmetry between both of the cerebral hemispheres in the brain is actually damaged while listening to rock music. This can cause a state of alarm in an individual along with lessened work performance and behavioral problems (O'Donnel, 1999).

One might wonder exactly how this baroque music has become the most studied in research. Baroque music at 60 beats per minute is said to aid with attention. When it is playing, it regulates the human heart rate and lowers blood pressure. This phenomenon allows people to concentrate more easily (O'Donnel, 1999). Chermak (2010) stated that baroque music at 60 beats per minute helps with speech therapy. Music and speech are two of the most cognitively complex uses of acoustic information by people. Therefore, it is used to improve spelling in people with dyslexia. It is used to improve phonological processing and to help with communication skills in autistic patients. Music has also been used to help stroke victims with speech recovery (Chermak, 2010).

c. Music and Vocabulary Retention

One of the most studied aspects of music's influence on the brain is how music affects vocabulary retention. Georgi Lozanov studied a high school Spanish class. He played baroque music at 60 beats per minute in the background of the classroom and had his students learn vocabulary words. The students were able to learn two years of vocabulary in 30 days. Also, the retention rate of these words weeks later was almost one-hundred percent (O'Donnel, 1999). Lozanov's research became the model for other researchers. Chie Qiu Ting explored which types of rehearsal methods would be the most beneficial while listening to baroque music, and if the order in which the students used the methods would affect how well they retained information. After a series of trials that incorporated rehearsal and imagery techniques, Ting found that neither strategy was affected by the order in which they were presented. He also concluded that using imagery was more effective than the repetition method. However, in contrast to Lozanov, he found higher mean scores with music at 120 bpm rather than at 60 bpm (Ting n.d.).

Like Ting, other researchers have found that music at 60 beats per minute is no more special than the rest of the music in the world. Some studies have concluded that baroque music improves a child's spatial ability. However, McKelvie and Low (2002) investigated the Mozart effect and did not have the same outcome as previous studies. One of the experiments evaluated the spatial IQ scores of children who listened to Mozart's sonata K.488 and those who listened to popular dance tunes. Each group was given a pre test and a post test, and neither of them showed a significant difference in scores. Then, a second experiment using a slightly different method gave the same results (McKelvie & Low, 2002). Jäncke and Sandmann (2010) did a study to verify the findings that background music enhances verbal learning. Songs were composed specifically for this study to make sure the test subjects would not be familiar with any of the songs. They had different tempos and varied in consonance. Five groups were formed from 75 subjects and were given non-word materials to learn. Each of the materials was presented with different kinds of background music. Noise was used as the control variable. "Event-related desynchronization (ERD) and event-related synchronization (ERS) of the EEG alpha-band were calculated as a measure for cortical activation" (Jancke & Sandmann, 2010). The study found that there was no difference in verbal learning performance between the different types of music (Jancke & Sandmann, 2010).

d. Music and Auditory Processing

Even though there are conflicting findings among studies that have been done, one question still remains: does music have an effect on auditory processing? The effects, thus far, have yet to be determined for sure, but past studies have shown promising results. One study showed that music, in general, has the ability to improve certain aspects of auditory processing along with language and literacy skills (Chermak 2010). Another study showed that people with previous musical training have the ability to detect auditory patterns which allows them to recognize sequences in sound patterns for longer periods of time than people who have not had musical training (Wang et al., 2009).

Recent studies are examining how music affects neurological components of hearing such as auditory evoked potentials. In 1998, The Department of Clinical Neurophysiology at The National Hospital for Neurology and Neurosurgery examined the cortical auditory evoked potentials and how they responded to complex tones changing in pitch and in timbre. The N1 occurred earlier when a sudden change in pitch or timbre took place. This means that there is some partial segregation of the neuronal populations responsive to sound onset and spectral change. The T-complex was larger in the right hemisphere which is consistent with previous studies that the right temporal lobe is definitely involved with music processing. (Jones et al., 1998).

Ross & Tremblay (2009) conducted a study in which subjects were presented (repeatedly) auditory stimuli during magnetoencephalographic (MEG) recording. The purpose of this particular study was to see how sound is processed in a listener's brain and to see if this sound would change auditory evoked responses at any point of the experiment. N1 and P2 responses were studied on different days with people of various ages. During each session, N1 amplitudes decreased continuously, and they recovered between sessions. P2 amplitudes seemed to stay the same throughout a session, but they increased between recording days. Age influenced P2 amplitude; amplitudes increased more in younger children. Age, however, had no effect on N1 amplitude changes. The increase in P2 wave amplitudes suggests that the auditory P2 response may be associated with learning, memory, and training (Ross & Tremblay 2009).

Trainor and Roberts (2003) studied AEP and music in which adult musicians' and non-musicians' AEP responses were analyzed in response to pure tones, violin tones, and piano tones. The study also looked at the response to the same stimuli in children who have had musical involvement and those who have not. P2 evoked responses were found to be larger in adults and in children who have had some sort of musical training and experience. The study also discovered that the auditory training enhances the P2 waves in non musician adults. These results show that the effects of music development can be seen at a very early age. The results also suggest that the P2 component is neuroplastic, and even though cortical representations may be greater if training begins at an early age, adults also have the ability to change (Trainor & Roberts 2003).

IV. Question/Hypothesis

One can see that music plays a significant role in neurophysiologic processes, even though the literature provides conflicting findings. What is known is that music does affect deeper auditory processes such as auditory evoked potentials. However, the special 60 beat-per-minute baroque music that seems to have a huge influence on brain activity has not been used with AEP. Also, previous studies chose to look at the P2 and N1 complex rather than the more robust P1 wave.

$Q_{1:}$ Does baroque music at a tempo marking of 60 beats per minute have a positive effect on auditory evoked potential (specifically P1 waves) in children of elementary school age?

$H_{1:}$ Baroque music at 60 beats per minute will affect auditory evoked potential in a positive manner.

This hypothesis is based on previous research that shows that music influences AEP and that baroque music has been the most influential type of music for neurophysiologic processes associated with P1.

V. Research Design/Method

a. Overall Design

This study was a within group design, post test only, with repeated measures. In this repeated measures design, each music condition was applied to determine whether or not a particulat music condition would contribute to an earlier latency or larger amplitude response. Counterbalancing was used to assure that an order effect did not influence the outcome. The independent variable was the non-test ear status which may have consisted of certain types of music being present or not. The two music types were characterized as having a specific rhythm of 60 beats per minute or not. Music in the non-test ear (if present) was presented through an ipod earpiece. A decision was made to measure the music level in equivalent levels. The ipod was calibrated by placing the left earphone bud of a fifth generation ipod nano on a 2cc coupler which was attached to a microphone on an external sound card. The sound card was linked to a computer. The software made a recording of the music and determined how many dB [SPL] a particular ipod volume setting was. The calibrated levels for each piece were as follows: Groove Merchant (120 BPM jazz piece) was averaged at 48 dB (A) which was eight clicks on the volume wheel of the ipod. Air Suite No. 3 (60 BPM baroque piece) was averaged at 44dB (A) which was ten clicks on the volume wheel.

The non-test ear status consisted of three levels: No sound, baroque music at 60 beats per minute, and non 60 beats per minute jazz music. The dependent variables were the latency of P1 and the amplitude of P1. Latency and amplitude of P2, P2-N2 intervals, and the default amplitudes of P1 and P2 were also noted in order to determine if any patterns occurred outside the originally selected variables. During testing, two runs at each level for each subject were obtained. In the test ear, a 40 millisecond speech segment ("dah") was presented at 60-65 dBn-HL. The "dah" stimulus repeated every 1.1 seconds. The following is an excerpt from an IRB proposal that Dr. Charles Marx filed describing the equipment being used:

> The Biologic Navigator Pro auditory evoked potential recording device will be used to capture the subjects' physiological response to a speech syllable /da/. Silver chloride stick-on (non-invasive) electrodes will be placed on top of the head (Cz), forehead, and behind one ear (mastoid). These electrodes acquire the physiological response from the central auditory pathways as the subject listens to the speech stimulus which is presented monaurally with a tubal insert earphone. This device and the recording electrodes are identical to those that have been used safely for many years in the assessment of hearing status in newborn infants and young children. Waveform analysis will be accomplished using the software features of the

Navigator Pro.

b. Sample Group and Procedure

Four normal hearing children at eight years of age volunteered to participate in this study. (The desired number was at least six participants). Flyers were distributed around the University of Southern Missississippi campus, and emails were sent to local elementary schools, churches, and other educational institutions for recruitment of test subjects. (See Appendix for recruitment documentation.) Recruitment efforts continued for five months. Details about the test procedures and what would be required of the subjects were included in the recruitment emails. Children at the age of eight years were chosen for the following reasons: The P1 wave is more robust in young children (Hall 2007). Also, children under the age of eight are less likely to sit quietly for the allotted period of time needed to complete all of the test runs for each subject.

The sequence of independent variable conditions within sets of two replicates were randomized for each subject. Each subject was tested independently. He or she was seated in a comfortable chair in a medium sized room that was relatively quiet, and instructions were given. He or she was instructed to stay awake and alert and to actively listen to music that may be playing. Non-invasive surface electrodes were attached to the subject above the left eye, beside the left eye, on the top of the head, at the center of the forehead, and on the mastoid of the right ear. An earphone that played the “dah” stimulus was inserted into the test ear (right ear) for each subject. Then, an ipod earphone (left bud) was inserted into the non-test ear. The output for the ipod was adjusted in accordance to the calibration done earlier. During the test, the subject was allowed to watch a video with no sound.

c. Measurements

The computer gathered 300 late auditory evoked samples per trial, and combined the samples into a single averaged waveform from which the dependent variables (latency and amplitude of P1) were derived. In this manner, the late AEP was obtained for the independent variable conditions two times in random order. The average total time for each subject was about 45 minutes. Following data collection, latency and amplitude of the P1 waves (along with the latency and amplitude of P2 waves, the interval between P2 and N2, and the default amplitudes of P1 and P2) were measured and analyzed.

d. Analysis

Analysis consisted of descriptive statistics. To test the null hypothesis, the mean amplitude and latency of P1 were compared for each level of the independent variable (status of the non-test ear). Descriptive statistics were used to show overall findings and to explore relationships among the three levels of independent variables. If music at 60 beats per minute influenced auditory processing in a manner that involved the electrophysiological centers responsible for generating wave P1 (the experimental hypothesis), then one would expect to see some differences in either the latency or amplitude of wave P1 across the non-test ear conditions of no music, music at 60 BPM, and music at < > 60 BPM.

VI. Results

Figures 1.1 through 1.4 represent the individual runs obtained on each test subject, and the figures are numbered to correspond with subject numbers. Figure 2.1 contains a summary of data shown in figures 1.1 through 1.4 along with means and standard deviations of P1 and P2 latency and amplitude, and P2-N2 interval.

Figure 1.1—Results for Subject One

A1 represents the response to no music. A3 represents the response to jazz music. A5 represents the response to baroque music. B1 through B12 are the raw unaveraged waveforms.

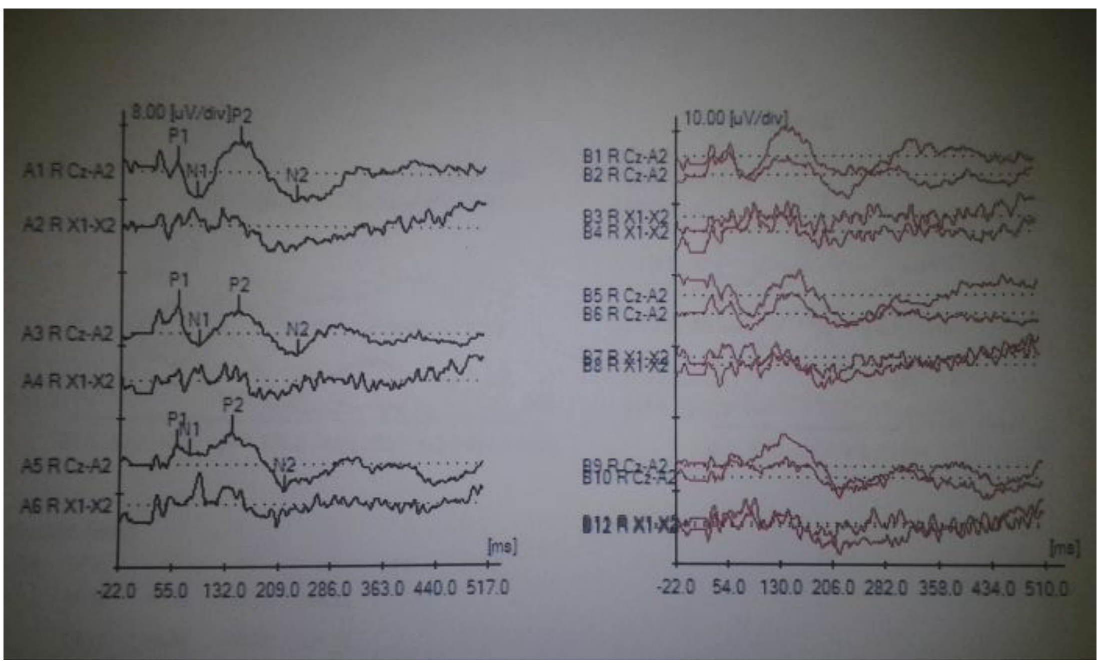


Figure 1.2—Results for Subject Two

A1 represents the response to jazz music. A3 represents the response to no music. A5 represents the response to baroque music. B1 through B12 are the raw unaveraged waveforms.

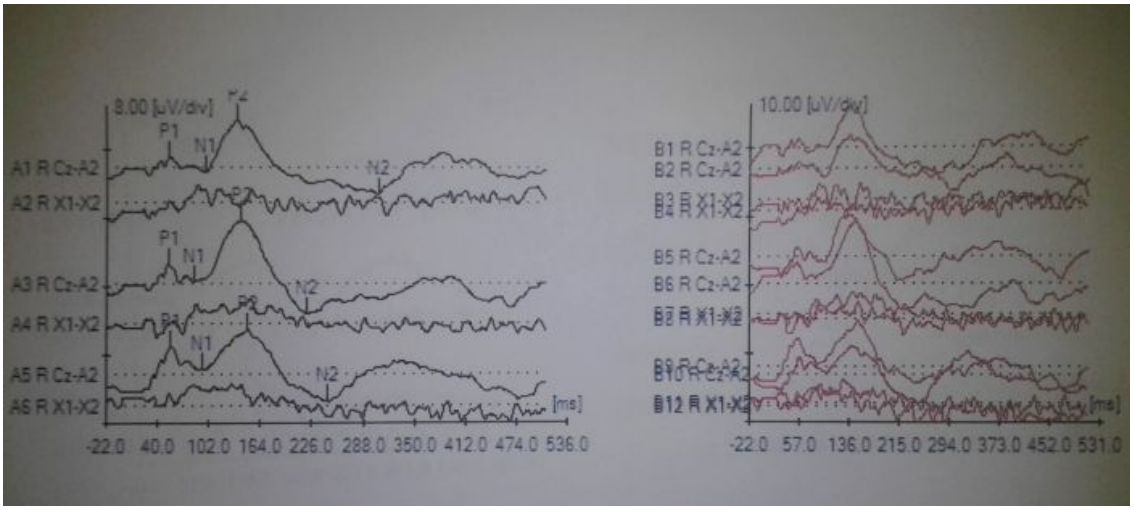


Figure 1.3—Results for Subject Three

A1 represents the response to baroque music. A3 represents the response to jazz music. A5 represents the response to no music. B1 through B12 are the raw unaveraged waveforms.

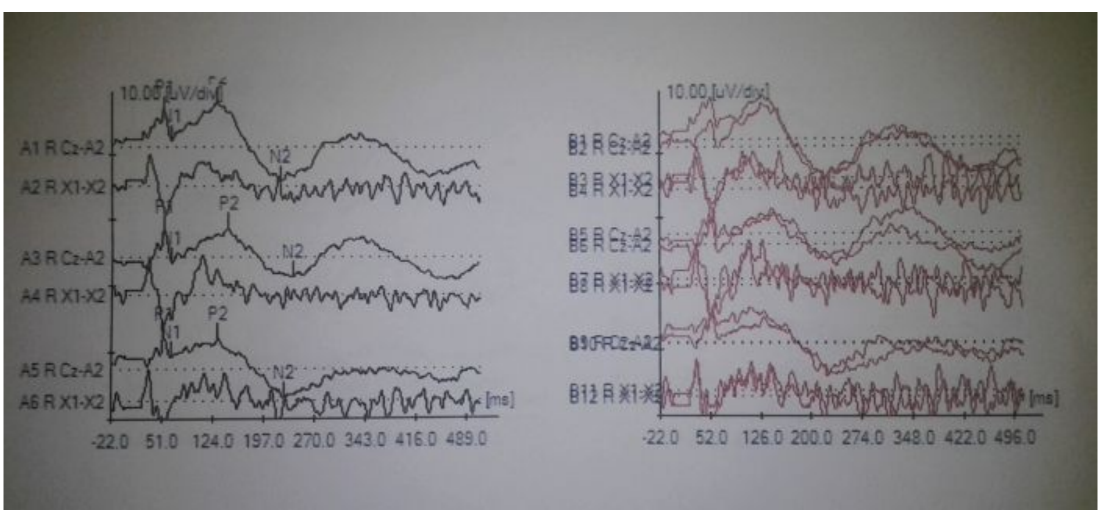
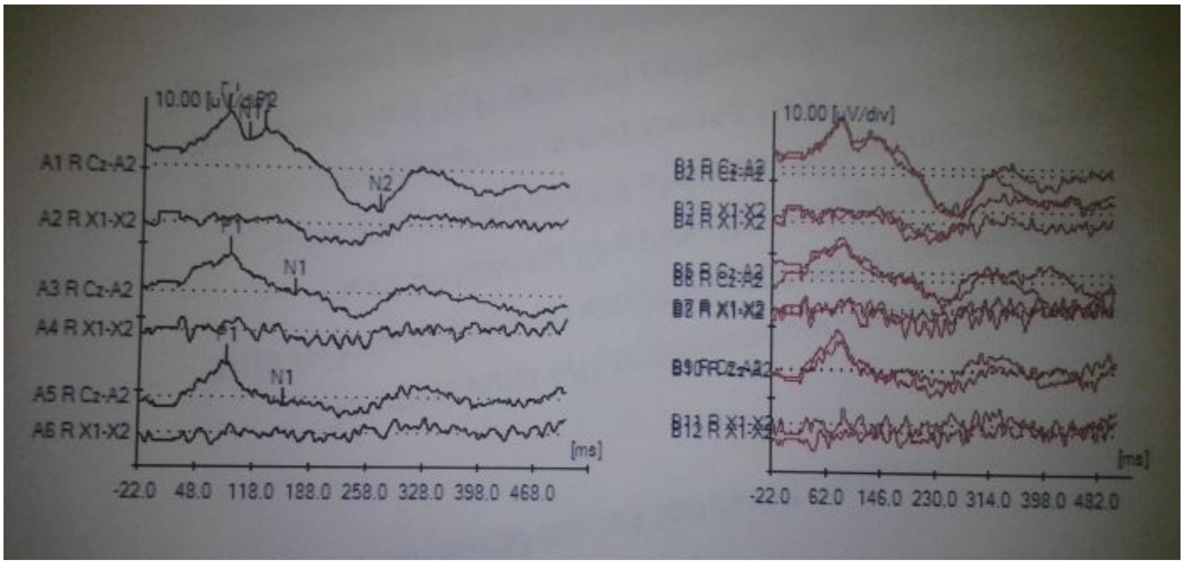


Figure 1.4—Results for Subject Four

A1 represents the response to no music. A3 represents the response to baroque music. A5 represents the response to jazz music. B1 through B12 are the raw unaveraged waveforms.



P1 latency results are as follows: For subject one, the no music condition had the earliest latency with equal latencies for the other two music conditions. For subject two, jazz and no music had the earliest latencies and baroque music had the latest response. For subject three, baroque music had the earliest latency with equal latencies for the other two music conditions. Subject four had the earliest latency with no music and showed the latest latency with baroque music.

P1 amplitude results are as follows: Subject one had the greatest amplitude with jazz music and the smallest amplitude with baroque music. Subject two had the greatest amplitude with the baroque music and the smallest with the jazz music. Subject three had the greatest amplitude with jazz music and the smallest with no music. Subject four had the greatest amplitude with jazz music and the smallest with no music.

P2 latency results are as follows: Subject one had the earliest latency with baroque music and the latest with no music. Subject two had the earliest latency with jazz music and the latest with baroque music. Subject three had the earliest latency with baroque music and the latest with jazz music. Subject four had a measurable P2 latency with no music, but did not produce a measurable latency with baroque or jazz music.

P2 amplitude results are as follows: Subject one had the greatest amplitude with baroque music and the smallest with jazz music. Subject two had the greatest amplitude with no music, and the smallest with baroque music. Subject three had the greatest amplitude with baroque music and the smallest with jazz music. Subject four had a measurable P2 amplitude with no music, but did not produce a measurable amplitude with baroque music and jazz music.

The results for the P2-N2 interval are as follows: Subject one had the greatest interval with jazz music and the smallest with baroque music. Subject two had the greatest interval with jazz music and the smallest with no music. Subject three had the greatest interval with no music and the smallest with baroque music. Subject four had a measurable interval for no music but did not produce a measureable interval for baroque and jazz music due to the lack of measurable latencies and amplitudes of the P2 wave for both variables.

Figure 2.1—Summary of Results for all Subjects at all Variables with Calculated Mean and Standard Diviation

	P1 latency (msec)	P1 amplitude (mV)	P2 latency	P2 amplitude	P2-N2 interval
no music	57.32	3.75	149.97	6.52	80.16
	54.19	1.93	140.6	10.96	79.12
	54.19	2.81	131.23	8.92	94.73
	82.3	3.67	127.07	11.01	143.66
mean	62.00	3.04	137.22	9.35	99.42
std. dev.	13.61	0.85	10.21	2.12	30.34
n	4	4	4	4	4
jazz	59.4	4.32	146.84	4.85	85.63
	54.19	1.65	135.39	8.63	169.69
	54.19	4.81	238.45	7.32	91.61
	84.38	5.81	0	0	0
mean	63.04	4.15	173.56	6.93	115.64
std. dev.	14.44	1.78	56.49	1.92	69.35
n	4	4	3	3	3
bach	59.4	1.07	139.56	6.53	78.08
	55.24	2.65	147.89	8.41	95.77
	53.15	4.32	130.19	11.8	90.57
	86.47	5.56	0	0	0
mean	63.57	3.40	139.21	8.91	88.14
std. dev.	15.49	1.96	8.86	2.67	9.09
n	4	4	3	3	3

VII. Discussion and Limitations

Once data were collected and analyzed, it was compared to the hypothesis. Confirmation of the experimental hypothesis would be beneficial because researchers in speech pathology and audiology would have a foundation to develop new methods of rehabilitation for children who have auditory processing related disorders as well as possible implications for those who have just received cochlear implants. Rejecting the null hypothesis would contribute to the research evidence that baroque music may enhance auditory processing in children. If so, further researchers could evaluate the use of music in the background while treatments are applied.

This study had limitations. Children from a small age range were being evaluated. Only four subjects volunteered to participate. Therefore, there are limitations in drawing conclusions. The lack of subject participation was not anticipated since extreme recruiting measures were undertaken by the researcher. Perhaps an incentive to participate may have yielded a sufficient number of subjects. Future studies of this type should have substantial funding to provide monetary benefits to volunteers.

VIII. Conclusion

Due to the low number of subjects, no firm conclusions can be drawn regarding the effects of presenting music to the non-test ear during late potential testing. The low number of test subjects willing to volunteer for the project (which came about even with extreme recruitment measures) could have occurred for the following reasons: busy schedules, parents unwilling to have their children connected to electrodes for the study, the children possibly being too frightened to volunteer, and lack of monetary compensation.

Despite the lack of available participants, a couple of possible trends were noticed when viewing the data after testing. The major trend noted was that the absence of music yielded earlier latencies in both P1 and P2. This result may be due to music acting as a source of “noise” in the non-test ear. This finding supports the general belief that music, of any variety, does not enhance auditory processing. The other trend was that the jazz music yielded a later latency and lower amplitude in P2. According to previous findings, baroque music at 60 BPM should be a more effective learning tool than jazz music (O'Donnel, 1999). However, unlike the majority of previous research discussed in the literature review, having no music proved to be more beneficial for the listener in this study. It is possible that the previous studies resulted in music's favor because these studies measured effects on the brain in a more general way than this current study did. Perhaps "no music" condition was not a condition. Even though no conclusions can be made from this study concerning the use of music, the data suggest that further investigation is warranted. Future studies may implement new measures or new controls that were not considered in this project. Some suggested changes would be:

- Test using an increased number of test subjects if enough volunteers are available or willing to participate. (As mentioned earlier, substantial monetary compensation might be necessary to acquire the desired number of test subjects.)
- Test using an age range from 5-9 years of age to expand the sampled population.
- Test using more music variables rather than just two.
- Test with a tempo variation of the baroque music alone and no music. (baroque music at 30 bpm, at 60 bpm, at 90 bpm, at 120 bpm, and no music)

IX. Appendix

The following is an example of an email sent to the schools, churches, and organizations in the Hattiesburg area. This is the email that was specifically sent to all of the students in the Honor's College at The University of Southern Mississippi. The email was changed only slightly for each type of group it was sent to. The information regarding the study stayed the same throughout.

> Hello all! I'm Lee Helen Weeks and I'm now recruiting for my study. The study that I will be doing is about how music affects a certain aspect of the brain in children that are of the elementary school age group. I'm looking for 10-20 participants who are 8 years old. These participants will need to have normal hearing.
>
> The study is going to be done at the USM Speech and Hearing Building. Basically, the only thing the child will need to do is sit in a comfy chair and have non invasive electrodes stuck to their forehead and ear. Then, they can sit back and listen to music and the computer will measure their brain waves. They will be allowed to watch a video with no sound if they wish. Overall, the study will take about 45 minutes for every student.
>
> This project is very important because if the hypothesis is proven to be correct, we could develop new methods of therapy for children who have received Cochlear Implants! I'm sure many of the participants would feel great knowing that they could be contributing to the cause!
>
> I am attaching assent forms and consent forms for the students and the parents. If you have or know of anyone who has an 8 year old sibling, son, cousin,

friend, ANYTHING, please let them know about this project. Also, give them a copy of the assent and the consent forms that are attached.

This will be something new and interesting for them to do. I would really appreciate your help. Here is my contact information. Please give it to anyone who is interested. They are more than welcome to contact me if they have any questions.

email: lee.weeks@eagles.usm.edu

phone: 251-509-5868

--Thank you so much,

--Lee Helen Weeks

In the emails sent to schools and organizations, the following post script was added: “I'm also attaching a flier that I made. If you can, could you hang them up on the bulletin boards around your facility or pass them out at some meetings? I do understand if you'd prefer not to, but I figured it wouldn't hurt to ask.”

The following pages contain examples of the flier, consent, and assent forms attached in each email. The flier is the same one that was placed on bulletin boards around the entire USM campus.

<u>DO YOU HAVE AN 8 YEAR OLD CHILD OR ONE WHO WILL BE WITHIN THE NEXT FEW MONTHS?</u>

He or she might be able to play a role in the development of therapy techniques for children who have received cochlear implants.

I'm Lee Helen Weeks and I'm a senior honor student majoring in speech and hearing sciences. I'm currently working on my thesis, and I need some 8 year old, normal hearing children to participate in my study. It would be truly amazing if you and your child would consider being a part of this, *as it has the potential to help so many other children* down the road.

PLEASE contact me for more details:

lee.weeks@eagles.usm.edu

or

251-509-5868

*****PLEASE ALSO PICK UP A CONSENT AND ASSENT FORM. I can email some to you if there are none left.*****

<u>Informed Consent for Research Project:</u> Music and its Effect on Late Auditory Evoked Potentials in Elementary School Aged Children

Subject Name: ________________________________ Date: __________

<u>Principle Investigator:</u> Lee Helen Weeks

<u>Other Investigators:</u> Charles G. Marx, Department of Speech and Hearing Sciences , Edward L. Goshorn, PhD.

Dear Parent:

The University of Southern Mississippi's Speech and Hearing Department requests your permission for your child to participate in a research project to develop a testing protocol for obtaining physiological responses to sound. This project will measure brainwaves to see if playing specific types of music would have any effect on a person's ability to understand speech. If certain types of music do affect auditory processing, then further studies could investigate the usefulness of music in the treatment of individuals with auditory disorders. This testing does not involve any procedures or protocols that are not done during a routine clinical evaluation. There are no known physical, psychological or social risks associated with participation in this study. Your consent for your child to participate permits the investigators to measure your child's brain waves using routine clinical procedures. You or your child will not receive any specific benefits such as monetary reward for taking part in this study. You may withdraw your child from participation at any time without consequence.

This procedure will involve placing stick-on (non-invasive) electrodes on top of the head, forehead, and behind one ear. Your child should feel only the sensation of someone rubbing the prep cream on their skin. This is similar to a technique that has been used for years to test the hearing of newborn babies and is considered perfectly safe. Following this, your child will have a speech sound presented to one ear at a normal conversational level, and music presented to the other ear at a comfortable volume. The entire procedure will take about 50 minutes. During this time the child will be seated in a comfortable chair and allowed to watch a video of their choosing.

Confidentiality and participant anonymity will be maintained by use of subject numbers rather than name once the data are collected. A separate data file will be maintained for each participant that contains only audiological and demographical data and will be organized by subject number rather than name. Your child's social security number will not be maintained in the research data file. These data files will be kept in the principal investigator's research lab in the Department of Speech and Hearing Sciences. Only the investigators listed above will have access to the data. If you have any questions concerning the audiological/electrophysiological procedures you may contact (601-266-6227) any of the investigators listed. In advance, thank you for your kind consideration of this request.

<u>Human Subjects Protection Review Committee</u>

This project has been reviewed by the Human Subjects Protection Review Committee, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research subject should be directed to the chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5147, Hattiesburg, MS 39406-0001, (601) 266-6820.

_______________________________________ ________________

Parent's Signature for consent to participate Date

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Lee Helen Weeks

Principal investigator

C. G. Marx, M. S., CCC-A

Edward L. Goshorn, Ph.D., FAAA, CCC-A/SLP

Late Auditory Evoked Potential Assent Statement

The Speech and Hearing Department at the University of Southern Mississippi is conducting research using a special type of hearing test. During this test, you will be seated in a comfortable, reclining chair and will be allowed to watch a video. Your teacher or your parent can accompany you during the test. The test uses a collection method that has been used for years to test the hearing of babies and young children. The picture below illustrates an example of the recording set-up and equipment. There is no discomfort associated with this procedure. Your participation in this project will help us gather valuable information that may help many other children in your community in the future.

Late Auditory Evoked Potential Assent Statement

Your parents say that you can take part in this special type of hearing test. You have just read about the procedure. This test tells us potentially valuable information about the relationship of hearing to language. Other children from your program may also be participating in this project. You do not have to do this if you do not want to. If you do participate, you will help us gather important information that may help children and their teachers in the future.

If you want to take part in the procedure, write your name below.

____

Signature of participant 8 years old

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Print name of participant

____

Signature of researcher Date

X. References

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