Neurologically-Informed Musicking (NIM) for Relaxation: Process and Effects

Ji Young Cho

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Abstract

This study aimed to look at the effects of client directed therapeutic musical improvisation on relaxation. The protocol used immediate brain wave data to inform a music therapist’s improvisation for the purpose of affecting the client’s state of rest.

Based on prior and existing music therapy techniques, this music therapy method was further developed by the researcher and thesis sponsor, and for the sake of consolidation and brevity, was given the name, Neurologically-Informed Musicking (NIM). The researcher asked the following questions: (1) What form does the NIM process takes when relaxation is a clinical goal? How (if at all) does the process promote relaxation? (2) Are there statistically significant relationships between electroencephalograph (EEG) measurements and NIM improvisation strategies associated with state of silence, rest, unrest, and sleep in a therapeutic setting? Comparisons among visual representations of measurements show (a) baseline EEG fluctuations between Silence and NIM, (b) bandwidth differences before and after changes in specific musical elements of improvisation. \( \alpha \)-test demonstrated that statistically significant differences in Theta/Beta ratio between silence (baseline) and NIM (improvisational music phase). However, \( t \)-test results showed no statistically significant differences in Theta/Beta bandwidth ratio upon specific changes across musical elements (key change, tempo change, trills, and rest). Based upon findings, it is evident that NIM may represent a useful music therapy protocol in facilitating relaxation or other clinical goals across a diversity of settings and clients. However, additional research is needed before more confident conclusions can be drawn.
NEUROLOGICALLY-INFORMED MUSICKING (NIM) FOR RELAXATION

MONTCLAIR STATE UNIVERSITY

NEUROLOGICALLY-INFORMED MUSICKING (NIM) FOR RELAXATION:

PROCESSES AND EFFECTS

by

Ji Young Cho

A Master’s Thesis Submitted to the Faculty of

Montclair State University

In Partial Fulfillment of the Requirements

For the Degree of

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NEUROLOGICALLY-INFORMED MUSICKING (NIM) FOR RELAXATION:

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JI YOUNG CHO

Montclair State University

Montclair, NJ

2015
DEDICATION

I dedicate my thesis to my Heavenly Father, my parents, and my brother.
ACKNOWLEDGEMENTS

Deepest appreciation is extended to my advisor, Prof. Brian Abrams, for his endless patience, incredible guidance, and inspiring thoughts throughout the past four years of my graduate school career. I also want to acknowledge Dr. Eric Miller and Dr. David Witten for sharing their creative support, expertise, and wisdom in the process of writing my thesis. I also appreciate my professors: Karen Goodman, who helped to formulate thoughts for my thesis topic, Amy Lyn Clarkson, and many of my supervisors, including Marissa Emple, James Ryley Maxson, Deborah D’Angelo, Kristen Brennan O’Grady, Margie Ellias, Alissa West. Thank you to my friends, Anna DeTitta DiMeo, Dongyoen Kang, Hyerim Katie Kim, Chunik Jeon, Ara Nam, Sooyeon Yun for their enormous support on this amazing journey.

Finally, I would like to thank all of the clients with whom I worked during my practicum and internship experiences. Without them, I would not be able to say who I am today. Throughout my encounters with my patients, I have learned to better communicate with people and had the privilege of sharing music with an honest heart. Most of all, I was able to realize the importance of patients’ needs as well as my desire in life. The relationship I had with my patients will inspire my whole life and career as a therapist, and I will not forget the love that I received and shared with them. My inner soul was touched by every single one of my patients and I hope to never stop conveying my gifts to this world.

As a young woman, I grew up playing the piano in front of people as a performer, but I am honored to use this talent in the field of music therapy. With my passion in psychology as well as my talents in music, I am thrilled to use both of these assets as a music therapist. I have realized that my true passion in this world is to serve people with the experiences that I have learned in Montclair State University,
Elizabeth Seton Pediatrics Center, Ramapo Ridge Psychiatric Hospital, Ben Samuels Children's Center, Matheny Medical and Educational Center. This thesis paper is only the beginning of my voyage as a music therapist and I hope to give my life to serve people with psychological needs throughout my life.
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**Introduction**

Music therapy interventions can help clients with health issues such as anxiety and stress. Relaxation techniques have been widely used in music therapy settings; American Music Therapy Association (2010) cites stress reduction as being one of the major goals of music therapy. Relaxation techniques, Receptive Music Therapy, Bioguided Music Therapy (BgMT) and Guided Imagery in Music (GIM) have become valuable tools in the music therapy field. This field continues to grow with innovative protocols.

From my internship experiences at Elizabeth Seton Pediatric Center with clients, who are non-verbal, I realized that I could not necessarily measure the clients’ needs during a session. Generally, the clients were not able to express themselves verbally during a session. Instead, they demonstrated non-verbal responses, such as physical tensions, changes in facial expressions, cooing and irregular breathing during the music therapy session. In order to provide optimal therapeutic interventions for clients, I became curious about outcomes where technology could measure their biofeedback and immediately direct music therapy protocols during remedial sessions. I tried to show the clients how music can be therapeutic but I realized that I needed more their mental responses guiding my improvised music in real time.

During my graduate school years, I studied Clinical Improvisation, Piano Improvisation and Special Topics in Music Therapy- Music, Physiology & Technology classes under the direction of Dr. Brian Abrams, Prof. Karen Goodman, and Dr. Eric Miller. The classes introduced piano improvisation as a therapeutic method. Biofeedback equipment, used in the context of therapeutic settings, expanded musical improvisation
strategies and outcomes. This thesis project evolved from those classes and I am pleased that I not only explored existing research but also developed an innovative thesis experiment. These experiences became a turning point and motivation for further research connecting technology and improvisation during therapeutic sessions. I feel like this is an inspiring catalyst for myself and other music therapists.

During this study, the researcher and thesis sponsor developed a new name for a process of relaxation, Neurologically-Informed Musicking (NIM). NIM utilizes improvised music, based upon the interaction between the listener (i.e., music therapy client), his neurological activity (as measured and conveyed via EEG, FMRI, or other technology), and the music therapists’ immediate responsive improvisation. In NIM, the listener’s physiological responses are regarded as musical responses with features such as flow, contour, form, etc., as part of a larger “work” (process) that may not have immediate, linear, stimulus-response significance, but which are better understood in the situated context of the listener’s unique identity. Hence, the exchange is construed as a form of musicking—in this instance, due to the goals, of health musicking (Stige, 2003).

**Literature Review**

The following review of literature will define general information on this research into four sections. First, the relationships between music and the brain will be reviewed. Second, different forms of physiological measurements will be introduced, as well as an explanation of how they are used to measure therapeutic interactions. Third, the researcher will review how music can be used to provide relaxation in receptive forms of
listening. Fourth, the researcher will explore the ways to use interactive music for healing relaxation with several physiological measures to serve as feedback mechanisms.

**Music and the Brain**

In recent years, understanding the importance of the interaction between music and the brain is dramatically increasing with studies by researchers (Donna, 2000; Hallam, 2010; Levitin, 2007; Pascual-Leone 2001; Patel, 2008; Peretz, 2005; Roberts, 2010; Sacks, 2007). Music’s potential influence on cognition, behavior, creativity, social development, and physical development is a relatively new understanding in the fields of psychology and neuroscience (Hallam, 2010). Sacks (2007) explains that external and internal music plays in our heads and forms a significant and mostly pleasant part of life for humans. Peretz (2005) explains that music performance and processing activate widely distributed networks of both cortical and subcortical brain areas. Moreover, Levitin (2007) describes that playing an instrument requires the orchestration of regions in our primitive, reptilian brain (the cerebellum and the brain stem), as well as higher cognitive systems such as the motor cortex (in the parietal lobe) and the planning regions of our frontal lobes, the most advanced region of the brain. Using all of this research, has given this area successful outcomes; however, taking this research a step further and gathering technological data during the music therapy session is another necessary step in order to promote new therapeutic interventions. Roberts (2010) shares a story of Levitin’s show:

Levitin works with the popular musician, Sting, to explain that studying music makes music engagement a significantly more whole brain activity than the
results of someone who has not studied music. Amateurs tend to hear more sound and less music, as the complexities are not processed across the brain’s hemispheres. Better and more knowledgeable musicians spread out the brain’s activity across the left and right hemispheres of the brain, as sound is processed with more thinking than just hearing. (p. 25)

According to Pascual-Leone (2001), music neuroscience literature has discovered that engagement in music can effectively change the brain. Additionally, Patel (2008) shows the relationship between music, language and the brain as a hidden connection while comparing ordinary language to instrumental music. For example, Donna (2000) explains that infant brains might be influenced to absorb musical structures. When mothers speak to babies, they instinctively talk with musicality (i.e., higher pitches; big, sweeping pitch contours; simple, melodic little ups and downs; singsong rhythms, and drawn-out vowels rich in overtones). When a music therapist can read the immediate effect on brain activity, when higher pitches, melodic contours, rhythmic changes etc. are improvised, the music therapist can direct the mood of therapy session to influence therapeutic relaxation outcomes.

The continuing discovery of the relationship between music and the brain is very significant for future study and therefore can influence the use of known music therapy techniques enhanced by the use of innovative technology, providing the therapist with cerebral information.
Measuring responses to music and brain interaction

As demonstrated in studies below, biofeedback is a process of observing of change in physiological activity that is helpful for improving health and performance. Kothurkar (1985) explains that biofeedback involves feedback from measuring instruments that yields moment-to-moment information about a biological function. Additionally, Bazanova, Mernaia and Shtark (2008) clarify that:

"biofeedback is to use the principles of adaptive feedback, i.e., the delivery of signals reflecting the state of intrinsic physiological parameters via sight, hearing or animated figures on a computer monitor to achieve the ability to “feel” intrinsic reactions to afferent spikes" (p. 437).

Miller (2011) exhibits several common measures used in physiological biofeedback training or therapy, which are great tools for assisting relaxation, including EMG (electromyogram), EDG (electrodermography), TEMP (thermal biofeedback), HR (heart rate), HRV (heart rate variability), BVP (blood volume pulse), and EEG (electroencephalography). As he describes, “EEG measures electrical cortical potentials—that is, electrical output of the brain and the synchronous firing of neurons in the brain increases the amplitude (strength) of the frequencies of the activation” (p. 90).

Also, Rice, Rorden, Little, and Parra (2013) explains that EEG has been used for decades in thousands of research studies in both the clinic and the lab. Despite the fact that these measurements have provided useful information, innovative use of equipment and data that directs music therapy improvisation, on the spot, during the session, is an invaluable tool in the science of music therapy. The following tables provide a graphic
description of the types of information that can be useful instruments during music therapy sessions.

The EEG frequency spectrum can be subdivided into smaller bandwidths for clinical purposes as shown in Table 1.

Table 1. EEG Brainwave Bandwidths

<table>
<thead>
<tr>
<th>Bandwidth name</th>
<th>Frequency range</th>
<th>Normal occurrence</th>
<th>Clinical Significance</th>
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<tr>
<td>Delta</td>
<td>0.5-3.5 Hz (Hertz)</td>
<td>Deep sleep; common state in infants, healing</td>
<td>Sign of significant brain dysfunction, lethargy/drowsiness or cognitive impairment</td>
</tr>
<tr>
<td>Theta</td>
<td>4-7.5 Hz</td>
<td>Drowsiness; Sometimes occurs during learning processes; Common state in young children, Creativity mystical experience, Inattention</td>
<td>Slowing often related to attention/cognitive impairments, internal focus</td>
</tr>
<tr>
<td>Alpha</td>
<td>8-13 Hz</td>
<td>Eyes closed, relaxation, Light meditation</td>
<td>Excessive alpha during demand states can be a sign of difficulties with learning, emotional stability, relating to the environment or others</td>
</tr>
<tr>
<td>Beta</td>
<td>13-40 Hz</td>
<td>State Commonly associated with alertness and activity, Cognitive tasking, Mental activity</td>
<td>Excessive beta is often associated with anxiety, irritability and poor integration</td>
</tr>
<tr>
<td>Gamma</td>
<td>Greater than 30 Hz</td>
<td>May be associated with Problem-solving and memory consolidation</td>
<td>Unknown</td>
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*Note.* Adapted from Demos (2005) and Thompson and Thompson (2003), Miller (2011)

When the brain receives and processes information, Alpha waves are created, which demonstrate meditative, relaxed state. Multiple sclerosis patients with opticus neuritis have reduced Alpha responses after visual stimulation, which means Alpha responses relate to sensory functions. On the other hand, Beta waves are generally faster and also considered the dominant rhythm in the brains of people actively thinking and listening (Adjouadi et al., 2004). Theta rhythm occurs as a normal rhythm during drowsiness and this occurs with predominance over the front-central regions during drowsiness between
the ages of 4 months to 8 years of age in young children (Basar and Guntekin, 2013). Delta rhythm occurs during the slow-wave sleep (SWS) and till now overwhelming majority of delta oscillation-related publications concern sleep (Knyazev, 2012).

Green (1977) says that although people can sense tense muscles, cold hands, or a pounding heart, people cannot detect brain-wave activity. People sense a state of consciousness, a series of subtle existential cues and control, but not the brain wave itself. Geison (2015) notes that, Adrian, the president of the Electroencephalographic Society, established in 1943, researched EEG responses to stimuli in sleep and wake states. EEG entered clinical practice followed by electromyography in the early 1950s. However, there was a contrast in the advancement of cardiology and that of neurology. While cardiology came to focus on physiological aspects, clinico-anatomical correlation became the central approach in neurology. Nonetheless, in present-day brain research, there are many more techniques that therapist can employ. According to Halchenko, Hanson, and Pearlmutter (2005), neurophysiologists, cognitive psychologists, cognitive scientists, and other researchers use non-invasive functional brain imaging such as electroencephalograph (EEG), magnetic resonance imaging (MRI) and functional magnetic resonance imaging (fMRI). Further research will develop techniques for using this information during the music therapy sessions.

Furthermore, instruments such as EEG and fMRI are often used in biofeedback for all kinds of therapeutic interventions. Menon and Crottaz-Herbette (2004) have shown that fMRI and EEG can provide the information necessary to understand the spatio-temporal aspects of information processing in the human brain. There is also a study that used an fMRI during jazz improvisation, which examined a distinctive pattern of changes
in prefrontal cortical activity (Limb & Braun, 2008). In this study, professional jazz pianists improvised on the piano keyboard during image acquisition by using similar tasks of similar to control the perceptual and motor features of performance.

In addition to therapeutic improvisation, methods also include recorded music. Chan (2008) introduced a way of using EEG indicators while using the Traiarchic Body-pathway Relaxation Technique (TBRT). In Chan’s study, Alpha asymmetry index and frontal midline theta activity were measured while 19 students listened to both TBRT and music audiotapes. The EEG pattern showed that there are positive outcomes of positive emotional experience, accompanied by focused internalized attention. When this information is available during music therapy sessions, the therapist has additional strategies to direct the desired outcomes. Furthermore, when this information is immediately available to the therapist, he/she increases his/her options for manipulating the protocols.

Miller (2011) introduces a Bio-guided Music Therapy (BgMT) as a therapeutic method. He describes that BgMT is an integration of music and biofeedback, and it depends on music as either an input to the psychophysiological system, and output of the psychophysiological system, or both. Also, he has confirmed the effectiveness of using biofeedback and improvisational music. According to his study:

In our first model, the music therapist receives the feedback information from the client; however, the client does not also receive it directly. Rather, the music therapist improvises musically or technologically as informed by the client’s feedback. The client receives an interpretation delivered by the music therapist relevant to the client’s clinical objective. This model is applicable to
the beginning stages of bio-guided music therapy for anxiety and stress reduction. (p.133)

These research shows that there is interaction between the information, the therapist, the listener and the music during the music therapy session itself. The goal of this research is to connect to all of these elements in real time.

Neurologic Music Therapy (NMT) utilizes EEG biofeedback capturing clients’ electrical brain activities. NMT uses brain waves as a marker of mental state, relaxation levels, etc. NMT is defined as the therapeutic application of music to cognitive, affective, sensory, language and motor dysfunctions due to disease or injury to the human nervous system (Thaut & Hoemberg, 2014). Research has already demonstrated the value of this application for the benefit of clients. Therefore, applying improvised NMT, based on data, which is collected during the music therapy sessions, has obvious advantages for developing creative and innovative protocols. When the therapist has the ability to read electronic data, and simultaneously improvise, he/she can develop the skills needed for effectively achieving the clients’ immediate goals in therapeutic sessions.

**Music and Relaxation**

Sorel (1994) illustrates one story of unintended relaxation: the historic meeting of Franz Liszt with Johannes Brahms. Liszt performed his own sonata for Brahms. Despite Liszt’s incredible playing, Brahms fell asleep during an impassioned section. Therefore, it is reported that Brahms became relaxed from Liszt’s music. For many, just like Brahms, music can be a unique tool for relaxing and sleeping, as well as staying alert and energized.
In music therapy, relaxation techniques are an important ways of promoting clients' physical and mental health (Esch, Fricchione, & Stefano, 2003; Penzien, Rains, & Andrasik 2002). According to Grocke and Wigram (2007), there are many relaxation methods used by therapists (beyond music therapy alone), teachers, nurses, pastoral care workers, and yoga instructors. Various relaxation techniques are used in clinical settings to assist with pain management, stress management, agitation and anxiety control, and increasing attention, as well as for offering opportunities to learn to relax and enhancing well-being.

Music has been widely used to promote relaxation, manage stress, reduce pain, and ease muscle tension. There are numerous studies that involve relaxation, and many of which involve music listening. Bruscia (1998a) describes music relaxation as “the use of music listening to reduce stress and tension, to reduce or counter condition anxiety, to induce body relaxation or to facilitate entry into altered states of consciousness” (p. 122). However, according to Tagg (2002), music is more than relaxing and beneficial; it can have an impact on a human’s emotions, which a therapist can use as a method for healing the mind and body. Hence, Bruscia and Tagg’s findings support this research to that continues to explore the effective use of improvised music to promote the participants’ relaxation, based on the belief of the power of music.

Especially in music therapy settings, receptive experiences have been broadly used for clients to achieve relaxation. Kejr, Gigante, Hames, Krieg, Mages, König, and Diel (2010) state that receptive music therapy (rMT) provides a good feeling and makes for a more effective healing process and reduces stress. Bruscia (1998a) defines receptive music therapy experiences as…
the client listens to music and responds to the experience silently, verbally, or in another modality. The music used may be live or recorded improvisation, performances or compositions by the client or therapist, or commercial recordings of music literature in various styles (e.g. classical, rock, jazz, country, spiritual, new age). (p. 120-121)

Grocke and Wigram (2007) says that receptive methods can be applied to most clients with physical and psychological functioning of all ages, from babies in utero to persons in their last moments of life. For clients whose pathologies limit verbal language, receptive Music Therapy (rMT) can be beneficial, because clients do not have to do anything except listen. Specifically in music therapy, therapists encourage client relaxation using live, improvised music on piano, keyboard, guitar, voice, and so forth, or by playing recorded music. Choosing appropriate music genres is an important part of rMT. Miles (1997) explains the benefits of using of familiar music to produce relaxing responses in the body. Also, Chafin (2004) expresses that classical music has been empirically demonstrated to reduce tension and promote relaxation.

Wolfe, O’Connel, and Wadon (2002) endeavored to assess the relaxing characteristics of music and have offered some guidance. Results from their study revealed that components such as tempo, dynamics, instrumentation, and melody can impact the relaxation achieved as a result of a musical piece. It was also found that familiarity with a particular composition’s qualities did not impact relaxation, and non-musicians and musicians tended to agree on which tracks the most/least were relaxing.

According to Scheufele (2000), the basic mechanisms by which relaxation exerts its effects are still not fully understood. Yet, a better understanding of the mechanisms of
relaxation could lead to more effective use of music therapy relaxation techniques. During music therapy sessions, it is important to individually tailor the music to clients’ needs moment-to-moment in order to achieve therapeutic goals (Carozza, 2015). The challenge in receptive music therapy is that therapists need to monitor how the clients are responding, but there few ways to assess and evaluate these responses while they are listening to the music. Although it is possible to pause and ask the client questions, this may pose certain challenges and may interrupt or disturb the listener. Moreover, although some therapists can observe subtle responses such as breathing, or facial expressions, these signs provide only limited access to the client’s internal responses.

**Interactive music for relaxation using physiological measures**

Miller (2011) writes, “It may be relatively easy to also include EEG measures without much disruption of the clinical process. Here, we would be interested in the strength of the meditative state as indicated by Alpha or Theta levels, and possibly Theta/Beta ratio to gauge the relationship of meditative state to cognitive activity or mental chatter” (p. 117). Additionally, Gruzelier (2009) emphasizes that the increase in the EEG bands in the Alpha or Theta range and Theta/Alpha ratio can be used to improve relaxation. Therefore, in this study, we used the EEG technique because EEG measurements reveal relaxation levels such as Delta, Theta, Alpha, Beta and Gamma, and EEG is the most detailed indicator of states of relaxation, along multiple bandwidths. EEG is reliable for measuring participants’ mental relaxation state, since there are many studies that attest to its accuracy. Gathering this data during the session directed the therapist improvisation to stimulate client’s responses in real time.
Gruzelier (2009) proposes the effectiveness of reinforcement of the Theta/Alpha wave activity ratio in a relaxed, creative process and well state of being, with particular application to the performing arts. The author discovered that limbic and long distance circuitry in the brain is mainly responsible for the diversity of effects of Alpha/ Theta training.

According to Sokhadze (2008), EEG biofeedback has been used in substance use disorders over the last three decades and it is employed in conjunction with other therapies in order to enhance certain therapy outcomes. McGrady, Bush, and Grubb (1997) describe that biofeedback-based relaxation interventions may be helpful in the treatment of neurocardiogenic syncope (a temporary loss of consciousness associated with a drop in arterial blood pressure, quickly followed by a slowed heart rate), (Grubb & McMann, 2001, p. 133), and with headaches in certain patients. Additionally, the last decade has seen the development of an EEG biofeedback Alpha/Theta protocol that has been conceptualized as an “EEG-based relaxation therapy” (Peniston & Kulkosky, 1999, p. 158). Also, Egner, Strawson, and Gruzelier (2002) describe a successful treatment of alcoholism by using Alpha/Theta neurofeedback training as a complementary therapeutic relaxation technique. Nevertheless, there are limitations of measuring physiological measures in therapeutic settings.

In order to fit clients’ needs without having to see what is going on neurologically, therapists have to understand the human being as a whole. Rogers (1959) stresses the client-centered approach, and the importance of person-to-person relationships in therapy. Sometimes, clients need a real human being to respond to them. Dryden (2007) states that:
For the person-centered therapist, a primary goal is to see, feel and experience the world as the client sees feels and experiences it, and this is not possible if he stands aloof and maintains a psychological distance in the interests of a quasi-scientific objectivity. (p.155)

There are computer programs, where a person is connected to a computer with biofeedback sensors. However, the computer biofeedback is not able to understand the human being and cannot build a therapeutic relationship with them. Computer biofeedback cannot really access human context, cannot understand musical context, and cannot understand the human being as a whole. However, a music therapist brings all of his/her sensibility and abilities to meet the client’s needs. Therapists are considering context with all kinds of levels. Hence, it is important to consider how human beings interact together. When this interaction is enhanced by direct neurological feedback, the therapist is connected to the client on a deeper level.

If the therapist uses EEG measures for relaxation treatments, the therapist might be able to improvise music with the clients’ brain activity. In order to achieve the therapeutic goal of relaxation, the therapist can play spontaneous music based on the clients’ feedback mechanisms. The client also responds to the music, which helps to develop musical interaction. Although the benefits of recorded music must not be dismissed, live improvisational music can be effective in order to provide music in the moment that is tailored to the clients’ needs (Segall, 2007).

Miller (2011) illustrates this in its simplest form by observing how the music therapist receives the client’s physiological data in real time and improvises music. (p. 142). He also describes, “The music therapist improvises musically as informed by the
client’s physiological data in real time” (p. 143). Also, he introduced an alternative approach: to increase slow wave activity such as the Theta/Alpha ratio while reducing EMG. Also, he says “Given the numerous choices of new age music on the market, the music therapist has a wide array of choices to select from, including the option to improvise in the moment” (p.193). Therefore, these studies confirmed the effectiveness of using improvised music and demonstrated the value of the improvisational music when it is used with physiological measurements.

According to Bruscia (1987), “music therapy improvisation is the use of live music-making, usually by therapist and client, in order to focus on therapeutic work: supporting with medical, neurological, social, psychological or psychodynamic thinking, encourages clients to read music therapy improvisation not as a purely musical event, but as an interpersonal one (in a way that mothers and babies read one another’s acts not as musical or temporal, but as emotionally expressive and communicative), and encourages clients to develop the created improvisation according to personal/therapeutic” (p. 275). Additionally, learning the technique of empathic improvisation might be important for future study. Wigram (2004) mentions Juliette Alvin’s (1975) music therapy method: “playing ‘to’ the client, using ‘empathic improvisation’ to reflect the client’s feelings, and Empathic improvisation and reflecting, require a response that is more specifically connected to the emotional state of the client” (p. 89). Furthermore, empathic improvisation...

Involves a therapeutic method that was first applied by Juliette Alvin where, typically at the beginning of a session, she would play (on her cello) an improvisation that empathically complemented the client’s ‘way
of being’. In practice, this means taking into account the client’s body
posture, facial expression, attitude on this particular day, previous
knowledge of the client’s personality and characteristics, and then playing
something to the client that reflects a musical interpretation of their own
way of being at that moment. It was intended by Alvin as a very empathic
technique, not attempting in any way to change the client’s feelings or
behavior, but simply to play to the client without any hidden manipulation
of their feelings. If a client comes into the therapy room agitated and
upset, this mood can easily be incorporated into an empathic
improvisation, whereby the therapist is not trying to ameliorate or reduce
the degree of distress which the client is currently experiencing, but
merely to play it back to them as a supportive and empathic confirmation.
(p. 89)

Furthermore, *entrainment* is a term that explains the phenomenon of matching
biological vibrations to musical rhythms in nature (Clayton, Sager, & Will, 2005). It has
been used as a music therapy intervention for pain management. The principle of
entrainment, which is the natural phenomenon of responding to musical rhythms, is
directly related to the Greek word “isomorphic,” commonly referred to as the iso-
principle (Lee, 2005). Cottrell (2000) explains that entrainment is a powerful tool in
behavior modification. Musical entrainment is a process of connecting [rhythmically]
 together the feelings conveyed through the music and feeling a sense of cohesion with
them. One might also have a feeling of connection with the composer or performer by
sharing the emotions and feelings conveyed in the music, either through its creation or through the performance.

Scheufele (2000) emphasizes that there is no special training in music that is required by clients. However, the music therapists require special training (especially, when improvisational music is used in clinical settings) in order to help clients’ healing through music techniques. Knowledge of the technique of empathic improvisation might be important and therefore, this study tried to understand how effective each improvisation technique is.

We already have roots in many traditions of the work of bio-guided music therapy, and this use of biofeedback equipment and musical improvisation methods for relaxation might be able to reinforce the previous studies. Nordoff-Robbins music therapy improvisation techniques are especially widely used in the music therapy settings (Cooper, 2010). This study also approached the Nordoff Robbins improvisational techniques such as musical, instrumental, melodic, harmonic, rhythmic responses. Furthermore, Schmidt (1984) describes dynamic components as raw materials. The therapist’s music elements such as melody, rhythm, harmony, dynamics, tempo, timbre, and register can enhance therapeutic impact and appeal. Thus, this study also focuses on the musical elements in order to examine the change of participants’ relaxation level. Eventually, this study shows details of matching a person’s immediate needs through improvisational music to achieve relaxation therapeutic goals by the researcher’s use of biofeedback data and the participant’s response to the therapist’s improvised NIM process. A final important note: Miller (2011) already introduced a way of using improvisation and biofeedback. This study seeks to build on his findings; using
immediate biofeedback data with improvisational techniques based on client’s and therapist’s interaction is another step in the growing field of music therapy. The improvisational music elements change, the reaction to the changes, in both the participants, and the researcher, are of key interest in this innovative study.

**Purpose of the Study**

The purpose of this study was to explore the processes and effects of interaction between neurological responses and improvised music, via a Neurologically-Informed Musicking (NIM) applied to the promotion of relaxation. Specific research questions were: (1) What form does the NIM process takes when relaxation is a clinical goal? How (if at all) does the process promote relaxation? (2) Are there statistically significant relationships between electroencephalograph (EEG) measurements and NIM improvisation strategies associated with state of silence, rest, unrest, and sleep in a therapeutic setting? Comparisons among visual representations of measurements show (a) baseline EEG fluctuations between Silence and NIM, (b) bandwidth differences before and after changes in specific musical elements of improvisation. The null hypotheses were that there would be no significant physiological responses to the music in NIM.

**Method**

**Research Design**

This study combines quantitative and qualitative arts-informed research methods. It examines the neurological data from the biofeedback equipment and the
improvisational relaxation music played for the client, as informed by the researcher’s experiences in graduate course work, including clinical improvisation with Dr. Brian Abrams (2012), piano improvisation class with Prof. Karen Goodman (2013), and bioguided music therapy with Dr. Eric Miller (2012). Those classes taught the effectiveness of different clinical improvisation techniques, how to develop solid improvisational musical forms, and piano improvisation in context of the biofeedback equipment in relation to live music.

Ethical matters were considered, and the study was reviewed and approved by the Institutional Review Board of Montclair State University in New Jersey. All participants signed informed consent and pseudonyms will be used to protect confidentiality.

**Experiment Participants**

There were three participants in this study. In the beginning, five volunteers were able to participate from the researcher’s academic community, including students, faculty members and alumni. The researcher offered a formal invitation via email, regardless their interests, in a relaxation session and the volunteered participants completed a pre-screening questionnaire for selection according to the following inclusion criteria:

a) Age 18 or over

b) English speaking in order to comprehend the pre-screening questionnaire and consent forms

c) Absence of hearing loss or other sensory disorders/loss

d) Absence of neurological problems such as seizure disorders, brain injury or stroke, or multiple sclerosis
Absence of diagnosed anxiety disorder or other psychiatric condition

The researcher contacted the participants to schedule the sessions. Data were collected on one male and four females, aged 31-63 years, Caucasians and one Asian. However, due to technical error, data on two participants were lost. Therefore, there were three participants in the study. Participant 1 was “Joshua”. At the time of the study, he was working at Montclair State University. He had never received formal music education but reported enjoying music while driving or at a party. He came to his session with curiosity and enthusiasm about music. Participant 2 was “Jayleen”. Her musical background consisted of more than 20 years of piano, and several years of viola. Participant 3 was “Ruth”. Ruth had studied piano and clarinet as a child, and had taken organ lessons as an adult. Before the session, Ruth disclosed that she worked outdoors, felt tired, and was ready to relax. Ruth arrived prepared to meditate in a state of rest.

Materials

Materials consisted of the composed music score, the biofeedback equipment, and Garage Band computer software. The labels of the equipment used in the experiments were produced by J&J Engineering C2+: (1) Bio-Explorer software that runs in Windows (displays signals, provides feedback, collects data, prints reports, and exports database compatible files), and (2) EEG (electroencephalography), a medical measure to record the electrical activity of brain. The C2+ amplifier was connected to the computer through a USB port. The C2+ amplifier was able to read neurological signals and supported all the biofeedback applications.
The Garage Band software is known as a sequencer or digital audio workstation (DSW). Garage Band can record and play back music in two different strategies: digital audio and MIDI. The researcher connected an electric keyboard to an Apple computer using a USB connection and created a "Steinway Grand Piano" sound. The improvisational music was recorded and the score was automatically saved by Garage Band software, which is a computer software program that enables a musician to create, record, and transcribe music.

Participants were individually tested in the David Ott lab room at the John Cali School of Music, Montclair State University. The researcher prepared the biofeedback equipment and other materials before the participants arrived. This study required participation in a research session at a lab during a scheduled appointment. The session first involved participants being connected to the biofeedback electronic equipment. The participants' brain reaction measurements were recorded by using J&J Engineering biofeedback products. The researcher affixed electrodes to the participants' scalp (on the participant's head and ears). The researcher's keyboard was connected to Garage Band software.

*Figure 1.* A Photo of the David Ott Lab with Materials
Procedure

Data collection. The research session took approximately one hour, involving the following components: (a) Participants signing a consent form; (b) Therapist’s preparation of equipment; (c) Establishing an EEG Baseline during Silence; and, (d) NIM process with live improvised music provided by the therapist while responding to the neurofeedback visual graphs.

Preparation. While the researcher was preparing for the research, the participants were comfortably reclining in a chair or lying down on the floor. The researcher affixed electrodes to the participants’ scalp using conductive gel and medical tape. The participants wore a soft eye mask to decrease ambient light. The preparation took approximately 15 minutes. The researcher positioned EEG electrodes on the participant’s head and ears. The researcher received the feedback from a monitor, which visually displays graphs, waves, and color signals. The EEG electrodes’ exact positions were in A1, A2 and Fz (ears and center of head).

Baseline. To establish a baseline measure, the researcher started the data recording during silence. Establishing the baseline took 5 minutes.

NIM stage. During the active music making stage, the researcher used Garage Band software. The researcher used an electric keyboard as the musical instrument, which was connected to the Garage Band software. The researcher obtained the recorded music and full music scores through the program. When the electrodes were secure and the baseline was established, the researcher began the music session with a soft, calming, improvised instrumental melody. Subsequently, the music was adjusted in response to the participant’s feedback from the monitor. The researcher played on a keyboard by
responding to the EEG neurofeedback information. Necessary changes were made to help the participants relax for 20 minutes. There were no words or vocal exchanges between the researcher and the participant. However, the researcher’s use of a variety of musical qualities - melody, harmony, texture, rhythm, phrasing, dynamics, timbre and tempo through strategy of improvisation - all supported relaxation. The researcher used musical elements such as broken chords, suspended notes, high tone melodies and key changes. Sometimes, the researcher used a composition’s underlying chord structure and melody in order to maintain clear musical structures. Improvisational live music was introduced for the participants in this study. Because of the improvisational nature of the music, the researcher did not indicate music elements that may have been shifting with relatively swift frequency, such as meter and key. Although people have different reactions to musical elements, the researcher (I) believes that music can positively impact the relaxation achieved. Therefore, this study used improvisational music, which also avoided introducing familiarity. The researcher checked the monitor and used the affect of the improvised music on the participant’s brain waves, to guide the researcher’s strategies.
In figure 2 the data were displayed on a computer and a large monitor, and visually scored to identify portions of the data. These displays both reflected what the client's neurological indicators suggested, as well as gave the researcher opportunities to increase relaxation further. The researcher used the feedback from this monitor, which visually displayed graphs, waves and color signals, and modified the improvisational music to match the participants' neurological measurements. Additionally, this study demonstrates that the meaning of the conversation between the therapist and the client can be better integrated when the therapist has immediate neurofeedback and improvises music using that information.

**Closing.** At the conclusion of the session, the researcher guided the participant back to an alert state by guiding and matching their breathing musically and verbally. The researcher asked the participants to open their eyes, as they felt ready.
Data Analysis

For the purposes of this study, the researcher divided and labeled the data analysis procedures into four steps: Process A, Process B, Effect A, Effect B.

**Process A (quantitative and qualitative).** The researcher made an attempt to represent the sequences of events that transpired between participants and the researcher neurologically and musically by using a simple chart. Additionally, the researcher provided descriptions (including texts and two specific moments’ graphs of Beta and Theta).

**Process B (quantitative).** In this phase, the researcher considered the overall pattern of responses during the course of the NIM. This was represented graphically, including the following components: (a) Bandpass Amplitude Signal tables (will change the table number - see Table 3, 4 and 5 that belong in the results section); (b) EEG waves were computed for three timed periods for Joshua, Jayleen and Ruth: at baseline (0 sec), beginning of NIM (5 minute), at the end of NIM (25 minute) (see Figures 5, 6 and 7).

**Effect A (quantitative).** The analysis generated a graphic trend “map” of the neurofeedback/music interaction (see Appendix A), including comparison of relaxation from baseline to NIM session A t-test compared the differences between baseline and improvisational music session EEG levels and Theta/Beta Ratio Change for each improvisation method, in terms of wave amplitudes and ratios (e.g. Theta/Beta ratio), as indicators of relaxation (quantitative procedures).

**Effect B (quantitative).** In this section, the researcher made comparisons among various musical "moments," and described the characteristics of the improvisation at specific points on the EEG graph. For example, the researcher compared the moment-to-
moment neurological changes (that reflect the affect of the improvised music on the participant’s state of relaxation) by demonstrating elevated Theta bands on the dialog graph in relation to the notated score. The researcher examined participants’ neurological reactions 30 measures before and after improvised music tempo and key changes. The changes were improvised based on immediate band waves data. The researcher tested her control over the clients’ relaxation states to assess its value in music therapy settings. The reliability and stability of the EEG discriminant function were evaluated by cross comparison of participants’ Theta/Beta ratios. Theta/Beta ratio has value in assessing subjects’ for ADHD. Alpha/Theta ratio has potential in assisting creativity in a therapeutic setting.

A Study of ADHD uses this ratio as the attention control for sensitivity, specificity, and behavioral correlates (Ogrim, Kropotov, & Hestad, 2012). Snyder and Hall (2006) show that the Theta/Beta ratio in their meta-analysis had a much higher predictive power than rating scales do, for separating ADHD and clinical controls. It is becoming important to train patients to reduce this ratio, since it reflects their control sensitivity, attention, etc. Moreover, Miller (2011) gives an example of using Theta reduction for ADHD to increase focus and concentration. He also shows that the increasing Theta could be considered for different rationales, including meditation or relaxation as opposed to cognitive tasking. This research is important for future studies because immediate feedback during a therapeutic session could help the therapists

The Theta/Beta ratio was used in the analysis of the EEG data. The Theta/Beta ratio was chosen because: a) it could reflect the relaxation state more accurately, b)
Theta/Beta might help reduce errors of mistaking artifact for actual signal (This approach compensating for the random “noise” that can occur at the inputs of the EEG sensors).

Results

The researcher analyzed each participant individually in the process A and process B sections and combined three participants’ quantitative results in the effect A and effect B sections. ¹

Process A (Research Summary of NIM Dialog & Description)

The followings are condensed neurological and musical simple chart that summarize the major events in time as they occurred between the researcher and the participants by using a dimensional simple basic chart and followings are descriptions (see Table 2).

Joshua. During the Silence, the active EEG Alpha band (light meditation, eyes closed) shows a high level. The researcher’s interpretation of this level was that he appeared to be thoughtfully relaxing. Also, Joshua’s low level Delta (sleep, healing) and Theta (creativity mystical experience, inattention) EEG bands showed that Joshua is not yet in an inattentive state of sleep. The EEG Beta (cognitive tasking, mental activity) bands showed minor signs of cognitive functioning while Joshua was mentally preparing himself for the experiments. The researcher was able to read his relaxation levels even

¹ Supplementary music files and scores to this article can be found online at
https://drive.google.com/folderview?id=0B7622RVK6o2nmfZnNXVjRTJnZy0weExrTvDrVRFh4MEZuc2
xPQVIDX1dja2twdG0wWXdXY1k&usp=sharing

https://www.dropbox.com/sh/13dp74ntm4wi44/AAD_WbGtJqYd_hBPZiGC7910a?dl=0
before starting the music as watched the monitor. The researcher made a decision to start
with single melody lines, because the researcher did not want the participant to alert as
the music started. There was no reason for choosing the key of C Major except that the
researcher felt comfortable with improvising in this key to start.

In musical measures (Measures, 67-87), when the improvisational music was
introduced in a C Major tonal center, the ascending/descending arpeggio pattern elicited
minor responses in Joshua’s EEG bands. Perhaps this was not significant and the
researcher was begun to prepare musical shifting. The researcher observed ascending
Beta band movement in Mm 118-126, when the researcher introduced musical trills (Mm
118-136). The researcher discovered unexpected simultaneous ascending movement in
the Delta/Theta and Beta bands with a descending movement in Alpha (light meditation,
eyes closed) band at Mm 137 as the researcher introduced a rest. To have an
alertness/anxiety and inattention at the same time seemed unusual, and the researcher felt
that we were having non-verbal conversation, pause and breathing. The researcher moved
from tonal center C Major to tonal center D Major in Mm 267. The researcher stimulated
a response in Joshua’s Alpha band, which increased; it indicated a light meditative state.
Alpha was active during the Rest moments for 13 measures. At Mm 345, the researcher
made a decision to reintroduce music with tempo change carefully in order to see if any
other responses come. Theta and Alpha ascended at Mm 346 and the researcher
maintained the tempo for a while. After improvising isolated loud tones of D Major
Chord between Mm 375-390, at Mm 389, Alpha peaked as the researcher ended with D
Major resolution. The researcher made a decision to change tempo and introduced D
Major in a high register.
After a rest at Mm 398, Alpha peaked as the researcher sustained an A pitch in a high register with sustained D in a low register. Delta and Theta ascended at the same time but the researcher was not able to observe those changes during the session. The researcher made a decision to change tempo and introduced D Major in a high register.

After a rest at Mm 398, Alpha peaked as the researcher sustained an A pitch in a high register with sustained D in a low register. Delta and Theta ascended at the same time but the researcher was not able to observe those changes during the session. The researcher introduced tempo changes at Mm 449 because the researcher felt disconnected, then Theta, Alpha and Beta ascended slightly three measures later. After this moment, the Joshua's Delta, Theta and Beta bands were slightly active with the Alpha band until the end of the session. At Mm 555, the researcher introduced a quotation from “Drummer Boy” and “Appassionato II Movement” by Beethoven; the neighboring I-IV-I chord patterns in order to guide Joshua to be awaken. Those changes stimulated a Delta/Alpha/Beta bands increase. The same unusual combination of meditative and cognitive activity occurred as in Mm 137 and it indicated that Joshua might be in between an inattention and alertness state of consciousness. For the purpose of research, the researcher sometimes avoided resolution. Instead of resolving to the tonal center, the researcher delayed the resolution by returning to the IV chord. Delaying resolution gave the researcher an opportunity to continue the musical improvisation; however, resolution and rest were necessary as well.

Jayleen. For Jayleen, Delta (sleep, healing) and Theta (creativity mystical experience, inattention) bands spiked and Alpha band (light meditation, eyes closed) also increased during the transition from silence to music. The researcher stimulated Jayleen
when the music began; however, gradually the participant began to be calmed with the researcher’s sedative melodies and second Delta and Theta peak moments were observed from Mm 72-87.

At Mm 116, Delta (sleep, healing) and Theta (creativity mystical experience, inattention) bands spiked as the researcher improvised within F Major with d minor and Bb Major chords intermingled. The pattern stimulated internal creative focus or hypnagogic imagery in a rapid eye movement (REM) state. The researcher felt comfortable having the non-verbal conversation and repeated same chords structures many times. Since the researcher was not able to observe many changes, the researcher introduced high-pitched melody at Mm 244. However, there were no obvious EEG band responses.

There are interesting observations, in that Alpha (light meditation, eyes closed) and Beta (cognitive tasking, mental activity) movements were similar in Mm 58-300. After a D Major resolution at Mm 302, the Alpha and Beta waves began to separate again. Although the researcher did not recognize it during the session, the researcher analyzed that the resolution initiated a meditative response and cognitive activity at the same time. Although the contradictory Alpha and Beta occasionally did mirror each other, the researcher did not expect these waves would move together for such a long period of time.

When a right hand melody (D D C# C# B ) simultaneously played with left hand chords (D G) repeated five times at Mm 279-292, the participants’ Delta (sleep, healing) and Theta (creativity mystical experience, inattention) spiked at Mm 291. Then the researcher introduced the D Major resolution at Mm 302. The previously less active Alpha (light meditation, eyes closed) band subsequently increased after the fifth
repetition. Although Alpha had been suppressed earlier, and remained active until the end of the session as the researcher improvises.

The researcher introduced a melody in the bass at Mm 357-372. In response, Jayleen's Alpha band increased and remained active until Mm 372 and Delta and Theta crossed up over Alpha again.

When the researcher introduced the chord progression in a higher register at Mm 379, although the Alpha band did slightly change, Delta (sleep, healing) and Theta (creativity mystical experience, inattention) bands began to rise between Mm 384-393, indicating a movement toward healing sleep. The researcher felt calm and relaxed, as well, but a little bit tedious. Sleeping modes mean that the researcher cannot interact with the client? It cannot be answered now.

Figure 3 is showing the relationship the particular musical elements (from the recording, 19:18'-20:10'). Beta bands (cognitive tasking, mental activity) peaked at Mm 446 (19:50') after the researcher changed tempo from *Lento* to *Andante Grazioso* at Mm 442. It indicated that the tempo change may have stimulated Jayleen to a more alert state. The researcher observed the Beta bands peak, and then purposely continued to improvise with an *Alberti type* bass (broken chords), trying to guide the Jayleen back to “restful inattention.”
Figure 3. Beta band waves of Jayleen.

In Mm 460-516, Delta (sleep, healing) and Theta (creativity, mystical experience, inattention) bands increased, showing that the Jayleen achieved a state of inattention as the researcher improvised in a Db Major tonal center. When the researcher introduced trills between Mm 472-478, then a pause and trills between Mm 479-484, the Delta and Theta ascending pattern was interrupted.

Jayleen may have been stimulated by the mysterious effect of the trills. There were similar patterns between Joshua and Jayleen observed. Delta and Theta bands actively responded to the music between Mm 496-516. Jayleen responded to the researcher's V-IV Progression (Ab/Gb in Db tonal center) by reacting with Delta and Theta band response. At Mm 514-515, as the researcher touched the V chord of Db Major, Delta, Theta, Alpha, and Beta bands simultaneously peaked. After the morendo (indicates a decrease in volume or tempo) in Db at Mm 521, the EEG bands were less active until the end of session. The researcher felt connected with Jayleen at the end of the session.
Throughout the session, Delta (sleep, healing) and Theta (creativity mystical experience, inattention) bands moved in a similar pattern. They were both active, both indicated more inattentiveness in Jayleen. Jayleen seemed to experience many moments of contemplation, as the Delta and Theta bands demonstrated. Alpha (light meditation, eyes closed) and Beta (cognitive tasking, mental activity) bands also showed similar movements. They indicated Jayleen’s wavering between cognitive activity and light meditation. However, it is unclear if these phenomena could be caused by environmental light, sounds, and medicine, or troubled rest affecting, which could all affect the ability to achieve healing sleep.

There were four moments that Beta (cognitive tasking, mental activity) moved. In each of the moments, there were transitions in the shape of the improvised music. Therefore, either the therapist’s musical improvisation or the client’s state of mind may have prompted Jayleen toward more mental activity. However, for the remainder of the 150 measures after the fourth attentive event, Jayleen achieved a pattern of healing sleep and relaxation, as the researcher improvised, alternating in Ab, Db and Gb Major tonal centers. Compared to Joshua and Ruth, Delta and Alpha demonstrated the highest level of sleep, healing, and meditation, in Jayleen.

Ruth. The transition from silence to improvised music demonstrated that Ruth had minor changes in her EEG band waves. Her Alpha band showed the highest elevation throughout the entire session and the researcher was unsure about which improvisational music styles to use. Without specific reasons, the researcher tried to use minor and mourning melody lines in the beginning and gradually changed to a Major key. The researcher observed slight descending Alpha band movements at Mm 73, as the music
tempo changed. The researcher tried to connect with Ruth nonverbally and played musical repetitions. However, Ruth’s brain responses were not as immediately obvious as the other participants. As the researcher introduced new musical texture (broken octaves in the left hand), the Alpha band slightly fluctuated at Mm 142.

Ruth did not noticeably respond when the researcher transposed from the tonal center of E Major to that of C Major at Mm 187. The researcher tried to influence the mood by: (a) by moving from a low register motif to a high register slow melody at Mm 230 to fluctuate Alpha; (b) by changing to a Latin rhythm to at Mm 261 to influence minor changes; (c) by introducing a new Waltz texture in C Major at Mm 364 to decrease Alpha; and, (d) by introducing “New Age” sounds at Mm 430, which led to minor changes. The researcher did not think of the responses as inappropriate reactions. Instead, the researcher was abled to focus on Ruth’s relaxed state, which was indicated by Alpha waves.

*Figure 4.* Theta band waves graph of Ruth

![Theta band waves graph of Ruth](image)

At Mm 280-300 (from the recording, 14:20’ to 15:00’), the researcher, to her astonishment, observed that Ruth’s Theta (creative inattention) band ascended and
descended simultaneously with the researcher’s ascending and descending melody line. It indicated that the musical changes might have influenced Ruth’s creativity or internal focus. Although Ruth’s Alpha band still maintained the highest elevation, this was an interesting observation.

At Mm 187-600, the researcher improvised in C Major. Even though the largest portion of this piece was in a C Major Tonal Center, the researcher attempted to affect Ruth by introducing variety of musical shapes, patterns in various registers, contrasting rhythms, textures and melody lines. The improvisation relied on syncopated rhythms, and avoidance of ii- V- I chord progressions. In Mm 537-570, the researcher touched high G many times expecting to alert the Ruth; there were minor changes but she still demonstrated activated Alpha. The researcher concluded that Ruth achieved her desire to relax but it therefore difficult to establish a connection with her.

Throughout the session, Ruth’s Delta (sleep, healing) band remained below 10th degree of frequency, which indicated that she was not in a sleep state at all. It was interesting to see how suppressed Delta was. The researcher preferred improvising on chord IV rather than a musically stronger V7. Between Mm126-127 the researcher could introduce a V chord, but the researcher did not because the researcher wanted to invite Ruth in a peaceful and friendly space. Traditionally, the IV chord is more peaceful and familiar.
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<td>Rhythmic Change</td>
<td>Key Change (C M to D M)</td>
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<td>Sustaining A pitch and D low register</td>
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<td><strong>Treatment</strong></td>
<td><strong>F Major Improvisation</strong> (1-122)</td>
<td>Non Musical Shift or Change</td>
<td>Tempo Change</td>
<td><strong>F Major Tonal Center</strong></td>
<td>High Pitched Melody</td>
<td>5th times of Same Chord Progression</td>
</tr>
<tr>
<td><strong>Jayleen</strong></td>
<td><strong>Measure</strong></td>
<td><strong>Transition</strong></td>
<td>72-87</td>
<td>99</td>
<td>116</td>
<td>244</td>
</tr>
<tr>
<td><strong>Reaction</strong></td>
<td>Spiked δ θ</td>
<td>δ θ 2nd Peak</td>
<td>Minor responses of α β</td>
<td>δ θ Peak</td>
<td>Minor Responses of δ θ</td>
<td>Minor Changes of δ θ (Spike)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Treatment</strong></td>
<td><strong>Bass Melody</strong></td>
<td><strong>High Tone Melody</strong></td>
<td>Tempo Changes to <em>Andante grazioso</em></td>
<td><strong>Db Major Tonal Center</strong></td>
<td>Trills and Pause</td>
<td>Tempo Changes: <em>Adagio</em></td>
</tr>
<tr>
<td><strong>Measure</strong></td>
<td>357</td>
<td>382</td>
<td>442</td>
<td>460</td>
<td>472-484</td>
<td>490-516</td>
</tr>
<tr>
<td><strong>Reaction</strong></td>
<td>α Peak</td>
<td>δ and θ cross up over α (446-448)</td>
<td>β Peak</td>
<td>δ θ Peak</td>
<td>Fluctuate δ θ</td>
<td>δ θ Activate until升降</td>
</tr>
</tbody>
</table>

*NEUROLOGICALLY-INFORMED MUSIC-KING (NIM) FOR RELAXATION*
Table 2. (Continued)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatmen t</td>
<td>E Major</td>
<td>Tempo Change</td>
<td>Tempo Change New Texture: LH Broken Octaves</td>
<td>Resolution</td>
<td>Key Change to C Major</td>
<td>Mood Change by Switching to high register</td>
<td>Rhythm Change to Latin</td>
</tr>
<tr>
<td>Ruth</td>
<td>Measure</td>
<td>Beginning</td>
<td>73</td>
<td>142</td>
<td>161</td>
<td>187</td>
<td>230</td>
</tr>
<tr>
<td>Reaction</td>
<td>Minor changes of $\beta$, $\delta$, $\gamma$</td>
<td>Descending $\alpha$</td>
<td>Fluctuate $\alpha$</td>
<td>Minor descending of $\theta$</td>
<td>Minor Responses of $\delta$, $\theta$, $\beta$</td>
<td>Fluctuate $\alpha$</td>
<td>Minor Responses of $\delta$, $\theta$, $\beta$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>Treatmen t</td>
<td>Ascending/Descending Melody</td>
<td>Rest</td>
<td>New Texture of Waltz in C Major</td>
<td>New Sounds of &quot;New Age Music&quot;</td>
<td>High Pitched of V</td>
<td>Alert of single melody GG</td>
<td></td>
</tr>
<tr>
<td>Measure</td>
<td>280-300</td>
<td>317</td>
<td>364</td>
<td>430</td>
<td>453</td>
<td>537</td>
<td></td>
</tr>
<tr>
<td>Reaction</td>
<td>Activated $\theta$</td>
<td>Descending $\alpha$</td>
<td>Descending $\alpha$</td>
<td>Minor Changes of $\theta$, $\delta$, $\beta$</td>
<td>Ascending $\theta$, $\alpha$</td>
<td>Ascending $\alpha$</td>
<td>Descending $\theta$</td>
</tr>
</tbody>
</table>
Process B (Pattern of responses during the course of the NIM)

This section divided into two parts and demonstrated individual statistical outcomes and graphs (a) Bandpass Amplitude Signal tables; (b) EEG waves were computed for three timed periods for Joshua, Jayleen and Ruth: at baseline (0 sec), beginning of NIM (5 minute), at the end of NIM (25 minute).

Data analyses revealed the following for the EEG measure:

### Table 3. Bandpass Filter Amplitude Signal for Joshua

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>Std. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delta</td>
<td>12.3n</td>
<td>35.1u</td>
<td>8.4u</td>
<td>4.5u</td>
</tr>
<tr>
<td>Theta</td>
<td>9.6n</td>
<td>52.8u</td>
<td>9.7u</td>
<td>5.3u</td>
</tr>
<tr>
<td>Alpha</td>
<td>31.7n</td>
<td>82.4u</td>
<td>18.1u</td>
<td>9.5u</td>
</tr>
<tr>
<td>SMR</td>
<td>10.1n</td>
<td>34.6u</td>
<td>5.6u</td>
<td>3.5u</td>
</tr>
<tr>
<td>Beta</td>
<td>13.1n</td>
<td>46.3u</td>
<td>9.3u</td>
<td>5.3u</td>
</tr>
<tr>
<td>Gamma</td>
<td>2.2n</td>
<td>31.7u</td>
<td>2.9u</td>
<td>1.8u</td>
</tr>
</tbody>
</table>

**Figure 5.** Brain activity levels at specific points of procedures for Joshua.

Delta (sleep, healing), Alpha (light meditation, eyes closed) and Beta (cognitive tasking, mental activity) show a trend toward increased Delta, Alpha and Beta from...
begin to end of the session although Alpha waves decrease during the improvisational music.

Table 4. Bandpass Filter Amplitude Signal for Jayleen

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>Std. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delta</td>
<td>9.8n</td>
<td>122.1u</td>
<td>12.6u</td>
<td>10.0u</td>
</tr>
<tr>
<td>Theta</td>
<td>19.4n</td>
<td>109.6u</td>
<td>13.2u</td>
<td>9.2u</td>
</tr>
<tr>
<td>Alpha</td>
<td>15.5n</td>
<td>65.6u</td>
<td>10.5u</td>
<td>7.8u</td>
</tr>
<tr>
<td>SMR</td>
<td>4.8n</td>
<td>48.0u</td>
<td>5.3u</td>
<td>3.7u</td>
</tr>
<tr>
<td>Beta</td>
<td>8.7n</td>
<td>62.2u</td>
<td>7.1u</td>
<td>4.8u</td>
</tr>
<tr>
<td>Gamma</td>
<td>4.0n</td>
<td>104.7u</td>
<td>2.6u</td>
<td>2.4u</td>
</tr>
</tbody>
</table>

Figure 6. Brain activity levels at specific points of procedures for Jayleen

Jayleen’s EEG demonstrates highest Delta (sleep, healing) and Theta (creativity mystical experience, inattention) waves during the session compare to those of Joshua and Ruth. Despite the transition of the silence to improvisational music (i.e., the brain waves look unique and she is alert as the music begins), Jayleen’s Delta and Theta waves demonstrate that she is in healing sleep or
inattention state. Interestingly, Delta, Theta and Alpha waves show that her relaxation level decreases at the end. Overall, Jayleen seems to visit both alert and relaxed state.

Table 5. Bandpass Filter Amplitude Signal for Ruth

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>Std. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delta</td>
<td>7.0n</td>
<td>53.4u</td>
<td>7.9u</td>
<td>4.5u</td>
</tr>
<tr>
<td>Theta</td>
<td>28.2n</td>
<td>77.6u</td>
<td>15.9u</td>
<td>9.1u</td>
</tr>
<tr>
<td>Alpha</td>
<td>32.4n</td>
<td>132.4u</td>
<td>33.8u</td>
<td>18.4u</td>
</tr>
<tr>
<td>SMR</td>
<td>22.5n</td>
<td>39.7u</td>
<td>8.3u</td>
<td>4.6u</td>
</tr>
<tr>
<td>Beta</td>
<td>23.2n</td>
<td>82.1u</td>
<td>15.4u</td>
<td>8.4u</td>
</tr>
<tr>
<td>Gamma</td>
<td>1.0n</td>
<td>54.9u</td>
<td>2.7u</td>
<td>1.7u</td>
</tr>
</tbody>
</table>

Figure 7. Brain activity levels at specific points of procedures for Ruth.

Throughout the session, Ruth’s Delta (sleep, healing) band remains below 12.61th degree of frequency. Although Ruth did not reach a state of healing sleep, the improvised music consistently affects the Alpha (light meditation, eyes closed) waves, indicating that she maintains and increases a constant state of light meditation.
Throughout the session, Ruth’s Delta (sleep, healing) band remains below 12.61th degree of frequency. Although Ruth did not reach a state of healing sleep, the improvised music consistently affects the Alpha (light meditation, eyes closed) waves, indicating that she maintains and increases a constant state of light meditation.

**Effect A**

In this section, differences between baseline and NIM session EEG levels were compared using a $t$-test. Findings demonstrate that the Theta/Beta ratio changes with each improvisation method, in terms of wave amplitudes. The entire neurological dialogs are in the Appendix A.

**Table 6. Comparison of EEG Measures in Silence and During NIM**

<table>
<thead>
<tr>
<th></th>
<th>$M$ (SD)</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silence</td>
<td>1.42 (0.90)</td>
<td>-</td>
</tr>
<tr>
<td>NIM</td>
<td>1.39 (0.77)</td>
<td>-</td>
</tr>
<tr>
<td>Difference between Groups</td>
<td>-</td>
<td>$p&lt;0.0001$</td>
</tr>
</tbody>
</table>

The $t$-test results demonstrate that the EEG variances between the baseline silence and improvisation states (NIM) are statistically significant. The results demonstrate that the participants’ relaxation levels descended during the improvisational music, meaning they became more alert during improvisation (NIM) compared to the silence.

**Effect B**

In this section, Paired $t$ tests were used to examine the differences between two parts: before and after changes in the musical improvisation.
Table 8. Statistical Differences in EEG Measures Before and After Musical Changes (Theta/Beta ratio)

<table>
<thead>
<tr>
<th></th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tempo Change</td>
<td>0.57</td>
</tr>
<tr>
<td>Key Change</td>
<td>0.52</td>
</tr>
<tr>
<td>Trills</td>
<td>0.31</td>
</tr>
<tr>
<td>Rest</td>
<td>0.62</td>
</tr>
</tbody>
</table>

Figure 8. Theta/Beta Ratio Changes (Improvement) For Each Improvisation Element combined, in one diagram.

This diagram demonstrates that participants’ relaxation level increases when the therapist changes the musical elements in the improvisation. These results show that introducing of Trills and Key Changes indicated an improvement in relaxation; the Theta/Beta ratio demonstrates that changes were achieved for the participants’ most relaxed state as compared to Tempo and Rest changes, when the participants’ degree of relaxation descended.
This diagram demonstrates that participants' relaxation level increases when the therapist changes the musical elements in the improvisation. These results show that introducing of Trills and Key Changes indicated an improvement in relaxation; the Theta/Beta ratio demonstrates that changes were achieved for the participants' most relaxed state as compared to Tempo and Rest changes, when the participants’ degree of relaxation descended.

Discussion

This study demonstrated an interaction between neurological responses and improvised music to promote relaxation based on the Neurologically-Informed Musicking (NIM). The researcher asked the following questions: (1) What form does the NIM process takes when relaxation is a clinical goal? How (if at all) does the process promote relaxation? (2) Are there statistically significant relationships between electroencephalograph (EEG) measurements and NIM improvisation strategies associated with state of silence, rest, unrest, and sleep in a therapeutic setting? Comparisons among visual representations of measurements show (a) baseline EEG fluctuations between Silence and NIM, (b) bandwidth differences before and after changes in specific musical elements of improvisation.

The results revealed significant differences in EEG wave patterns between baseline (silence) and improvisational music. However, there were unexpected outcomes because a major goal of this study was to use brain wave data to immediately promote relaxation. The statistical results further demonstrated that while NIM did help the participants' relaxation level, it also increased non-verbal communication with the
researcher. Occasionally, researchers make discoveries beyond the purposes of their studies. Initially, this research was meant to examine the statistical differences between the recorded baseline status of silence and the EEG band waves when improvisational music (NIM) was introduced during the research session. Since many clients require relaxation as the therapeutic goal, the researcher’s first objective was to use this protocol for relaxation. However, the researcher learned that a therapist could also develop protocols, using this process, to stimulate creative areas of the brain. Various types of clients (Coma, Vegetative State, Depression, NICU, Dementia, Traumatic Brain Injury, etc.) could potentially benefit from further development of this process. For example, the researcher discovered that EEG bands were affected when improvisational music stimulated the clients’ brain activity. At certain moments during the session, the researcher responded to the participants’ EEG band waves by changing the improvisational musical elements. During analyses of the data, the researcher observed that the participant responded to the music with both the Theta bands of creativity and the Alpha bands of Meditation. Therefore, despite the limitations, this study shows that further research will likely use improvisational music and immediate neurofeedback, during music therapy protocols, beyond the goal for relaxation.

The researcher followed and coordinated the improvised music with participants’ brain waves. Furthermore, the researcher sometimes tried to introduce various musical changes and redirect participants’ relaxation in order to assess if the participants were responding to the music or not. In many ways, these processes represented ongoing, interactive assessments. Thus, the processes ended up being less about the degree to which the improvisational music promoted the participants’ relaxation levels, and more
about how the researcher and participants interacted with one another. The researcher discovered possibilities for using real time improvised music and immediate neurological feedback in very diverse settings. Despite the study’s small sample size, the descriptive statistics showed that, although the music improvisations did stimulate participants’ brain waves for relaxation objectives, it also demonstrated a nonverbal communication between the participants and researcher. This study recognizes that future research will find more therapeutic methods of responding to neurological responses using improvised music (during actual sessions), and it allows for more deeply shared nonverbal musical relationships.

According to Carozza (2015), in order to achieve therapeutic goals, it is necessary to use individually tailored protocols in every moment of a music therapy session. The challenge is monitoring how the clients are responding, but there are few ways to assess and evaluate these responses while the clients are listening to improvised music. This research makes it possible to measure participants’ response to music without pausing and asking the client questions. Although some therapists can observe subtle responses such as breathing, or facial expressions, these signs provide only limited access to the client’s internal responses. Therefore, this research opens up possibilities to explore and discover more protocols for non-verbal communication between therapist and client.

There were several moments when Alpha and Theta bands responded individually: tempo change, a sustaining A pitch and low register, and V of Db Major and high pitched of V. These moments were not consistent. Peniston and Kulkosky (1989, 1991) demonstrated that the neurofeedback protocol aims to raise levels of Alpha (8-12 Hz) and
Theta (4-8 Hz) band activity. However, this study’s results did not demonstrate any consistent Alpha and Theta responses based on musical changes.

In addition, there was an interesting moment when the researcher introduced ascending and descending melody for Ruth. Ruth showed the changes of Theta and the subsequent musical changes may have influenced Ruth’s creativity, mystical experience, and inattention. Thompson and Thompson (2003) explain that elevated Theta activity could be related with memory recall and with withdrawing from external stimuli. Moreover, Green (1977) mentioned that deep relaxation and Theta feedback are combinations that are necessary for creativity.

Moreover, the researcher had anticipated that musical rest would produce more relaxation; however, the Theta/Beta ratio indicated the opposite. An explanation could be that the rest stimulated the participants into a state of expectation instead of relaxation. This information is useful when a therapist is reading neurofeedback data as he/she is improvising.

**Clinical Implications**

Gathering electronic data from the client’s brain activities is a powerful tool, especially when the information is available during the actual therapeutic session. In this research, the music therapist uses nonverbal electronic and musical communication to connect with the clients. However, additional therapeutic implications of this research are explored in this section. Based on the results and the effective use of the neurological and musical dialog between the participants and the researcher, the researcher became aware of further potential strategies for applying this research to non-verbal clients. This type of
protocol encourages therapists to develop procedures, not only for helping verbal clients, but also for certain clients with traumatic brain injury, neuro-disability, dementia, abuse history, or depression.

Initially, the researcher designed this protocol to help people relax by using neurological information to direct the improvised music in a real time. The participants were all verbal. During the process of collecting data, however, it became apparent that the therapist could use the feedback, not only for information about the participants’ state, but also he/she could use the information to stimulate areas of the brain. EEG is informative; therefore, other goals could be established.

In the past, researchers have had difficulties measuring non-verbal clients’ reactions to musical stimulation, especially if they are in Vegetative State, NICU, Stroke, and Coma, etc. However, findings suggest that clinicians can measure client levels of relaxation through neurological changes that does not depend on verbal discussion before nor after music therapy. Obtaining electronic feedback during the therapeutic sessions gives the music therapist the ability to assess the clients’ mental reaction to improvised music without relying on words. The therapist follows neurological responses to meet clients’ needs- as displayed in the EEG measurements. This study may have revealed layers of applications using combining neurological and musical strategies.

The Alpha and Theta wavelength movement, in response to music could be a potentially useful clinical tool. However, the protocols require therapists to be trained to read and knowledgeably interpret EEG and electronic data in order to improvise music during therapeutic protocols. Additionally, music improvisation techniques can stimulate children’s brain activity to treat ADD and other behaviors. EEG indexes of relaxation are
typically marked by increments in reduction in frontal Beta activity (Jacobs, Benson and Friedman 1996). Beta and decreasing Theta brainwaves are located at central scalp locations, which affect attention, impulse, and hyperactivity (Linden, Habib and Radojevic, 1996). Therefore, protocols, that include collecting information during therapeutic sessions, have many possibilities for relaxation for treating various disorders with relaxation methods. In this way, the therapist might be able to control the subjects’ active and relaxed state when improvising.

Additionally, this approach is contraindicated for hearing impaired patients. Since music involves vibration, it may be able to use equipment that communicates music through vibration.

Shannon and LaGasse (2013) explains that, “inclusion of neurological functioning and the neurological model in the Scope of Practice suggests that board certified music therapists should have a basic understanding of neurological concepts as they relate to music therapy” (p. 11). She also mentions that, recently, a special interest group for Neurologic Music Therapy (NMT) has been established by the Neurorehabilitation World Federation. The group acknowledges the contributions of NMT to rehabilitation science, and the potential benefits of music-based interventions.

In order to apply NIM effectively, the clinician must possess a number of key competencies. These include music abilities, music theory, color codes of brainwaves, technical skills, ability to develop rapport, and self-awareness.

**Music abilities.** A music therapist normally has the advantages of reading a client’s charts and diagnoses, and observes a client’s sessions in therapeutic settings. However, for this type of research, the music therapist must have skills beyond
instinctively improvising from prepared music scores. The researcher must become expert at following and matching the qualities of the musical improvisation (i.e., emotional characteristics of different keys, chord progressions, dynamics, tempo, register range, harmony, dissonance, and cadence) to the immediate biofeedback, indicated by the color-coded EEG bands display. The music therapist has to be an exceptional musician that can read the brain waves, and spontaneously improvise music.

Music theory. The therapist must have the ability to apply music theory and inspiration of the tonal areas in order to use chord progressions that will affect the client and achieve the goals and objectives of the therapeutic session. For example, there is a difference between the original objective of this research (Relaxation – indicated by Alpha bands, Deep sleep and Drowsiness indicated by Delta and Theta bands) and an interesting observation discovered on analyzing the research (Mental activity indicated by Beta bands). The knowledge for adapting chord progressions - changing keys might be able to help the therapists to guide the clients to achieve their therapeutic goals.

Color code for the brainwaves. In addition, music therapists must prepare the color code for the brainwaves, making sure to always use the same codes for each of the EEG bands. During the therapeutic sessions, the music therapist must be able to recognize the changes in the brain waves as indicated by the color codes EEG bands. The researcher must become adept using innovative strategies and biofeedback technology during the therapeutic session, which is multi-tasking.

In addition, the researcher has to read the information of the screen, which changes every seconds. When the brain waves are signaling that the person is doing cognitive activity, so the music therapist can spontaneously improvise in order to produce
the desired relaxation. Instead of using color-coding, there is an alternative way of getting EEG feedback, such as establishing auditory cues.

**Technical skills.** The researcher should develop technical skills with practice at this innovative research. The researcher must prepare for the session, take into consideration the immediate emotional states of both the therapist and the clients, and in addition, must become familiar with the machinery of connecting the biofeedback electronic equipment, preparing conductive gel and medical tapes, a soft eye mask, positioning a chair, and connecting the keyboard to the Garage Band software program. This is an expertise that will develop over time.

**Relationships and self-awareness.** In addition, the value of the therapeutic relationship is what music therapists should value for future study. Erskine (1998) claims that the relationship between the therapist and client can never be standardized, prescribed, or even quantified. The uniqueness of each therapeutic relationship begins from the therapist’s attunement and involvement. Erskine explains that:

“Attunement is a process of communion and unity of interpersonal contact, which goes beyond empathy and a kinesthetic and emotional sensing of others. Knowing their rhythm, affect and experience by metaphorically being in their skin, and going beyond empathy to create a two-person experience of unbroken feeling connectedness by providing a reciprocal affect and/or resonating responses are attunement” (p, 235).

Most importantly, this study encourages developing an awareness of human musical interaction, especially musical transference and counter-transference, for the therapeutic process. For this type of research, many things could happen before the
sessions, it did not mean that the participant was not listening. The brainwaves’
nonetheless can be positive responses for someone.

Besides eliciting relaxation, this research demonstrated that NIM could
stimulate areas of the brain for other purposes and objectives. The results also
demonstrate the moments that the EEG waves respond to stimulated music. Each time
the therapist uses these therapeutic strategies; he/she becomes more skilled at
understanding the EEG bands’ movement and will become more capable at directing
the improvisation to achieve the desired responses in participants. Using these
methods is complicated but it could be an exciting and optimal way to treat clients in
music therapy.

Reflection upon the Research Process

This research has been fascinating; however, the researcher recognized that
there were several limitations. In this study, there were environmental conditions that
affected the participants’ neurological responses. For example, sudden environmental
noise, loss of electricity, equipment failure, loss of data and music score due to
technological failure. Also, the researcher’s level of confidence using new
interventions interrupted the constancy of the therapeutic session among the
participants. These environmental variables affected this research process.

The room was not a soundproof; one participant even mentioned that during
five minutes of silence, she could hear some sounds from neighboring music practice
rooms (i.e., voice and instruments such as flute and trumpet). The researcher’s
expertise using the equipment as student affected her composure. Future research
would develop a researcher’s skills as well as taking precautions such as giving
participants earplugs (for establishing baselines during the silent moments) in order to
get a more accurate brainwave data that influences therapeutic improvisations during sessions.

Moreover, statistical issues such as a small sample size, technical differences in the number of utilized leads, and differences in band definition are important limitations. The results are also dependent on the studied population. Future research may examine this protocol with students in a school setting and patients in a hospital. Some practical questions that can be asked are: How would the results be impacted if the researcher were to become more practiced? How would the results be impacted if music therapy students who already are familiar with NIM were participants? Future investigations may examine the relationship between GIM and neurological response. Different levels of consciousness of relatedness of GIM could be interesting to measure using biofeedback. Future research could also measure the therapist’s EEG waves as extra information in order to assess the therapist’s brain activity.

One serious limitation of this study was the utilized Garage Band software program. It provided technical difficulties that resulted in lost data for two participants. Although the pitches were technically correct, they did not reveal the true tonal structure. In addition, rhythmically, the software did not reveal the simplicity of the rhythmic pulse. However, future studies might be able to elicit some notable outcomes.

Additionally, there were other limitations to the study: participants’ responses are sometimes obvious, but not always, and the sophisticated EEG number changes are not able to guide the researcher to meet participants’ needs during the entire session. There are also outside variables (i.e., caffeine, sleepiness, worries, problems, and so on) that may influence brainwaves. Nevertheless, this study illustrates an
approach to interacting in music therapy and its findings encourage future study and clinical work.

It is also important to question if the participants were in a relaxed state because of the music, or for other reasons. Throughout the 20 min of improvised music, even as the researcher introduced the musical changes of all types, there were absolutely no noteworthy EEG wave changes for Joshua and Ruth. This raises more questions than it provides answers.

Another limitation was that there was only one experimental session with each participant. Future studies might be able to try to work with as many people as possible to expand scopes of study. Also, future studies can investigate 10 sessions with one participant to see results as the therapist and client relationship builds over time.

Future studies could study the effectiveness of musical features on perceived emotion. Can improvisational music, which is interactions of loudness, melodic contour, harmony, tempo, durations, texture, timbre, and instrumentation, contribute to the perceived emotion? Also for the future studies, instead of using silence as the baseline, it would be interesting to see the baseline started off in an urban setting or with loud music.

There are several considerations that must be taken into account for future research. First, the technique of collecting and observing neurofeedback has to be practiced often in order for the therapist to become adept at using the information in the actual settings. In addition to the general plans for the musical techniques of improvisation, the therapist must have a clear knowledge of the color-coded EEG bands. Once familiar with neurofeedback, the researcher or therapist could immediately use the feedback to guide the participant’s cognitive stages and direct the
music to produce the desired effect of relaxation. Further studies may help clarify the relationship between EEG movements and improvised music.

The Therapist has to understand what's going on, and understand to improvise in order to get desired protocols. Even though the researcher improvises, she is not improvising *ex nihilo*. The researcher is improvising while responding in keys, musical changes, and so on, but still 100% not sure. The researchers always have to leave room for discovering patterns and never sure what will happen in real situations.

**Conclusion**

In conclusion, this study used the novel protocol NIM- observing participant brain waves, recognizing their needs for either stimulation or rest, and choosing improvised musical elements to ultimately guide them into a state of relaxation. It was fascinating to share appropriate improvised music, experimenting with new strategies based on electronic feedback and stimulating their unconscious world. Music therapists must practice the application of this emerging music therapy strategy; further research is needed to support this clinical application of gathering neurological information and developing improvisation protocols in a real time therapeutic sessions. This is a never-ending story of finding diverse and innovative healing tools to achieve therapeutic goals for clients with various syndromes. The world will know the meaning and importance of music therapy when the music therapists and students plant seeds, observe, and experience the reward of healthy patients with beautiful minds.
References


NEUROLOGICALLY-INFORMED MUSIC-KING (NIM) FOR RELAXATION


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Appendix A

Supplementary EEG waves
1. Joshua

- Delta
- Theta
- Alpha
- Beta

Graph showing brainwave activity over time.
2. Jayleen

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![Graph showing neurophysiological data with labels Delta, Theta, Alpha, Beta, and a horizontal line labeled 'F Major Improvisation'.]
NEUROLOGICALLY-INFORMED MUSIC-KING (NIM) FOR RELAXATION

5th times of Same Chord Progression

Resolution

Bass Melody
High Tone Melody

Tempo Changes to Andante grazioso
3. Ruth
NEUROLOGICALLY-INFORMED MUSIC-KING (NIM) FOR RELAXATION

![Graphs showing brain activity over time](image)

- Delta
- Theta
- Alpha
- Beta

High Pitched of V

Alert of single melody GG

20 Min

25 Min