11-15-2013

Neural Activation on Guided Imagery and Music: A Functional MRI Study

Sang Eun Lee
Lesley University

Recommended Citation

Lee, Sang Eun, "Neural Activation on Guided Imagery and Music: A Functional MRI Study" (2013). *Expressive Therapies Dissertations*. 80.
https://digitalcommons.lesley.edu/expressive_dissertations/80

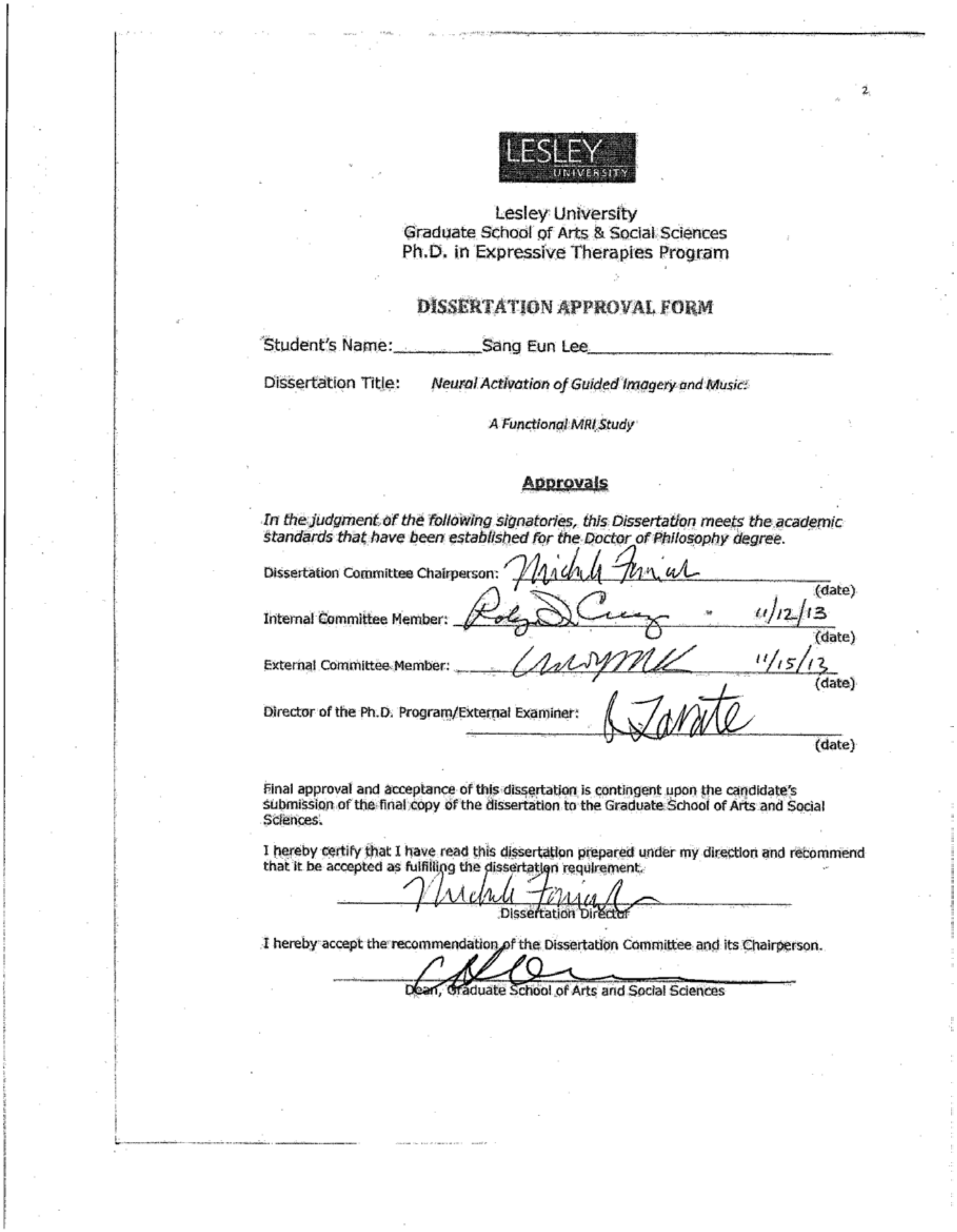
NEURAL ACTIVATION ON GUIDED IMAGERY AND MUSIC: A FUNCTIONAL MRI STUDY

A DISSERTATION
Submitted by

SANG EUN LEE

In partial fulfillment of the requirements
For the degree of
Doctor of Philosophy

LESLEY UNIVERSITY
November 15, 2013



2

LESLEY UNIVERSITY

Lesley University
Graduate School of Arts & Social Sciences
Ph.D. in Expressive Therapies Program

DISSERTATION APPROVAL FORM

Student's Name: Sang Eun Lee

Dissertation Title: *Neural Activation of Guided Imagery and Music:*

A Functional MRI Study

Approvals

In the judgment of the following signatories, this Dissertation meets the academic standards that have been established for the Doctor of Philosophy degree.

Dissertation Committee Chairperson: ____________ (date)

Internal Committee Member: ____________ 11/12/13 (date)

External Committee Member: ____________ 11/15/13 (date)

Director of the Ph.D. Program/External Examiner: ____________ (date)

Final approval and acceptance of this dissertation is contingent upon the candidate's submission of the final copy of the dissertation to the Graduate School of Arts and Social Sciences.

I hereby certify that I have read this dissertation prepared under my direction and recommend that it be accepted as fulfilling the dissertation requirement.

Dissertation Director

I hereby accept the recommendation of the Dissertation Committee and its Chairperson.

Dean, Graduate School of Arts and Social Sciences

STATEMENT BY AUTHOR

This dissertation has been submitted in partial fulfillment of requirements for an advanced degree at Lesley University and is deposited in the University Library to be made available to borrowers under rules of the Library.

Brief quotations from this dissertation are allowed without special permission, provided that accurate acknowledgment of sources is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the Graduate College when in his or her judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

SIGNED: Sang E. Lee

ACKNOWLEDGEMENTS

To those who supported me throughout my doctoral journey, my sincere appreciation.

First, thank you to my doctoral committee, Dr. Michele Forinash and Dr. Robyn Cruz, members of faculty at the doctoral program in Expressive Therapies at Lesley University, and Dr. Hyunwook Park, member of faculty in Department of Electrical Engineering at Korean Advanced Institute of Science and Technology (KAIST), for their constant encouragement, intellectual support, and of course tolerance and patience. I especially acknowledge the support I received from my advisor and dissertation committee chair, Dr. Michele Forinash. She believed in my process from the start, which enabled me complete my work successfully. I am very indebted to Dr. Robyn Cruz in that she strongly supported me until the last moment in my process of dissertation. Further, thanks to the support and consideration from Dr. Hyunwook Park, I could complete the dissertation as conducting this fMRI experiment. Again, my gratitude.

In addition, I am deeply grateful to Dr. Yeji Han, member of faculty and Dongmi Im, fMRI analysis assisstant at fMRI center, KAIST who generously gave many hours of their valuable time to ensure all fMRI experiment processes were done properly. Further, I am deeply grateful to my editor, Michele Morris, member of faculty at the English Language Center at Michigan State University for the language skills he taught me to apply to my text.

To my family, I express my deep appreciation. Without their love and long kindness, I could have not completed this journey. My family was my constant catalysts of strength and endurance all these years. Besides, I would like to express my heart-felt gratitude to my friends and seniors who always supported and prayed me to overcome a lot of difficulties during the doctoral period.

Most important, my greatest gratitude goes to my Heavenly Father who has blessed me with these amazing people. He made all this possible. Thank you, Lord.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

Figure

ABSTRACT

Music and imagery have been used for working emotions such as awareness, arousal, enhancement, reflection and transformation of emotions in therapeutic relationship; these are crucial processes in music psychotherapy. To illuminate the empirical adequacy of concepts of theory in guided imagery and music (GIM) as one of music psychotherapeutic methods, the present study investigated the neural bases of arousal and emotional processing in response to recall and re-experience of personal negative emotional episodes via GIM and the efficacy of GIM for arousal and emotional processing via functional magnetic resonance imaging (fMRI) data.

For this study, classical music and verbal stimuli were presented to 24 right-handed healthy participants, to measure the blood oxygen level dependent (BOLD) signal changes during arousal and emotional processing through GIM. Volume analyses for the contrast of GIM to guided imagery (GI) or music and region of interest (ROI) analysis for the difference of three conditions - GIM, music, and GI – were conducted in the regions of bilateral amygdala, insula, and anterior cingulate gyrus. Results included that in the contrast of GIM to music, 11 neural regions (left anterior cingulate gyrus, left amygdala, left thalamus, left claustrum, left insula, bilateral precentral gyrus, left superior temporal gyrus, bilateral middle temporal gyrus, left inferior parietal lobule, right cuneus, and bilateral culmen) were activated, whereas there was no activated neural regions in the contrast of music to GIM. In the contrast of GIM to GI, 9 neural regions (right posterior cingulate gyrus, bilateral parahippocampal gyrus, bilateral precentral gyrus, left superior frontal gyrus, left middle frontal gyrus, bilateral middle occipital gyrus, bilateral cuneus, right lingual gyrus, and inferior parietal lobule) were activated, whereas 3 neural regions

(right superior temporal gyrus, bilateral middle temporal gyrus, and left inferior parietal lobule) were activated in the contrast of GI to GIM. The ROI analysis revealed statistically significant differences among three conditions in bilateral amygdala, insula, and anterior cingulate gyrus.

Findings suggest that guided imagery and music as multimodal stimuli are effective approach in emotional work with personal episodic memories, indicating activation of various neural regions functioning in emotions, various kinds of sensory modalities, integration of cross-modal sensory, episodic memory, empathy, and out-of-body experience.

CHAPTER 1

Introduction

Awareness, arousal, enhancement, reflection, and transformation of emotions in therapeutic relationship are approaches in several psychotherapeutic philosophies (Greenberg & Pascual-Leone, 2006). Thus, a number of studies have been conducted to corroborate the therapeutic effectiveness of emotional processing (Coombs, Coleman, & Jones, 2002; Greenberg et al., 2006). Traditionally, for emotional processing, talk has been used in therapy and counseling. However, to work effectively with clients, each of whom has a different expressive style, various artistic modalities using an expressive form for communication have been used (Malchiodi, 2007). One of these modalities is music.

Music arouses, evokes, and expresses emotions and human personality traits such as grief, aggression, tenderness, and calmness (Robinson, 1994), so that music is described as the language of emotions (Gfeller, 2008; Langer, 1942; Winner, 1982). According to Goldberg (1992), music has emotional elements crucial in consciously generating and in unconsciously generating emotions. This being so, music has long been used as a healing tool for attaining harmony and balance between body and mind. Also, music can induce imagery, which reflects human emotions and personalities and has symbolic meanings. However, imagery has been ignored by experimental psychologists who considered that mental imagery had no functional significance and that it is difficult to provide controllable material for empirical work (Deese, 1965; Sheikh & Panagiotou, 1975). Since the late 1960s, as researchers emphasized scientific inquiry and provided image theories for elucidating phenomena as behavioral expressions (Greenwald, 1970; King, 1973, Lang, 1979; Sheikh et al., 1975), the use of mental imagery in psychotherapy became important (Ahsen, 1972; Gendlin & Olsen, 1970; Sheikh et al., 1975; Shapiro, 1970). Thus, many researchers examined the advantages of mental images for therapeutic interaction (Sheikh et al., 1975) such as relationship between images and emotional reactions, the power of images as stimuli (Lazarus, 1971; Sheikh & Panagiotou, 1975), images as intuitive mediators (Ahsen, 1972), and images producing perceptual clarity (Bugelski, 1968). Moreover, the importance of imagery in psychotherapy still has been acknowledged in many aspects such as emotional imagery related to fear and anxiety (MeNeil, Vrana, Melamed, Cuthbert, & Lang, 1993; Vrana, Cuthbert, & Lang, 2007) and memory reflected on imagery (Edwards, 2007; Hackmann & Holmes, 2004). Thus, these aspects have been influential in developing therapeutic techniques and theories.

In particular, the representative music-centered psychotherapy method focusing on music and imagery is the Bonny Method of Guided Imagery and Music (BMGIM). It uses specifically-sequenced classical music programs to stimulate and sustain an individual's inner journey, and to positively transform emotions through imagery (Bonny, 1978a; McKinney, Antoni, Kumar, Tims, & McCabe, 1997; Reid, 1989). In other words, music is a catalyst in inducing imagery and evoking and intensifying emotions in imagery (McKinney, et al., 1997). Moreover, emotional responses to music and imagery change physiological and psychological aspects. Therefore, music and imagery are crucial factors in the BMGIM method.

Accordingly, studies in various fields - including in neuroscience - have been conducted about the function of music and imagery for verifying the effectiveness for therapeutic techniques and theories. However, in neuroscience in particular, it has been intensively and scientifically studied for only about the last 20 years. During this period, music and imagery have been studied in neural networks pertinent to emotional recognition. Currently, neuroimaging techniques including positron emission tomography (PET) and functional magnetic resonance imaging (fMRI) demonstrate the activations of cortical and subcortical structures represented as responses to specific tasks or stimuli related to music and imagery. Demonstrating such neural dynamics can locate and highlight the relationship between activated neural regions and tasks or stimuli related to music and imagery; this helps to develop new treatments and to predict treatment outcomes. Particularly, BMGIM achieves therapeutic goals as accessing and reintegrating memories in traumatic imagery which recur as direct sensory and emotional experiences with distortion (Körlin, 2002). Accordingly, research based on neuroscience can support the rationale for clinical use of music and imagery, and contributes to development of the BMGIM method.

The present study's purpose was to investigate the neural basis of arousal and emotional processing as responses to guided imagery and music with personal emotional episodes and the effectiveness of guided imagery and music with personal emotional episodes for arousal and emotional processing as providing fMRI data. For this, neural activations by guided imagery and music, guided imagery, and music, were examined with the following research questions:

1. Which neural regions will be activated by guided imagery and music, compared to music?

2. Which neural regions will be activated by guided imagery and music, compared to guided imagery?

3. Are there significant differences of the blood oxygen level dependent (BOLD) signal changes among three conditions – guided imagery and music, guided imagery, and music - in neural regions associated with negative emotional processing?

CHAPTER 2

Literature Review

This chapter supports arguments for research about the psychotherapeutic potential of music and imagery, reviewing literature on music and imagery from the neuropsychological viewpoint. It comprises four sections: the first presents literature on music and imagery as psychotherapeutic tools; the second presents literature on neural activation by emotional processing, especially negative emotions; the third presents literature on neural activation related to emotions as responses to musical stimuli; the fourth presents literature on neural activation as responses to imagery.

Music and Imagery as Psychotherapeutic Tools

Music long has been related to emotional expression. It often has been considered as the language of emotions (Gfeller, 2008; Langer, 1942; Meyer, 1956; Trainor & Schmidt, 2003; Winner, 1982). Music expresses not only emotions, but also human personality characteristics such as aggression, tenderness, and calmness (Robinson, 1994). According to Goldberg (1992), music has emotional elements such as mode, rhythm, and tempo which generate conscious as well as unconscious emotions. Also, Orleans (1991), who developed a musical projective technique, mentioned musical elements reflecting human emotions. According to him, anxious or depressed individuals projected their feelings into all music selections, and feelings are reflected by musical tempo, melody, and rhythm. Since antiquity, music has been used as a healing tool, to attain harmony between body and mind. Also, music can induce imagery. Osborne (1981) investigated human responses while listening to music in a relaxed state. Via two experiments, he categorized types of responses to music as thoughts, emotions, sensations, and images. The study indicated that imagery was a principal response to music as image responses were significantly greater than other response types.

As noted above, music and imagery reflect human emotions and personality. In particular, imagery has symbolic meanings associated with inner issues. Music could accompany imagery with specific moods. This implies that music and imagery can be used as crucial psychotherapeutic tools, for instance as relaxation techniques (Bonny, 1989; Browning, 2001; Clark, McCorkel, & Williams, 1981; Colwell, 1997; Daveson, 1999; Edwards, 1998; Fratianne, Prensner, Huston, Super, Yowler, & Standley, 2001; Good, Stanton-Hicks, Grass, Anderson, Lai, Roykulcharoen, & Adler, 2001; Scartelli, 1984; Sahler, Hunter, & Liesveld, 2003; Standley, 2000; Tan, Yowler, Super, & Fratianne, 2008). Further, the effects of relaxation such as reducing anxiety or fear, and to treat painful emotions relative to psychological issues, have contributed to music being developed as a psychotherapy method (Codley, 1987; Pelletier, 2004; Robb, Nichol, Rutan, Bishop, & Parker, 1995; Standley, 1986, 2000).

The Bonny method of guided imagery and music (BMGIM) developed by Helen Bonny in the early 1970s is a representative music-centered psychotherapy that intentionally integrates music with imagery in therapeutic intervention (Band, Quilter, & Miller, 2001-2002). It uses specifically-sequenced classical music programs to stimulate and sustain inner journeys through imagery. Music as a catalyst in such holistic processes (McKinney et al., 1997) evokes emotions, memories, and all types of sensory and cognitive imagery via interaction (Bonny, 1978a). This method helps positive transfer of emotions in finding and resolving inner issues with painful emotions, by exposing and exploring them (Bonny, 1978b; McKinney et al., 1997; Reid, 1989). That is to say, emotional responses to music and imagery change physiological and psychological aspects. Thus, it can be said that, in the BMGIM method, music and imagery are crucial elements. Many practitioners and researchers have described the effects of music and imagery as psychotherapeutic elements explaining the therapeutic process of BMGIM in individual subjective experiences.

Since the 1990s, researchers have been interested in musical processing for internal body systems, including the autonomic nervous system (Hodges, 1996; Thaut, 2002). Researchers have demonstrated the effect of music and imagery as evidence-based research (Jacobi, 1994; McDonald, 1990; McKinney et al., 1997; McKinney & Tims, 1995; McKinney, Tims, Kumar, & Kumar, 1997; Wrangsjö & Körlin, 1995). As the study related the effect of reducing stress and changing mood, McKinney et al. (1997) investigated the effects of guided imagery and music (GIM) on mood changes including depression, fatigue, total mood disturbance (TMD) and cortisol level associated with a number of harmful effects on health in stressed individuals as a steroid hormone. Twenty-eight healthy adults with experiences of GIM, hypnosis, and psychosynthesis sessions were randomly assigned to an experimental group (*n*=14) and a control group (*n*=14). They were provided six GIM sessions biweekly by a professional GIM therapist. Profile of Mood States (POMS) was used to measure mood change (every 2 weeks before each session), and blood sampling measured changes in cortisol levels (a week before the first session, a week after the last session, and 6 weeks later). Results showed that the scores of depression, fatigue, TMD, and cortisol levels of the experimental group were significantly reduced, as compared with the control group. Moreover, there was significant correlation between decreases in cortisol levels and mood disturbance. In addition, these effects remained at 12 weeks after the first session. This study indicates that GIM affects mood change and reduces cortisol levels.

To demonstrate the physiological effect of classical music and imagery, McKinney, Tims, Kumar, and Kumar (1997) demonstrated the effect of classical music and imagery on decreasing plasma β-endorphin with healthy adults. Seventy-eight participants chosen via eight health and psychological criteria were assigned randomly to one of four groups: Music Imaging (MI), Silent Imagery (SI), Music Listening (ML), and control group. The same classical music piece, as a musical intervention, was provided to the MI and the ML groups. Also, induction for relaxation was provided to MI and SI, but absent any instruction for imaging. To remove influence due to differing time period of interventions applied to each group, quiet free time was provided to the ML group instead of time for relaxation induction applied to the MI and SI groups. Quiet free time also was provided to the control group during interventions applied to other groups. The level of plasma β-endorphin in the MI group was significantly more reduced than in the other groups. The SI groups also showed decreased levels of plasma β-endorphin. This result indicates that music and imagery is effective in relaxation.

Wrangsjö and Körlin (1995) demonstrated the effects of BMGIM for applicability in psychiatry as a psychotherapy method. Fourteen participants with psychiatric symptoms such as depression or crisis reactions, and inner issues such as interpersonal relationships, but without any psychotic symptoms, participated, and were treated by therapists trained in BMGIM. Participants received individual sessions for 90-120 minutes; six participants received fewer than 10 sessions, while six received 10-20 sessions. Unexpectedly, two left after 15 sessions. The experimental design was a pre-post repeated measures design. For measurement, the Hopkins Symptom Check List (HSCVL-

90), the Inventory of Interpersonal Problems (IIP), and the Sense of Coherence Scale (SC) were used. Results were that psychiatric symptoms were decreased significantly by GIM therapy sessions. Especially, perception of life experiences as meaningful and manageable, as measured by the SC scale, was increased significantly. These results indicated that GIM helped improve psychiatric symptoms, and helped resolve interpersonal issues. It is meaningful that this study applied music and imagery to participants for reducing their psychotic symptoms, but not for relaxing.

Recent study of music and imagery in the field of neuroscience is interesting. Hunt (2011) investigated BMGIM therapeutic effect of using the neurophenomenology approach which combines participants' descriptions of music and imagery experience, and brain data. Four participants experienced six different kinds of individual sessions using pre-recorded music and verbal instructions for collecting both data. Phenomenological interviews including modality and stability of imagery, awareness of guiding, music, and altered state of consciousness (ASC) and electroencephalography (EEG) data were collected. Cross-case comparisons integrating both data for each participant determined patterns of individual experience and brain activity. Results showed that ASC involves constant imagery experience with physical relaxation; there are patterns of neural regions activated by imagery with similar real life processes, and beta and gamma frequencies are crucial in maintaining an ASC during imagery experience. Thus, this study indicated that GIM manifests internal subjective experience in biological phenomena, and that GIM is a unique, powerful therapeutic tool for engaging body and mind.

As mentioned above, music and imagery effectively reveal various psychological and physiological needs. Prior research focusing on individual subjective experiences explained the effect. And since the 1990s, evidence-based research indicates effectiveness as combined therapeutic tools. In particular, as Hunt (2011) investigated the effectiveness in neurophenomenology, music and imagery were strongly supported as powerful psychotherapeutic tools.

Neural Activation and Emotions

Emotion as an important aspect of human experience (Vytal & Hamann, 2010) is a complicated theoretical concept in human nature (Ekman & Davidson, 1994; LeDoux, 1995). Also, as a powerful motivator, emotion generates actions and organizes behaviors for prominent goals (Davidson & Irwin, 1999; Leknes & Tracey, 2008). That is to say, emotion triggers specific behavior by certain stimuli such as an objects or situation, and is used to regulate homeostasis of the human organism such as avoiding danger or using benefits for humans (Damasio, 2011). Thus, working emotions such as awareness, arousal, regulation, active reflection, and transformation of emotions are crucial processes in psychotherapy. In particular, awareness of distressing emotions - via approach and exploration - is the first step towards feeling better (Greenberg et al., 2006). Thus, emotions have been studied variously as aspects of psychology, such as emotion in cognitive processing, conscious and unconscious emotional processing, physiological signals via emotions, and so on (Ekman & Davidson, 1994)

As neuroscience has been developed with neuroimaging techniques such as positron emission tomography (PET) and functional magnetic resonance imaging (fMRI) since the early 1990s, researchers have been interested in neural activation by emotions, and studies in affective neuroscience have increased (LeDoux, 2000; Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012) including focus on the fear mechanism in amygdala, which suggests the importance of interactions between cognitive and emotional processes for understanding mind and brain (LeDoux, 2000).

Morris, Frith, Perrett, Rowland, Young, Calder, and Dolan (1996) investigated differences between neural responses in amygdala to facial expressions of fear and happiness. While five healthy participants were viewing fearful or happy faces in various intensities using photographs, PET measured neural activities. Neural responses to fearful expression compared to happiness were activated significantly in the left amygdala, left periamygdaloid cortex, left cerebellum, right superior frontal gyrus, and left cingulated gyrus, whereas happiness expression, compared to fearful, activated in the right medial temporal gyrus, right putamen, left superior parietal lobule, left calcarine sulcus ($p < .001$, uncorrected). Results thus showed neural responses to fearful expression were involved in amygdala. Moreover, in responses significantly interacting with the emotional intensity indicated by behavioral tests, including rating and discrimination tests, neural activity results coincided with cognitive behavioral perceptions.

Recently, studies supported that basic emotional processing (anger, fear, disgust, happiness, and sadness), including changes of expressions, memories, imagery, and other cognitive activities, have consistent and specific neural correlates in limbic, paralimbic, and cortical neural regions (Davidson, Putnarn, & Larson, 2000; Davidson & Slagter, 2000; Lee, Meador, Loring, Allison, Brown, Paul, Pillai, & Lavin, 2004). To examine this assumption, studies used functional neuroimaging techniques, such as fMRI or PET, which measure blood oxygen level dependent (BOLD) signals or regional cerebral blood flow (rCBF) (Phan, Wager, Taylor, & Liberzon, 2002). Thus, showing changes in the BOLD signals or rCBF, the studies demonstrated the relationship between emotions and the activated neural regions.

Lee et al. (2004) examined brain circuitry in terms of emotional experiences and differences of the activation of the cerebral hemispheres between positive and negative emotional experience. Through this study, they supported the theory about regular neural patterns represented by the type of emotions. Participants were 10 healthy individuals without a history of, or current facts indicating, neurological or psychiatric illness or of alcohol or substance abuse. To demonstrate relationships between emotions and neural activations, 20 positive, 20 negative, 20 neutral, and 20 non-sense drawings were provided, presenting negative and positive emotional images. For measurement, functional MRI was used. Results showed that emotional processing and affective experience by emotional pictures significantly increased blood flow in the mesial frontal gyrus, anterior cingulate gyrus, dorsolateral frontal gyrus, amygdala, anterior temporal regions, and cerebellum bilaterally. In addition, positive pictures activated the left hemisphere, whereas negative pictures activated the right hemisphere. Results supported theories about the importance of circuitry linking mesial temporal-, anterior cingulate-, and frontal- gyri with subcortical structures in positive and negative emotional processing and affective experience.

In many studies conducted on supporting neural correlates with emotions, some research strongly supports the correlation between brain regions and emotional processing, showing overall neural correlates with emotions through meta-analysis across previous studies (Barrett & Wager, 2006; Kober, Barrett, Joseph, Bliss-Moreaw, Lndquist, & Wager, 2008; Lindquist et al., 2012; Murphy, Nimmo-Smith, & Lawrence, 2003; Phan et al., 2002; Vytal et al., 2010). Moreover, these meta-analyses were conducted focusing on two approaches: locationist approaches, in which basic emotion categories consistently and specifically map on to neural regions; and psychological constructionist approaches, in which various emotional operations including emotion, perception, and cognition consistently occur across various neural regions and emotional categories (Lindquist et al., 2012).

As the first meta-analysis, Phan et al. (2002) examined common or segregated patterns of neural activations by various emotional tasks via a meta-analysis across studies in functional neuroanatomy of emotion with functional magnetic resonance imaging (fMRI) and positron emission tomography (PET). Between 1993 and 2000, this study compiled 55 studies, i.e., 43 PET and 12 fMRI, investigating emotions in healthy participants. They classified the brain as 20 non-overlapping regions, and characterized each region according to responses by individual emotions (fear, sadness, anger, etc), induction method (visual, auditory, autobiographical recall/ imagery), and presence and absence of cognitive demand. Results showed that emotional processing activates in the medial prefrontal cortex; fear is associated with activation of amygdala; sadness contributes to activation of the subcallosal cingulate; the occipital cortex and amygdala activate by emotional induction via visual stimuli; emotional recall/imagery activates in the anterior cingulate and insula; and emotional tasks with cognitive demand involve the anterior cingulate and insula. This study identified patterns and regions that are crucial components of the neuroanatomy of emotion. Thus, it is meaningful that this study powerfully supported the theory about regular neural patterns about specific emotions as synthesizing related previous quantitative research.

The latest meta-analysis was by Lindquist et al. (2012) who reviewed 91 PET and fMRI studies with induction for eliciting emotional experience and perception of fear, sadness, disgust, anger and happiness published between 1990 and 2007. They supported the meta-analysis by Kober et al. (2008) who determined consistent neural patterns during emotional processing and perception across 162 studies. Moreover, this study was characterized as comparing locationist approaches with psychological constructionist approaches. As a result, there were consistent and selective activated regions for emotional experience or perception, but there was no region with psychological constructionist approaches. Thus, the authors proposed that regions such as amygdala, anterior insula, and orbitofrontal cortex contribute to basic feelings including pleasure and displeasure. For example, motivationally significant external information or novel or uncertainty stimuli activate in amygdala, emotional awareness in anterior insula, and integrating sensory information in orbitofrontal cortex. Besides, closely-related regions for basic feeling are anterior cingulate for attention and motor response, dorsolateral prefrontal cortex for attention, dorsomedial prefrontal cortex and hippocampus for simulating past experience such as knowledge and memory, and ventrolateral prefrontal cortex for language.

As reviewed above, many studies supported that there are consistency and specificity of regions activated by emotional categories such as fear, anger, happiness, disgust, and sadness (Dalgleish, 2004; Davidson & Sutton, 1995; Ledoux, 1995). Representative regions activated by emotional categories are amygdala, prefrontal cortex, anterior cingulate, ventral striatum, insula, and cerebellum (Dalgleish, 2004). Amygdala is a crucial region for producing emotions, in particular negative emotion, especially fear (Ledoux, 1995). According to Davidson et al. (1995), the function of the prefrontal cortex is maintaining emotions and organizing behaviors for particular goals with the important role for regulating emotions and behavior. Beside, much research investigated the functions of anterior cingulate related to attention, subjective emotional awareness, and the launch of motivated behaviors; ventral striatum activated by positive emotions; insula activated by body experiences of emotions, especially disgust; and cerebellum for emotional regulations.

Studies reveal that various neural regions are activated according to emotional categories. However, there are the cognitive aspects such as memory, attention, perception, and mental imagery other than affective factor, for emotional arousal (Cacioppo & Gardner, 1999; Kober et al., 2008; Lindquist et al., 2012). Thus, studies have been conducted on emotional and non-emotional processes (Davidson, 2000).

Studying emotional processes by episodic memories, Damasio, Grabowski, Bechara, Damasio, Ponto, Parvizi and Hichwa (2000) investigated the neural basis of four target emotions and feelings: sadness, happiness, anger, and fear induced by recalled and re-experienced personal life episodes. Thirty-nine participants, without neurological or psychiatric disorder and not taking any medication, participated in a PET experiment, during which participants were requested to recall, re-experience and re-enact personal emotional episodes with the four emotions, and to recall a specific same episode that was emotionally neutral. Results showed that the four emotions activated in structures such as the insular cortex, secondary somatosensory cortex, cingulate cortex, and nuclei in brainstem tegmentum and hypothalamus, which are related to the representation and/or regulation of the organism state. In addition, some regions mentioned above, such as some brainstem nuclei, hypothalamus, and subsectors of insula and cingulated, produce regulative signals indispensable to conserve homeostasis, indicating the close anatomical and physiological relationship between emotion and homeostasis. Thus, the result supports that the feeling state of emotions is based on specific neural patterns, which are continuously changed by emotional state.

Hamann (2001) reviewed current research findings about cognitive and neural mechanisms implicated in encoding, consolidating, and retrieving explicit emotional memory. Hamann's review used data from neuroimaging studies with normal participants, which used positron emission tomography (PET) and functional magnetic resonance imaging (fMRI) as measurements. According to this review, both positive and negative emotional stimuli create memory representation, and the processes of encoding and post-encoding of events with emotional stimuli influence memory representation. Moreover, consolidation processes - i.e., processes of post encoding - activate the amygdala. It was also noted that the amygdala constantly relates to negative emotions and emotional memory for negative stimuli. However, recent research demonstrates amygdala activation for positive stimuli. Thus, this argument, in addition to previous research, notes that emotional arousal and associated amygdala activation appear to be primary factors modulating memory for emotional stimuli, regardless of kinds of stimuli (Hamann, Timothy, Scott, & Clinton, 1999; Cahill & McGaugh, 1998). Accordingly, many neuroimaging research studies consistently have found the amygdala and associated limbic areas to be involved in encoding, consolidating, and retrieving of emotional explicit memory for negative- as well as for positive- emotional stimuli.

Neural patterns of emotional stimuli are still being studied, so this matter is still being discussed and debated. However, as reviewed above, a number of studies support neural mechanisms with regular neural patterns activated by specific emotions.

Neural Activation and Music in Emotions

Across cultures, various kinds of music evoke emotional responses (Peretz & Hebert, 2000; Trehub, 2003). They powerfully arouse, evoke, and express emotions and human personality characteristics such as aggression, tenderness, and calmness (Robinson, 1994). Moreover, emotional states are intensified and transformed by music (Juslin & Västfjäll, 2008). According to Krumhansl (1997), music is a stimulus for strongly evoking emotions with positive and negative emotional valence. Thus, music enhances emotional experience as an intriguing stimulus (Baumgartner, Lutz, Schmidt, & Jäncke, 2006). Philosophers long have been, and neuroscientists recently have become, interested in music (Andrade & Bhattacharya, 2003). However, only over the last decade have such neuroscientific studies become intensified and systematic (Peretz & Zatorre, 2005). During that period, music, as a human characteristic, was studied in neural networks involved in aspects of perception, memory, and emotional recognition and, currently, electrophysiology and imaging techniques, such as positron emission tomography (PET) or functional magnetic resonance imaging (fMRI), demonstrate cortical and subcortical structures activated by music (Andrade et al., 2003; Peretz et al., 2005). Neuroimaging studies have investigated musical stimuli inducing emotions (Koelsch, Fritz, Yves, Cramon, Müller, & Friederici, 2006), and some studies have emphasized significant facts about music and emotions in the brain (Peretz et al., 2005).

Blood, Zatorre, Bermudez, and Evan (1999) addressed that well-done studies have been done of aspects of relations between neural correlates and emotional responses to music, between neural correlates and musical perception, and between neural correlates and other forms of emotions. They also investigated the coincidence of emotional process in the brain by music and general stimuli, demonstrating neural activities with consonant and dissonant musical stimuli using positron emission tomography (PET) scanning examining cerebral blood flow. A new melody made as consonant and dissonant sound having harmonic structure was used as a determinant via a pilot study. The melody activated specific paralimbic and neocortical regions which were congruent with regions activated by emotional processing results in previous non-music studies including right parahippocampal gyrus, right precuneus, bilateral orbitofrontal, medial subcallosal cingulate, and right frontal polar regions. Moreover, consonance presented differently from dissonance *vis-a-vis* positive and negative feelings, rather than happy and sad.

Aligned with the above study demonstrating different neural activations between pleasant and unpleasant music, Koelsch, et al. (2006) investigated the influence of pleasant (consonant) and unpleasant (dissonant) music on emotional processing in the brain. Eleven individuals without special musical experience participated, and pleasant and unpleasant music excerpts (mean duration 55 seconds per excerpt) were provided twice in turn. The blood oxygenation level dependent (BOLD) signal was measured by fMRI to measure activation of neural areas by musical stimuli, and a five-point emotional state rating was reported during intervals between music excerpts, to measure the degree of (un)pleasantness. Results showed significant difference between pleasant and unpleasant music ratings ($p < .001$). The BOLD signal significantly increased with unpleasant music and strongly decreased with pleasant music in amygdala, hippocampus, parahippocampal gyrus, and temporal poles. This indicates that the cerebral network in these structures can be activated by emotional processing via unpleasant music (dissonant). Additionally, activations with pleasant music were presented in inferior frontal gyrus (IFG) related to processes of musical syntactic analysis and working memory operations, the anterior superior insula, the ventral striatum, and the Rolandic operculum related to a motor-related circuitry for forming pre-motor representations, and Heschl’s gyrus. Also, they reported Rolandic operculum related to the function of the mirror system. This study indicated the effect of music stimulus for emotional processing.

Studying the functions of music for pleasure and reward, Blood and Zatorre (2001) investigated how neural mechanisms are activated by highly positive emotional responses to music, to assess the relationship between brain circuitry through regional cerebral blood flow (rCBF) changes measured by PET and emotional intensity rating. Ten musicians listened to participant-selected music for intense pleasant emotional responses, and to other participant-selected music for neutral emotional responses as control music whose emotional intensity was rated by participants (rating was less than 3 on a scale of 0 to 10). Also, two baseline conditions existed: noise and silence. PET results showed that rCBF activations increased in left ventral striatum, dorsomedial midbrain, bilateral insula, right OFC, thalamus, anterior cingulate cortex, supplementary motor area and bilateral cerebellum during participant-selected music. In particular, the activations of rCBF decreased in right amygdala, left hippocampus/amygdala, and ventral medial prefrontal cortex. This is similar to neural patterns observed in other neural imaging studies about pleasant emotion and euphoria.

Mitterschiffthaler, Fu, Dalton, Andrew, and Williams (2007) demonstrated the influence of classical music on neural correlates of temporary mood changes for investigating activations in specific cortical and subcortical regions with neural regular patterns by emotional processes as responses to happy and sad music stimuli. To select the happy and sad music stimuli, a pilot study was conducted in which 20 classical music pieces were selected by 53 healthy volunteers via a visual analogue scale. Sixteen healthy individuals listened to 20 musical stimuli comprising 5 happy, 5 sad, and 10 neutral music pieces. Participants were assigned to two order groups: 5 happy – 5 neutral – 5 sad, and 5 sad – 5 neutral – 5 happy. The blood oxygenation level dependent (BOLD) signal was measured in brain responses to the mood state induced by those stimuli. Mood state ratings were reported by a visual analogue scale during the functional scan. Results showed that the BOLD signal increased with happy music in the ventral and dorsal striatum relative to reward experience and movement, anterior cingulate relative to targeting attention, parahippocampal gyrus, and auditory association areas, and with sad music in the hippocampus/amygdala and auditory association areas relative to the appraisal and musical processing. Neutral music increased the BOLD signal in the insula and auditory association areas. In addition, mood state rating showed interaction between music stimulus and order, indicating higher affect ratings for happy music first, lower affect ratings for sad music first, and medium affect ratings for neutral music first ($p = .05$). As shown above, the study indicates emotional processing is induced by happy music stimuli involved in reward, movement, and targeting attention, and by sad music stimuli involved in appraisal and emotions. This study supported previous studies in that there are regular neural patterns about happy and sad stimuli.

As factors of emotional recognition in music, mode and tempo can express the happy-sad dissimilarity (Peretz et al., 2005). Khalfa, Schon, Anton, and Liégeois-Chauvel (2005) conducted studies of neural mechanisms of musical emotions by mode and tempo. They demonstrated the lateralization of neural regions relative to recognition of negative and positive emotions according to musical mode and tempo. Thirteen healthy participants were tested with 24 classical instrumental music excerpts, 12 happy (fast tempo), and 12 sad (slow tempo) in 12 major and 12 minor modes, of 10 seconds duration per excerpt. The 24 musical excerpts, generating intended emotion, were selected by 8 volunteers via a rating on a 5 point scale. Two lists of musical stimuli included 12 fast and 12 slow with 12 silent periods. Participants were presented with half of the excerpts in pseudo-randomized order in one of two sessions. After each 10-second period, participants were measured by fMRI according to tempo effect, mode effect, and interaction between tempo and mode. In addition, a 5-point scale measured judging emotions by music. Results revealed that the minor mode significantly activated in the left medial and superior frontal gyrus and in the bilateral posterior cingulum gyri, but the major mode did not activate in any area. Besides, tempo-mode interaction condition significantly activated in the left medial frontal gyrus, the right middle frontal gyrus, and the right anterior cingulate gyrus. However, there was no significant effect by tempo. Findings indicate that mode and tempo in music emotional discrimination affect activations of the orbitofrontal and cingulate cortices, which are involved in emotional processing.

In addition, to show the effect of combination with visual and auditory stimuli, Baumgartner, Esslen, and Jäncke (2006) examined emotional processing in the brain evoked by pictures and classical music using Electroencephalogram (EEG). Pictures of the international Affective Pictures System (IAPS) and classical music excerpts for strong arousal emotions (happiness, sadness, and fear) were provided to 24 right-handed participants as three kinds of stimuli such as picture and music, picture, and music. In addition, psychophysiological and psychometrical measurements were used. Results showed that presented emotions induced by combined stimuli were most accurate, then next most accurate by visual stimulus, then next-next most accurate by auditory stimulus. Moreover, ratings of both psychophysiological and psychometrical measurements increased significantly in the combined stimuli, next classical music, then picture. This indicates that intense neural activations were generated by combined stimuli in emotional and arousal regions such as frontal, temporal, parietal, and occipital neural structures. The finding showed the impact of music on enhancing emotional experience. Moreover, this study showed that combined stimuli are more powerful for evoking emotions.

Many studies on music and the brain indicate a close relationship between music and emotions, and consistent neural patterns on musical stimuli. Therefore, the studies provide neural basis of emotional processing induced by music.

Neural Activation and Imagery in Emotions

Mental imagery occurs when information is perceived from memories of past events and daydreams of future events via the mind's eye or ear (Holmes, Geddes, Colom, & Goodwin, 2008; Holmes & Mathews, 2010). It is represented as various sensory modalities such as visual-, auditory-, and motor- imagery, which activate their associated regions in the brain (Kosslyn, Ganis, & Thompson, 2001). It long has been recognized that imagery generates emotions, which occur differently in various emotions (Holmes et al., 2010; Lyman & Waters, 1989). In particular, distressing mental images related to past or future from the depths of the mind are more affective (Holmes et al., 2008). Through their review of previous research, Holmes et al. (2010) theorized why image impacts on emotion. According to them, imagery directly influences the emotional neural network which responds to various sensory signals; these are perceived as real emotional events, and as contacts with emotional episodic memories in the past.

As developing neuroimaging techniques, a number of neuroimaging studies demonstrate mental imagery, illustrating that such imagery has identical neural mechanism of perception in identical modalities and can activate in regions related to emotion, memory, and motor control (Kosslyn et al., 2001). Furthermore, reporting imagery as stimuli for evoking emotions (Lazarus, 1971; Sheikh et al., 1975), in particular imagery-related episodic memory (Damasio et al., 2000; Holmes & Hackmann, 2004), has increased the importance of using images in psychotherapy (Ahsen, 1972; Gendlin et al., 1970; Sheikh et al., 1975; Shapiro, 1970). Thus, imagery has been used in psychotherapy (Singer & Pope, 1978) and in a medical-healing program (Achterberg, 1985). In particular, evoking fear imagery has been effective in psychotherapy for treating phobias and anxiety (Lang, 1977). Accordingly, in the neuropsychological view, understanding how the brain causes one to experience one's inner world, including thoughts and feelings, is crucial.

According to previous studies, nucleus accumbens (NAc) and medial prefrontal cortex (mPFC), engaged by appetitive signals, and amygdala, modulated by emotional intensity of appetitive and aversive signals, are related to emotional perception and learning. Costa, Lang, Sabatinelli, Versace, and Bradley (2010), based on previous research, also demonstrated patterns of neural activation and connectivity among these regions with 29 participants. After entering the fMRI scanner, participants were asked to read narratives with visual presentation related to pleasant-, neutral-, and unpleasant-scenes through a monitor, then to imagine each described event. Results were that the NAc and the mPFC were activated by pleasant imagery, and the amygdala was activated by pleasant and unpleasant imagery. It showed the obvious functional connectivity of both the NAc and the mPFC during imaging pleasant events. In addition, activation of the amygdala with the NAc and the mPFC was correlated only while imagining pleasant scenes. Thus, motivational circuits for pleasant imagery differ from those for unpleasant imagery; the former engages appetitive, the latter aversive. Results indicate that narrative imagery is useful for clinical use. Also, it shows the existence of neural patterns of responses to imagery related to specific emotions.

Schienle, Schäfer, Pignanelli, and Vaitl (2009) demonstrated neural activations on negative imagery measured by fMRI and the relationship between neural correlates and worry tendencies measured by the Penn State Worry Questionnaires (PSWQ) with 19 healthy and non-mediated females. Two categories of pictures with worry- and happiness-related contents were provided for imagery. Through cue words such as watch or imagine, participants watched a picture, then rated the experience. Afterwards, they imagined the picture, then rated imagery vividness. Regions of the precuneus, the middle temporal gyrus, and the postcentral gyrus were activated by negative imagery compared to negative perception, and the insula and the parietal cortex were revealed by regions of interest in the (ROI) analysis ($p < .005$). The positive imagery compared to positive perception activated in the regions of the precuneus, the inferior parietal gyrus, and the superior temporal gyrus, and the insula and inferior parietal cortex were represented by ROI analysis ($p < .005$). In addition, there were positive correlations between the experience of vividness of pleasant and unpleasant pictures, and activations of the regions for emotional regulation, imagery vividness, and recovery of memory, whereas there were negative correlations between worry tendencies and neural activations in the ACC, the prefrontal cortex, the parietal cortex, and insula. It indicates that high PSWQ scorers disengaged from negative imagery.

Besides, Kreiman, Koch, and Fried (2000) demonstrated the relationship between neural activations and visual imagery with nine patients. While participants imagined after viewing images, the activity of 427 neurons in the brain was recorded to demonstrate the importance of hippocampus, amygdala, entorhinal cortex, and hippocampal gyrus as regions for the representation and recognition of visual images. The result showed neural activations in these brain structures during the formation of mental images from pictures as visual stimuli. In particular, it showed that amygdala was activated during emotions of fear and anger. This study indicates that vivid visual images can be evoked in minds without visual input.

As mentioned above, many studies have investigated that neural activations of imagery are represented according to various types of imagery such as visual-, auditory-, and motor- imagery. Kosslyn et al. (2001) reviewed the previous studies. According to them, mental imagery draws on brain mechanisms used in other activity processes such as perception and action. For example, visual imagery activates in the earliest visual cortex and affects mechanisms related to controlling physiological processes, such as heart rate and breathing with effects similar to those occurring with perceptual stimuli. Moreover, imagery related to emotional events activates the autonomic nervous system (ANS) and the amygdala. Also, mental imagery from negative emotional stimuli activates the anterior insula, which is the primary cortical region of feedback from ANS.

In studies on emotional mental imagery, memory is a special topic, and especially, intrusive imagery related to autobiographical memory has been considered to carry more emotion (Holmes et al., 2004). Also, some studies investigated the influences of mental imagery as emotional stimuli on the emotional neural network which responds to various sensory signals, in particular, imagery related to emotional episodic memory. According to Hamann (2001), encoding processes for initial represented memory and post-encoding processes for consolidating memory are to enhance emotional arousal. Amygdala, as a primary region for both processes is a crucial mechanism for enhancement of emotional stimuli. Thus, emotional arousal and related amygdala activations are crucial in modulating memory for emotional stimuli.

Many studies of mental imagery related to memory in the neuroscience view have been conducted focusing on posttraumatic stress disorder (PTSD). Britton, Phan, Taylor, Fig, and Liberzon (2005) demonstrated neural patterns during script-driven imagery-related past experiences in posttraumatic stress disorder (PTSD) patients (PTSD patients: PP), combat veterans without PTSD (combat control participants: CC), and normal control participants (normal control participants: NC). There were 45 participants in the three groups for this study. Stimuli were narratives recorded from personal past experiences such as neutral daily events, negative and traumatic experiences, or common extremely stressful events which were replayed during PET scanning. Results revealed that amygdala activation and ventral medial prefrontal cortex (vmPFC) deactivation were showed in NC, vmPFC and amygdala deactivations in CC. In PP, there was no amygdala activation or deactivation, whereas vmPFC and rostal anterior cingulate cortex (rACC) deactivations were represented. In addition, there was insula activation in all three groups, but more left insula activation in NC, and right insula activation in CC, than in PP. This study indicates that negative autobiographical memory was associated with vmPFC deactivation and insula activation, and amygdala activation was related to negative experiences.

As reviewed above, mental imagery affects human emotion biologically and neurologically. Many research studies have reported associations between neural activations and emotional responses to imagery. Moreover, demonstrating regions of neural activation by imagery, research supports the rationale for clinical use of imagery.

CHAPTER 3

Method

Twenty-four healthy volunteers participated in this experiment. Stimuli consisted of 4 minutes of classical music and verbal instructions provided during fMRI scanning. To investigate the neural basis of arousal and emotional process through guided imagery and music (GIM) with personal emotional episodic memories and effectiveness of GIM, Volume analysis and Regions of Interest (ROI) analysis were conducted. Volume analysis was conducted to demonstrate functional neuroanatomy of arousal and emotional processing induced by guided imagery and music with personal episodic memory compared to music or guided imagery. ROI analysis was conducted to demonstrate differences of neural activations among three conditions-guided imagery and music, guided imagery, and music.

Accordingly, this chapter describes research design and methodology in detail including characteristics and screening processing about participants, stimuli, experimental procedures, data acquisition, and data analysis.

Participants

Twenty-seven right-handed participants (13 males and 14 females) were recruited from undergraduate students at the Korean Advanced Institute of Science and Technology (KAIST), Daejoen, Korea. The fMRI data from 3 participants (3 females) of the 27 were excluded because of the problem of the structural images due to excessive head movement and drowsiness. Thus, data from the remaining 24 participants (13 males and 11 females) were used for this study. This study was reviewed and approved by the

Institutional Review Board of Lesley University, and informed consent forms were obtained from all participants.

Before fMRI tasks, participants completed a background questionnaire for screening to select those with normal hearing ability, no history of past or current neurological and psychiatric disorder, claustrophobia, medical and chronic disease, and surgery with metallic supplements, no past or current drug and alcoholic abuse and dependence, and no experiences of imagery or hypnosis therapies. Also, right-handedness by Edinburgh Handedness Inventory (Right Handed: R > +40, EHI; Oldfield, 1971), and anxiety, depression and alexithymia by the State-Trait Anxiety Inventory (STAI; Spielberger, Gorssuch, & Lushene, 1970), the Self Rating Depression Scale (SDS; Zung, 1965), and the Toronto-Alexithymia Scale (TAS; Taylor, Ryan, Super, & Bagby, 1985) were assessed. Assessment tools translated into Korean were used in this study, so that the standards for anxiety, depression, and alexithymia were also based on translated assessment tools. Cut-off scores of the state and trait anxiety in STAI for normal condition are each under 42.5 and 44.5 (Kim, 1978), and that of SDS for normal condition is under 47 (Lee & Song, 1991); also, that of TAS for normal condition is under 51 (Lee, Lim, & Lee, 1996). Participants were screened by cut-off scores of those assessments.

Thus, results of the background questionnaires and those assessments indicated that participants were aged 19-26, and their EHI scores were between 50 and 100. In addition, ranges of scores of state anxiety were between 20 and 44, of trait anxiety between 23 and 49, SDS between 21 and 45, and TAS between 21 and 51 (see Table 1). This indicates that all participants were right-handed as presenting above 40 in the scores of the EHI. Also, as scores of those STAI, SDS, and TAS of all participants presented below the cut-off scores, all participants passed the screening via those assessment standards. Thus, they all participated in the functional MRI experiments.

Table 1

Mean and Range of Ages, Scores of Assessments about Right-handedness, Anxiety, Depression, and Alexithymia in Participants

	All (*n*=24)	Male (*n*=13)	Female (*n*=11)
	M (SD) Range	*M* (SD) Range	*M* (SD) Range
Age	21.5 (1.96) 19 - 26	21.14 (1.68) 20 - 26	21.9 (2.26) 19 - 26
EHI	94.10 (12.03) 50 - 100	91.19 (15.25) 50 - 100	97.55 (5.47) 86 - 100
STAI			
State	36.5 (8.38) 20 - 49	36.31 (8.01) 22 - 49	36.73 (9.19) 20 - 49
Trait	35.75 (7.67) 23 - 49	36.54 (6.49) 27 - 49	34.82 (9.12) 23 - 49
SDS	32.79 (7.34) 21 - 45	33.15 (7.20) 23 - 45	32.36 (7.83) 21 - 44
TAS	40.67 (8.07) 21 - 51	41.46 (7.75) 21 - 51	39.73 (8.71) 25 - 51

Note. EHI, Edinburgh Handedness Inventory; STAI, State-Trait Anxiety Inventory; SDS, Self-rating Depression Scale; TAS, Toronto-Alexithymia Scale. Cut-off score for screening of EHI > 40; STAI, State > 42.5 & Trait > 44.5; SDS > 47; TAS > 51.

Stimuli

Two kinds of stimuli were used for arousal and emotional processing: music and verbal instructions. The musical stimulus, “Mars” in *Bringer of War from the Planets* by Gustav Holst, was provided in music and guided imagery and music (GIM) conditions. The music has been shown to be able to evoke negative emotions such as anger or fear from the literature (Baumgartner, Esslen et al., 2006; Bush, Borling, & Stokes-Stearns, 2009; Krumhansl, 1997; Peretz, Gagnon, & Bouchard, 1998). Four minutes of the musical selection were used. Verbal instructions were used for recall and re-experience of personal negative emotional episodes as the condition of guided imagery. Verbal instructions with contents of personal episodic memories were used to evoke various kinds of sensory imagery focusing on active imagination for arousal and negative emotional processing such as anger and fear. Both music and verbal instructions were pre-recorded for the experimental paradigm.

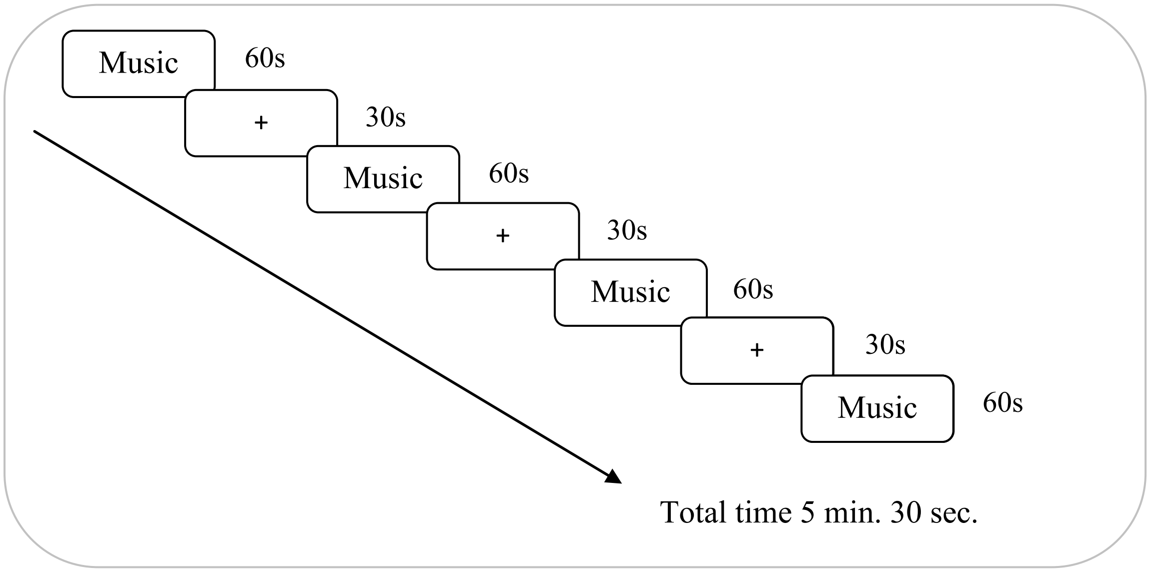
Procedure

First, participants were asked to recall and re-experience negative episodes that evoked emotions of fear and anger. They were asked to do this to perform tasks in the fMRI scanning. These negative episodes were about conflicts with others and conflicts within themselves. Participants were encouraged to recall these episodes using detailed images within their minds, and to evoke a higher degree of emotion. Afterwards, in the fMRI scanning, they were asked to lie down, and soft pads were placed about their heads to prevent or minimize movement from disturbing the measurements.

For the fMRI scanning, two successive, different sessions were conducted, using music, verbal instructions, and an inter-stimulus interval of silence. The inter-stimulus interval was provided to avoid previous stimuli influencing the next. Each participant had two sessions for definitely distinguishing the effects by three conditions-guided imagery and music (music in the session 2), guided imagery (verbal instructions in the session 2), and music (music in the session 1). In particular, this was for distinguishing the effects by both music and guided imagery and music conditions. Because the intention of given music in the session 1 and 2 was different even though given music was same for both conditions, two different sessions were provided. However, participants had two sessions successively for avoiding participants to have both sessions in different experimental environment.

Figure 1 shows this experimental paradigm. In session 1, 60 seconds of music excerpts were presented four times, and 30 seconds of inter-stimulus intervals were presented between each music stimulus. Thus, total time for the first session was 5 minutes 30 seconds conducting the condition of just music. In session 2, music excerpts and verbal instructions were presented alternately four times. Also, inter-stimulus intervals were presented before verbal instructions. To achieve the condition of guided imagery and music, the excerpt was provided immediately after the verbal instructions. The same length as in the first session was used for music excerpts and inter-stimuli intervals, but the length of verbal instructions varied thus: 60 seconds, 30 seconds, 30 seconds, and 30 seconds, in that order. The first verbal instruction was longer than the other, to prepare participants to concentrate on their inner selves and on emotions for evoking personal episodes. All verbal instructions were used to recall and re-experience personal, negative, emotional episodes. Thus, total time for the second session was 8 minutes conducting the conditions of guided imagery and guided imagery and music. During the conditions, fMRI scanning was performed.

Session 1



Session 2

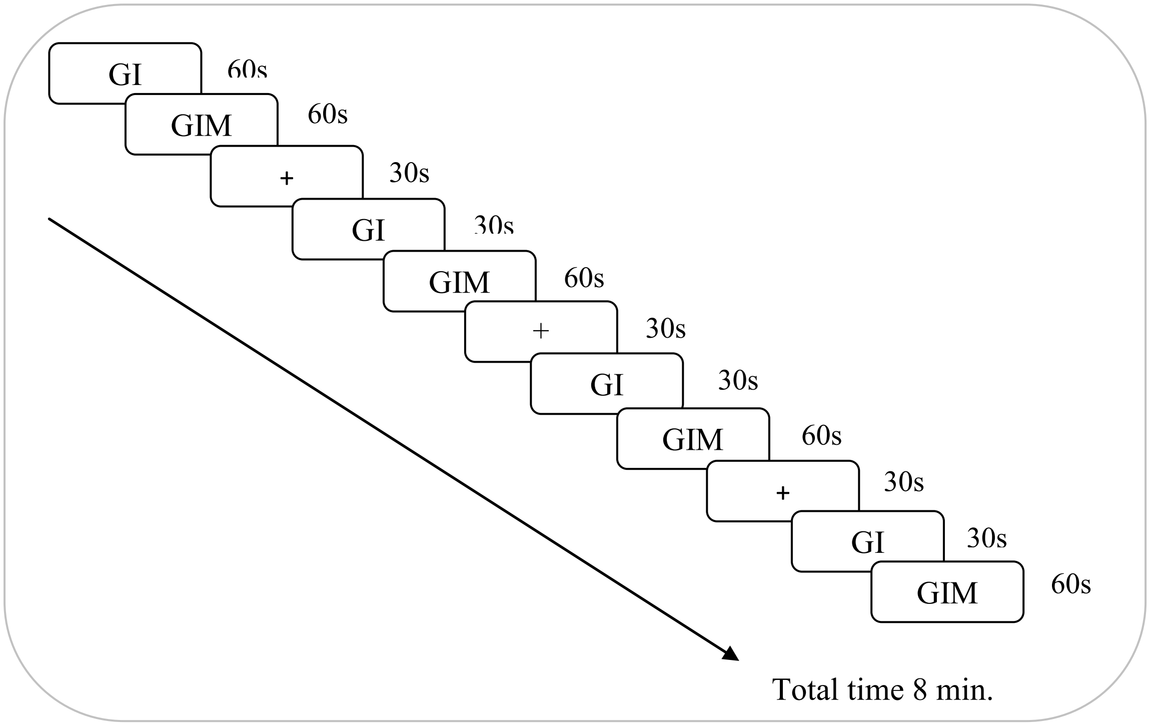


Figure 1. Experimental Paradigm: In each trial, length of music was 60 seconds, of GI (guided imagery) 30 seconds except for the first GI (60s), of GIM (guided imagery and music) 60 seconds, and of + (inter-stimulus interval) 30 seconds. A stimulus in the condition of music was music alone, of GI verbal instructions, of GIM music as soon as providing verbal instructions as a stimulus for GI, and of + (inter-stimulus interval) silence.

Image Acquisition

The fMRI Experiments were conducted at the KAIST fMRI center. Functional magnetic resonance imaging (fMRI) was performed on a 3T MRI system (SIEMENS Magnetom Verio, Germany) with a quadrature head coil, for inhibiting head movement throughout fMRI scanning to promote neuroimaging efficiency (KAIST-BSRC, 2012). To measure blood-oxygen-level dependent (BOLD) effects, a gradient-echo echo planar imaging (EPI) sequence was used with the following imaging parameters: no. of slices = 36; slice thickness = 3 mm; no gap between slices; field of view (FOV) = 192 × 192 mm; matrix size = 64 × 64; TR/TE = 2000 / 30 ms; flip angle = 90; voxel size 3 mm × 3 mm × 3 mm. T2-weighted anatomical images were acquired using a three-dimensional magnetization-prepared rapid acquisition gradient-echo (3D-MPRAGE) sequence with TR = 1800ms; TE = 2.52 ms; matrix size 256 × 256 × 128.

Auditory stimuli were provided through NordicNeuroLab (NNL) audio system specialized in MRI research, which helped to minimize disturbance due to MRI scanner noise as well as auditory masking effects. The flat frequency response of headphones was 8Hz-35Hz, and passive noise attenuation was 30dB (Korea University Brain Imaging Center, KUBIC, 2011). In addition, to observe whether participants actively performed experiment tasks, the Arrington Research Inc. eye tracking system was used (Arrington Research Inc., 2012).

Data Analysis

Functional image preprocessing and subsequent analyses were conducted using the Statistical Parametric Mapping software package (Ver.: SPM99, SPM2, Wellcome Trust Centre for Neuroimaging, London) on a Matlab (The MathWorks, Natick, MA) platform. After realignment of image sequences, coregistration was performed followed by spatial smoothing using an 8-mm Gaussian kernel filter with full width half maximum (FWHM). Participant effects, namely the blood oxygen level dependent (BOLD) signal changes, were estimated using a general linear model (GLM). Analyzed functional data were mapped onto anatomical images. Contrast images were generated for each participant for contrast of interest (contrast of guided imagery and music to music or guided imagery). An independent samples *t*-test was used to determine whether there was a significant effect of guided imagery and music compared to music or guided imagery at $p < 0.001$, uncorrected, and the size of cluster, which is activated region, larger than or equal to 30 voxels.

Region of interest (ROI) analysis was conducted for 3 regions - bilateral amygdala, bilateral insula, and bilateral anterior cingulate gyrus - utilizing MarsBar ROI toolbox (Brett, Anton, Valabregue, & Poline, 2002) and small volume correction (SVC) of SPM. The 3 regions were derived from a standard set of automated anatomical labeling (AAL) archives (Tzourio-Mazoyer, Landeau, Papathanassiou, Crivello, Etard, Delcroix, Mazoyer, & Joliot, 2002) in the Montreal Neurological Institute (MNI) template (Collins, Zijdenbos, Kollokian, Sled, Kabani, Holmes, & Evans, 1998). Regions were selected based on examination of cluster locations, induced by the conditions of guided imagery and music, music, and guided imagery, and deviated from a baseline, and previous studies including the meta-analytic review by Lindquist et al. (2012) of which regions activated as responses to negative emotions. Those regions from Average BOLD activity were extracted from a sphere 6 x 6 x 6 mm within those significant peak activations ($p < 0.05$, uncorrected).

Neural activation for each ROI analysis (amygdala, insula, and anterior cingulate gyrus) for 3 conditions: guided imagery and music, guided imagery, and music was compared using a one-way analysis of variance (ANOVA) in IBM SPSS statistics 20. When ROI analyses yielded statistically significant differences of neural activations, post-hoc pair-wise comparisons were conducted to determine specific significant differences between stimuli.

CHAPTER 4

Results

This study investigated the neural basis of arousal and emotional processing as responses to recall and re-experience of personal negative emotional episodic memories through guided imagery and music and the effectiveness of guided imagery and music with personal episodes for generating arousal and emotional processing. To do this, both volume analysis and ROI analysis of functional MRI data were conducted with 24 healthy participants (13 males and 11 females). In the volume analysis, comparing functional neuroanatomy of arousal and emotional processing induced by guided imagery and music to that of guided imagery or music, it was revealed that guided imagery and music activated neural regions having various functions much more than guided imagery or music alone. In the ROI analysis, activation maps from participants revealed significant differences in blood oxygen-level dependency (BOLD) signal changes among the conditions of guided imagery and music, guided imagery, and music. Of those conditions in the experimental paradigm, music provided for the condition of guided imagery and music, same music as the condition of guided imagery and music provided for the condition of music, and verbal instructions provided for the condition of guided imagery.

Therefore, this chapter describes neural regions activated by guided imagery and music compared to those activated by music alone, or guided imagery alone. Second, differences of BOLD signal changes among conditions of guided imagery and music, guided imagery, and music are described.

Volume Analysis

Comparison between Guided Imagery and Music and Music Effects

This comparison between the neural regions activated by the conditions of guided imagery and music, and music was conducted via independent samples *t*-test in the SPM software package. The result of the contrast of guided imagery and music to music was revealed by subtracting neural regions activated by music from those by guided imagery and music (guided imagery and music > music), and that of contrast of music to guided imagery and music was revealed by subtracting neural regions activated by guided imagery and music from music (music > guided imagery and music).

Result of the contrast of guided imagery and music to music revealed 11 significant neural regions at $p < .001$, uncorrected and the size of cluster, which is the activation region, is larger than or equal to 30 voxels. As indicated in Table 2 and Figure 2, significant BOLD signal changes for the contrast of guided imagery and music to music were found in the left anterior cingulate gyrus (lACG - BA32), the left amygdala, the left thalamus, the left claustrum, the left insula, the bilateral precentral gyrus (BA 6), the left superior temporal gyrus (lSTG - BA 22), the bilateral middle temporal gyrus (bMTG - BA 21), the left inferior parietal lobule (lIPL - BA 39), the right cuneus (BA 18), and the bilateral culmen. In contrast, no neural regions having significant BOLD signal changes were found for the contrast of music to guided imagery and music ($p < .001$, uncorrected & number of voxels ≥ 30).

Comparison between Guided Imagery and Music and Guided Imagery Effects

This comparison between the neural regions activated by the conditions of guided imagery and music, and guided imagery was conducted via independent samples *t*-test in the SPM software package. Thus, the result of the contrast of guided imagery and music to guided imagery was revealed as subtracting neural regions activated by guided imagery from those activated by guided imagery and music (guided imagery and music > guided imagery), and the contrast of guided imagery to guided imagery and music was revealed by subtracting neural regions activated by guided imagery and music from guided imagery (guided imagery > guided imagery and music). Neural regions having significant BOLD signal changes for the contrast of guided imagery and music to guided imagery and that of guided imagery to guided imagery and music are reported in Table 3. Significant activated clusters were surpassed at the uncorrected threshold of $p < .001$ and the cluster's size which was larger than or equal to 30 voxels.

The BOLD signal changes for the contrast of guided imagery and music to guided imagery were significantly greater than those for the contrast of guided imagery to guided imagery and music in 9 neural regions including the right posterior cingulate gyrus (rPCG – BA 23), the bilateral parahippocampal gyrus (BA 30/19), the bilateral precentral gyrus (BA 4/6), the left superior frontal gyrus (lSFG – BA 6), the left middle frontal gyrus (lMFG – BA 6), the bilateral middle occipital gyrus (bMOG - BA 18/19), the bilateral cuneus (BA 18/30), the right lingual gyrus (BA 19), and the inferior parietal lobule. Contrarily, the BOLD signal changes for the contrast of guided imagery to guided imagery and music were significantly greater than those for the contrast of guided imagery and music to guided imagery in three neural regions including the right superior temporal gyrus (rSTG – BA 22), the bMTG (BA 21), and the left inferior parietal lobule (lIPL – BA40).

Figure 3 indicates neural activation maps for guided imagery and music compared to guided imagery (guided imagery and music > guided imagery), and Figure 4 for guided imagery compared to guided imagery and music (guided imagery > guided imagery and music). Figure 5 indicates the comparison between guided imagery and music and guided imagery.

Table 2

List of Peak Coordinates for Comparison between Guided Imagery and Music and Music Effects (p < .001 uncorrected & number of voxels ≥ 30*)*

Peak coordinate regions	Side	Brodmann Area	Number of Voxels	Peak Intensity *(t)*	Peak MNI Coordinate (x, y, z)
Guided Imagery and Music > Music					
Limbic lobe					
Anterior cingulate gyrus	L	32	34	4.2969	-8, 12, 46
Insula	L	n/a	34	5.1146	-44, -26, 22
Sub-cortical gray nuclei					
Amygdala	L	n/a	34	4.8008	-32, 4, -16
Thalamus	L	n/a	323	6.8295	-4, 28, -6
Claustrum	L	n/a	83	5.7096	-34, -8, -6
		n/a	71	5.2302	-30, 6, 16
Cerebellum					
Culmen	L	n/a	181	4.3238	-12, -42, -8
	R	n/a	62	4.9265	20, -42, -16
Frontal lobe					
Precentral gyrus	L	6	204	5.7504	-56, 0, 18
	R	6	34	4.6142	60, 4, 4
Temporal lobe					
Superior temporal gyrus	L	22	75	5.4628	-58, -48, 16
Middle temporal gyrus	L	21	34	5.4368	-52, 4, -22
	R	21	52	5.3363	48, 2, -22
Occipital lobe					
Cuneus	R	18	2177	6.339	4, -78, 26
Parietal lobe					
Inferior parietal lobule	L	39	34	4.1407	-46, -70, 22
Music > Guided Imagery and Music					
No region					

Note. MNI, Montreal Neurological Institute. L, Left; R, right. Peak intensity (*t*), scores of BOLD signal changes.

Table 3

List of Peak Coordinates for Comparisons between Guided Imagery and Music and Guided Imagery Effects (p < .001 uncorrected & number of voxels ≥ 30 *)*

Peak coordinate regions	Side	Brodmann Area	Number of Voxels	Peak Intensity (*t*)	Peak MNI Coordinate (x, y, z)
Guided Imagery and Music > Guided Imagery					
Limbic lobe					
Posterior cingulate gyrus	R	23	249	4.7846	4, -64, 16
Parahippocampal gyrus	L	30	110	5.4024	-24, -46, -2
	R	19	37	3.7177	30, -48, -6
Frontal lobe					
Precentral gyrus	L	4	46	4.6198	-64, -8, 22
	R	6	79	5.0164	8, -20, 66
		6	67	4.8338	52, -8, 24
		4	52	4.4226	46, -18, 34
Superior frontal gyrus	L	6	189	4.9450	-6, 4, 68
Middle frontal gyrus	L	6	34	4.5198	-38, -8, 44
Occipital lobe					
Middle occipital gyrus	L	18	92	4.5653	-14, -90, 10
		19	43	4.9582	-34, 78, -2
	R	18	174	4.4576	34, -84, -6
Cuneus	L	30	75	4.1697	-20, -72, 10
	R	18	37	5.1211	24, -82, -14
Lingual gyrus	R	19	31	4.1895	32, -62, -2
Parietal lobe					
Inferior parietal lobule	L	39	58	4.5653	-50, -72, 12
Guided Imagery > Guided Imagery and Music					
Temporal lobe					
Superior temporal gyrus	R	22	176	4.5637	54, -32, -2
Middle temporal gyrus	L	21	1704	7.8628	-58, -34, -2
	R	21	270	5.4395	64, -14, -10
Parietal lobe					
Inferior parietal lobule	L	40	33	3.8301	-44, -52, 52

Note. MNI, Montreal Neurological Institute. L, Left; R, right. Peak intensity (*t*), scores of BOLD signal changes.

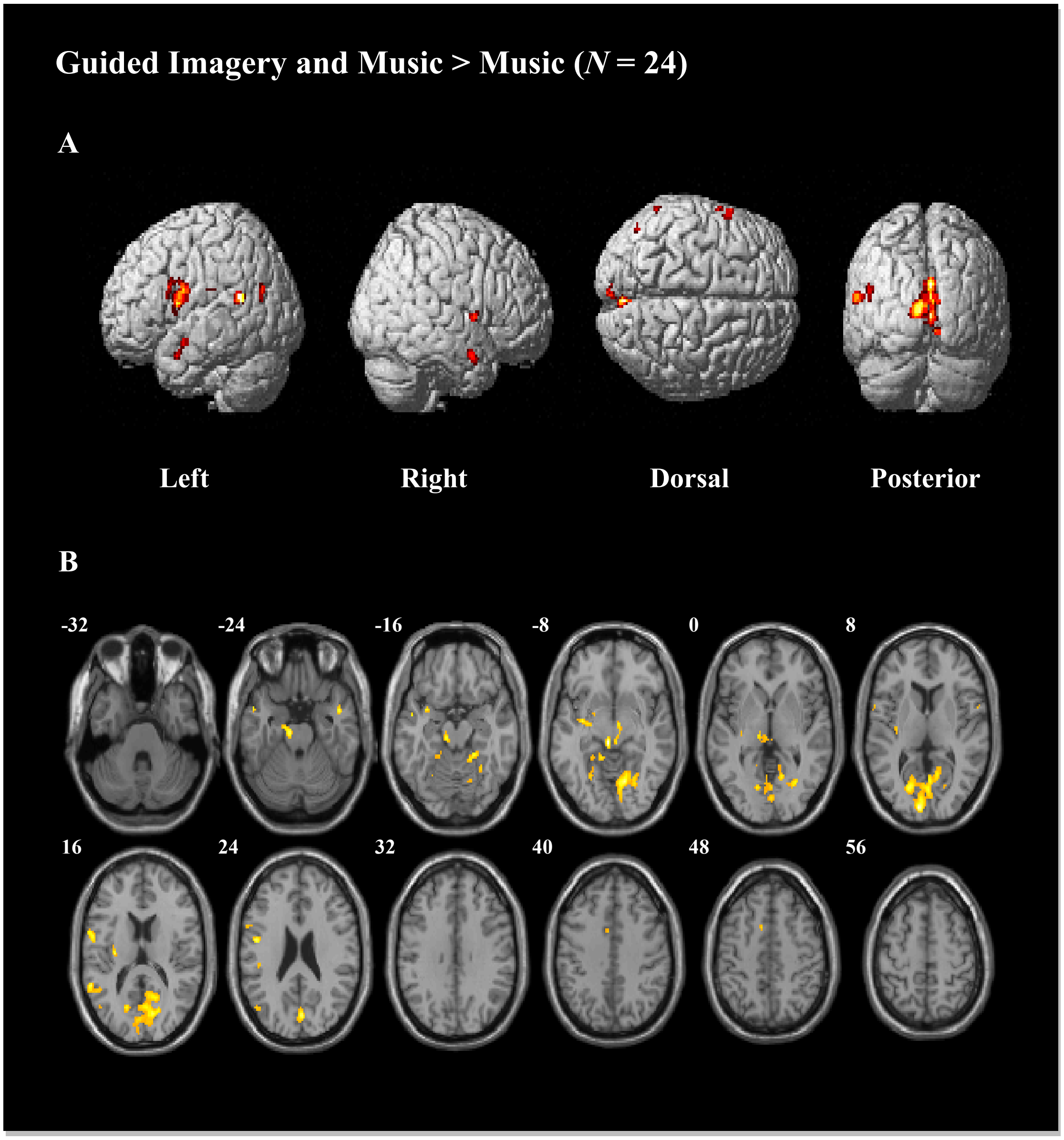


Figure 2. Brain Contrast Maps for Guided Imagery and Music > Music: Clusters surpassing a corrected cluster-threshold of $p<0.001$ and the larger or equal size of cluster than 30 voxels. (A) Map of clusters projected on a standard rendered template brain. (B) Corresponding axial slices from z -32 to 56 in 8mm increments.

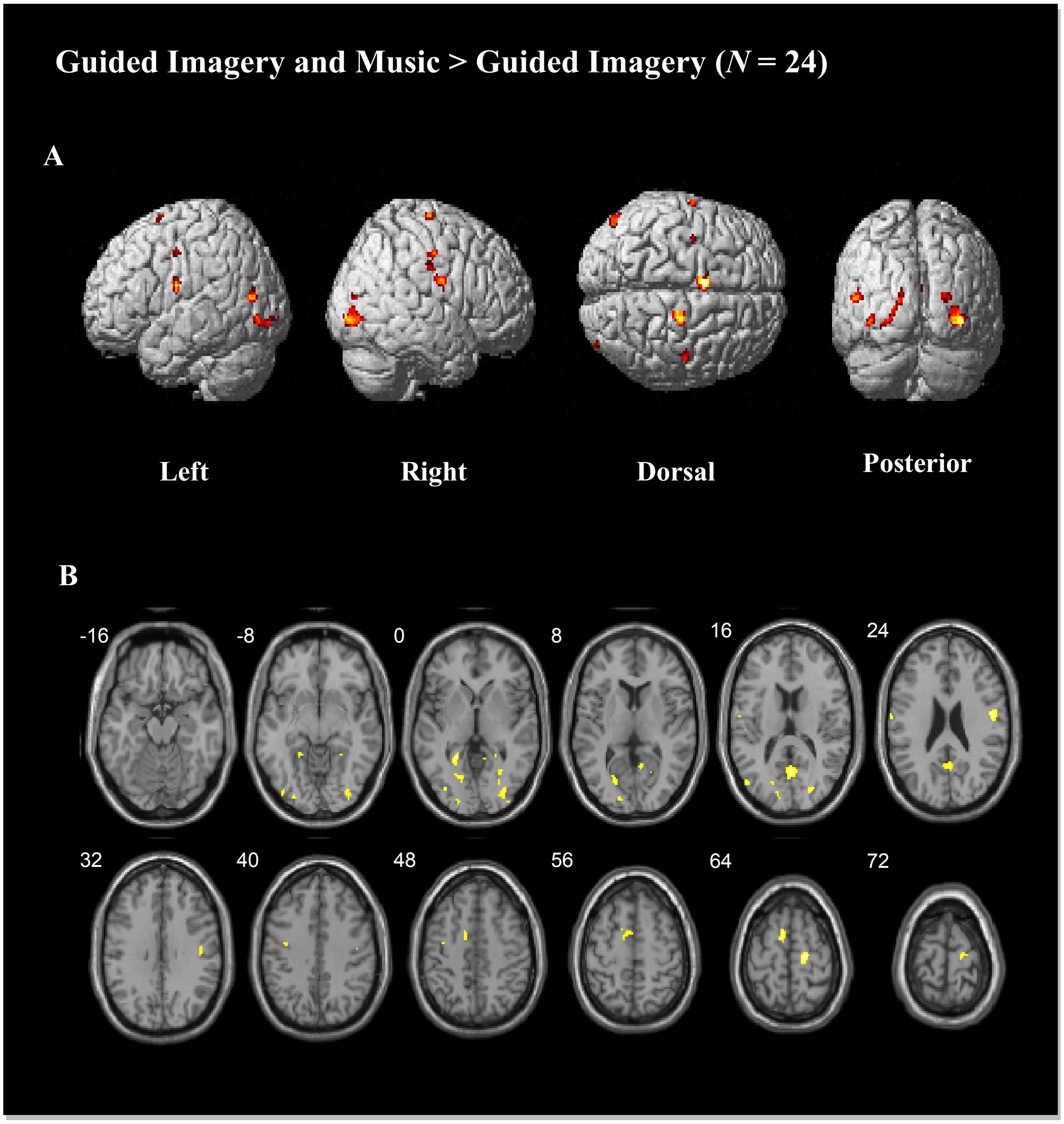


Figure 3. Brain Contrast Maps for Guided Imagery and Music > Guided Imagery: Clusters surpassing a corrected cluster-threshold of $p<0.001$ and the larger or equal size of cluster than 30 voxels. (A) Map of clusters projected on a standard rendered template brain. (B) Corresponding axial slices from z -16 to 72 in 8mm increments.

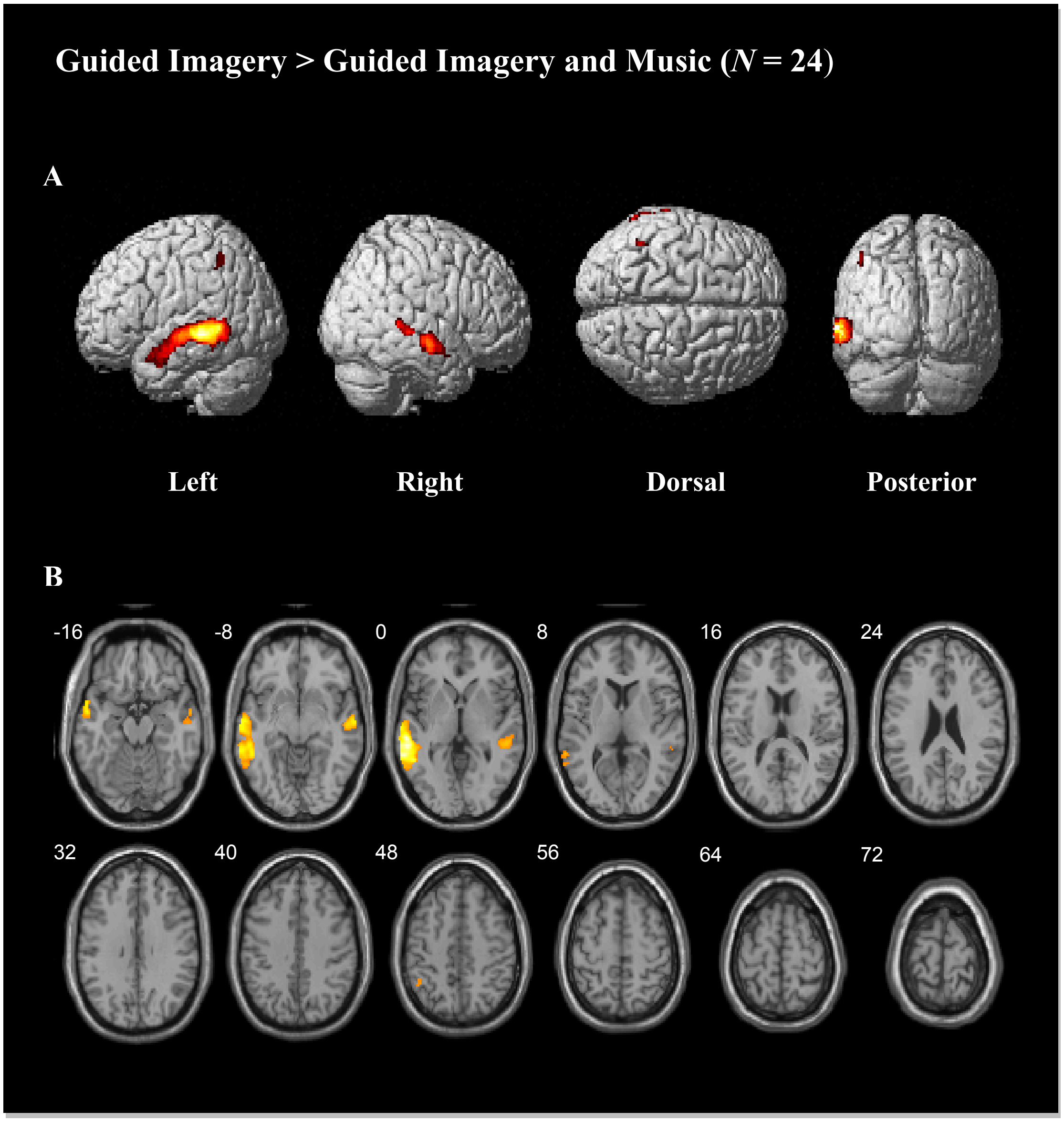


Figure 4. Brain Contrast Maps for Guided Imagery > Guided Imagery and Music: Clusters surpassing a corrected cluster-threshold of $p<0.001$ and the larger or equal size of cluster than 30 voxels. (A) Map of clusters projected on a standard rendered template brain. (B) Corresponding axial slices from z -16 to 72 in 8mm increments.

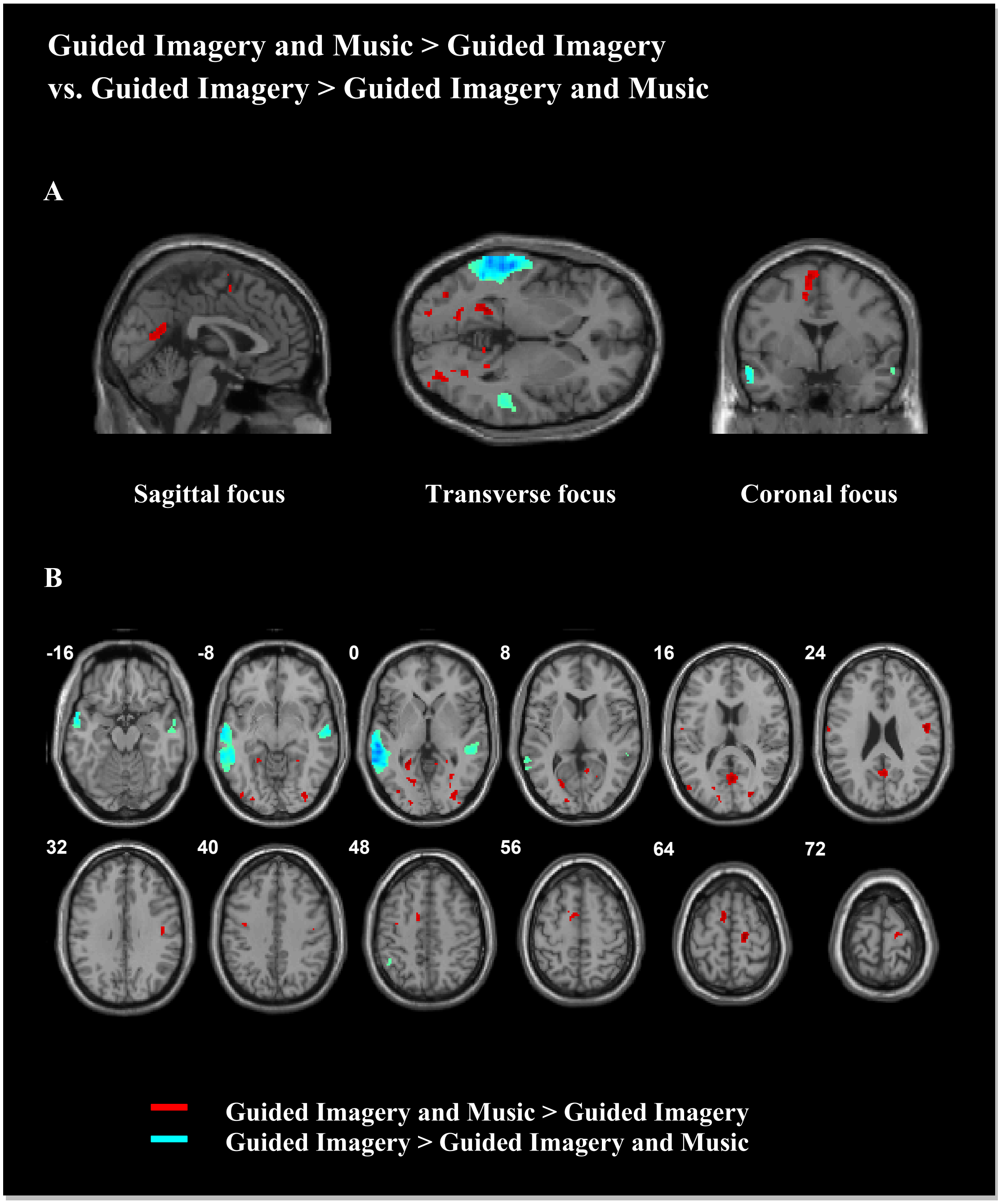


Figure 5. Comparison between Brain Contrast maps for Guided Imagery and Music > Guided Imagery and Guided Imagery > Guided Imagery and Music: Clusters surpassing a corrected cluster-threshold of $p<0.001$ and the larger or equal size of cluster than 30 voxels. (A) Three foci of slice cluster maps (B) Corresponding axial slices from z -16 to 72 in 8mm increments

Regions of Interests (ROI) Analysis

Based on examination of individual activation maps of functional MRI generated by three stimuli including guided imagery and music, guided imagery, and music, and deviated from baseline which is not compared to any other stimulus (see Figure 6), and also neural regions associated with negative emotional processing presented by previous studies, neural regions – namely the bilateral amygdala, the bilateral insula, the bilateral anterior cingulate gyrus - were selected for ROI analysis from AAL archives (Tzourio-Mazoyer, et. al., 2002) in MNI template (Collins, et. al., 1998) (See Table 4 and Figure 7).

Table 4
Region of Interest (ROI) Characteristics

Anatomical Region	side	Peak MNI Coordinate (*x*, *y*, *z*)	Brodmann area
Amygdala	L	-20, -2, -18	n/a
	R	28, -6, -16	n/a
Insula	L	-34 -30, 16	13
	R	46, 18, 2	13
Anterior cingulate gyrus	L	-2, 4, -8	25
	R	10, 18, 28	24

Note. Cluster $p < .05$. L, left; R, right.

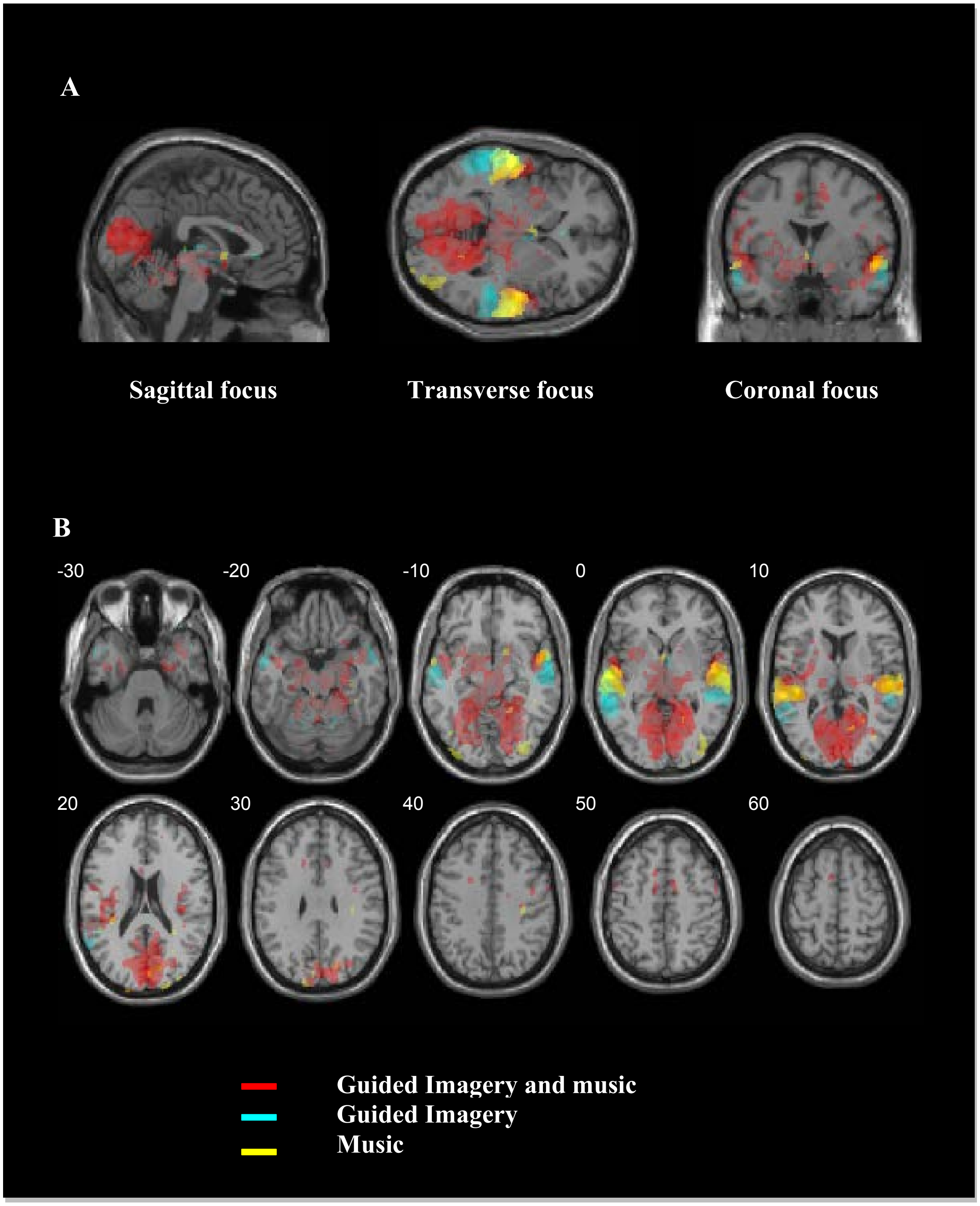


Figure 6. Whole Neural Regions for Regions of Interest (ROI) Analysis (*N* = 24): Clusters corresponding to results from the examination of individual activation maps of fMRI induced by guided imagery and music, guided imagery, and music deviated from baseline ($p < .05$). (A) Three foci of slice cluster maps (B) Corresponding axial slices from *z* -30 to 60 in 10 mm increments

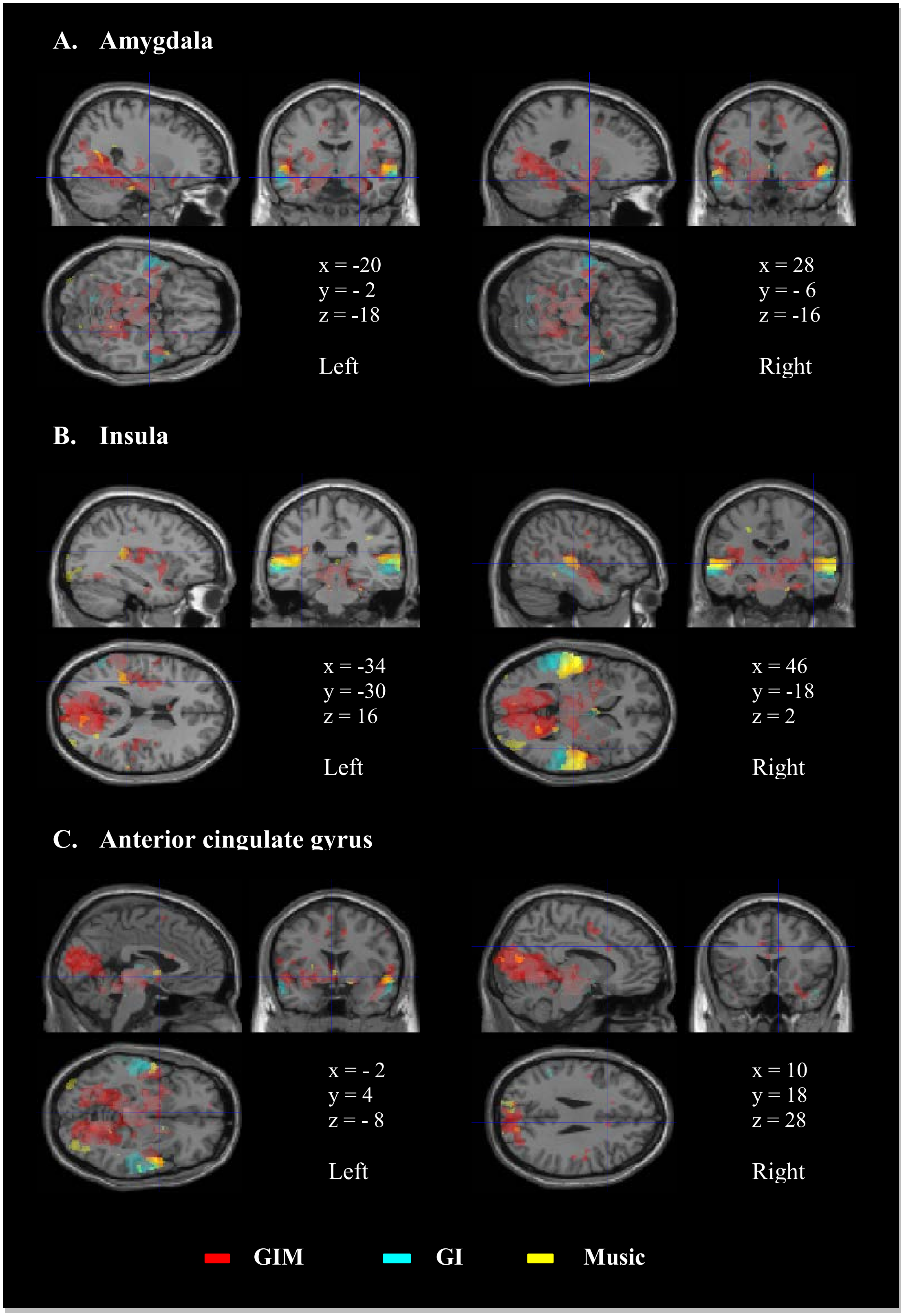


Figure 7. Three Neural Regions for Regions of Interest (ROI) Analysis (*N* = 24). GIM, Guided imagery music; GI, Guided imagery.

Averages of the BOLD signal changes for three conditions processing in selected regions ($p < .05$) were yielded in the ROI analysis (see Table 5 and Figure 8). The highest average of BOLD signal changes in the bilateral amygdala, insula, and anterior cingulate gyrus were presented during guided imagery and music processing compared to guided imagery or music processing. Also, averages of BOLD signal changes during guided imagery in three regions were higher than those during music processing. Besides, averages of BOLD signal changes during music processing in those regions were lower than guided imagery and music and guided imagery processing.

One-way analysis of variance (ANOVA) revealed statistically significantly different effects among three conditions including guided imagery and music, guided imagery, and music in the left amygdala ($F_{(2, 69)} = .660$, $p = .022$), the right amygdala ($F_{(2, 69)} = 1.579$, $p = .008$), the left insula ($F_{(2, 69)} = .167$, $p = .035$), the right insula ($F_{(2, 69)} = .589$, $p = .023$), the left anterior cingulate gyrus ($F_{(2, 69)} = .181$, $p = .035$), the right anterior cingulate gyrus ($F_{(2, 69)} = .660$, $p = .010$) (see Table 6). Following up on this, post-hoc pair-wise comparisons were performed to understand quadratic effects of stimuli. In these multiple comparisons, participants had significant BOLD signal changes in the bilateral three neural regions for guided imagery and music greater than guided imagery or than music. Also, significant neural activation for guided imagery was greater than for music in those regions.

Table 5

Neural Activation T during Processing of Three Conditions: GIM, GI, Music

Anatomical Region	side	*T (SD)* GIM	GI	Music
Amygdala	L	.7783 (1.49)	.5914 (1.65)	.3154 (.99)
	R	.3684 (.84)	.3185 (.82)	.0086 (.60)
Insula	L	.5264 (.73)	.5168 (.99)	.3899 (1.00)
	R	.5740 (.86)	.5529 (1.14)	.3124 (.73)
Anterior cingulate gyrus	L	.4481 (.97)	.3317 (1.10)	.2735 (1.00)
	R	.2880 (.61)	.1508 (.62)	.0036 (.55)

Note. T, beta activation measure - average BOLD signal changes in the 3 regions ($p < 0.05$, uncorrected). SD, standard deviation. L, left; R, right. GIM, guided imagery and music; GI, guided imagery.

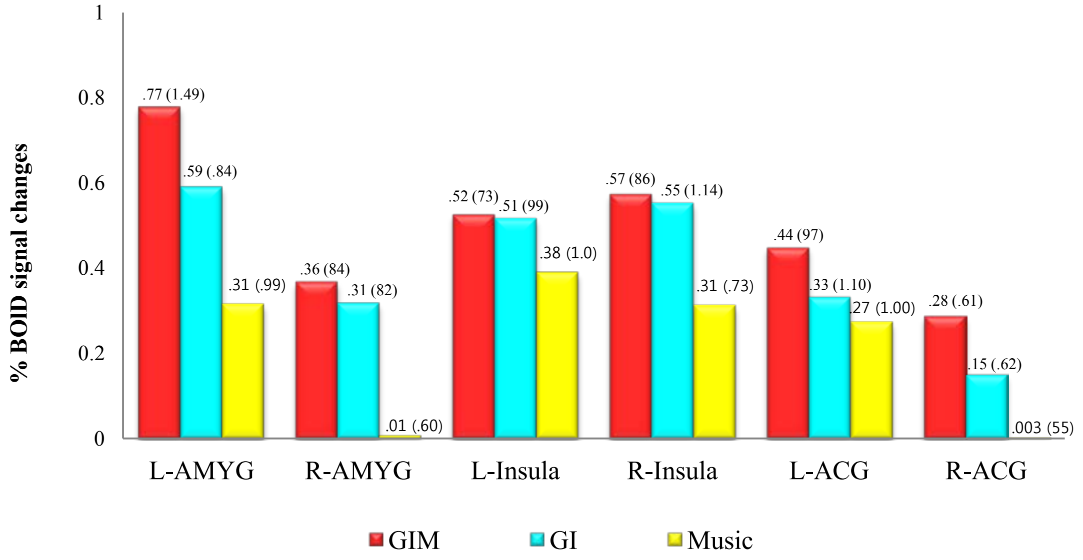


Figure 8. Differences of BOLD Signals Changes of Anatomical Regions for ROI Analysis: Bilateral Amygdala (AMYG), Bilateral Insula, and Bilateral Anterior Cingulate Gyrus (ACG). L, left; R, right. GIM, guided imagery and music; GI, guided imagery.

Table 6

Results of One-way ANOVA: The Comparison for Mean of the BOLD Signals across Three Conditions (GIM (a), GI (b), & M (c))

Anatomical Regions	side	*df*	*F*-value	*p*-value	Post-hoc
Amygdala	L	2	.660*	.022	a > b, a > c, b > c
	R	2	1.579**	.008	a > b, b > c, a > c
Insula	L	2	.167*	.035	a > b, b > c, a > c
	R	2	.589*	.023	a > b, b > c, a > c
Anterior cingulate gyrus	L	2	.181*	.035	a > b, b > c, a > c
	R	2	1.380*	.010	a > b, b > c, a > c

Note. *$p < .05$, **$p < .01$. L, left; R, right; GIM, guided imagery and music; GI, guided imagery; M, music.

Summary of Results on Research Questions

Research question 1 was: Which neural regions will be activated by guided imagery and music, compared to music? The contrast of guided imagery and music to music revealed significant activation in 11 neural regions including the left anterior cingulate gyrus, the left insula, the left amygdala, the left thalamus, the left claustrum, the bilateral culmen, the bilateral precentral gyrus, and the left superior temporal gyrus, the bilateral middle temporal gyrus, the right cuneus, and the left inferior parietal lobule. In contrast, there was no significant activation in any neural region for the contrast of music to guided imagery and music.

Research question 2 was: Which neural regions will be activated by guided imagery and music, compared to guided imagery? The contrast of guided imagery and music to guided imagery revealed significant activation in nine neural regions including the right posterior cingulate gyrus, the bilateral parahippocampal gyrus, the bilateral precentral gyrus, the left superior frontal gyrus, the left middle frontal gyrus, the bilateral middle occipital gyrus, the bilateral cuneus, the right lingual gyrus, and the inferior parietal lobule. On the contrary, there were significant neural activation in three neural regions including the right superior temporal gyrus, the bMTG, and the left inferior parietal lobule.

Research question 3 was: Are there significant differences of the blood oxygen level dependent (BOLD) signal changes among 3 conditions – guided imagery and music, guided imagery, and music - in neural regions associated with negative emotional processing? There were statistically significant differences in BOLD signal changes among 3 conditions including guided imagery and music, guided imagery, and music in the bilateral amygdala, insula, and anterior cingulate gyrus. In addition, participants had significant BOLD signal changes in the bilateral three neural regions for the condition of guided imagery and music greater than music alone or guided imagery. Also, there were significant BOLD signal changes for guided imagery greater than music alone in those regions.

CHAPTER 5

Discussion

The ultimate aim of the present study was to investigate the effect of guided imagery and music on arousal and emotional processing with personal episodic memory through human brain-mapping data by functional magnetic resonance imaging. Thus, this study examined different effects of neural dynamics on arousal and emotional processing induced by three different kinds of auditory stimuli: music after verbal instructions for the condition of guided imagery and music, music for the condition of music, and verbal instructions for the condition of guided imagery. This study finding was intended to be presented by two kinds of analyses, namely Volume and Region of Interest (ROI) analyses.

Thus, in more detail this chapter describes and illustrates this study's findings. The first section summarizes results and implications. The second illuminates strengths, limitations, suggestions for further research, and conclusion.

Summary of Results and Implications

Volume analysis

Arousal and emotional processing induced and/or intensified by guided imagery and music, guided imagery, and music conditions, activated neural regions. Volume analysis identified specific neural regions activated by guided imagery and music compared to music, or to guided imagery. Eleven significant regions associated with the functions of emotional and visual processing, integration of cross-modal sensory processing, episodic memory, empathy, and out-of-body experience were revealed by responses to guided imagery and music compared to music, but no region was associated with music compared to guided imagery and music. In the second comparison between guided imagery and music and guided imagery, nine neural regions associated with the functions of episodic memories, visual and motor processing, and empathy were revealed by guided imagery and music compared to guided imagery, whereas three regions associated with the functions of visual and language processing were revealed by guided imagery compared to guided imagery and music.

Thus, both comparisons between guided imagery and music and music or guided imagery presented the effectiveness of guided imagery and music for neural activations. That is, guided imagery and music engaged many neural regions associated with emotional and sensory processing as well as episodic memories, and also empathy greater than music or guided imagery. Moreover, the ROI analysis revealed the effectiveness of guided imagery and music intensifying arousal and emotional processing through mental imagery indicating that greater BOLD signal changes were found in neural regions associated with emotional processing for guided imagery and music than for music or guided imagery. Thus, the neural basis for arousal and emotional processing of guided imagery and music was provided comparing neural regions activated by guided imagery and music to those by music or guided imagery in volume analysis.

Comparison between guided imagery and music and music effects. In the contrast of guided imagery and music to music, eleven neural regions were activated including the left ACG, the left insula, the left amygdala, the left thalamus, the bilateral precentral gyrus, the lSTG, the bMTG, the lIPL, the right cuneus, the left claustrum, and the bilateral culmen, whereas no activation occurred in neural regions in contrasting music to guided imagery and music.

First, the ACG plays roles in diverse autonomic functions including regulating blood pressure or heart rate and cognitive functions including modulating attention, rewards anticipation, motivation, and emotional responses (Bush, Luu, & Posner, 2000; Decety & Jackson, 2004; Jackson, Brunet, Meltzoff, & Decety, 2006). In particular, BA 32 known as the dorsal region of anterior cingulate gyrus (dACG) is associated with two emotional categories such as sadness and conflict (Lindquist et al., 2012) and helps generate and regulate emotions as one of the core affective regions (Kober et al., 2008) for discerning and guiding behavior when facing sensory inputs on conflicts (Botvinik, 2007; Bush et al., 2000; Teasdale, Howard, Cox, Ha, Brammer, Williams, & Checkley, 1999). Thus, it may be assumed that guided imagery and music induced negative emotions such as sadness and conflict through guided imagery.

The insula also has been reported to play a significant role in emotional response, especially the perception of disgust. According to the meta-analysis study by Lindquist et al. (2012), the left insula has a role in anger experience, the right insula in disgust experience. It may be assumed that the provided musical stimulus played a role in evoking anger, which corresponds to the function of the left insula as reported by the study of meta-analysis by Lindquist, et al. As one of the other representative neural regions for emotional processing, the left amygdala activated. A number of previous neural studies have corroborated the amygdala role as a critical emotional processing region responding to fear and aversive conditioning (Adams Jr., Gordon, Baird, Ambady, & Kleck, 2003; Adolphs, Tranel, Hamann, Young, Calder, Phelps, Anderson, Lee, & Damasio, 1999; Costafreda, Brammer, David, & Fu, 2008; Kim & Hamann, 2007;

LeDoux, 2000; Morris et al., 1996). Moreover, according to Whalen, Rauch, Etcorff, Mclnerney, Lee, and Jenke (1998), the amygdala was activated by subliminally-presented facial expressions in normal participants. In particular, emotional processing of facial expressions of fear activated in the left amygdala has been reported by functional imaging studies (Morris et al., 1998). Thus, it may be assumed that participants had emotional experiences with their episodic memories including emotional arousal from facial expressions. Moreover, this result corresponded to the theme of their personal episodes which were conflict between or among people around them and themselves. This indicates that people with facial expressions existed in their imagery. Thus, guided imagery and music engaged emotional processing with personal episodes through imagery

As a recently considerable region in emotional processing, the cerebellum, especially the bilateral culmen as the portion of anterior vermis, was activated. Traditionally, this region had been reported as a motor structure. However, studies indicate it is activated in various sensory and cognitive processing (Petacchi, Laird, Fox, & Bower, 2005). Moreover, it was reported that this region was activated by the perception and production of rhythm as the musical element (Penhune, Zatorre, & Evans, 1998). However, in the last decade, much research data report the cerebellum to be involved in affective regulation, association between sensory stimuli and emotional behavior, and episodic memory, specifically fear (Strata, Scelefo, & Sacchetti, 2011). Liotti, Mayberg, Brannan, McGinnis, Jerabek, & Fox (2000) by functional neuroimaging study reported the activation of the cerebellum by anxiety and sad mood in healthy participants. Thus, the culmen activation in this study supports previous literature.

The thalamus, activated as a subcortical region, plays a crucial role in receiving sensory signals and sending them to linked primary cortical regions (Sherman, 2006). In particular, as it is related to spatial recall and spatial sensory data, it has a crucial function for episodic memory in humans (Aggleton, O'Mara, Vann, Wright, Tsanov, & Erichsen, 2010; Burgess, Maguire, & O'Keefe, 2002). Thus, the result indicates that guided imagery and music intensified to remind participants of their personal emotional episodes.

Also, activation of the precentral gyrus, especially BA 6 composed of the premotor cortex, was observed. This area has been suggested to be involved in planning and executing motor movement related to sensory guided movement (Elias, & Saucier, 2006). Moreover, it has been reported that the function of the secondary motor cortex, including premotor cortex, activated as response to motor imagery (Decety et al., 1995; Jeannerod & Decety, 1995; Elias et al., 2006) and the premotor cortex triggered by external stimuli (Deiber, Passingham, Colebatch, Friston, Nizon, & Frackowiak, 1991). Guided imagery and music, it may be assumed, generated motor imagery. Which may indicate that this region could function as the mirror neuron system acting as the tool that reads actions and minds of others, empathizing with others, and language evolving gesture performance and understanding (Keysers, & Gazzola, 2006; Rizzolatti, & Craighero, 2004). Thus, the premotor cortex activation in this study supports the previous studies indicating that participants experienced phenomena such as empathy, mind and body language understanding, and so on, related to conflict with others or self in episodic memories through mental imagery.

The STG (BA22) is a significant region for speech processing (Bigler, Mortensen, Neeley, Ozonoff, Krasny, Johnson, Lu, Provencal, McMahon, & Lainhart, 2007). In particular, the left side of the STG observed in this study has been reported as the locale of understanding written and spoken language (Ryan, Nadel, Keil, Putnam, Schnyer, Trouard, & Moscovitch, 2001; Wernicke, 1995). Thus, it may be assumed that guided imagery and music generated language processing in personal episodic memories through mental imagery, despite there being no stimulation for language processing during guided imagery and music.

As responses to visual processing, the bilateral MTG, and the cuneus as an extrastraite visual cortex, were activated. Particularly, the MTG (BA 21) has been known to have an important role in the processing of visual motion. That is to say, this region is activated by moving visual stimuli (Dubner, & Zeki, 1971). Also, the cuneus in the occipital lobe has a role in receiving and interpreting visual images. Especially, the activation of BA 18 is modulated by visual and spatial attention and memory retrieval (Matsuka, Yamauchi, Hanson, & Hanson, 2005). Revealed as the activation of both regions, it can be assumed that although there were no direct verbal instructions for generating imagery related to episodic memories in guided imagery and music, music helped participants to concentrate on their episodic memories and to intensify visual mental imagery generated by verbal instructions.

Besides, the inferior parietal lobule (BA 39) as portion of the junction of temporal, occipital, and parietal lobes and a part of mirror neurons, was activated. The region, namely angular area 39, is associated with processing of language, calculation, spatial cognition, memory retrieval, attention, and mind (Seghier, 2013) and integrating processing of different sensory modalities including auditory, visual, and somatosensory information (Bernstein, Auer Jr., Wagner, & Ponton, 2008; Clark, Egan, McFarlane, Morris, Weber, Sonkkilla, Marcina, & Tochon-Danguy, 2000; Joassin, Pesenti, Maurage, Verreckt, Bruyer, & Campanella, 2011). In particular, this region is associated with awareness of self's intentional and resultant movement (Farrer, Frey, Van Horn, Tunik, Turk, Inati, & Grafton, 2008), and episodic memory (Seghier, 2013), Interestingly, recent studies have demonstrated that the activation of BA 39 is due to out-of-body experience (Blanke, Landis, Spinelli, & Seeck, 2004). It may be assumed that music helped participants concentrate on imagery processing in episodic memories.

Last, claustrum activation was observed, the function of which is controversial. However, Crick and Koch (2005) summed up the function of communication between both right and left hemispheres of the brain, through reviewing previous literature. That is, the claustrum works to integrate various sensory modalities for perceiving a single object. Thus, it may be assumed that guided imagery and music helped intensify arousal processing as integrating with various kinds of sensory information in imagery experiences.

Taken together, guided imagery and music engaged in the neural regions associated with the functions of the processing of emotions, especially negative, various kinds of sensory modalities, integration of cross-modal sensory, episodic memory, empathy, and out-of-body experience through imagery generated by verbal instructions for recalling episodic memory. Regions associated with emotional processing were the ACG, the insula, the amygdala and the culmen; especially, the ACG, the insula, and the amygdala were representative neural regions associated with basic negative emotional categories from the literatures. Also, the culmen and the thalamus have a role in sensory processing, and the amygdala is the region linked to emotional arousal by facial expression. Episodic memories activated in the culmen, the thalamus, the lIPL (BA 39), and visual processing engaged in the MTG (BA 21) and the cuneus. Regions that can be linked to motor imagery were the culmen and the precentral gyrus. In particular, the precentral gyrus, as the premotor cortex, was involved in processing related to human phenomena such as understanding actions and minds of others, and empathy as one of the mirror neurons. Moreover, the claustrum and the lIPL were involved in the integration of various sensory modalities. Therefore, music provided in the condition of guided imagery and music not only intensified imagery processing evoked by verbal instructions, but also participated in various arousal processing related to personal emotional episodes, indicating that multimodal stimuli activated in various neural regions.

Comparison between guided imagery and music and guided imagery effects. In the contrast of guided imagery and music to guided imagery, nine neural regions were activated including the rPCG, the bilateral parahippocampal gyrus, the bilateral precenral gyrus, the lSFG, the lMFG, the left MTG, the bilateral MOG, the bilateral cuneus, and right lingual gyrus. In contrast, the rSTG, the bilateral MTG, and the lIPL were activated in the contrast of guided imagery to guided imagery and music.

First, in the contrast of guided imagery and music to guided imagery, activations occurred in the rPCG (BA 23) and the bilateral parahippocampal gyrus (BA 19). Both are associated with working memory. The PCG plays a significant role in pain and episodic memory (Nielsen, Balsley, and Hansen, 2005; Kozlovskiy, Vartanov, Nikonova, Pyasik, & Velichkovsky, 2012), and the parahippocampal gyrus plays a main role in memory from encoding and recognition of scenes, i.e., in imagining landscapes rather than objects or faces (Aquirre, Detre, Alsop, & D’Esposito, 1996; Ishai, 1996). It may be assumed that guided imagery and music worked as a stimulus for generating pain and episodic memory as well as intensifying the processing of mental imagery. Also, BA 30 as portions of the left cuneus and the left parahippocampal gyrus was observed, and is the retrospenial region in the posterior cingulate region, which plays a role in cognitive functions including episodic memory, navigation, imagination, and future planning (Vann, Aggletion, & Maguire, 2009). In particular, the retrospenial region is activated in recalling past autobiographical experiences (Svoboda, Mckinnon, & Levine, 2006; Vann et al., 2009). It can be assumed that guided imagery and music helped generate imagery with recalling episodic memories.

As the motor cortex, the activations of the precentral gyrus, the lSFG and the lMFG in the frontal lobe, were observed. The activated precentral gyrus is located in BA 4 and 6, and the activated lSFG and lMFG are located in the caudal portions of BA 6. Activated BA 4 as the primary motor cortex has a role in controlling coordinated activity of muscles based on sensory responses as interconnecting with the somatosensory cortex (Elias et al., 2006). Also, BA 6, as mentioned above, is not only is involved in planning and executing motor movement by sensory feedback, but also is implicated in understanding others, empathy, self-awareness and so forth, as a portion of mirror neurons. Considering this activation associated with the theme of personal episodes related to conflicts with others or self, it may be assumed that guided imagery and music helps participants work with their episodic memories as arousing and intensifying mental imagery with a multisensory stimulus.

Activation of the lIPL (BA39) was also observed, which is the same as in the condition of guided imagery and music of the comparison between guided imagery and music and music. As mentioned above, previous literature has reported the function of this region as involved in the processing of language, numbers, spatial cognition, content and episodic memory, multimodal sensory processing, awareness of self's intentional and resultant movement, and out-of-body experience. Thus, it can be assumed that guided imagery and music helped participants to be more immersed in imagery experiences in episodic memory than in providing verbal instructions. Also, guided imagery and music engaged as a multimodal sensory stimulus.

Visual imagery is common in imagery processing. This present study revealed that guided imagery and music engaged as the stimulus in evoking visual imagery as indicating visual cortex activations such as BA 18 including the bilateral MOG and the right cuneus and BA 19 including the lMOG and the right lingual gyrus as extrastriate cortical areas. As described above, BA 18 has roles in visual and spatial attention, memory retrieval, and interpretation of images. Also, the function of BA 19 is involved in tracking movement of objects in space (Galletti, Battaglini, & Fattori, 1990).

In contrast, in the condition of guided imagery in this comparison, three regions were activated including the right superior temporal gyrus (rSTG), the bilateral MTG, and the left inferior parietal lobule (lIPL). The function of the rSTG is involved in auditory processing for distinguishing differences among melody, pitch, and sound intensity in language processing (Phillips & Sakai, 2005). The bilateral MTG is involved in visual motion processing. Also, the lIPL is functionally involved in emotional perception from facial stimuli (Radua, Phillips, Russell, Lawrence, Marshall, Kalidindi, El-Hage, McDonald, Giampietro, Brammer, David, & Surguladze, 2010). The lIPL, particularly the supramarginal gyrus, is implicated in the perception and processing of language (Gazzaniga, Ivry, & Mangun, 2009). Thus, those activated regions indicate that verbal instructions evoked visual imagery with the contents of their personal emotional episodes as auditory stimuli. Thus, it may be assumed that guided imagery directly worked as a verbal stimulus to induce scenes related to episodic memories compared to guided imagery and music.

Taken together, whereas guided imagery mainly engaged in neural regions associated with the functions of auditory and visual and language understanding processing including the rSTG, the bilateral MTG, and the lIPL, guided imagery and music engaged in neural regions associated with the functions of episodic memories, sensory processing such as motor and visual processing, functions of mirror neurons such as empathy, and so on. In contrasting guided imagery and music to guided imagery, regions involved in episodic memories were the rPCG, the bilateral parahippocampal gyrus, and the cuneus (BA 30). The activated precentral gyrus including BA 4 and BA 6 associated with motor processing by sensory feedback. Also, as mirror neurons, regions associated with various functions related to understanding others, such as empathy with others, awareness of self's intentional and resultant movement, and so on, were the premotor cortex (BA 6) including the precentral gyrus, the lSFG, the lMFG, and the lIPL. Last, activated regions involved in visual processing were the bilateral MOG, the right cuneus, and the right lingual gyrus. Thus, guided imagery and music, compared to guided imagery, more intensified mental imagery including motor and visual processing with episodic memories, and helped participants work with personal emotional episodes immersed in mental imagery. Therefore, music in the condition of guided imagery and music was more effective for arousal and emotional processing than was verbal instructions in the condition of guided imagery.

Regions of Interest (ROI) Analysis

To determine whether differences existed among three conditions including guided imagery and music, guided imagery, and music on arousal and emotional processing through mental imagery with negative episodic memory, BOLD signal changes in the bilateral amygdala, insula, and anterior cingulate gyrus ROIs were analyzed. Those have been reported as representative neural regions associated with feeling negative emotions such as fear, anger, and sadness. As shown in the results, significant differences emerged among three conditions in BOLD signal changes.

More important, the BOLD signal change in guided imagery and music was higher than in other conditions. The intermediate signal change was in the condition of guided imagery, and the lowest was in music. It may be assumed that guided imagery and music had a role in evoking arousal and emotional processing, as well as in intensifying arousal and emotional processing through mental imagery induced by verbal instructions in the guided imagery condition. On the other hand, guided imagery had a direct role in evoking arousal and emotional processing providing verbal instructions for recalling and re-experiencing personal emotional episodes, and music evoked arousal and emotional processing induced by music itself. In other words, guided imagery and music rendered more accurate and profound those emotions evoked by verbal instructions in the condition of guided imagery. The result revealed the effectiveness of guided imagery and music as multimodal stimuli on arousal and emotional processing for inducing personal negative episodes. Support for this interpretation comes from the study of Baumgartner, Esslen et al. (2006) which demonstrated that combined stimuli including pictures and classical music made the quality of emotional states the most accurate and effective for arousal and emotional processing, compared to each stimulus of pictures or music excerpts. Therefore, music noticeably enhances arousal and emotional experience through mental imagery evoked by verbal instructions for inducing personal negative episodic memory.

Strengths, Limitations, and Suggestions for Further Research

The present study investigated the neural basis of guided imagery and music as showing the neural regions activated by arousal and emotional processing in mental imagery as responses to music and verbal instructions related to negative emotional episodic memory. For the arousal and emotional processing, multimodal stimuli including music and verbal instructions were used in this study, whereas most previous neuroimaging studies used visual stimuli rather than auditory stimuli, despite music having been considered as an emotional stimulus. According to Baumgartner, Esslen et al, (2006), although most emotional experiences in real life are evoked by combined stimuli with different modalities, most neuroimaging study of emotional processing has been conducted by visual stimuli, in particular by facial expressions or scenes. Thus, music as an emotional facilitator has not been as long and as widely studied in neuroimaging research. Therefore, of importance is that this study revealed neural dynamics of arousal and emotional processing from various kinds of sensory imagery generated by verbal instructions and music as auditory stimuli. Moreover, the findings support previous studies on the effectiveness of guided imagery and music as multimodal stimuli on arousal and emotional processing. As reported from previous studies, this study suggests that music not only evokes emotions and various kinds of sensory imagery as an auditory stimulus, but also noticeably enhances arousal and emotional processing through imagery evoked by verbal instructions. Therefore, it indicates the potential of fMRI study for corroborating the efficacy of guided imagery and music on arousal and emotional processing in the brain as a fundamental research.

Another significance of the present study is that it is one of only a few neuroimaging studies to provide the neural basis of, and scientific evidences for, arousal and emotional processing induced by guided imagery and music. Most previous research has been conducted to verify the efficacy of guided imagery and music by the paradigm of qualitative research, because phenomena in individual experiences cannot be accounted for in the same way as quantitative research can be. However, and important, visible data is necessary to corroborate arousal and emotional processing induced by guided imagery and music, and its effectiveness, as multiple stimuli. Thus, some research has been conducted as the paradigm of quantitative research providing data of physiological responses, neural regions activated by each element such as music or imagery or electroencephalography (EEG) data. Moreover, as developing neuroimaging techniques, researchers increasingly have been interested in the function of music or imagery in the neuropsychological view. However, there was no fMRI study for corroborating the neural basis of arousal and emotional processing by guided imagery and music, and demonstrating effectiveness. Thus, of significance is that this study tried to provide the neural basis of arousal and emotional processing from guided imagery and music, as well as to corroborate the efficacy of guided imagery and music for arousal and emotional processing.

Despite these significant aspects, the present study has limitations, particularly in the aspect of musical stimulus. For that musical stimulus to be applied to the experimental paradigm, four one-minute whole-music parts were applied to each music condition for arousal and emotional processing. In general, one minute may be too short to induce emotions and imagery, although imagery processing already is in progress by verbal instructions. Thus, such short music inserts might make it difficult to be deeply immersed in imagery processing for evoking unconscious emotions. That is to say, longer interludes of music may be needed for participants to be fully immersed in emotional processing with imagery. This is why the music programs, include more than a couple of music pieces allowing space and time for exploration, experience, intensification, and integration for the inner self to be explored. This is music psychotherapy, for example, the Bonny method of guided imagery and music (BMGIM).

Another aspect of limitation to consider in this study is one of the given three conditions: guided imagery and music. For this process of guided imagery and music, participants received only music stimulus, but it was expected that the verbal instructions given before music stimulus have a role in inducing various sensory types of imageries having successive effect on the next guided imagery and music condition. However, it could not entirely rule out the possibility of the effect of music itself on evoking emotions as well as various sensory types of imagery. Thus, there could be vagueness about whether it is the effectiveness of guided imagery and music or music itself, because this study did not provide music with verbal instructions in the condition of guided imagery and music. However, results from the comparison between guided imagery and music and music, showed that verbal instructions in the condition of guided imagery played a role as a successive stimulus for imagery processing to the next guided imagery and music condition indicating different neural activations between both of guided imagery and music and music.

Despite the significant results found in this study, further studies with various trials such as demonstrating neural activations with experimental paradigm for using full length of music, correlation between activated neural regions, different neural activations in specific neural regions according to kinds of stimuli, gender effect on arousal and emotional processing in the brain and so on are needed to increase the validity and reliability of the study. Particularly, further studies focusing on different neural activation for the specific neural regions related to therapeutic goal of guided imagery and music may suggest the efficacy of guided imagery and music as a music psychotherapy method.

Conclusions

Via neuroimaging data, the present study has demonstrated the neural basis and efficacy of guided imagery and music on arousal and emotional processing. Many factors in the condition of guided imagery and music contributed to various observed neural structures and functions more than did other conditions including guided imagery or music. In other words, in the condition of guided imagery and music, activations of neural regions associated with emotions as well as various sensory, memory processing and so forth, were observed, whereas only few activations of neural regions, or none, were observed in conditions of guided imagery or music. In addition, differences of the BOLD signal changes in neural regions associated with negative emotional processing were observed among three conditions. Moreover, the BOLD signal change in the condition of guided imagery and music was higher than in other conditions including guided imagery or music.

Therefore, results showed that when combined with another stimulus, music plays a more powerful role in inducing and enhancing arousal and emotional processing. Thus, it suggests that guided imagery and music as multimodal stimuli are effective as an approach in emotional work with personal episodic memories that is necessary for psychotherapy.

Ultimately, this study suggested neural basis on arousal and emotional processing by guided imagery and music with personal emotional episodic memories for understanding of the neural network including cortical and sub-cortical structures and functions, which will help develop music psychotherapy.

Appendix A

RESEARCH CONSENT FORM

RESEARCH CONSENT FORM

Study of Neural Activation on Music and Imagery: A Functional MRI Study

Principal Investigator: Sang Eun Lee, co-researcher, Michele Forinash, Director of the PhD program in Expressive Therapies, Lesley University

You are being asked to volunteer in this study to assist in my doctoral research on Neural Activation on guide imagery and music: A Functional MRI Study. The purpose of the study is to examine the effectiveness of guided imagery and music for evoking negative emotions related to personal inner issues.

You will be initially interviewed and asked to fill in questionnaires about personal, background information that includes right-handedness, normal hearing ability, a history of neurological insult and psychiatric disorders, experiences of professional music education and imagery or hypnosis therapies, and personal emotional episodes in your life. For inducing negative emotions such as anger or fear, you will be asked to recall, re-experience, and re-enact your personal episode related to negative emotions before fMRI scanning. During fMRI scanning, you will be asked to listen to a piece of classical music in session 1 and to listen to a piece of classical music after instructions for guided imagery in session 2. The whole experiment will be total 45 minutes in length.

You will be personally interacting with only me as the principal researcher. This research project is anticipated to be finished by approximately May 2013.

I, ____, consent to participate in the experiment for this study

I understand that: *fill in below what you will be doing.*

- I am volunteering for fMRI experiment involving guided imagery and music, approximately 45 minutes in length.
- My identity will be protected.
- Personal, background information including right-handedness, normal hearing ability, a history of neurological insult and psychiatric disorders, experiences of professional music education and imagery or hypnosis therapies, and personal emotional episodes in your life, and your imagery and emotional experiences during fMRI will be kept confidential and used anonymously only, for purposes of presentation and/or publication.
- The research data will be used only for the purpose of analyzing data, and will be kept in a locked computer in the investigator's possession for possible future use.
- Your participation in this study is voluntary; you have the right to withdraw at any point in the study, for any reason, and without any prejudice, and the personal, background information collected and records and reports written will be kept in strict confidence in locked file cabinet in the investigator's possession for possible future use. However, this

information will not be used in any future study without my written consent.

- The expected benefits associated with participation in this study are the opportunities to develop a music therapy method as providing scientific rationale for performing Bonny method of guided imagery and music (BMGIM), one of music psychotherapies.
- I may choose to withdraw from the study at any time with no negative consequences.
- At your written request, you will receive a copy of the final paper in English at the completion of the study.

Confidentiality, Privacy and Anonymity:

You have the right to remain anonymous. If you elect to remain anonymous, I will keep your records private and confidential to the extent allowed by law. I will use pseudonym identifiers rather than your name in on study records. Your name and other facts that might identify you will not appear when we present this study or publish its results.

If you have any question about this study, you can contact my advisor, Dr. Michele Forinash at 1-617-349-8166 or forinash@lesley.edu; or Sang Eun Lee at 82-10-4606-2711 or slee20@lesley.edu with any additional questions.

We will give you a copy of this consent form to keep.

a) **Investigator's Signature**:

___________	_________________________	_______________________
Date	Investigator's Signature	Print Name

b) **Subject's Signature**:

I am 18 years of age or older. The nature and purpose of this research have been satisfactorily explained to me and I voluntarily agree to become a participant in the study as described above. I understand that I am free to discontinue participation at any time if I choose, and that the investigator will gladly answer any questions that arise during the course of the research.

___________	__________________________	_______________________
Date	Investigator's Signature	Print Name

There is a Standing Committee for Human Subjects in Research at Lesley University to which complaints or problems concerning any research project may, and should, be reported if they arise. Contact the Dean of Faculty or the Committee at Lesley University, 29 Everett Street, Cambridge Massachusetts, 02138, telephone: (617) 349-8517.

Appendix B

RECRUITMENT FLYER

Healthy Volunteers Needed for a Brain Imaging Study

Investigation of Neural Activation on Guided Imagery and Music
: A functional MRI study

- Purpose

To examine the effectiveness of guided imagery and music on arousal and emotional processing related to inner issues

- Detailed description

Objective

To see how different neural activations between the conditions of guided imagery and music, guided imagery, and music are

Study population

30 Right handed healthy adults

Procedure

Estimated duration: 40 - 50 minutes

- Eligibility

Inclusion criteria

1. Aged over 18 years as undergraduate students in the Korean Advanced Institute of Science and Technology (KAIST)
2. Right-hand dominant
3. Have a normal neurological and psychological exam
4. Have no metal in the body (dental fillings are OK)
5. Have the capacity to give informed consent

Exclusion criteria

1. Pregnancy
2. Any abnormal finding on neurological and psychiatric assessment
3. Any finding that prevents undergoing an fMRI scan on the questionnaires
4. Any history of any brain injury
5. Presence of any neurological and psychiatric problems
6. Presence of any medical illness
7. Presence of claustrophobia or any other restriction for undergoing a imaging scanning

- Study date: September 5 2013
  Estimate enrollment: 30

- Contacts and locations

Contact

Dong Mi Im	(042) 350 8494	dmim@kaist.ac.kr
Sang Eun Lee	(010) 4606 2711	slee20@lesley.edu

Location

N23, fMRI Lab, 291 Daehak-ro (373-1 Guseong-dong), Yuseong-gu, Daejeon 305-701,
Republic of Korea

Appendix C

BACKGROUND QUESTIONNAIRES

Background Questionnaires

Name ____

Gender ____________________________ Age ____________________________

1. Have you ever experienced imagery and hypnosis therapies by professionals?

   Yes ______ No ______

2. Do you have any chronic disease?

   Yes ______ No ______

3. Do you have any history or current evidence of neurologic illness?

   Yes ______ No ______

4. Do you have any history or current evidence of psychiatric illness?

   Yes ______ No ______

5. Do you have any history or current evidence of alcohol or substance abuse?

   Yes ______ No ______

6. Do you have any history or current evidence of auditory illness?

   Yes ______ No ______

7. Do you have any history or current evidence of claustrophobia or any other restriction for preventing from undergoing fMRI scanning?

   Yes ______ No ______

8. Do you have any history or current use of psychotropic medication?

   Yes ______ No ______

9. Do you have any magnetically-activated implant or device such as cochlea implant?

   Yes ______ No ______

Appendix D

EDINBURG HANDEDNESS INVENTORY

Edinburgh Handedness Inventory

Your Initials:__________________

Please indicate with a check (✓) your preference in using your left or right hand in the following tasks.

Where the preference is so strong you would never use the other hand, unless absolutely forced to, put two checks (✓✓).

If you are indifferent, put one check in each column (✓ | ✓).

Some of the activities require both hands. In these cases, the part of the task or object for which hand preference is wanted is indicated in parentheses.

Task / Object	Left Hand	Right Hand
1. Writing		
2. Drawing		
3. Throwing		
4. Scissors		
5. Toothbrush		
6. Knife (without fork)		
7. Spoon		
8. Broom (upper hand)		
9. Striking a Match (match)		
10. Opening a Box (lid)		
Total checks:	LH =	RH =
Cumulative Total	CT = LH + RH =	
Difference	D = RH – LH =	
Result	R = (D / CT) × 100 =	
Interpretation: (Left Handed: R < -40) (Ambidextrous: -40 ≤ R ≤ +40) (Right Handed: R > +40)		

Adapted from Oldfield, R. C. (1971).

Appendix E

STATE-TRAIT ANXIETY INVENTORY

State-Trait Anxiety Inventory (STAI)

Participant's initials Date of Assessment

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you feel *right* now, that is, *at this moment*. There is no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

		Not at all	Somewhat	Moderately So	Very much so
1.	I feel calm	1	2	3	4
2.	I feel secure	1	2	3	4
3.	I am tense	1	2	3	4
4.	I feel strained	1	2	3	4
5.	I feel at ease	1	2	3	4
6.	I feel upset	1	2	3	4
7.	I am presently worrying over possible misfortunes	1	2	3	4
8.	I feel satisfied	1	2	3	4
9.	I feel frightened	1	2	3	4
10.	I feel comfortable	1	2	3	4
11.	I feel self-confident	1	2	3	4
12.	I feel nervous	1	2	3	4
13.	I am jittery	1	2	3	4
14.	I feel indecisive	1	2	3	4
15.	I am relaxed	1	2	3	4
16.	I feel content	1	2	3	4
17.	I am worried	1	2	3	4
18.	I feel confused	1	2	3	4
19.	I feel confused	1	2	3	4
20.	I feel pleasant	1	2	3	4

Adapted from Spielberger et al. (1970)

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you *generally* feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

	Not at all	Somewhat	Moderately So	Very much so
21. I feel pleasant	1	2	3	4
22. I feel nervous and restless	1	2	3	4
23. I feel satisfied with myself	1	2	3	4
24. I wish I could be as happy as others seem to be	1	2	3	4
25. I feel like a failure	1	2	3	4
26. I feel rested	1	2	3	4
27. I am "calm, cool, and collected"	1	2	3	4
28. I feel that difficulties are piling up so that I cannot overcome them	1	2	3	4
29. I worry too much over something that really doesn't matter	1	2	3	4
30. I am happy	1	2	3	4
31. I have disturbing thoughts	1	2	3	4
32. I lack self-confidence	1	2	3	4
33. I feel secure	1	2	3	4
34. I make decisions easily	1	2	3	4
35. I am inadequate	1	2	3	4
36. I am content	1	2	3	4
37. Some unimportant thought runs through my mind	1	2	3	4
38. I take disappointments so keenly that I can't put them out of my mind	1	2	3	4
39. I am a steady person	1	2	3	4
40. I get in a state of tension or turmoil as I think over my recent concerns and interest	1	2	3	4

Adapted from Spielberger et al. (1970)

Appendix F

ZUNG SELF-RATING DEPRESSION SCALE

Zung Self-rating Depression Scale

Participant's initials Date of Assessment

Please read each statement and decide how much of the time the statement describes how you have been feeling during the past several days

Make check circle in appropriate column.	A little of the time	Some of the time	Good part of the time	Most of the time
1. I fell down-hearted and blue	1	2	3	4
2. Morning is when I feel the best	1	2	3	4
3. I have crying spells or feel like it	1	2	3	4
4. I have trouble sleeping at night	1	2	3	4
5. I eat as much as I used to	1	2	3	4
6. I still enjoy sex	1	2	3	4
7. I notice that I am losing weight	1	2	3	4
8. I have trouble with constipation	1	2	3	4
9. My heart beats faster than usual	1	2	3	4
10. I get tired for no reason	1	2	3	4
11. My mind is as clear as it used to be	1	2	3	4
12. I find it easy to do the things I used to	1	2	3	4
13. I am restless and can't keep still	1	2	3	4
14. I feel hopeful about the future	1	2	3	4
15. I am more irritable than usual	1	2	3	4
16. I find it easy to make decisions	1	2	3	4
17. I feel that I am useful and needed	1	2	3	4
18. My life is pretty full	1	2	3	4
19. I fell that others would be better off if I were dead	1	2	3	4
20. I still enjoy the things I used to do	1	2	3	4

Adapted from Zung (1965)

Appendix G

THE TORONTO-ALEXITHYMIC SCALE

The Toronto-Alexithymia Scale (TAS-20)

Participant's initials Date of Assessment

Using the scale provided as a guide, indicate how much you agree or disagree with each of the following statements by circling the corresponding number. Give only one answer for each statement.

	Strongly Disagree	Moderately Disagree	Neither Agree nor Disagree	Moderately Agree	Strongly Agree
1. I am often confused about what emotion I am feeling.	1	2	3	4	5
2. It is difficult for me to find the right words for my feelings.	1	2	3	4	5
3. I have physical sensations that even doctors don't understand.	1	2	3	4	5
4. I am able to describe my feelings easily.	1	2	3	4	5
5. I prefer to analyze problems rather than just describe them.	1	2	3	4	5
6. When I am upset, I don't know if I am sad, frightened, or angry.	1	2	3	4	5
7. I am often puzzled by sensations in my body.	1	2	3	4	5
8. I prefer to just let things happen rather than to understand why they turned out that way.	1	2	3	4	5
9. I have feelings that I can't quite identify.	1	2	3	4	5
10. Being in touch with emotions is essential.	1	2	3	4	5
11. I find it hard to describe how I feel about people.	1	2	3	4	5
12. People tell me to describe my feelings more.	1	2	3	4	5
13. I don't know what's going on inside me.	1	2	3	4	5
14. I often don't know why I am angry.	1	2	3	4	5
15. I prefer talking to people about their daily activities rather than their feelings.	1	2	3	4	5
16. I prefer to watch "light" entertainment shows rather than psychological dramas.	1	2	3	4	5
17. It is difficult for me to reveal my innermost feelings, even to close friends.	1	2	3	4	5
18. I can feel close to someone, even in moments of silence.	1	2	3	4	5
19. I find examination of my feelings useful in solving personal problems.	1	2	3	4	5
20. Looking for hidden meaning in movies or plays distracts from their enjoyment.	1	2	3	4	5

Adapted from Taylor et al. (1985)

Appendix H

VERBAL INSTRUCTIONS CONTI

Verbal Instructions Conti

1st Instruction (60 seconds)

Focus on my breath.

Inhale and exhale… Breathe deeply…and feel my body rhythm.

Now, focus on my inner world.

Everything that I hear in my external world is further and further from me.

I can focus on my inner world.

Now, I am going to recall the episode that I feel bad.

The memory leads me to the bad emotions at that time.

Trust what I feel.

When music starts, I am in the memory with the emotion

2nd Instruction (30 seconds)

Negative emotions such as fear or anger… such emotions lead me to the memory.

Feel me there.

Trust and accept whatever happens to me.

Music helps to be able to look at me in the memory with the bad emotions.

3rd Instruction (30 seconds)

Now, I feel the negative emotion more forcefully.

What makes I feel it in the memory.

Focus on my emotions and imagination.

When music starts, my emotions in the memory is going to be clearer.

4th Instruction (30 seconds)

Now, the bad feeling in the memory is deeper and deeper.

Look at me in the memory with the deep emotions.

What do I do with full of negative emotions such as fear or anger.

Music is with me.

Appendix I

THE fMRI SYSTEM

The fMRI System (SIEMENS Verio - installed in 2012)

Magnet (Oxford OR63)

→ 3T + 70cm Open Bore, 173cm Bore Length

→ Stray Field (0.5mT): 4.7m x 2.6m

→ Gradient Power : 45mT/m 200mT/m/ms

→ Trueform Magnet Design

RF Coils

→ 32 Rx Channels x 102 intergated Coil Elements

→ 32ch Head Coil.Head/Neck/Spine/PA Matrix Coils

→ 4ch Flex Large /Small Coils, Loop Coils

Target Regions

→ Whole Body with TimCT(Continuously Moving Table)

→ Head, Cardiac, Spine,Abdomen,etc.

REFERENCES

Achterberg, J. (1985). *Imagery in healing: Shamanism in modern medicine.* Boston, MA: New Science Library.

Adams Jr., R. B., Gordon, H. L., Baird, A. A., Ambady, N., & Kleck, R. E. (2003). Effects of gaze on amygdala sensitivity to anger and fear faces. *Science, 300*(5625), 1536.

Adolphs, R., Tranel, D., Hamann, S., Young, A. W., Calder, A. J., Phelps, E. A., Anderson, A., Lee, G. P., & Damasio, A. R. (1999). Recognition of facial emotion in nine individuals with bilateral amygdala damage. *Neuropsychologia, 37*(10), 1111-1117.

Aggleton, J. P., O'Mara, S. M., Vann, S. D., Wright, N, F., Tsanov, M., & Erichsen, J. T. (2010). Hippocampal-anterior thalamic pathways for memory: Uncovering a network of direct and indirect actions. *European Journal of Neuroscience, 31*(12), 2292–2307.

Aquirre, G. K., Detre, J. A., Alsop, D. C. & D’Esposito, M. (1996). The parahippocampus subserves topographical learning in man. *Cereb Cortex, 6*(6), 823-829.

Andrade, P. E., & Bhattacharya, J. (2003). Brain tuned to music. *Journal of the Royal Society of Medicine, 96*, 284-287.

Ahsen, A. (1972). *Eidetic parents test and analysis*. New York, NY: Brandon House.

Arrington Research (2012). Arrington Research Eyetracker. Retrieved December 18, 2012, from http://www.arringtonresearch.com

Band, J. P., Quilter, S. M., & Miller, G. M. (2001-2002). The influence of selected music and inductions on mental imagery: Implications for practitioners of guided imagery and music. *Journal of the Association for Music and Imagery, 8,* 13-33.

Barrett, L. F., & Wager, T. D. (2006). The structure of emotion: evidence from neuroimging studies. *Current Directions in Psychological Science. 15*(2), 79-83.

Baumgartner, T., Esslen, M., & Jäncke, L. (2006). From emotion perception to emotion experience: Emotions evoked by pictures and classical music. *International Journal of Psychophysiology, 60*(1), 34-43.

Baumgartner, T., Lutz, K., Schmidt, C. F., & Jäncke, L. (2006). The emotional power of music: How music enhances the feeling of affective pictures. *Brain Research, 1075*(1), 151-164.

Bernstein, L. E., Auer Jr., E. T., Wagner, M., & Ponton, C. W. (2008). Spatiotemporal dynamics of audio visual speech processing. *Neuroimage, 39*(1), 423-435.

Bigler, E. D., Mortensen, S., Neeley, E. S., Ozonoff, S., Krasny, L., Johnson, M., Lu, J., Provencal, S. L., McMahon, W., & Lainhart, J. E. (2007). Superior temporal gyrus, language function, and autism. *Developmental Neuropsychology, 31* (2), 217-238.

Blanke, O., Landis, T., Spinelli, L, & Seeck, M. (2004). Out-of-body experience and autoscopy of neurological origin. *Brain, 127*(2), 243-258.

Blood, A. J., & Zatorre, R. J. (2001). Intensely pleasurable responses to music correlate with activity in brain regions implicated in reward and emotion. *Proceedings of the National Academy of Sciences of the United States of America, 98*(20), 11818-11823.

Blood, A. J., Zatorre, R. J., Bermudez, P., & Evans A. C. (1999). Emotional responses to pleasant and unpleasant music correlate with activity in paralimbic brain regions. *Nature Neuroscience, 2*(4), 382-387.

Bonny, H. (1978a). The role of taped music programs in the GIM process *Monograph #2*. Salina, KS: Bonny Foundation.

Bonny, H. (1978b). *Facilitating guided imagery and music sessions.* Salina, KS: Bonny Foundation.

Bonny, H. (1989). Sound as symbol: Guided imagery and music in clinical practice. *Music Therapy Perspectives, 10,* 7-10

Botvinick, M. M. (2007). Conflict monitoring and decision making: reconciling two perspectives on anterior cingulate function. *Cognitive, Affective & Behavioral Neuroscience, 7*(4)*,* 356-366.

Brett, M., Anton, J. L., Valabregue, R., & Poline, J. B. (2002). Region of interest analysis using an SPM toolbox. Paper presented at: 8th International Conference on Functional Mapping of the Human Brain [Sendai, Japan: NeuroImage, 16 (2)].

Britton, J. C., Phan, K. L., Taylor, S. F., Fig, L M., & Liberzon, I. (2005). Corticolimbic blood flow in posttraumatic stress disorder during script-driven imagery. *Biological Psychiatry, 57*(8), 832-840.

Browning, C. A. (2001). Music therapy in childbirth: Research in practice. *Music Therapy Perspectives, 19*(2), 74-81.

Bugelski, B. R. (1968). Images as mediators in one-trial paired-associate learning. II: Self timing in successive lists. *Journal of Experimental Psychology, 77*(2)*,* 328-334.

Burgess, N., Maguire, E. A., & O'Keefe, J. (2002). The Human Hippocampus and Spatial and Episodic Memory. *Neuron 35* (4), 625–41.

Bush, C., Borling, J., & Stokes-Stearns, S. (2009). *Level two: GIM training manual.* Unpublished manuscript. Virginia Beach, VA: Mid-Atlantic Training Institute.

Bush, G., Luu, P., & Posner, M. I. (2000). Cognitive and emotional influences in anterior cingulate cortex. *Trends in Cognitive Sciences, 4*(6)*,* 215-222.

Cacioppo, J. T., & Gardner, W. L. (1999). Emotion. *Annual Review of Psychology, 50*, 191-214.

Cahill, L., & McGaugh, J. L. (1998). Mechanisms of emotional arousal and lasting declarative memory. *Trends Neuroscience, 21*(7), 294-299.

Clark, C. R., Egan, G. F., McFarlane, A. C., Morris, P., Weber, D., Sonkkilla, C., Marcina, J., Tochon-Danguy, H. J. (2000). Updating working memory for words: a PET activation study. *Human Brain Mapping, 9*(1), 42-54.

Clark, M. E., McCorkel, R. R., & Williams, S. B. (1981). Music-therapy-assisted labor and delivery. *Journal of Music Therapy, 18*(2), 88-109.

Codley, C. A. (1987). The use of music therapy in pain clinics. *Music Therapy Perspectives, 4*, 24-28.

Collins, D. L., Zijdenbos, A., Kollokian, V., Sled, J. G., Kabani, N., J., Holmes, C. J., & Evans, A. C. (1998). Design and construction of a realistic digital brain phantom. *IEEE Transactions on Medical Imaging, 17*(3), 463-468.

Colwell, C. M. (1997). Music as distraction and relaxation to reduce chronic pain and narcotic ingestion: A case study. *Music Therapy Perspectives, 15*(1), 24-31.

Coombs, M. M., Coleman, D., & Jones, E. E. (2002). Working with feelings: The importance of emotion in both cognitive-behavioral and interpersonal therapy in the NIMH treatment of depression collaborative research program. *Psychotherapy: Theory, Research, Practice, Training, 39*(3), 233-244.

Costa, V. D., Lang, P J., Sabatinelli, D., Versace, F., & Bradley, M. M. (2010). Emotional imagery: Assessing pleasure and arousal in the brain's reward circuitry. *Human Brain Mapping, 31*(9)*,* 1446-1457.

Costafreda, S. G., Brammer, M. J., David, A. S., & Fu, C. H. Y. (2008). Predictors of amygdala activation during the processing of emotional stimuli: A meta-analysis of 385 PET and fMRI studies. *Brain Research Reviews, 58*(1), 57-70.

Crick, F. C., & Koch, C. (2005). What is the function of the claustrum? *Philosophical Transactions of the Royal Society B- Biological Sciences, 360*(1458), 1271-1279.

Dalgleish, T. (2004). The emotional brain. *Nature Review Neuroscience, 5,* 583-589.

Damasio, A. (2011). Neural basis of emotions. *Scholarpedia, 6*(3), 1804.

Damasio, A. R., Grabowski, T. J., Bechara, A., Damasio, H., Ponto, L. L. B., Parvizi, J., & Hichwa, R. D. (2000). Subcortical and cortical brain activity during the feeling of self-generated emotions. *Nature Neuroscience, 3*(10), 1049-1056.

Davidson, R. J., & Irwin, W. (1999). The functional neuroanatomy of emotion and affective style. *Trends in Cognitive Sciences, 3*(1), 11-21.

Davidson, R. J. (2000). Cognitive neuroscience needs affective neuroscience (and vice versa). *Brain & Cognition, 42*(1), 89-92.

Davidson, R. J., Putnarn, K. M., & Larson, C. L. (2000). Dysfunction in the neural circuitry of emotion regulation – A possible prelude to violence. *Science, 289*(5479), 591-594.

Davidson, R. J., & Slagter, H. A. (2000). Probing emotion in the developing brain: functional neuroimaging in the assessment of the neural substrates of emotion in normal and disordered children and adolescents. *Mental Retardation and Developmental Disabilities Research Reviews, 6*(3)*,* 166-170.

Davidson, R. J., & Sutton, S. K. (1995). Affective neuroscience: The emergence of a discipline. *Current Opinion in Neurobiology, 5*(2), 217-224.

Daveson, B. A. (1999). A model of response: Coping mechanisms and music therapy techniques during debridement. *Music Therapy Perspectives, 17*(2), 92-98.

Decety, J., & Jackson, P. L. (2004). The functional architecture of human empathy. *Behavioral and Cognitive Neuroscience Review, 3*(2)*,* 71-100.

Decety, J., & Jeannerod, M. (1995). Mentally simulated movements in virtual reality: does Fitts's law hold in motor imagery? *Behavioural Brain Research, 72*(1-2), 127-134.

Deese, J. (1965). *The structure of associations in language and thought.* Baltimore: Johns Hopkins press.

Deiber, M. P., Passingham, R. E., Colebatch, J. G., Friston, k. J., Nizon, P. D., & frackowiak, R. S. (1991). Cortical area and the selection of movement: A study with positron emission tomography. *Experimental Brain Research, 84*(2), 393-402.

Dubner, R., & Zeki, S. (1971). Response properties and receptive fields of cells in an anatomically defined region of the superior temporal sulcus in the monkey. *Brain Research, 35*(2), 528-532.

Edwards, J. (1998). Music therapy for children with severe burn injury. *Music Therapy Perspectives, 16*(1), 21-26.

Edwards D. (2007). Restructuring implicational meaning through memory-based imagery: Some historical notes. *Journal of Behavior Therapy and Experimental Psychiatry*, *38*(4), 306–316.

Ekman, P., & Davidson, R. (1994). *The nature of emotion: Fundamental questions.* New York: Oxford University Press.

Elias, L. J., & Saucier, D. M. (2006). *Neuropsychology: clinical and experimental foundations.* Boston, MA: Pearson Education, Inc.

Farrer, C., Frey S. H., Van Horn, J. D., Tunik, E., Turk, D., Inati, S., & Grafton, S.T. (2008). The angular gyrus computes action awareness representations. *Cereb Cortex, 18*(2), 254-261.

Fratianne, R., Prensner, J., Huston, M., Super, D., Yowler, C., & Standley, J. (2001). The effect of music based imagery and musical alternate engagement on the burn debridement process. *Journal of Burn Care and Rehabilitation, 22*(1), 47-53.

Galletti, C., Battaglini, P. P., & Fattori, P. (1990). 'Real motion' cells in area V3A of macaque visual cortex. *Experimental Brain Research, 82*(1), 67-76.

Gazzaniga, M., Ivry, R. B., & Mangun, G. R. (2009). *Cognitive neuroscience: The Biology of the mind.* New York: W.W. Norton & Company, Inc.

Gendlin, E. T., & Olsen, L. (1970). The use of imagery in experiential focusing. *Psychotherapy: Theory, Research and Practice, 7*(4)*,* 221-223.

Gfeller, K. E. (2008). Music: A human phenomenon and therapeutic tool. In W. B. Davis, K. E. Gfeller, & M. H. Thaut (3rd Eds). *An introduction to music therapy: Theory and practice.* (2008). Silver Spring, MD: American Music Therapy Association, Inc.

Goldberg, F. S. (1992). Images of emotion: The role of emotion in guided imagery and music. *Journal of Association for Music and Imagery, 1*, 5-17.

Good, M., Stanton-Hicks, M., Grass, J. A., Anderson, G. C., Lai, H. L., Roykulcharoen, V., Adler, P. A. (2001). Relaxation and music to reduce postsurgical pain. *Journal of Advanced Nursing, 33*(2), 208-215.

Greenberg, L. S., & Pascual-Leone, A. (2006). Emotion in psychotherapy: A practice-friendly research review. *Journal of Clinical Psychotherapy: In Session, 62(5),* 611-630.

Greenwald, A. G. (1970). Sensory feedback mechanisms in performance control: with special reference to the idiomotor mechanism. *Psychological Review, 77*(2), 73-79.

Hamann, S. (2001). Cognitive and neural mechanisms of emotional memory. *Trends in Cognitive Sciences, 5*(9), 394-400.

Hackmann, A., & Holmes, E. A. (2004). Reflecting on imagery: A clinical perspective and overview of the special issue of memory on mental imagery and memory in psychopathology, *Memory, 12* (4), 389-402.

Hamann, S. B., Timothy, D. E., Scott, T G., & Clinton, D. K. (1999). Amygdala activity related to enhanced memory for pleasant and aversive stimuli. *Nature Neuroscience, 2,* 289-293.

Hodges, D. A. (1996). *Handbook of music psychology* (2nd ed.). San Anonio, TX: IMR Press.

Holmes, E. A., Geddes, J. R., Colom, F., & Goodwin, G. M. (2008). Mental imagery as an emotional amplifier: Application to bipolar disorder. *Behaviour Research and Therapy, 46*(12), 1251-1258.

Holmes, E. A., & Hackmann, A. (2004). A healthy imagination? Editorial for the special issue of memory: Mental imagery and memory in psychopathology. *Memory, 12*(4). 387-388.

Holmes, E. A., & Mathews, A. (2010). Mental imagery in emotion and emotional disorders. *Clinical Psychology Review, 30*(3), 349-362.

Hunt, A. M. (2011). *A neurophenomenological description of the guided imagery and music experience.* Unpublished doctoral dissertation. Temple University, Philadelphia, PA.

Ishai, A. (1996). Distributed representation of objects in the human ventral visual pathway. *Proceedings of the National Academy of Sciences of the United States of America, 96*(16), 9379-9384.

Jacobi, E. M. (1994). *The efficacy of the Bonny method of guided imagery and music as experiential therapy in the primary care of persons with rheumatoid arthritis.* Unpublished doctoral dissertation, Union Institute, Cincinnati, OH.

Jackson, P. L., Brunet, E., Meltzoff., A. N., & Decety, J. (2006). Empathy examined through the neural mechanisms involved in imagining how I feel versus how you feel pain: An event-related fMRI study. *Neuropsychologia, 44*, 752-761.

Jeannerod, M., & Decety, J. (1995). Mental motor imagery: A window into the representational stages of action. *Current Opinions in Neurobiology, 5*(6), 727-732.

Joassin, F., Pesenti, M., Maurage, P., Verreckt, E., Bruyer, R., & Campanella, S. (2011). Cross-modal interaction between human faces and voices involved in person recognition. *Cortex, 47*(3), 367-376.

Juslin, P. N., & Västfjäll, D. (2008). Emotional responses to music: The need to consider underlying mechanisms. *Behavioral and Brain Sciences, 31*(5), 559-621.

Korean Advanced Instute of Science and Technology Brain Science Research Center (KAIST-BSRC). (2012). MRI system configuration. Retrieved January, 2012, from http://www.fmri.re.kr/e_introduce/e_introduce_1.asp

Keysers, C., & Gazzola, V. (2006). Towards a unifying neural theory of social cognition. *Progress in Brain Research, 156,* 379-401.

Khalfa, S., Schon, D., Anton, J., & Liegeois-Chauvel, C. (2005). Brain regions involved in the recognition of happiness and sadness in music. *Neuroreport, 16* (18), 1981-1984.

King, D. L. (1973). An image theory of classical conditioning. *Psychological Reports, 33*, 403-411.

Kim, J. T. (1978). *The relationship between specific anxiety and sociality: focusing on STAI of Spielberger.* Unpublished master's thesis, Korea University, Seoul, Korea.

Kim, S. H., and Hamann, S. (2007). Neural correlates of positive and negative emotion regulation. *Journal of Cognitive Neuroscience, 19* (5), 776-798.

Kober, H., Barrett, L.F., Joseph, J., Bliss-Moreau, E., Lindquist, K., & Wager, T.D. (2008). Functional grouping and cortical-subcortical interactions in emotion: A meta-analysis of neuroimaging studies. *NeuroImage, 42*(2)*,* 998–1031.

Koelsch, S., Yves, V., Fritz, T., Cramon, D. Y. v., Muller, K., & Friederici, A. D. (2006). Investigating emotion with music: A fMRI study. *Human Brain Mapping, 27*(3)*,* 239-250.

Koelsch, S., Fritz, T., Schulze, K., Alsop, D., & Schlaug, G. (2005). Adults and children processing music: An fMRI study. *NeuroImage 25*(4)*,* 1068-1076.

Kosslyn, S. M., Ganis, G., & Thompson, W. L. (2001). Neural foundations of imagery. *Neuroscience, 2*(9)*,* 635-642.

Korea University Brain Imaging Center (KUBIC) (2012). System information. Retrieved December 24, 2012, from https://fmri.korea.ac.kr/sub_kor/sub_02_02.php

Kozlovskiy, S. A., Vartanov, A. V., Nikonova, E. Y., Pyasik, M. M., & Velichkovsky, B. M. (2012). The Cingulate cortex and human memory processes. *Psychology in Russia: State of the Art, 5*, 231–243.

Körlin, D. (2002). A neuropsychological theory of traumatic imagery in the Bonny method of guided imagery and music (BMGIM). In K. E. Bruscia & D. E. Crocke (Eds.), *Guided imagery and music: The Bonny method and beyond* (pp. 379-415). Gilsum, NH: Barcelona Publishers.

Kreiman, G., Koch, C., & Fried, I. (2000). Imagery neurons in the human brain. *Nature, 408*(6810)*,* 357-361.

Krumhansl, C. L. (1997). An exploratory study of musical emotions and psychophysiology. *Canadian Journal of Experimental Psychology. 51*(4), 336-353.

Lang, P. J. (1977). Imagery in therapy: An information processing analysis of fear. *Behavioral Therapy, 8*(5)*,* 862-886.

Lang, P. J. (1979). A bio-informational theory of emotional imagery. *Psychophysiology, 16 (6),* 495-511.

Langer, S. (1942). *Philosophy in a new key*. New York: Mentor Books.

Lazarus, A. A. (1971). *Behavior therapy and beyond*, New York: McGraw-Hill.

Lazarus, A. A., & Abramovitz, A. (1962). The use of “emotive imagery” in the treatment of children’s phobias. *Journal of Mental Science, 108*, 191-195.

LeDoux, J. E. (1995). Emotion: clues from the brain. *Annual Review of Psychology, 46*, 207-235.

LeDoux, J.E. (2000). Emotion circuits in the brain. *Annual Review of Neuroscience. 23*, 155-184.

Lee, G. P., Meador, K. J., Loring, D. W., Allison, J. D., Brown, W. S., Paul, L K., Pillai, J. J., & Lavin, T. B. (2004). Neural substrates of emotion as revealed by functional magnetic resonance imaging. *Cognitive and Behavioral Neurology, 17*(1), 9-17.

Lee, Y., H., Lim, H., D., & Lee, J., Y. (1996). Development and validation of a Korean version of the 20-item Toronto Alexithymia scales (TAS-20K). *Journal of the Korean Neuropsychiatric Association, 35*(4), 888-899.

Lee, Y., H., & Song, J., Y. (1991). The study for reliability and validity of BDI, SDS, MMPI-D. *Journal of Korean Psychological Association, 15*(1), 98-113.

Leknes, S., & Tracey, I. (2008). A common neurobiology for pain and pleasure. *Nature Reviews Neuroscience, 9*, 314-.20.

Lindquist, K. A., Wager, T. D., Kober, H., Bliss-Moreau, E., & Barrett, L. F. (2012). The brain basis of emotion: A meta-analytic review. *Behavioral and Brain Sciences, 35*(3)*,* 121-202.

Liotti, M., Mayberg, H. S., Brannan, S. K., McGinnis, S., Jerabek, P., & Fox, P. T. (2000). Differential limbic-cortical correlates of sadness and anxiety in healthy subjects: Implications for affective disorders. *Biological Psychiatry. 48*(1), 30-42.

Lyman, B., & Waters, J. C. E. (1989). Patterns of imagery in various emotions. *Journal of Mental Imagery, 13*(1), 63-74.

Malchiodi, C. A. (2007). Expressive therapies: History, theory, and practice. In C. A. Machida (Eds.). *Expressive: The therapies* (pp. 1-15), Spring Street, NY: The Guilford Press.

Matsuka, T., Yamauchi, T., Hanson, C., & Hanson, S. J. (2005). Representing categorical knowledge: An fMRI study. In B. G. Bara, L. Barsalou, & M. Bucciarelli (Eds.), *the Proceedings of the 27th Annual Meeting of the Cognitive Science Society* (pp. 1425-1430), Mahwah, NJ: Lawrence Erlbaum.

McDonald, R. G. (1990). *The efficacy of guided imagery and music as a strategy of self-concept and blood pressure change among adults with essential hypertension.* Unpublished doctoral dissertation. Walden University, Minneapolis, MN.

McKinney, C. H., & Tims, F. C. (1995). Differential effects of selected classical music on the imagery of high versus low imagers: Two studies, *Journal of Music Therapy, 32*(1), 22-45.

McKinney, C. H., Antoni, M. H., Kumar, M., Tims, F. C., & McCabe, P. M. (1997). Effects of guided imagery and music (GIM) therapy on mood and cortisol in healthy adults. *Healthy Psychology, 16*(4), 390-400.

McKinney, C. H., Tims, F. C., Kumar, A. M., & Kumar, M. (1997). The effect of selected classical music and spontaneous imagery on plasma β-endorphin. *Journal of Behavioral Medicine, 20*(1), 85- 99.

McNeil, D. W., Vrana, S. R., Melamed, B. G., Cuthbert, B. N., & Lang, P, J. (1993). Emotional imagery in simple and social phobia: Fear versus anxiety. *Journal of abnormal psychology, 102*(2), 212-225.

Meyer, L. B. (1956). *Emotion and meaning in music*. Chicago: University of Chicago Press

Mitterschiffthaler, M. T., Fu, C. H. Y., Dalton, J. A., Andrew, C. M., & Williams, S. C. R. (2007). A functional MRI study of happy and sad affective states induced by classical music. *Human Brain Mapping, 28*(11)*,* 1150-1162.

Morris, J. S., Frith, C. D., Perrett, D. I. Rowland, D., Young, A. W., Calder, A. J., & Dolan, R. J. (1996). A differential neural response in the human amygdala to fearful and happy facial expressions. *Nature, 383*(6603), 812-815.

Morris, J. S., Oehman, A., & Dolan, R. J. (1998). Conscious and unconscious emotional learning in the human amygdala. *Nature, 393*(6684), 467-470.

Murphy, F. C., Nimmo-Smith, I. & Lawrence, A. D. (2003). Functional neuroanatomy of emtoions: A meta-analysis. *Cognitive, Affective & Behavioral Neuroscience, 3*(3), 207-233.

Nielsen, F.A., Balslev, D., & Hansen, L. K. (2005). Mining the posterior cingulate: segregation between memory and pain components. *NeuroImage, 27*(3), 520-532.

Oldfield, R. C. (1971). The assessment and analysis of handedness: The Edinburgh inventory. *Neuropsychologia*, *9*(1), 97-113.

Orleans, J. F. (1991). *Toward a musical Rorschach: The development of a diagnostic, musical, projective assessment technique.* Unpublished doctoral dissertation, University of Kansas, Lawrence, KS.

Osborne, J. (1981). The mapping of thoughts, emotions, sensations, and images as responses to music. *Journal of Mental Imagery*, *5*, 133-136.

Pelletier, C. L. (2004). The effect of music on decreasing arousal due to stress: A meta-analysis. *Journal of Music Therapy, 41*(3), 192-214.

Penhune, V.B., Zatorre, R.J., & Evans, A.C. (1998). Cerebellar contribution to motor timing: A PET study of auditory and visual rhythm reproduction. *Journal of Cognitive Neuroscience 10*(6), 752-765.

Peretz, I., & Hebert, S. (2000). Toward a biological account of music experience. *Brain and Cognition, 42*(1), 131-134.

Peretz, I., Gagnon, L., & Bouchard, B. (1998). Music and emotion: perceptual determinants, immediacy, and isolation after brain damage. *Cognition, 68*(2), 111-141.

Peretz, I., & Zatorre, R. J. (2005). Brain organization for music processing. *Annual Review of Psychology, 56,* 89-114.

Petacchi, A., Laird, A. R., Fox, P. T., & Bower, J. M. (2005). Cerebellum and auditory function: An ALE meta-analysis of functional neuroimaging studies. *Human Brain Mapping, 25*(1)*,* 118-128.

Phan, K. L., Wager, T., Taylor, S. F., & Liberzon, I. (2002). Functional neuroanatomy of emotion: A meta-analysis of emotion activation studies in PET and fMRI. *NeuroImage, 16*(2), 331-348.

Phillips, C., & Sakai, K. L. (2005). Language and the brain. In Y*earbook of Science and Technology* (pp. 166–169). Boston, MA: McGraw-Hill Publishers.

Radua, J., Phillips, M. L., Russell, T., Lawrence, N., Marshall, N., Kalidindi, S., El-Hage, W., McDonald, C., Giampietro, V., Brammer, M. J., David, A. S., & Surguladze, S. A. (2010). Neural response to specific components of fearful faces in healthy and schizophrenic adults. *NeuroImage, 49*(1), 939–946

Reid, W. H. (1989). *The treatment of psychiatric disorders*. New York, NY: Brunner/Mazel.

Rizzolatti, G., & Craighero, L. (2004). The mirror-neuron system. *Annual Review of Neuroscience, 27*, 169-192.

Robb, S. L., Nichols, R. J., Rutan, R. L., Bishop, B. L., & Parker, J. C. (1995). The effects of music assisted relaxation on preoperative anxiety. *Journal of Music Therapy, 32*(1), 2-21.

Robinson, J. (1994). The expression and arousal of emotion in music. *Journal of Aesthetics and Art Criticism, 52*(1), 180-189.

Ryan, L., Nadel, L., Keil, K., Putnam, K., Schnyer, D., Trouard, T., & Moscovitch, M. (2001). Hippocampal complex and retrieval of recent and very remote autobiographical memories: Evidence from functional magnetic resonance imaging in neurologically intact people. *Hippocampus, 11*(6), 707-714.

Sahler, O. J., Hunter, B. C., & Liesveld, J. L. (2003). The effect of using music therapy with relaxation imagery in the management of patients undergoing bone marrow transplantation: A pilot feasibility study. *Alternative Therapies in Health and Medicine, 9*(6), 70-74.

Scartelli, J. P. (1984). The effect of EMG biofeedback and sedative music, EMG biofeedback only, and sedative music only on frontalis muscle relaxation ability. *Journal of Music Therapy, 21*(2), 67-78.

Schienle, A., Schäfer, A., Pignanelli, R., & Vaitl. (2009). Worry tendencies predict brain activation during aversive imagery. *Neuroscience Letters, 461*(3), 289-292.

Seghier M. L. (2013). The angular gyrus: multiple function ad multiple subdivisions. *The Neuroscientist, 19*(1), 43-61.

Sherman, S. (2006). Thalamus. *Scholarpedia 1* (9): 1583.

Shapiro, D. L. (1970). The significance of the visual image in psychotherapy. *Psychotherapy: Theory. Research and Practice, 7*(4)*,* 209-212.

Sheikh, A. A., & Panagiotou, N. C. (1975). Use of mental imagery in psychotherapy: A critical review. *Perceptual and Motor Skills, 41*(2)*,* 555-585.

Singer, J., & Pope, K. S. (Eds.) (1978). *The power of human imagination: New methods in psychotherapy.* New York: Plenum Press.

Spielberger, C.D., Gorssuch, R.L., & Lushene, R. E.(1970). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press, Inc.

Standley, J. M. (1986). Music research in medical/dental treatment: Meta-analysis and clinical applications. *Journal of Music Therapy, 23*(2), 184-193.

Standley, J. M. (2000). Music research in medical treatment. In AMTA (Ed.). *Effectiveness of music therapy procedures: Documentation of research and clinical practice* (3rd ed., pp. 1-64). Silver Spring, MD: American Music Therapy Association.

Strata, P., Scelfo, B., & Sacchetti, B. (2011). Involvement of cerebellum in emotional behavior. *Physiological Research, 60* (1). S39-S48.

Svoboda, E., McKinnon, M. C., & Levine, B. (2006). The functional neuroanatomy of autobiographical memory: a meta-analysis. *Neuropsychologia, 44*(12), 2189-2208.

Taylor, G. J., Ryan, D. P., & Bagby, R. M. (1985). Toward the development of a new self-report alexithymia scale. *Psychotherapy and Psychosomatics, 44*(4), 191-199.

Tan, X., Yowler, C. J., Super, D. M., & Fratianne, R. (2008). Music therapy significantly reduces pain, anxiety, and muscle tension involved with burn debridement. *Journal of Burn Care and Research, 29*(2), S83.

Thaut, M. H. (2002). Physiological and motor responses to music stimuli. In R. F. Unkefer & M. H. Thaut (Eds.), *Music therapy in the treatment of adults with mental disorders* (pp. 33-41). St. Louis, MO: MMB.

Teasdale, J. D., Howard, R. J., Cox, S. G., Ha, Y., Brammer, M. J., Williams, S. C. R., & Checkley, S. A. (1999). Functional MRI study of the cognitive generation of affect. *American Journal of Psychiatry, 156*(2)*,* 209-215.

Trainor, L. J., & Schmidt, L. A. (2003). Processing emotions induced by music. In I. Peretz, & Zatorre. R. J. (Ed.), *The cognitive neuroscience of music* (pp. 310–324). Oxford: Oxford University Press.

Trehub, S. E. (2003). The developmental origins of musicality. *Nature Neuroscience, 6*(7), 669-673.

Tzourio-Mazoyer, N., Landeau, B., Papathanassiou, D., Crivello, F., Etard, O., Delcroix, N., Mazoyer, B., & Joliot, M. (2002). Automated anatomical labeling of activations in spm using a macroscopic anatomical parcellation of the min mri single-subject brain. *NeuroImage, 15*(1), 273-289.

Vann, S. D., Aggletion, J. P., & Maguire, E. A. (2009). What does the retrosplenial cortex do? *Nature, 10*(11), 792-803.

Vrana, S. R., Cuthbert, B. N., & Lang, P. J. (2007). Fear imagery and text processing. *Psychophysiology, 23*(3), 247-253.

Vytal, K., & Hamann, S. (2010). Neuroimaging support for discrete neural correlates of basic emotions: a voxel-based meta-analysis. *Journal of Cognitive Neuroscience, 22*(12), 2864–2885.

Wernicke, K. (1995). The aphasia symptom-complex: A psychological study on an anatomical basis. In Paul Eling (Eds.). *Reader in the History of Aphasia: From Franz Gall to Norman Geschwind* (pp. 69-89). Amsterdam: John Benjamins Publishing Co.

Whalen, P. J., Rauch, S. L., Etcoff, N. L., Mclnerney, S. C., Lee, M. B., & Jenike, M A. (1998). Masked presentations of emotional facial expressions modulate amygdala activity without explicit knowledge. *Journal of neuroscience, 18*(1), 411-418.

Winner, E. (1982). *Invented worlds*. Cambridge, MA : Harvard University Press.

Wrangsjö, B., & Körlin, D. (1995). Guided imagery and music as a psychotherapeutic method in psychiatry. *Journal of the Association for Music and Imagery, 4,* 79-92.

Zung, W. W. K. (1965). A self-rating depression scale. *Archives of General Psychiatry, 12,* 63-70.