Cortical Activity Patterns in Art Making vs. Fine Motor Movement as Measured by EEG

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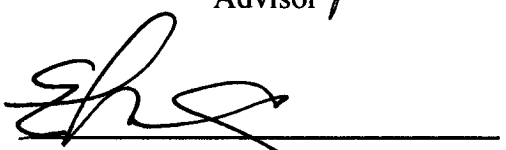

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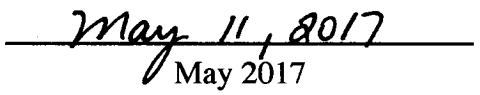

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ABSTRACT

This quantitative study explores the differences in cortical activation patterns when subjects create art versus when they engage in a rote motor task. It is hypothesized that a statistically significant difference occurs in cortical activity patterns during art making compared with non-creative rote motor behavior and that such differences can be detected and quantified with the electroencephalogram (EEG.) Ten consenting study subjects (one with formal art training, three with some art experience, and six with no art experience) underwent EEG recording at baseline (multiple measures) and with art making, and also with rote motor tasking. Baseline control recordings showed minimal changes in EEG while art making was associated with a persistent change from baseline of significant direction and amplitude involving both hemispheres, a change that was similar to the persistent change in EEG following rote motor tasks. These preliminary findings suggest that EEG may be a meaningful biomarker for cortical activation in the study of creative arts and points to further exploration using Mobile Brain Body Imaging (MoBI) in experimental designs. This system provides a reproducible, measurable, and quantitative methodology for evaluating brain activity and function in the study of the neuroscientific basis of creative arts, neuroaesthetics, and art therapy.

Keywords: art therapy, creative arts, creativity, EEG, qEEG, neuroaesthetics, neurophysiology, rote motor movement

DEDICATION

This work belongs to the recipients of art therapy, who bring a willingness to healing, you are my delight. I believe that if you dream big and work hard great accomplishments can be made. I'm so happy to share this very special moment with my beautiful family and friends. Without their love and support, none of this would be possible.

Alex Shaikh

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Alex Shaikh

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I would like to dedicate my contributions to my family. To my mother, your support and encouragement knows no bounds. To my father, your passion for knowledge has always served as a guiding force throughout my entire education. And to my loving partner, Jesse, for the smiles and laughs that helped me through my academic journey. Were it not for my family, none of this would have been possible.

Kaitlin E. Knapp

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AND

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Kaitlin E. Knapp

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

INTRODUCTION

Understanding the mechanisms involved in any psychic process is difficult, as the ambiguities involved in human behavior and expressions are inherently complex and multidimensional. Creativity is no exception, and historically the creative process has been difficult to explore scientifically as it is not localized to one area, or even one network, within the brain. It might not be possible or desirable to find a cogent definition of creativity that is generalizable across society, but increasing our understanding of how the creative process works, what it is, and how to measure it will enhance innovation and the ability to effectively solve problems in a range of disciplines related to the health and well-being of our society. Research regarding the processes involved in creativity and the brain is especially important in the realm of medicine and healthcare, as we are faced with complex challenges in the research and implementation of effective treatments to address diseases of the brain, the resultant behaviors, and the impacts these have on patients and their families.

According to a report of *How Creativity works in the Brain* offered through the National Endowment for the Arts (2015), research in neuroscience and cognitive psychology has identified some of the components of creativity including memory, divergent and convergent thinking, and flow. Cognitive science has expended due diligence to understand the implicit and explicit systems in the brain as they are involved in the creative process (Dietrich, 2004), yet the more we learn about these dynamic potentials the more questions we have about why and how things work as they do. For example, identifying the existence of implicit and explicit systems might help us understand (1) some distinctions between consciousness and unconsciousness, and (2) how emotions and memories may be connected to behavior and thought processes. However,

some neurologist will acknowledge that a cogent definition of consciousness is difficult to articulate. Such a definition is important to understand as it is a foundation for most evidence-based practices.

Neuroaesthetics does not address therapeutic implications, therefore further investigation of how the physiological and psychological aspects of aesthetic experience relate to one another is an important goal for the future (Chatterjee, 2010). The field of neuroaesthetics is moving us toward a greater understanding of creativity by focusing on the nature of visual perception and brain function, the cortical patterns involved in both viewing and making art, and the areas of the brain where art making likely takes place (Chatterjee, 2014; Chatterjee & Vartanian, 2014; Freedberg & Gallese, 2007; Ramachandran & Hirstein, 1999; Umilta et al., 2012; Zeki, 1999b). Utilizing data gained from the field of neuroaesthetics can provide a foundation upon which to study the implied processes that take place throughout art therapy assessment and intervention. This area of research is particularly important for the profession of art therapy as it is becoming more aware of the value of neuroscience in both theoretical and applied practice (Hass-Cohen & Findlay, 2015; Kaplan, 2000; Lusebrink, 2014; Malchiodi, 2003; McNamee, 2004; Riley, 2004). Without empirical evidence to support frameworks for understanding and applying clinical art therapy interventions, art therapists must rely on interpretive frameworks, which are often idiographic and do not allow generalizations to be made for larger populations.

Efforts to study the relationship of brain function and art making have been made by researchers interested in art therapy practice (Belkofer & Konopka, 2008; Belkofer, Konopka, & Van Hecke, 2014). These studies compared brainwave patterns before and after art making using electroencephalogram, EEG as a measure. The study in 2008 was a single subject design and the 2014 study included a sample size of ten participants. Results included higher frequency bands

of alpha and beta, with decreases in theta and delta. While this research does not involve art therapy is does create a foundation for continued research which would include therapeutic interventions.

A study with normal participants showed a difference in cortical motor (neocortex) activation when viewing original abstract art versus a graphic representation of the same piece (Umilta et al., 2012). These results indicate the original art as dynamic and the result of an artist's creative gesture, while the static graphic representation lacked a perceptual context (Umilta et al., 2012). These findings suggest that the motor system of the brain is involved differently based on the elements of art that the viewer perceives. This current project seeks to explore the differences in neocortical, more conscious brain activity when subjects actually engage in the creative act of drawing versus simply moving. It is hypothesized that there will be a statistically significant difference in the cortical activation patterns when a person makes art versus a simple movement, and these distinctions will provide evidence to enhance our understanding of brain function and art. A manuscript article has been placed in the results, discussion and conclusion sections for review. These data will also provide evidence to support the study of clinical art therapy interventions and understanding of how creative expression contributes to patient health and well-being in the context of the therapeutic relationship.

CHAPTER II

LITERATURE REVIEW

Introduction

We can understand that all mental processes involved in art therapy and in art making are derived from activity in the brain (Kapitan, 2010), but there is little research involving EEG recordings and analyses of the brain in regards to the creation of visual imagery. Taking an EEG involves a noninvasive medical procedure, which measures brainwave activity from the scalp's surface. Malchiodi (2003) argued that science will be central to understanding how art therapy works, will better define its effectiveness, and will improve the ability to develop more effective protocols to test art therapy interventions. Although there have only been a handful of neuroimaging studies in the field of art therapy, qEEG has been a promising method to research art-making, the distinctions in properties of art materials, and art processes (King & Kruk, 2016). The medical term, qEEG defines the analysis of EEG measures, through current algorithms which provide a brain mapping of activation patterns. This current project will contribute to the limited yet growing knowledge base on the subjects of art therapy and neuroscience. A review of empirical data shows all proposals on the neural basis of creativity fail when generalized to creativity as a whole (Dietrich, 2004). Gaining a greater understanding of the neural correlates involved in artistic expression will provide evidence for why and how art therapy is effective. This type of scientific evidence is crucial for validation and growth of the art therapy profession and also contributes to the growing fields of neuroaesthetics and cognitive neuroscience.

Neuroanatomy

The human brain is made up of three major areas: the forebrain, midbrain, and hindbrain (National Institute of Neurological Disorders and Stroke, 2015). Of these, the largest is the

forebrain, or prosencephalon, which sits atop both the midbrain and hindbrain. As indicated in Figure A1 (see Appendix A), almost all of the dorsal, or upper section of the human brain is comprised of the forebrain. Directly beneath this large subsection is the smallest unit, the midbrain or mesencephalon (Nolte, 1999). Working further into the ventral (lower half of the brain) is the hindbrain, which consists of the brain stem, cerebellum, and part of the spinal column. In order to understand complexities of the human brain, visual maps and reports have been included in the appendix to illustrate the neuroanatomical landscape.

A complex organ, the brain is responsible for a variety of tasks. The cerebral cortex is the outermost layer of the brain's dominant cerebrum (Carter, Aldridge, Page, & Parker, 2014). Given these complexities and responsibilities, the brain's cortices are broken down into areas or lobes. These four major lobes depicted graphically in Figure B1 (see Appendix B) include the (1) frontal lobe, (2) parietal lobe (Appendix C), (3) occipital lobe (Appendix D), and (4) temporal lobe (Appendix E) (Patestas & Gartner, 2016; Ribas, 2010).

Systems of the brain.

Reducing the functions of the lobes and cortices does not provide an understanding of the brain's interactive and interconnect system. The brain's connectivity has been more recently understood in terms of a complex system, a network (Telesford, Simpson, Burdette, Hayasaka, & Laurienti, 2011). According to Telesford et al. (2011), networks do not need to be anatomically connected to influence functions. Using network science as a framework and approach to brain studies is crucial to value the complex system of the brain. In our current investigation the sensory, motor, and visual processing systems are be discussed.

Sensory processing system.

Making sense of the world requires that the brain and environment interact through the

body's somatosensory system via connections of light, sound waves, and pressure (Carter et al., 2009). External stimuli are transmitted as electrical signals to areas of the cerebral cortex, which is involved in the coordinated processing of sensations including, sight, sound, touch, smell, and taste (Carter et al., 2009). The sensory system processes external stimuli and internally creates neural connections, related to memory, emotion, and other internal drivers (Sadock & Sadock, 2007). Association material from the sensory system provides a stimulus for actions to the motor system. While an abundance of sensory information enters the brain, only a small amount is made visible to conscious sensation. Most sensory information is extinguished immediately in processing and what remains is either made conscious or unconscious, the latter which also influences our behaviors (Carter et al., 2009).

Motor processing system.

According to Sadock and Sadock (2007), motor system information processing is modulated by cortical influence. This motor information processing may look like the planned and executed choreography of movement. The motor system includes large coordinated movements through the primitive system of the brainstem that develops in infancy (Sadock & Sadock, 2007). The basal ganglia (see Appendix F, Figure F1) makes up a portion of nerve-cell bodies, called nuclei, located in the midbrain, which are involved in motor control (Carter et al., 2009).

These nuclei oversee the smooth integration of sensory input and output responses. Involvement of the basal ganglia system includes planned movement and unconscious learned coordination with rapid response. The functional response of these intricate systems require cooperation from each area, while any component that does not relay the circuitry signals impedes the motor response. In terms of motor system processing, any break in the signal

processing is like a scratched record that is stuck on a loop, stopping the entire album from playing.

According to Hass-Cohen and Findlay (2015), the organization of the motor system could be considered a *three-tier schematic*. In similarity, the triune brain theory developed by P. D. Mclean is a model of human brain evolution, which includes the reptilian, paleomammalian (limbic system), and neomammalian brains. These three basic anatomical and biological formations interconnected in neural assembly indicate a greater amount of information processing than would occur in independent operation (Mclean, 1990). Tier one, includes the parietal, temporal, and frontal lobes of cortical association. The middle tier includes the motor cortex (Figure G1, see Appendix G), the thalamus, hypothalamus, and cerebellum. The spinal cord and brainstem account for tier three at the bottom (Kalat, 2012). Reconsidering views that motor and sensory organization are separate means that "...sensory pathways also carry copies of the motor instructions so that sensorimotor processing is unified throughout all levels of thalamocortical functions" (Sherman & Guillery, 2011, p. 1075). The higher association circuits receive information from the middle level; in particular, the basal ganglia (see Appendix F, Figure F1) supports emotional regulation and the cerebellum (Hass-Cohen & Findley, 2015). The field of art therapy uses this knowledge to amplify understanding in intervention and media choice within the therapeutic relationship for the betterment of patients and clients.

The cerebellum coordinates signals from the motor cortex to integrate the motor neurons, see Appendix H (Carr et al., 2009); this process modulates movements with concern to precise timing. The cerebellum facilitates a variety of functions, such as retaining memories of fine motor sequences. This particular function is significant to our current study: evaluating cortical activity in relation to fine motor movements. Lower levels of the motor system transmit

information to the middle level and receive commands from the higher levels (Hass-Cohen & Findlay, 2015). In relation to art making, this sequence may be illustrated like this:

> [when] one picks a paintbrush, the motor cortex receives the information and, in turn, sends the appropriate messages to the hand. The hand's muscles adjust and balance fine motor actions, allowing one to fulfill the action and load the brush with paint, thus allowing art making to become an executed reality. (Hass-Cohen & Findlay, 2015, p. 62)

This mind-body connection is integrated in the neuroscience of processing sensation, association, and movement.

Visual processing system.

The sensation of sight is processed in the visual cortex, seen in Appendix I, which is part of the brain's visual processing system, taking exterior information and distributing it to other cortices (Nolte, 1999). In the act of observing a piece of art, it is the visual processing system that translates visual details gleaned from the production into readable information (Figure I1). Pulses are sent to other visual areas (V1-V5) for further processing (Figure I2 and Figure I3).. These five areas make up part of the dorsal and ventral visual pathways (Carter et al., 2014). "The cells of area V5, specialized for visual motion" (Lo & Zeki, 2014, p. 1), become activated, or excited, when they are presented with the perception of visual movement. It can be inferred that movement will be involved during a directive art making task as well as during a rote motor task. Therefore, it is possible that the fifth visual area, V5, will become activated during our EEG readings. One study (Dursteler, Wurtz, & Newsome, 1987) found that if the V5, also known as the middle temporal visual area (MT), were to become damaged, the difficulty perceiving motion and processing movement stimuli would ensue, suggesting V5 does function as the "motion center" proposed by Zeki (1999a). These five visual areas are seated within various cortices

across the brain. In particular, motor system information processing, which takes place in V5, is also regulated in other areas of the brain.

Neuroaesthetics: History and Field of Research

In the nineteenth century, Gustav Fechner introduced the term empirical aesthetics to describe a branch of experimental psychology (Bergeron, 2011; Seeley, 2011). Chatterjee (2011b) proposed that "artists during the early twentieth century were dissecting their visual world and in the process 'discovered' modules that neuroscientists later found in the visual brain" (p. 8). More recently, the field of neuroaesthetics has made efforts "to characterize neuroaesthetics as the cognitive neuroscience of aesthetic experience" (Pearce et al., 2016, p. 265). Neuroaesthetics aims to investigate the neurocognitive and evolutionary strengths of the aesthetic experience, through devices of study including beauty and art. While these studies may lead to factions of beauty, the focus remains on "emergent states, arising from interactions between sensory-motor, emotion-valuation, and meaning-knowledge neural systems" (Chatterjee & Vartanian, 2014, p. 371).

Neuroaesthetics can relate to areas such as dance/movement, literature, and music (Chatterjee, 2010); however, for the purpose of our research and this literature review, we will be discussing visual neuroaesthetics as it pertains to viewing and creating works of art. One area of particular interest for individuals investigating neuroaesthetics is whether or not artistic productions and/or aesthetic preference is predetermined by evolutionary basis or universal laws (Kirk et al., 2009; Myin, 2000; Ramachandran & Hirstein, 1999; Zaidel, 2010; Zaidel, Nadal, Flexas, & Munar, 2013; Zeki & Lamb, 1994), which will be explored in more length following this section.

Previous neuroaesthetic studies utilizing neuroimaging have largely focused on viewing

artwork and the associated brain activation as opposed to creating artwork and comparing cortical functions to movement, as is the case in our study. Current neuroimaging technology allows for advanced understanding of art and how the viewer's brain reacts (Jacobsen et al., 2006), illuminating motion, emotion, and empathy within the aesthetic experience (Freedberg & Gallese, 2007). By comparison, the contribution of neuroimaging research on the brain during the creation of artwork is limited. The act of creating art engages the whole brain (Likova, 2012), which progressive research methodology and neuroimaging technology affirm (Dietrich, 2004). Bergeron (2011) states that by utilizing neuroimaging research, we can gain a better understanding of an individual's "aesthetic engagement with artworks" (p. 13).

The brain is a complicated organ; similarly, the fields that aim to better our understanding share in its complexities. Related fields include the larger umbrella of empirical aesthetics, perceptual psychology, and cognitive neuroscience. In Nadal and Skov's (2015) article, the similarities and differences between the cognitive neuroscience of art and neuroaesthetics are explained. The principle aim of the cognitive neuroscience of art is to better understand the biological underpinnings, or neural mechanisms, involved in the creation of art. While neuroaesthetics maintains a broader interest in aesthetic appeal and production, the point at which these two fields overlap is their interest of aesthetic qualities in artistic productions (Nadal & Skov, 2015). Seeley (2011) states that "the cognitive neuroscience of art is a subdivision of empirical aesthetics devoted to just that, the application of neuroscientific methods to the study of our engagement with artworks" (p. 1). Seeley (2011) later states that if we are to understand how humans are psychologically connected to the exterior world, we must continue to explore the field of neuroscience.

Huang (2009) further investigates the differences of art and neuroscience, stating that

while art is not commonly known for its scientific merits, both science and art endeavor to gain more knowledge. In fact, several researchers and theorists have made the claim that artists are neuroscientists in their own right (Cavanagh, 2005; Zeki, website). Cavanagh (2005) attributes an artist's ability to represent the visual world in "simpler, reduced physics" as a neuroscientific process, while Zeki's claim revolves around an artist's interest in investigating the capacities of the human brain. According to Nadal and Skov, (2015) the primary goal of the cognitive neuroscience of art is to better understand the biological underpinnings involved in producing works of art. Given that this field is akin to that of neuroaesthetics, it makes sense that biological theories can be found within both areas of study. Current neuroscience research on the aesthetic experience favors evolutionary perspectives on humans' ability to "integrate observations, identify problems, and seek solutions" (Phenninger & Shubik, 2001, p. 235).

Neuroaesthetics: Evolutionary and Biological Theory

Historically, producing art implied a biological function for survival. Art and the evolutionary approaches of aesthetics direct their attention to gaining knowledge about the world (Dietrich, 2004, 2015; Solso, 2003; Zaidel, 2010, 2013, 2015; Zeki, 2001). The brain regions involved in producing art serve various functions related to biology, communication, creativity, and insight (Zaidel, 2009). Biology is related to an artist's genetic qualities such as skill, creativity, cognitive ability, and physical energy (Zaidel, 2015).

Evolutionary theory of art.

Dissanayake's bottom-up approach to the study of *homo aestheticus* builds a relationship between the ubiquity of art and the primordial need for art in terms of biology. She writes, "art is more than aesthetics and aesthetics is more than art" (Brown & Dissanayake, 2009, p. 43). The meaning of art is understood more intensely than the modernized view of aesthetic features in

that the term aesthetics has bearing in any visual perception, whether or not it is art (Dissanayake, 2015).

Art as an adaptation contributes to survival and reproductive success (Dissanayake, 2015). In pre-modern civilizations, art was primarily used during rituals, which signified important periods or transitions in life. The interaction between mother and infant ritualized the biological evolution of bonds through attention and communication. Here, the perennial stress of survival is alleviated in the connection of attachment. Historically, art was primarily participatory and children learned about their culture through viewing, producing, and engaging with art (Dissanayake, 2015).

From a biological perspective, art is first about an object that is made special through the ingredients of art, including the formal elements, all of which signify the environment to be in and where attention should be directed. According to Dissanayake (2016):

> Today, artification may provide the same results to individuals when making/participating; hence, the benefits of arts therapies, such as the treatment of trauma through neurobiologically-informed *relational* non-verbal communication (Chapman, 2014). Although much contemporary art is often deliberately conceptual, anarchic, and private, its makers, like their Pleistocene predecessors, continue to artify important things and to make ordinary reality extraordinary. (p. 19)

Biological theory of art and the brain.

Dr. Eric Kandel, Nobel laureate and expert in neurobiological and behavioral research, also explores the research between science and art (Kandel, 2012, 2016). Bottom-up and top-down processing are basic components of neurological study. When applied in the context of viewing and making art, these processes are intricately involved in perception and experience.

The prediction and regulation of sensory information is modulated in the bottom-up and top-down processes; this modulation acts as a volume control versus a mediating on-off switch (Kandel, 2012).

While the midbrain and hindbrain house neurons of the bottom-up processing, the neurons of the top-down processing are located particularly in the prefrontal cortex (Kandel, 2012). The bottom-up modulatory system, which in part is genetically determined, relies heavily on early stages of the visual system. The bottom-up process includes the influence of the oxytocin-vasopressin modulatory system, which is concerned with social bonding, exchange, and trust. An elementary component of the top-down processing system is 'reappraisal, which relies, on inferences and comparisons to previous experiences stored in memory' (Kandel, 2012, p. 422). The top-down modulatory system involves the hippocampal memory storage and medial prefrontal cortex (Kandel, 2012). These simultaneous systems have been understood to impact the viewer of art perception in the social brain (Brothers, 1990).

Theories of creativity and the brain.

In *Some Notes on Brain, Imagination and Creativity*, Antonio Damasio (2001) writes, "from an evolutionary perspective, the oldest decision-making device pertains to basic biological regulation; the next, to personal and social realms, and the most recent, to the collection of abstract-symbolic operations under which we can find artistic and scientific reasoning…" (p. 59). Furthermore, individuals interact with the environment to create social and cultural artifacts (Damasio, 2001). Theories of creativity and the brain cannot be reductionistic from the perspective of three levels: a (1) genome and (2) activity-specified level of brain circuitry and (3) changes in the brain as a result of interactions within physical, social, and cultural environments (Damasio, 2001).

Theories of art and the brain.

According to Zaidel (2010), there are three major theories of art related to the brain. Of these three brain theories of art, the first contains the most pertinent information for our study, stating there are specific brain regions that "link art [making] to multiple neural regions" (p. 177); meaning, art is not solely connected with one specific cerebral hemisphere, pathway, or region. Zadiel first explored art's link to multiple neural regions in an earlier study (2005), which explored physiological responses and the pathways involved in the neuropsychology of art. The most common manner of exploring the connection between brain regions and art making is by researching artistic expressions following damage to specific regions of the brain (Zadiel, 2010). Zaidel's 2005 study compared both pre- and post-damage output from subjects with previous artistic experience. The findings indicated that a participant's artistic skill is preserved despite lateral damage or its cause. This suggests that artistic expression is a "multi-process activity...that depends on several brain regions...rather than on a single cerebral hemisphere, region or pathway" (Zaidel, 2010, p. 178), as mentioned previously.

Laws of Neuroaesthetics

Neuroaesthetics is a discipline much like others with laws and principles that contribute to and govern the field. Semir Zeki proposed laws pertaining to the visual system (Zeki & Lamb, 1994) as well as the visual brain (Zeki, 2001) while Vilayanur Ramachandran contributed eight laws of aesthetic experience (Ramachandran & Hirstein, 1999). And while not formally labeled as a law of neuroaesthetics, Erik Myin (2000) proposed two theories of perception and visual art, which assist in distinguishing between the neuroaesthetics of viewing and creating art.

Laws of the visual system.

Kinetic art was reportedly the springboard for research investigating the connections

between brain activity, aesthetic experiences within viewing art, and the physiology of visual perception (Zeki & Lamb, 1994). In order to understand how viewing and creating art affects the brain, we must look for research pertaining to the activation of brain regions given the assigned tasks. Zeki and Lamb (1994) postulated that all artistic expressions must obey what they call "laws of the visual system"; the first law states that visual stimuli from the exterior world does not singularly affect the retina (see Appendix I, Figure I1), the part of the eye that receives images and relays them to the brain. The second law states that visual stimuli are processed in separate sections of the visual cortex prior to being united as one image. In other words, when an exterior stimulus occupies the viewer's attention, this information is collected by the light sensitive retina and other associated areas of the visual system and is processed by multiple areas of the visual cortex before finally coming together to make one cohesive image in the viewer's brain.

The separate sections of the visual cortex, mentioned in Zeki's second law, include five separate visual areas (V1-V5), as seen in Appendix I, Figure I3. V1 operates as the primary visual area, and V5 acts as the principle location for visual motion. The latter is largely unresponsive to static stimuli, meaning that the likelihood that V5 will be activated when presented with stimuli that lacks movement is low. Contrary to earlier studies, Zeki and Lamb (1994) found that when participants were presented with Isia Leviant's work *Enigma*, which strategically tricks the eye into perceiving movement from static, geometric imagery, changes occurred in regional cerebral blood flow (rCBF) within the visual cortex and was limited only to V5. These results were compared to an additional condition that observed a similar image that had been altered to diminish the perception of movement within the rings.

Laws of the visual brain.

Semir Zeki (2001) proposed two "supreme" laws of the visual brain: constancy and abstraction. The term constancy refers to staying the same and within the visual brain. Variances occur constantly while processing external visual stimuli, which, as we have learned from the laws of the visual system, do not singularly affect the retina and are processed in parts. Zeki (2001) states that despite the dynamic changes in an object's distance, illumination, and viewing angle, the human brain is capable of retaining specific characteristics of the visual stimuli for future recognition. One example of this law in action is a person's facial recognition abilities at various angles other than straight on, an ability previously attributed to the fusiform gyrus (Kanwisher, McDermott, & Chun, 1997). In visual art, an artist may attempt to produce an object based on its essence or core principles as opposed to an exact rendering, which additionally encompasses irrelevant dynamic properties. The second law of the visual brain is abstraction, which plays a crucial role in our efficient knowledge-acquiring system (Zeki, 2001). "Art," as stated by Zeki (2001), "abstracts and externalizes the inner workings of the brain" (p. 52).

Eight laws of aesthetic experience.

Neuroaesthetic pioneer and theorist Ramachandran (1999) and his colleague Hirstein proposed the eight laws of the aesthetic experience in their text *The Science of Art: A Neurobiological Theory of Aesthetic Experience*. Ramachandran and Hirstein (1999) theorized that these eight laws aid our understanding of design, visual art, and aesthetics. The laws are (1) grouping, (2) peak shift experience, (3) isolation, (4) contrast, (5) symmetry, (6) generic viewpoint, (7), perceptual problem-solving and (8) visual metaphor. These laws are meant to convey a set of universal principles, a common denominator of art, which can be applied across cultures. The principles, or laws, of their essay suggest heuristics that artists either consciously or

unconsciously create art to excite the visual areas of the brain (Ramachandran & Hirstein, 1999). Three foundations of this suggestion support their position of essentials in art: (1) internal logic in the phenomenon of art, (2) evolutionary rationale, a question of *why* arts particular form, and (3) neurophysiology, concerning activated brain circuitry. In an attempt to render the laws through one visual expression, an image titled *Still Walk* has been included for reference and delineation (see Appendix J, Figure J1). These principles offer logical, biological, and neurophysiological foundations for considering aesthetics. Influential British, scientist and novelist, C. P. Snow (1959) talked about two severed cultures of the sciences and humanities, which until merged could not solve the intellectual problems of the western world. Ramachandran and Hirstein (1999) propose that in the interface of the brain, and perhaps through art these two cultures do meet. Neuroaesthetics, a science of art, offers progressive integration, especially when implemented through the clinical field of art therapy.

Visual sciences.

In his article "Two Sciences of Perception and Visual Art," Myin (2000) explores two kinds of *vision science*, representational and nonrepresentational. According to Myin, it is assumed that the human brain uses a certain "code" while creating these representations. The role of the brain is compared to the artist during the creation of visual representations of physical objects (Myin, 2000):

> Given that both the brain and the artist are in the same business of representation, perhaps the overt representing of the artist is highly constrained by how the brain represents the visual world internally. Art could be classified in respect to how successful it is in manipulating the brain's representational schemes. The artist can then be portrayed as a kind of experimental psychologist who probes the visual system with pictures (p. 45).

As previously stated, Cavanagh (2005) and Zeki (website) have made the claim that artists are neuroscientists in their own right. Here, Myin attributes the artist's ability to portray and alter reality as a kind of experimental psychologist.

The latter in this dichotomy, Myin's nonrepresentational alternative, states that *invariants* replace the mind's representations. It is not uncommon for the term nonrepresentational to be associated with abstract art, but within this context, vision utilizes the surrounding environment to create a nonrepresentational image as opposed to using only what lies internally (Myin, 2000). According to Myin, and given what we know about this nonrepresentational alternative, the materials which an artist uses may take part in the artistic production itself, regardless of where the artistic process falls within this dichotomy.

Neuroaesthetics of Viewing Art

Within the spectrum of neuroaesthetic research, both viewing art and creating art may be found, both of which are of interest to our present study. Research regarding the neuroaesthetics of viewing art encompasses both aesthetic appeal and artistic preference, exploring their impact on the human brain.

Brain regions involved: Activation, art, & preference.

Primarily, neuroimaging studies explore brain activation while viewing art as opposed to creating it (Zaidel, 2010). Several studies explore artistic preference and aesthetic appeal (Kawabata & Zeki, 2004; Nadal et al., 2008; Vartanian & Goel, 2004). Neurologist Vartanian and Cognitive Neuroscientist Goel (2004) discovered through their investigation of abstract and representational images that the right caudate nucleus, bilateral occipital, and fusiform gyri, as well as the left cingulate sulcus, all showed an increase in activation when a participant showed aesthetic preference for an image. All of these brain regions play a part in "evaluating reward-

based stimuli that vary in emotional valence" (Vartanian & Goel, 2004, p. 897).

In Zaidel's (2010) review of previous literature, which relates to the link between art and brain localization in theories of art and the brain, a study viewing "beautiful" and "ugly" paintings was cited (Kawabata & Zeki, 2004). This study found that the brain regions involved in such comparisons appeared within both the motor cortex and the orbitofrontal cortex. When showing an aesthetic preference for art, it makes logical sense that the orbitofrontal cortex is involved due to its role in the cognitive processing of decision-making (Fuster, 1997).

Motor cortex and viewing art.

Ramachandran (2000) makes a link between mirror neurons and what he calls *motor command neurons* based on Rizzolatti's (1999) research with monkeys. Oberman et al. (2005) found that these motor command neurons were activated in the premotor cortex during observed actions. Based on neuroanatomy research (Vanderah & Gould, 2016), the premotor cortex sends signals to the spinal column, which implies that the premotor cortex is, in part, responsible for the planning and/or execution of an individual's actions. McGregor and Gribble (2015) state that the mirror neuron system (see Appendix G, Figure G1) is "part of a broader action observation network (AON) including supplementary motor area (SMA), premotor, primary motor (M1) and primary somatosensory (S1) cortices, superior parietal lobule (SPL), and middle temporal visual area (V5/MT)" (p. 677).

A study completed by Keysers and Gazzola (2009) concluded that mirror neurons do not solely exist in the premotor cortex, but can be found in at least five brain regions (see Appendix G, Figure G1) including the inferior parietal lobe, the temporal lobe, the ventral and dorsal premotor cortex, and the supplementary motor cortex. The parietal and temporal lobes have been found to activate during sensory input processing (Radua et al., 2010; Smith & Kosslyn, 2007).

Several studies have found that an observer of art can both physically and emotionally be stimulated through viewing art (Freedberg & Gallese, 2007; Umilta et al., 2012). Freedberg and Gallese (2007) studied physical, or body empathy, experienced by viewers, which can be defined as a parallel physiological response located in the parts of the body experiencing the sensation in both the subject and the observer.

Umilta et al. (2012) elaborated on Freedberg and Gallese's findings, the aim of investigation was to explore the motor system's role in the viewing of art. In their study, high-density electroencephalography (EEG) was utilized to measure the level of intensity of mu rhythm suppression within the motor cortex of fourteen healthy volunteers (Umilta et al., 2012). Images were displayed via monitors of both original artworks and digital graphic renderings of the originals, creating a collection of six images that were randomly presented fifteen times each.

After the EEG recordings were taken, the participants were asked to score each of the six images on (1) familiarity, (2) aesthetics, (3) amount of movement present, and (4) whether or not the image was "real" (Umilta et al., 2012). The findings showed that in comparison to the digital renderings of the static works of art, viewing cuts in a canvas incited higher scores for both aesthetic appraisal and the level of perceived movement, making it the first study to collect evidence of cortical motor systems involved in the observation of static images without the representation of explicit movement as subject matter (Umilta et al., 2012). This motor activation, as measured by EEG, during the observation of static art is a strong indication of motor cortex involvement in the perception of visual art.

Carr (2014) further elaborated on the function of mirror neurons in the observation of pain, whether in reality or by subject of a portrait. She found that, in both instances, the neural networks of the viewer were activated as if they were personally experiencing the pain they

witnessed. These findings were collected from a single-subject case study of a 49-year-old male diagnosed with Chronic Obstructive Pulmonary Disease (COPD), a progressive lung disease. The case study investigated four portraits, which were co-designed and painted by the researcher for the patient, Paul. Carr painted these portraits following the participant's response to a stimulus artwork, *Broken Column* by Frida Kahlo. The participant reported that he chose the work created by the Latina Surrealist due to his level of empathetic understanding, stating, "you know what she's going through" (p. 61).

An understanding of how an individual perceives a work of art includes both somatic responses within the body (Carr, 2014) as well as motor cortex activation in the brain (Freedberg & Gallese, 2007; Umilta et al., 2012), both of which have been attributed to mirror neurons. According to Hass-Cohen and Findlay (2015), "fine motor and perceived movement have traditionally been expressive components of art therapy," suggesting that there are "cognitive and emotional advantages to incorporating motion into the interpersonal space and to exploring images of actual and implied action" (p. 10). The authors write that mirror neuron functions can be used therapeutically to strengthen the link between cognition and emotion (Hass-Cohen & Findlay, 2015).

Neuroaesthetics of Creating Art

Our present study focuses on the production of art in a directive approach, in order to differentiate how the brain functions during art making compared to simply moving. A directive art making method allows for reduced variability between subjects. This area of the neuroaesthetics spectrum explores theoretical approaches of creativity, and research regarding art production with implications for clinical art therapy practice and the brain regions associated with work on the Expressive Therapies Continuum (ETC), seen in Appendix K, Figure K1.

Direction of neuroaesthetics research.

As reviewed earlier, the field of neuroaesthetics has developed its characterization as "a cognitive neuroscience of aesthetics" (Pearce et al., 2016, p. 265), which includes studies of individuals, sensory stimuli, and context. Along with colleagues, Anjan Chatterjee (2010) developed the Assessment of Art Attributes (AAA), in order to equip researchers with instrumentation to assess art attributes in a computational and quantitative measure. As an initial instrument design the AAA provides potential solutions of quantification. Progress in the field of neuroaesthetics to understand the impact of creativity on individuals and communities will take place with multimodal investigations, including art production. The needed and interesting anecdotal observations (Chatterjee et al., 2010, p. 256) of neuroaesthetics research are in excess. However, quantifiable, computational modes of inquiry are limited and needed, further elaborating that "neurophysiological investigations of art production and perceptions have the potential to offer critical insight into the biology of art" (Chatterjee et al., 2010, p. 256). Research focused on how physiological and psychological aspects of aesthetic experience relate to one another while support needed therapeutic implications, such as clinical art therapy.

Neuroaesthetics research.

According to Chatterjee (2015), there is not a specific art center of the brain to study the effect of art making. Contrary to popular belief, individuals who are categorized as creative do not solely rely on the right hemisphere of the brain. "The production of art is highly complex with different components mediated by different parts of the brain" (p. 343), with the resulting artwork operating as a cogent collaboration of these different components (Chatterjee, 2015).

Ferber et al. (2007) identified brain regions associated through fMRI, using a modified drawing tablet as the control for movement tasks to copy and draw from memory. This study

which included twelve healthy volunteers, found that the drawing task could activate the anterior cingulate, described by Ferber et al. (2007) as “an area associated with motor control and linking intention with action” (p. 1089). The drawing from memory task also evoked stimulus in the medial frontal gyrus. The anterior cingulate is where motor control, drive, and cognition interface due to proximity with the motor and prefrontal cortex and parietal areas, “pointing to its role in conflict monitoring, and linking intention with action” (Paus, 2001, p. 417). Drawing requires the access of memory and sustained attention as the external stimuli is retrieved and internal modulating assesses whether the production is congruent with the original intention. Visual processing and crossmodal attention were required during the copying task.

Likova (2012) wrote that the creation of art, specific to drawing, involves, "an amazing process that requires precise orchestration of multiple brain mechanisms, perceptual processing, memory, precise motor planning and motor control, spatial transformations, emotions, and other diverse cognitive functions” (p. 1). The totality of brain processes that art production elicits connects the relationship of creativity and survival. Likova (2012) details this process by saying, “drawing, and in particular memory-guided drawing, challenges the encoding of detailed spatial representations, their retrieval from memory and ‘projection’ back into a mental high resolution ‘screen,’ so as to guide the motion of the drawing hand with the requisite precision” (p. 1). Likova (2012), using fMRI measurement, investigated how the brain of a congenitally blind individual was activated during drawing. The subject was analyzed during pre- and post- training drawing exercises. Training included a drawing from tactile memory, with the use of a cognitive-kinesthetic approach and a raised-line drawing model, which was explored with the left hand before drawing them from memory with the right. This is one of the few studies to investigate the involvement of the primary visual cortex (V1) in non-visual memory. With detailed results of

topographical brain mapping, V1 has been shown to operate as a "visual-spatial buffer, or 'sketchpad,' for working memory" (Likova, 2012, p. 1). The cognitive-kinesthetic, tactile-memory task may be used to explore plasticity rehabilitation of individuals with blindness.

Bolwerk, Mack-Andrick, Dörfler, and Maihöfner Bolwerk (2014) completed the first study linking the neural effects of visual art production with psychological resilience in adulthood. Fourteen adult participants 65 years and older were divided into two groups for 10-week-long art interventions, one visual art production group, created art in an art class and one cognitive art evaluation group, viewed art at a museum. The neural effects of each group were measured before and after each week of participation by fMRI to investigate the brain's default mode network (DMN). Analysis of the DMN was identified through a seed voxel correlation analysis (SCA) in the posterior cingulate cortex. The German equivalent of the Resilience Scale (RS-11) was used to relate the covariance of fMRI results and psychological resilience. Results for the visual art production group versus the cognitive art evaluation group showed a greater spatial increase in functional connectivity of the posterior cingulate cortex to the frontal and parietal cortices. In the study, significance to psychological resilience was related to the visual art production group, indicating a stabilizing effect of art production and well-being, especially in older adults.

Creativity and the Brain Research

According to Dietrich (2004), the study of how creativity happens in the brain encourages new insights through study. Notions of creativity include the mad artist, right hemisphere predominance, and divergent thinking. In view of advanced neuroimaging technology and the evolution of creativity, an organized mode of creativity and the brain emerged. Dietrich (2004) explores creativity in his text *The Cognitive Neuroscience of Creativity*:

> Concisely stated, creativity results from the factorial combination of four kinds of mechanisms. Neural computation that generates novelty can occur during two modes of thought (deliberate and spontaneous) and for two types of information (emotional and cognitive). Regardless of how novelty is generated initially, circuits in the prefrontal cortex perform the computation that transforms the novelty into creative behavior. To that end, prefrontal circuits are involved in making novelty fully conscious, evaluating its appropriateness, and ultimately implementing its creative expression. (p. 1023)

Professor of Cognitive Neuroscience Arne Dietrich and Riam Kanso (2010) argue that there are subdomains of creativity and three are presented, that researchers use to study creativity. In whole review, the categories present a variety of data and fragmented notion of creativity that cannot be generalized, which further supports the notion of types of creativity and their various neural mechanisms (Dietrich and Kanso, 2010). In their meta-analysis, Dietrich and Kanso (2010) reported that in 1950 Joy Paul Guilford proposed that divergent thinking would assist in the study of creativity, which is under much scrutiny and criticism as a legitimate method of study for human creativity. Divergent thinking, as defined by Guilford (1967), is the "ability to generate multiple solutions to an open-ended problem" (Dietrich & Kanso, 2010, p. 822). The second category is artistic creativity and includes: (1) free drawing and/or composing music, (2) imaging the creative act of painting, and (3) creating abstract drawings. The third category, insight, can be argued to be a "right[ful] subfield of creativity because the first step toward a finished creative product is...a creative insight" (Dietrich & Kanso, 2010, p. 823). Comparing neuroimaging studies of divergent thinking and artistic creativity, some studies have found that there are additional brain structures, like the motor areas, which were not found in divergent thinking studies.

Art Therapy and the Brain Research

Lusebrink (1990) understood the support of brain research on contemplating art production and stated that visual expression is processed on different levels of complexity. In a later text (2004) Lusebrink wrote, "an expression through art media can also originate from complex cognitive activity involving decisions and internal imagery, thus activating the sensory channels and motor activity" (p. 125). The brain makes use of visual, somatosensory, and motor information processing, with conjunction to areas of emotional and memory processes (Lusebrink, 2004).

The expressive therapies continuum (ETC) was developed as a model of creative functioning through human development and information processing (Lusebrink, 1990). The vertical spine of creativity is balanced through hierarchical planes of the sensory-kinesthetic level, perceptual-affective level, and cognitive-symbolic level. During art production, an individual's choice in media corresponds with levels of the ETC and reflects brain functions of the temporal, orbital, parietal, and frontal lobes (Hinz, 2009). This three-tier hierarchical structure provides for the variety of component functions involved in visual expression and suggests a commanding functional level.

Vertical and horizontal movement on the ETC reflect levels of hierarchical brain processing. Multiple functions may be involved in visual expression, but usually there is a particular component that predominates (Lusebrink & Hinz, 2016). On a therapeutic level, recognizing a client's component preference can "reflect strengths in visual expression and which reflect respective deficits" (Lusebrink & Hinz, 2016, p. 49). The particular level of strength and/or deficit in component functioning "mirror[s] preferences in the reception, processing, integration, and expression of information, emotion, and action in other aspects of

life" (Lusebrink & Hinz, 2016, p. 49).

Direction of art therapy research: Art making and neuroimaging.

Belkofer and Konopka's (2008) study is a modified, single-subject design that used electroencephalograph (EEG) data to explore the human brain after one hour of art making. The primary author of this study, Belkofer, acted as the single subject (N = 1). In order to study the effects of art making on the brain, two 22-minute EEG readings were taken; the first acted as a baseline measure, and the second was taken immediately following the art making process. This study was without direction for the participant's art making. Following the first EEG reading, the single participant was asked to make art for one hour and was given materials that are commonly found in art therapy settings including (1) charcoal sticks, (2) graphite pencils, (3) a pad of 11" x 8.5" white paper, (4) watercolor paints, and (5) watercolor brushes (Belkofer & Konopka, 2008).

The participant created two images, one using drawing materials and the other using watercolors. EEG recordings were taken pre- and post-art making, and the researchers choose to leave the electrodes attached in order to quickly obtain post results. However, the researchers reported that the movement from one space to another may have influenced the recordings, stating that "the simple shift from sitting still to movement may have caused changes in brain chemistry that lingered after returning to the booth for the second reading" (Belkofer & Konopka, 2008, p. 60). They found that in comparing pre-and post-data, higher frequency bands, like alpha and beta waves, were present after drawing and painting (Belkofer & Konopka, 2008).

The results of this study show that activation occurred predominantly within the occipital, parietal, and temporal lobes (Belkofer & Konopka, 2008). And while alpha and beta waves showed marked increases, delta and theta brainwaves decreased in the same brain regions. Parietal and occipital lobe activation is an indication that the participant has "increased visual

processing demands" (p. 61). In terms of the increased activity within the temporal lobe, it is believed that this is where spiritual and emotional connections can be made (Belkofer and Konopka, 2008).

Belkofer and Konopka (2008) reference Rubin (2001) in regard to how art therapy treatment modalities explore a client's spirituality in order to achieve self-awareness. Rubin's study provides the framework for future research incorporating art therapy, perhaps following this study's method in assessing a participant before and after an art therapy intervention (Belkofer & Konopka, 2008). "Artistic experience, the length of treatment, the size and choice of media, and the willingness to actively engage with images are just a few of many variables that could help determine certain neurobiological processes…" (Belkofer & Konopka, 2008, p. 62).

In a recent study that explored residual effects of a drawing activity in brain activity in a small sample, Belkofer, Van Hecke, and Konopka (2014) stated that their non-directive art approach may have been too general and suggested the use of a less open-ended art task. Choosing a directive, which reduces the spontaneous artistic response, is an approach that may reduce variability within a groups' body of artwork. This particular study was completed as a pre/post within-group study, this time utilizing quantitative electroencephalogram (qEEG) to measure the effects of 20 minutes of art making on the brain. The sample increased (N = 10) with six participants being artists and the remaining four lacking previous artistic skill.

Unlike in the first study, participants were given more direction, "...for the next 20 minutes, use the materials to create an image. Your image can be representational (people, places, or things), abstract (shapes and lines), or both" (Belkofer, Van Hecke, & Konopka, 2014, p. 63). Each participant received one piece of 14" x 17" paper and a set of 16 oil pastels. Results of the study indicated changes in the frontal areas of their non-artist participants, which they

attributed to the unfamiliar tasks. By comparing these two groups, researchers also found an increase in alpha frequency may play an important role in drawing (Belkofer, Konopka, & Van Hecke, 2014). However, unlike the previous study, the results showed activity in the spatial/visual regions of the cortex.

A study using qEEG, by Kruk, Aravich, Deaver, and deBeus (2014) compared the brain activity during drawing and clay sculpting in fourteen female participants between the ages of 22 and 25. At the time of its completion, "...there [were] few randomized controlled studies of the effects of art making and the neurobiological substrate of different art-making processing streams" (Kruk et al., 2014, p. 53). Participants completed a pre- and post-measure of state versus trait anxiety using the State-Trait Anxiety Inventory, STA1 Form Y1. Nineteen EEG electrode sites were placed on the left and right medial frontal lobes as well as the left and right medial parietal lobes. Control readings required the participants to open and close their eyes and crumple tissue paper; readings were taken before and after five minutes of freely sculpting with clay and five minutes of drawing.

Choosing two different tasks allowed for more specific investigation into how certain tasks, e.g. drawing and sculpting with clay, affect the brain. The first task, clay making, was nondirective, instructing participants to "make something out of the clay. It doesn't have to be 'some *thing*' It can be abstract" (p. 54). For the drawing task, participants were asked: "make a picture of your favorite weather for 5 minutes" (p. 54). Results indicated the right medial parietal lobe increased in gamma power activation with the drawing and clay conditions. In comparison, the right medial frontal lobe showed a decrease in gamma power and an increase in theta power during the clay condition. One suggestion made for future inquiry is that manipulating tissues as a control may not be an adequate condition. For the drawing task, materials included felt-tipped

markers and 9” x 12” gray drawing paper. Kruk, Aravich, Deaver, and deBeus hypothesized that by including a drawing task in addition to a nondirective clay making task, the directive would evoke a perceptual reaction and cognitive response (Kruk et al., 2014). Results indicated that using a directive during the drawing task affected the frontoparietal network differently when compared to the non-directive art making using clay. The researchers stated that “drawing on paper in response to a directive likely would elicit a cognitive reaction and possibly a perceptual response” (Kruk et al., 2014, p. 54).

Neuroimaging

Creativity and the neural mechanisms involved in its process are not well known (Dietrich & Kanso, 2010). American Psychological Association published a meta-analysis (Dietrich & Kanso, 2010) comparing 72 experiments that explore insight, creativity in art, and divergent thinking. The method of data collection within these experiments include electroencephalogram (EEG), event-related potential (ERP), and other neuroimaging techniques such as functional magnetic resonance imaging (fMRI), near-infrared imaging (NIRS), positron emission tomography (PET), single-photon emission computerized tomography (SPECT), and magnetic resonance imaging (MRI). According to Zaidel (2010), neuroimaging techniques have been repeatedly used to uncover more about the “nature of art from the viewer’s perspective” (p. 179). And while neuroimaging technologies have been used for the neuroaesthetics of viewing art, the challenge of exploring the physical brain of an artist during the artistic process remains. Utilizing the electroencephalogram (EEG), we explored the differences in cortical function between art making and rote fine motor tasks.

EEG justification.

EEG was not widely used as a method of interpreting the brain’s involvement in

creativity until the late 1990s (Dietrich & Kanso, 2010). Electroencephalography is a noninvasive measurement of electrical patterns at the surface of the scalp that reflects brain activity, commonly referred to as brainwaves. According to Dietrich and Kanso (2010):

> EEG data are reported in frequency ranges. At the low end of the scale is delta activity, which is a regular, low-amplitude wave of 1–5 Hz. This frequency band reflects a low neuronal firing rate and is mostly associated with deep sleep. Theta activity is a medium-amplitude, medium-frequency rhythm of 5–8 Hz. A person exhibiting this rhythm reports feeling drowsy. Alpha activity is a fairly regular pattern between 8 and 12 Hz. The alpha band is prominent when a person is minimally aroused—awake but relaxed. Beta activity, which is an irregular pattern between 12 and 30 Hz, occurs mostly during alertness and active thinking. Finally, there is the gamma rhythm, which represents oscillations around the 40 Hz mark that are associated with the binding of perceptual information. (p. 824)

Understanding how brain waves interact will illustrate the strength of their relationship. A stronger excitatory and inhibitory postsynaptic potentials, convergence of brainwave connections relates to a more efficient synchrony transfer of information and sensory binding (Dietrich, 2010). The use of quantitative electroencephalogram (qEEG), or brain mapping, provides an analysis of the EEG measurement. By using qEEG, we can map brain activation, which will be important to provide a clear visual of neural mechanisms. Researchers Bhattacharya and Petsche (2005) found that EEG was more appropriate than other neuroimaging procedures for measuring higher brain functioning, stating that "...modern imaging studies using functional magnetic resonance imaging (fMRI) or positron emission tomography (PET) are extremely popular and useful in the localization of brain functions...they are not ideal to detect the functional cooperation between distant cortical regions" (2005, p. 2).

Other neuroimaging techniques, such as MRI, have been used to measure brain activity as a portrait artist created art (Solso, 2000). Like the EEG, MRI technology also uses noninvasive means to evaluate soft tissue in the human body by taking pictures of the head. Computed tomography (CT) scans, X-ray, and ultrasounds are also used in medical imagery, but do not provide as much information as MRI. Limitations of using MRI include limited space during the scan and the subject's head must be held tightly for the machine to obtain a readable impression.

Radiation exposure is one disadvantage to PET scans, also known as positron emission tomography. In addition, the temporal resolution (TR) or measurement precision with reference to time is limited by its recording speed. Similarly, fMRI and fNIRS are also limited by TR. PET neuroimaging works by identifying blood flow in the brain. It can also be used in cardiology, oncology, musculo-skeletal imaging, and the study of infectious diseases (Carlson, 2012). Even with its multi-use appeal, clinical and research PETs are difficult to maintain. The cost of a PET scan is also a distinct disadvantage when coupled with maintenance issues.

PET scans are not the only costly method of neuroimaging; fMRIs and MEGs are also on this list. In contrast, research that incorporates EEG and ERP technologies is less expensive to maintain. Functional magnetic resonance imaging (fMRI) measures blood flow, much like PET scans. Brain activity and cerebral blood flow (CBF) are interconnected (Logothetis et al., 2001), allowing brain activity to be detected by measuring CBF. Therefore, when a participant is completing a task and a particular lobe, pathway, or cortex is activated, more blood will flow to the area in use. Disadvantages and associated risks with an fMRI scan are nerve tingling, high-pitched noises, and claustrophobia (Huettel, Song, & McCarthy, 2009). Given the space limitations of fMRI, MRI, PET, and SPECT scanners, other neuroimaging techniques, such as

EEG, are more appropriate to study cortical activation during art making and rote motor tasks.

Near infrared spectroscopy (NIRS) also utilizes cerebral blood flow to localize brain activation sites. Specifically, NIRS technology absorbs and transmits NIR light into the human body in order to assess changes in an individual's hemoglobin concentration (Zeller, 2013). NIRS can both assess amount of activity and specific location within the brain due to the individual's hemoglobin levels. This process is noninvasive and more portable than other neuroimaging technologies such as fMRI. NIRS technology is available in a wireless format, making it more usable during participant tasks, but it is limited to scanning cortical tissue and cannot accurately assess activation throughout the entire human brain.

Event-related potential (ERP) is largely used in the evaluation of cognitive diseases and, as the name suggests, explores the effect of an event-related stimuli, such as motor, sensory, and/or cognitive stimuli, on the brain. When a subject is presented with a particular event the ERP or event-related potential scan shows the activity, which then allows technicians to understand how the information is processed in the brain. One of the major advantages of this form of neuroimaging is that it is done in real time. Like other neuroimaging technologies, ERP has its disadvantages. While ERPs have very good temporal resolution, they also have unsatisfactory spatial resolution (Luck, 2012); because of this, ERPs are less appropriate for research interested in identifying location of specific brain activity and more appropriate for studying neural activation speed.

Motor imagery.

Of our two motor tasks--flipping a coin and rotating a pencil--the latter required some forethought as it likely was an unfamiliar task. Mental visualization will assist subjects as they attempt to approach these movement tasks. One study (Glevins, Smith, McEvoy, & Yu, 1997)

found increases in theta brainwaves as the difficulty level of a cognitive task elevated, eliciting increased attention and need for practice. The same study also found that "decreas[es in] alpha...indicates that this signal is inversely related to the amount of cortical resources allocated to task performance" (p. 374). Much has been done to explore cortical activation via EEG following motor imagery tasks (Decety, 1996; Neuper, Scherer, Reiner, & Pfurtscheller, 2005; Pfurtscheller, Brunner, Schlögl, & Lopes de Silva, 2006; Posner & Presti, 1987; Requin, 1991), with findings suggesting participation from the frontal lobe, prefrontal lobe, and mu desynchronization.

Motor imagery is a process whereby individuals visualize and rehearse a particular action, which can be felt by the practitioner (Decety, 1996). In his article *Do Imagined and Executed Actions Share the Same Neural Substrate?*, neuroscientist Jean Decety found that motor imagery and motor control share the same neural mechanisms via (1) regional cerebral blood flow (rCBF), (2) mental chronometry, and (3) autonomic responses. Results indicated that the frontal cortex plays a major role in both motor imagery and execution, while dorsolateral frontal and prefrontal cortices are responsible for the brain's ability to time an action (Decety, 1996; Posner & Presti, 1987; Requin, 1991). Further support for prefrontal cortex activation comes from Duncan's (1986) study, which found that damage to this section of the human brain impacts the individual's behavior control and executive functions. Neuper, Scherer, Reiner, and Pfurtscheller (2005) found similar results, stating that "motor imagery of motor actions can produce replicable EEG patterns over primary sensory and motor areas" (p. 668) with fourteen normal subjects. Participants were asked to perform four tasks: (1) motor execution (ME), squeezing a ball; (2) imagery of hand movement (MIK), imagining the kinesthetic act of squeezing a ball; (3) observation of hand movement (OOM), watching someone squeeze a ball;

and (4) imagery of hand movement (MIV), visualizing the movements that go into squeezing a ball (Neuper et al., 2005). This study is different in that it examined two aspects of motor imagery, visual-motor representation, i.e. a mental video of the required movements, and kinesthetic representations, i.e. how the overt motor output would feel, both showing notable changes in the EEG recording.

One year later a follow-up study (Pfurtscheller et al., 2006) explored mu rhythms through EEG as nine participants imagined right and left hand, tongue, and foot movements. This was done with 60 EEG electrodes, resulting in desynchronization in mu rhythm during the motor imagery of hand movements (Pfurtscheller et al., 2006). To reduce artifacts and truly measure motor imagery, subjects were asked to keep still and relaxed as they watched the visual stimuli on a screen. After presented with the image, each participant was asked to imagine the motor execution (ME) involved in moving those body parts. What Pfurtscheller found was event-related desynchronization (ERD) as well as event-related synchronization (ERS) when participants imagined such movement tasks (Pfurtscheller et al., 2006).

In review of the neuroaesthetics and art therapy literature it is clear that discussing, viewing and creating art from a neuroscientific perspective is natural because humans and therefore the brain make art. While qualitative research is crucial to the context of an understanding of how art is responsible for physiological and psychological changes in the body, it is also part of a larger system of research. Neuroimaging holds a promising potential to be a beneficial tool in providing quantitative research to contribute numerical, and objective data collection. The collective of such research methods may join the fields of science and art in partnership of the humanities, to support one another.

CHAPTER III

METHODOLOGY

Art Making Task

Diagnostic drawing series.

Our study's art task was taken from Barry Cohen's (1988) Diagnostic Drawing Series (DDS), which originally was designed to assess a participant with three directives. According to its creator, the DDS is the most extensively researched art therapy assessment, providing researchers and clinicians with a valid and reliable directive task. The materials used throughout the three drawings are 18" x 24" white paper and a 12-pack of Alphacolor or Blick pastels. Pastels offer ease of application, sophistication over crayons, and versatility in use (Cohen, 1985). And while previous studies included the use of grey paper, the DDS requires white drawing paper which works as a "bright surface" (Cohen, 1985, p. 1) behind the colored pastel and is durable, while the size avoids constricting boundaries, encouraging large movements. The paper may be turned in any direction, allowing room for personal preference and accessibility.

First, the individual is asked to "make a picture using these materials" (Cohen, 1985, p. 12). This spontaneous task can evoke a spectrum of affective responses from the individual, ranging from bad to good (Cohen, Hammer, & Singer, 1988). For the second drawing, participants are asked to "draw a picture of a tree" (Cohen, 1985, p. 13). The tree stimulus was chosen because it is a common image in daily life and is seen in most early childhood drawings. In terms of structural level, the drawings move from least structured to most structured, ending with a subjective task that also allows for self-reflection and -assertion (Cohen, Hammer, & Singer, 1988). This third task, applied to our present study, asks participants to "make a picture of how you're feeling, using lines, shapes, and colors" (Cohen, 1985, p. 13).

In a therapeutic setting, the resulting artwork would be used to explore the client's inner experience, stating that "the person best placed to understand the experience of the patient is the patient" (Cohen, Hammer, & Singer, 1988, p. 13). Given that this drawing series has been evaluated for its reliability and validity as an art therapy assessment (Mills, Cohen, & Meneses, 1993), our study utilized the same materials and administration technique, which encourages a largely nonverbal exchange during the art making task. The DDS's reliability and validity does not apply in our study as the DDS is not being administered to subjects in standardized form. Our study excluded the DDS in three parts and only allow for the third directive to "make a picture of how you're feeling, using lines, shapes, and colors within the circle." This choice to use one of the three tasks in the DDS relates to the amount of time available with each participant.

The time allotted each participant to complete this task was 12 minutes, similar to the DDS's allotted 15 minutes per task. Participants was provided with a 12-count pack of color pastels and a 18 x 24 sheet of white paper with a pre-drawn mandala. The drawing paper that participants received only included the pre-drawn mandala/circle boundary without any guidelines inside or outside the mandala/circle. This choice was made to potentially enhance the creative space. Providing the mandala, which is a circle that represents unity and symbolizes containment, will likely increase the participant's focus and attention according to Michele Roush's (2013) dissertation which investigated how mandalas help those with severe mental illness. Among her many successful post-intervention findings, one was "increased focused attention" (Roush, 2013, p.296). In Susanne Fincher's *Creating Mandala's for Insight, Healing and Self-Expression,* mandalas are described as producing an "inner order" (p. 18). Fincher describes the ancient and cross-cultural impact of mandalas and how they "have traditionally served as instruments of meditation to intensify one's concentration on the inner self in order to

achieve meaningful experiences" (p.18).

The intent of including a pre-drawn mandala is to provide structure, boundaries, and containment, increase attention, improve mood, and reduce anxiety. Brown and Robbins (1996) showed that children with ADHD and ADD who worked with mandalas improved their focus. Curry and Kasser (2005) showed mandalas can alleviate anxiety, which is especially relevant to the current study as Belkofer and Konopka (2014) suggested EEG procedures might be anxiety provoking. Babouchkina and Robbins (2015) completed a randomized study providing subject groups work with mandalas and squares using a similar directive of, draw how you feel. The group using mandalas had elevated mood responses versus the group who used squares. It was said the unity of the circular shape proved to be an "active ingredient" (Babouchkina & Robbins, 2015, p. 34).

The DDS was designed for adolescents and adults in clinical settings in order to collect information on a patient's behavioral and affective states and their cognitive capacity (Brooke, 2004). The overall purpose was to connect the analysis of artwork to a Diagnostic and Statistical Manual of Mental Disorders (DSM) diagnosis and assess client's responses to various levels of structure throughout the tasks. The third task chosen for our study was originally intended to promote abstract thinking and to explore a client's ability to access and represent their affective state in a work of art (Brooke, 2004). By choosing this directive task results may be be more standardized across our sample size (N = 10) in contrast to a more open-ended or nondirective approach to art making.

In a formal DDS assessment, the client would complete a Drawing Inquiry Form, with 4-6 questions per task including "how would you describe this picture?" and "what do these images represent for you?" (Cohen, 1985, p. 9), and later rated using the Diagnostic Drawing

Series Drawing Analysis Form II (DAF2) (Cohen, 1985/2012). Given that the present study did not include a formal DDS administration and did not result in further art therapy sessions, this inquiry form and rating guide was omitted from the data collection process.

Motor Tasks

Given that our motor task control took place for 12 minutes, it was important to insure that participants do not lose interest in the task, which could result in a decline in brain activity. In order to maintain attention and engagement throughout the movement condition, two tasks were used for 6 minutes each. This approach allowed data to be collected with the same interval markers as the 12-minute drawing task previously mentioned. Participants began by flipping a coin for 6 minutes. Next, they were asked to rotate a pencil for 6 minutes between fingers. These fine motor movement tasks require attention for successful completion. It is hypothesized that, participants are accessing the primary motor cortex to plan how to best accomplish the movements.

Movement conditions.

As mentioned previously, Kruk et al. (2014) utilized a movement condition as a control, but later criticized the choice for being inadequate in comparison to the two art-making tasks, specifically its difference in clay making. The movement control condition required subjects to crumple a facial tissue in their hand for three minutes. This particular movement was chosen to simulate the movements enacted during the clay making task, minus the intention of creating art. Crumpling tissues was designed as a condition in order to control for general movements over more specific movements like eye and head movements (Kruk et al., 2014).

Coin rotation task.

The coin rotation task (CRT) requires individuals to utilize rapid, coordinated fine motor

movements as they rotate a nickel 180 degree using the thumb, index finger, and middle finger (Mendoza, Apostolos, Humphreys, Hanna-Pladdy, & O'Bryant, 2009). The coin rotation task (CRT) is effective at measuring psychomotor processing speed and proves to be cost effective in comparison with similar task measurements (Mendoza et al., 2009). The grooved pegboard test (GPT) is also a standard criterion measure of psychomotor processing speed, but includes bulky, expensive, and complicated handling. The CRT is a standard research instrument of psychomotor processing, which has influenced our choice in motor tasks for being valid, convenient, and inexpensive.

The procedure for the CRT involves participants rotating a coin through continuous 180-degree turns with the use of their thumb, index, and middle fingers. According to Halstead (1947), the ability of upper body mobility and dexterity function proves to be instrumental in understanding the brain's processing, which can also be seen in flipping a coin. As a test of neurophysiological integrity and brain function, the use of the CRT may be assessed with a patient in a matter of ten seconds. In clinical diagnosis, the CRT has been researched for dexterity measurement in relation to limb kinetic apraxia (LKA) with various populations including people with neurodegenerative disorders (Gebhardt, Vanbellingen, Baronti, Kersten, & Bohlhalter, 2008; Quencer et al., 2007; Vanbellingen et al., 2011). Foki et al. (2010) conducted the first neuroimaging research study while using the CRT as a measure of dexterity of patients with Parkinson's disease (PD). The fMRI results of neural correlates demonstrated that the CRT is an effective measure of limb kinetic apraxia (LKA). Participants of the healthy control group performed faster rotations of the CRT per 20-second intervals compared to the patients with PD. In healthy patients, the most significant neural activation was in the left postcentral cortex, along with observable synchrony of the right occipito-parietal and parastriate cortices (Foki et al.,

2010).

Design

The current preliminary experimental study is an evidenced-based human-subjects design. The intention is to provide information with which to further establish and explore the links between creativity and neuroscience in the effort of advancing the field of art therapy. Researchers exploring art and the brain use a variety of neuroimaging devices, including the noninvasive electroencephalogram (EEG), to record cortical activity. By extension of the EEG, quantitative electroencephalogram (qEEG) is the analysis of EEG digitized data. However, Dietrich and Kanso (2010) state that there is not a cohesive picture of which brain mechanisms are involved in the process of making art.

The reproduction and application of the investigation's results will contribute to objectivity in the use of scientific understanding. This study will add to a limited body of research involving EEG recordings and analyses of the brain during the creation of visual imagery and seek to further explore how art making impacts the brain. There have been a few studies in art therapy literature that have shown preliminary results while using qEEG technology for measuring brainwave activity in response to art making (Belkofer & Konopka, 2008; Belkofer, Van Hecke, & Konopka, 2014; Kruk et al., 2014). Using these data as foundation for further inquiry, this current research is constructed as a within-subject design because every participant (N = 10) is subjected to every treatment condition, a directive art making task and two rote motor tasks. In order to control for variations in time of day, food eaten, and amount of sleep from the night before, all tasks were completed in one session. Each subject was also asked to complete every task, eliminating the need for a control group by using every participant as their own control.

Location

EEG equipment for recording and computerized technology for assessments was made available for the conduct of this study from a midsize research hospital in the Midwest. Participants were escorted to the second floor reading room to review and sign the informed consent form (see appendix.) Following this, subjects were seated in one of several EEG testing rooms where they were introduced to the machinery and the individuals conducting the research: a Neuro technologist, a Neurophysiologist consultant; and two graduate research assistants. After the completion of the data collection, participants were brought to the second floor washroom and back to their vehicles.

Enrollment Information

The first participant was recruited by early January of 2017 with data collection taking place in two phases on Saturday, February 4, 2017 and Saturday, February 11, 2017 from 7:00 AM to 6:00 PM both days. Each day five subjects were seen, with ten total participants (N = 10). Six participants were female; four were male. Ages ranged from 23 years of age to 68 years. All subjects identified themselves as Caucasian and were right-handed, which was important to know when viewing the EEG recorded and analyzed data given that the hand used impacts the side of the brain that is firing and data analysis. Information related to the participant's dominant eye was not taken during this study.

Subject type and source.

Participants were normal volunteers from a capital city and surrounding suburbs, in the Midwest. The aim of the present study was to explore variances in cortical activity between the various tasks; therefore, an abnormal population was not required to accomplish this goal. Utilizing a normal population makes the results more generalizable to a broader population. With

an almost even number of males to females and a wide age range, the results will be more generalizable to a wider span of individuals.

Recruitment

Subjects were recruited using a convenient sample—students and faculty of a University and surrounding community members of a capital city in the Midwest. Participants were recruited by word of mouth, flyers (Appendix L) and emails. Participants were either made aware of the study and its aims due to their connections with the facility in which the study took place or were in direct contact with the graduate research assistants. Each participant expressed an interest in supporting the researchers or contributing to the expansion of neuroscience and art making research. The present study was advertised on a university campus and surrounding community via word of mouth.

Subject Inclusion/Exclusion Criteria

Criteria for participation included being 18 years or older, identified as a part of a normal non-patient population, and able to provide consent. Exclusion characteristics included being a minor, having a prior history of major head injury, stroke, seizure disorder, or brain or skull surgery, or taking psychotropic or other medications, such as narcotics, that can affect EEG recording.

Investigational Methods and Procedure

Following recruitment, subjects were asked to attend one of the two data collection dates (Saturday February 4 or Saturday February 11), with five participants per day. Sessions occurred every two hours on the top of the hour, allowing time for these steps: obtain informed consent, introduce subjects to the research team, measure scalps, place electrodes, take three baseline readings, have subjects complete one directive art making task and two rote motor tasks, and

clean up. Upon arrival at their predetermined session time, each subject was brought to the second floor for the graduate research assistants to obtain informed consent. Informed Consent (Appendix N) included the study title, investigation methods, time commitments, confidentiality, potential risks, and use of the data. Subjects' names and signatures can be found on this document only. From that point, all participants were assigned a code to which all raw data would be attached, keeping the identity of each subject confidential.

It took approximately 30 minutes for a subject to read and sign the informed consent and to have his/her scalp measured for electrode placement. Following this, subjects began the first baseline measurement sequence. This 12-minute process included two intervals of eyes open and eyes closed instructions for 3 minutes each. This baseline procedure was repeated after both of the directive task sequences. The total time of baseline measures for each participant lasted 36 minutes (three 12-minute recordings). After the first baseline reading, participants were asked to use the 12 pack of chalk pastels to draw for 12 minutes how they were feeling, using line, shape, and color within the pre-drawn mandala. Next, the second of three baseline measures was taken. Every participant followed the same order of data collection: (1) baseline, (2) art making, (3) baseline, (4) coin flip, (5) pencil rotation, (6) baseline. The rote fine motor condition was divided into two tasks taking 6 minutes each. Participants were asked to flip a Presidential $1 gold coin (8.100 g in mass and 26.49 mm in diameter) for the first 6 minutes and to rotate an unsharpened No. 2 pencil between their fingers using their dominant hand for the remaining 6 minutes. The final phase of the EEG data collection was to complete the third baseline measure.

Materials

The art making portion of this study required a 12 pack of chalk pastels and a 12'' x 18'' sheet of white paper with a pre-drawn mandala. Chalk pastels were chosen because they are a

diverse medium that can be used in different ways (i.e. controlled clean lines, smeared and loose line quality). These art materials were also chosen based on their ease of availability to art therapists in various locations. A Presidential $1 gold coin was chosen for the coin flip task because is it larger (26.49 mm) in diameter than the standard American quarter (0.955 mm), contributing to the ease of the task for subjects who may be unfamiliar with the task. The standard No. 2 pencil was also chosen for ease of availability. In order to take a continuous EEG reading throughout the various tasks, an EEG monitoring machine, electrodes, and electrode cream were utilized.

Informed Consent

Informed consent was obtained in person and in written form. (Appendix N) The form was read individually by the participant and signed with a witness, a graduate research assistant who was made available should questions arise. After giving consent, participants were directed to the EEG exam room for electrode placement and introductions to the tasks to be completed. The materials and directive were stated aloud to each participant prior to the task with short demonstrations of how the motor tasks were to be completed. Prior to data collection, subjects were also offered the opportunity to practice the motor tasks to ensure they were able to perform them during the data collection.

Data Collection

Reliability and validity of the measure.

Teplan (2002) posits that the EEG's greatest attribute is speed, stating, "complex patterns of neural activity can be recorded occurring within fractions of a second after a stimulus has been administered" (p. 3). Given the limitations above, the literature supports our use of EEG and qEEG over other neuroimaging devices (Bhattacharya & Petsche, 2005; Kruk et al., 2014;

Teplan, 2002). Detecting collaborations between cortical regions will be an essential component in our analysis of how the brain responds to various tasks.

Baseline (36 minutes total).

To obtain a baseline control, rest measurements were taken by asking the participant to open and close eyes. Electrical impulses in the brain are evaluated using an EEG. The test measures the electrical activity through several electrodes placed on a participant's scalp. (An electrode is a conductor through which an electric current can pass safely.) The electrodes transfer information from the brain through wires to an amplifier and a machine that measures and records the data. The tests involved three steps. First, the participant was asked to sit in a chair at a table. Second, the technician measured the participant's head, using a pencil to mark where electrodes would be attached to the scalp. These spots are scrubbed with a special cream to help the electrodes transmit a high-quality reading. In the third step the technician put a sticky gel adhesive on 16 to 25 electrodes and placed these electrodes at various marked spots on the scalp. The electrodes are flat metal disks with wires attached that lead to the computer system.

In this study, the technician fitted the EEG on the subject and the graduate research assistants delivered the directives in the presence of the technician, who constantly monitored to ensure ease of data collection and control for artifact. Artifact in EEG is electrical data gathered from areas other than the cerebral cortex, such as from other body parts or elements in the environment. Once the test began, the electrodes sent electrical impulse data from the brain to the recording machine. This machine converts the electrical impulses into visual patterns that can be seen on a screen and saved to a computer. On the screen, the electrical impulses look like wavy lines with peaks and valleys, which indicate brainwave frequencies. The technician directed the participants to do certain things while the test was in progress, such as lie still, open

and close eyes, or loosen the jaw. After the directives were complete, the technician removed the electrodes. During the EEG procedure, very little electricity passes between the electrodes and the participant's skin. The electrodes do not send any electrical current, and the participants will feel little to no discomfort.

Art making task (12 minutes).

In a recent study that explored residual effects of a drawing activity in brain activity in a small sample, Belkofer, Van Hecke, and Konopka (2014) stated that their non-directive art approach may have been too general and suggested the use of a less open-ended art task, such as drawing a face or a house. Choosing a directive, or objective, approach may reduce variability between subjects. Further support for the use of a directive art task comes from Kruk, Aravich, Deaver, and deBeus (2014) who found that drawing with markers following a directive had a different effect on the frontoparietal network when compared to the non-directive art task using clay. Based on the limitations found using a nondirective task, a directive task of "draw a picture of how you feel using lines, shapes and colors in the circle" was chosen. The mandala was provided as a mechanism to introduce boundary and has been shown to alleviate anxiety (Curry and Kasser, 2005); the latter point is especially relevant to our study as EEG has been cited as being potentially anxiety provoking (Belkofer & Konopka, 2014).

Rote fine motor task (12 minutes).

The participants assigned to this condition were asked to perform two rote fine motor tasks: flipping a coin and rotating a pencil. This condition was separated into two tasks to ensure that participant's attention was held on the tasks, to subsequently maintain an activated level of brain activity. The coin flip task was chosen due to its use in other qEEG studies (Foki, et al., 2010; Mendoza, Apostolos, Humphreys, Hanna-Pladdy, & O'Bryant, 2009), while the pencil

rotation task was chosen after reviewing a similar art making and qEEG study done by Kruk et al. (2014) that introduced a motor task of crumbling a tissue as a control of movement from art making movement. The current study design organized the rote fine motor tasks with increasing difficulty (coin flip then pencil rotation) to increase the level of cortical brain activation.

Data Analysis

To analyze the raw EEG data, we tested differences within individual subjects, across all subjects and within groups. More specifically, we compared three treatment levels within individual subjects, across all ten subjects and within three artistic experience groups using the EEG total power measurements for each frequency interval. The three levels of the considered treatments are baseline eyes closed, after art making eyes closed, and after rote motor task eyes closed, respectively. The EEG measurements are recorded in the form of square root of total Power v. Frequency across specified time periods and geographic locations. The analysis was done for each frequency level and each location thereby allowing for the detection of a greater number of variations in the data. ANOVA with repeated measure models are applied and PROC MIXED procedure in SAS is used to perform the analysis. For an elaborated statistical analysis, reference the 2.4 and 2.6 in the Materials and Methods section of the manuscript submitted to Frontiers in Neuroscience.

Possible Risks & Special Precautions

Subjects are notified that they may experience some mild discomfort from the electrode adhesive, which is similar to a Band-Aid. Participants do not experience any additional feelings or discomforts, as the EEG procedure only receives electrical activity and does not transmit electrical current. Participants' identifying information is kept confidential as subjects were assigned numerical identification for purposes of communication within the study. However,

there is a risk of loss of confidentiality as consent forms are retained for the study's records.

CHAPTER IV

RESULTS

Cortical Activity Patterns in Art Making vs Rote Motor Movement as Measured by EEG

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Abstract

This quantitative study explores the differences in cortical activation patterns when subjects create art versus when they engage in a rote motor task. It is hypothesized that a statistically significant difference occurs in cortical activity patterns during art making compared with non-creative rote motor behavior and that such differences can be detected and quantified with the electroencephalogram (EEG.) Ten consenting study subjects (one with formal art training, three with some art experience, and six with no art experience) underwent EEG recording at baseline (multiple measures) and with art making, and also with rote motor tasking. Baseline control recordings showed minimal changes in EEG while art making was associated with a persistent change from baseline of significant direction and amplitude involving both hemispheres, a change that was similar to the persistent change in EEG following rote motor tasks. These preliminary findings suggest that EEG may be a meaningful biomarker for cortical activation in the study of creative arts and points to further exploration using Mobile Brain Body Imaging (MoBI) in experimental designs. This system provides a reproducible, measurable, and quantitative methodology for evaluating brain activity and function in the study of the

neuroscientific basis of creative arts, neuroaesthetics, and art therapy.

Keywords: art therapy, creative arts, creativity, EEG, qEEG, neuroaesthetics, neurophysiology, rote motor movement

1 Introduction

The creative process is difficult to explore with science as it is not localized to one area, or even one network, within the brain. It might not be possible or desirable to find a cogent definition of creativity that is generalizable, but increasing our scientific understanding of the creative process, what it is, and how to measure it will enhance innovation and problem solving related to the health and well being of patients and society. Research regarding creativity and the brain is crucial for medicine and healthcare, as we are faced with complex challenges to identify evidence based interventions that consistently address how to optimally treat diseases of the brain, the resultant behaviors, and the impact on patients and their families. Neuroaesthetics, defined simply as "the study of the neuronal processes that underlie aesthetic behavior" (Skov & Vartanian, 2009, p. 3) crests the wave of the avant garde and provides opportunity to explore the many complexities involved in the neurosciences and arts.

Neuroaesthetics does not address therapeutic implications, therefore a further investigation of how the physiological and psychological aspects of aesthetic experience relate to one another is an important goal for the future (Chatterjee, 2010). The field of neuroaesthetics is moving us toward a greater understanding of creativity by focusing on the nature of visual perception and brain function, the cortical patterns involved in both viewing and making art, and the areas of the brain where art making likely takes place (Chatterjee, 2014; Chatterjee & Vartanian, 2014; Freedberg & Gallese, 2007; Ramachandran & Hirstein, 1999; Umilta et al., 2012; Zeki, 1999b). Since its inception in the 1940's, the field of art therapy has intuited the connections between artistic expression and brain processes with the identification of three primary tenets, all of which can be underscored with neurobiological principles: (1) the bilateral and multidirectional process of creativity is healing and life enhancing; (2) the materials and methods utilized affect self-expression, assist in self-regulation, and are applied in specialized ways, and (3) the art making process and the artwork itself are integral components of treatment that help to understand and elicit verbal and nonverbal communication within an attuned therapeutic relationship (King, 2016). However, without empirical evidence to prove these tenets, art therapists must rely on interpretive frameworks, which are often idiographic and do not allow generalizations to be made for larger populations.

Efforts to study the relationship of brain function and art making have been made by researchers in art therapy (Belkofer & Konopka, 2008; Belkofer et al., 2014). These studies compared brainwave patterns before and after art making using Quantitative Electroencephalogram (qEEG) as a measure. [Note: qEEG is a medical term used to differentiate simple interpretation of raw data waveforms based on visual inspection from algorithm based information extraction, yet any processed EEG other than the raw EEG is quantitative. For the purposes of this paper, the term EEG will be used and will define both terms.] The study in 2008 was a single subject design and the 2014 study included a sample size of ten participants. Results of the 2008 study results included higher frequency bands of alpha and beta activation, with decreases in theta and delta. The 2014 study utilized EEG to measure residual changes after 20 minutes of drawing. Their ten subjects included six artists and four non-artists, showing a significant difference among artists in the left posterior temporal, parietal, and occipital EEG

recordings. In contrast, non-artists showed changes in right parietal and prefrontal brain.

A study with normal participants showed a difference in cortical motor activation when viewing original abstract art versus a graphic representation of the same piece. These results indicate the original art as dynamic and the result of an artist's creative gesture, while the static graphic representation lacked a perceptual context (Umilta et al., 2012). These findings suggest that the motor system of the brain is involved differently based on the elements of art that the viewer perceives. Our current project seeks to explore the differences in cortical activity when subjects engage in the creative act of drawing versus simply moving. It is hypothesized that there is a statistically significant difference in the cortical activation patterns when a person makes art versus a simple movement, enhancing our understanding of brain function and artistic expression.

We can understand that all mental processes involved in art therapy and in art making are derived from activity in the brain (Kapitan, 2010), but there is limited research involving EEG recording in regards to the creation of visual imagery. This current project contributes to the limited yet growing knowledge base on the subjects of art therapy and neuroscience and explores the use of EEG to capture data. A review of empirical data shows all proposals on the neural basis of creativity fail when generalized to creativity as a whole (Dietrich, 2004). Gaining a greater understanding of how the brain functions in art and in artistic expression will provide evidence for why and how art therapy is effective. This type of scientific evidence is crucial for validation and growth of the art therapy profession and also contributes to the growing fields of neuroaesthetics and cognitive neuroscience.

The brain is an intricate organ; similarly, the fields that aim to better our understanding share in its complexities. Related fields include the larger umbrella of empirical aesthetics, perceptual psychology, and cognitive neuroscience. More recently, the field of neuroaesthetics has made efforts to be characterized, as the "cognitive neuroscience of aesthetic experience" (Pearce et al., 2016, p. 265). Neuroaesthetics aims to investigate the neurocognitive and evolutionary strengths of the aesthetic experience through devices of study including beauty and art. While these studies may lead to factions of beauty, the focus remains on "emergent states, arising from interactions between sensory-motor, emotion-valuation, and meaning-knowledge neural systems" (Chatterjee & Vartanian, 2014, p. 371).

Previous neuroaesthetic studies utilizing neuroimaging have largely focused on viewing artwork and the associated brain activation as opposed to creating artwork (Chatterjee, 2010) and comparing cortical functions to movement, as is the case in our study. Current neuroimaging technology allows for advanced understanding of art and how the viewer's brain reacts (Jacobsen et al., 2006), illuminating motion, emotion, and empathy within the aesthetic experience (Freedberg & Gallese, 2007). Thus far, the contribution of neuroimaging research on the brain during the creation of artwork is limited. The act of creating art engages the whole brain (Likova, 2012), which progressive research methodology and neuroimaging technology affirm (Dietrich, 2004). Recording what the brain does during movement such as art making is difficult due to artifact and it is essential to ferret out the noise so that the data may be reduced in a meaningful way. Advanced technology such as Mobile Brain Body Imaging (MoBI) allows for a recording of brain activity using EEG and fNIRS to capture what the brain does, organizes, and senses (Gramann et. al 2014). This innovative technology is relatively low cost and provides great opportunities for art therapy research in the efforts to correlate the value of symbolic and non-verbal expression with brain function throughout the therapeutic process. Bergeron (2011) states that by utilizing neuroimaging research, we can gain a better understanding of an individual's

"aesthetic engagement with artworks" (p. 13).

One area of interest in neuroaesthetics investigation is whether or not artistic productions and/or aesthetic preference is predetermined by evolutionary basis or universal laws (Dissanayake, 2015; Kirk et al., 2009; Myin, 2000; Ramachandran & Hirstein, 1999; Zaidel, 2010; Zaidel et al., 2013; Zeki & Lamb, 1994), which will later be explored in more length. According to Nadal and Skov, (2015) the primary goal of the cognitive neuroscience of art is to better understand the biological underpinnings involved in producing works of art. Historically, producing art implied a biological function for survival. Art and the evolutionary approaches of aesthetics direct their attention to gaining knowledge about the world (Dietrich, 2004, 2015; Solso, 2000; Zaidel, 2010, 2013, 2015; Zeki, 2001) and the brain regions involved in producing art serve various functions related to biology, communication, creativity, and insight (Zaidel, 2009).

From a biological perspective, art is first about an object that is made special through the ingredients of what comprise it, including the formal elements, all of which signify the environment to be in and where attention is directed (Dissanayake, 2015). Theories of creativity and the brain cannot be reductionistic from the perspective of three levels: a (1) genome; (2) activity-specified level of brain circuitry; and (3) changes in the brain as a result of interactions within physical, social, and cultural environments (Damasio, 2001).

According to Zaidel (2010), there are three major theories of art related to the brain. Of these, the first contains the most pertinent information for our study, stating there are specific brain regions that "link art [making] to multiple neural regions" (p. 177); meaning, art is not solely connected with one specific cerebral hemisphere, pathway, or region. The most common manner of exploring the connection between brain regions and art making is by researching artistic expressions following damage to specific regions of the brain (Zadiel, 2010). Zaidel's 2005 study compared both pre- and post-damage output from subjects with previous artistic experience. The findings indicated that a participant's artistic skill is preserved despite damage to the brain or its cause.

Neuroaesthetics is a discipline much like others with laws and principles that contribute to and govern the field. Zeki and Lamb (1994) postulated that all artistic expressions must obey what they call "laws of the visual system"; the first law states that visual stimuli from the exterior world does not singularly affect the retina, the part of the eye that receives images and relays them to the brain. The second law states that visual stimuli are processed in separate sections of the visual cortex prior to being united as one image. In other words, when an exterior stimuli occupies the viewer's attention, this information is collected by the light sensitive retina and other associated areas of the visual system and is processed by multiple areas of the visual cortex before finally coming together to make one cohesive image in the viewer's brain. The separate sections of the visual cortex, mentioned in Zeki's second law, include five separate visual areas (V1-V5). V1 operates as the primary visual area, and V5 acts as the principle location for visual motion. The latter is largely unresponsive to static stimuli, meaning that the likelihood that V5 will be activated when presented with stimuli that lacks movement is low.

Further, Zeki (2001) proposed two "supreme" laws of the visual brain: constancy and abstraction. The term constancy refers to staying the same within the visual brain. In visual art, an artist may attempt to produce an object based on its essence or core principles as opposed to an exact rendering, which additionally encompasses irrelevant dynamic properties. The second law of the visual brain is abstraction, which plays a crucial role in our efficient knowledge-acquiring system (Zeki, 2001). "Art," as stated by Zeki (2001), "abstracts and externalizes the

inner workings of the brain" (p. 52).

Ramachandran and Hirstein (1999) proposed eight laws of the aesthetic experience in *The Science of Art: A Neurobiological Theory of Aesthetic Experience*. They theorized that these eight laws aid our understanding of design, visual art, and aesthetics. The laws are (1) grouping, (2) peak shift experience, (3) isolation, (4) contrast, (5) symmetry, (6) generic viewpoint, (7), perceptual problem-solving and (8) visual metaphor. These laws are meant to convey a set of universal principles, such as logical, biological, and neurophysiological foundations for considering aesthetics. C. P. Snow (1959) discussed two severed cultures of the sciences and humanities, while Ramachandran and Hirstein (1999) propose that in the interface of the brain, and perhaps through art, these two cultures do meet. Neuroaesthetics offers progressive integration, especially when implemented through the clinical applications of art therapy.

Several studies explore artistic preference and aesthetic appeal (Kawabata & Zeki, 2004; Nadal et al., 2008; Vartanian & Goel, 2004). Neurologist Vartanian and cognitive neuroscientist Goel (2004) discovered through their investigation of abstract and representational images that the right caudate nucleus, bilateral occipital, and fusiform gyri, as well as the left cingulate sulcus, all showed an increase in activation when a participant showed aesthetic preference for an image. All of these brain regions play a part in "evaluating reward-based stimuli that vary in emotional valence" (Vartanian & Goel, 2004, p. 897).

Through literature review, Zaidel (2010) examines the link between viewing art and brain localization and cites a study viewing "beautiful" and "ugly" paintings (Kawabata & Zeki, 2004). This study found that the brain regions involved in such comparisons appeared within both the motor cortex and the orbitofrontal cortex. Further, the orbitofrontal cortex is involved in aesthetic preference of art due to its role in the cognitive processing of decision-making (Fuster, 1997). These studies in neuroaesthetics support our question of motor cortex involvement when exploring the differences between rote fine motor and art making tasks. This region of the brain is made up of the (1) primary motor cortex, (2) the premotor cortex, and (3) the supplementary motor area, all of which work together and are tasked with the planning and execution of the body's movements (Campbell, 1905). Several studies have found that an observer of art can both physically and emotionally be stimulated through viewing art (Freedberg & Gallese, 2007; Umilta et al., 2012). Freedberg & Gallese (2007) studied physical, or body empathy, experienced by viewers, which can be defined as a parallel physiological response located in the parts of the body experiencing the sensation in both the subject and the observer.

Umilta et al. (2012) elaborated on Freedberg and Gallese's findings to explore the motor system's role in the viewing of art. In their study, high-density electroencephalography (EEG) was utilized to measure the level of intensity of mu rhythm suppression within the motor cortex of fourteen healthy volunteers (Umilta et al., 2012). Images were displayed via monitors of both original artworks and digital graphic renderings of the originals, creating a collection of six images that were randomly presented fifteen times each. The findings showed that in comparison to the digital renderings of the static works of art, viewing cuts in a canvas incited higher scores for both aesthetic appraisal and the level of perceived movement, making it the first study to collect evidence of cortical motor systems involved in the observation of static images without the representation of explicit movement as subject matter (Umilta et al., 2012). This motor activation, as measured by EEG, during the observation of static art is a strong indication of motor cortex involvement in the perception of visual art.

Progress to understand creative expression requires multimodal investigations that include the exploration into the production of art. Cognitive neuroscientist Arne Dietrich (2004)

has worked towards gaining a better understanding of the explicit and implicit systems which are involved in the creative process and helps us see that a task like art making in a state of flow involves the smooth sensory input and motor output that cleanly bypasses consciousness. Gramann et. al (2010) assert that human cognition is inseparable to our own (and others) motor behavior; movement is an essential component of the flow state. The state of flow (Csikszentmihalyi, 1996) is 'the designing or discovering of something new' within a psychological state of optimal attention and engagement. A type of creativity, the state of flow may be beneficial to people in art therapy because unconscious material may be elicited more easily via extraction of the implicit system. Art therapist Gioia Chilton (2013) discussed the process of flow during art making and theorized that artistic visual expression which involves cerebral systems that process sensory information are related to the functions and structures of the brain. She discussed how movement elicits the implicit system in the artist, while the explicit system is prominently activated during the process of reintegrating information during verbalizations in response to the work. An artist's declarative moment of surprise to discover their artwork may indicate the engagement of the implicit system and therefore a flow state: "When artists say that they 'do not know what the artwork means,' it is quite possibly due to the down-regulation of the prefrontal cortex that limits this kind of cognitive processing" (Chilton, 2013, p. 66). Clinical implications include the assessment of a client's artistic skills and potential alleviation of anxiety while attending to tasks at hand.

Ferber et al. (2007) identified brain regions associated through fMRI, using a modified drawing tablet as the control for movement tasks to copy and draw from memory. This study, which included twelve healthy volunteers, found that the drawing task could activate the anterior cingulate, described by Ferber et al. (2007) as "an area associated with motor control and linking intention with action" (p. 1089). The drawing from memory task also evoked stimulus in the medial frontal gyrus. The anterior cingulate is where motor control, drive, and cognition interface due to proximity with the motor and prefrontal cortex and parietal areas, "pointing to its role in conflict monitoring, and linking intention with action" (Paus, 2001, p. 417).

Likova (2012), using fMRI measurement, investigated how the brain of a congenitally blind individual was activated during drawing. The subject was analyzed during pre- and post-training drawing exercises. Training included a drawing from tactile memory, with the use of a cognitive-kinesthetic approach and a raised-line drawing model, which was explored with the left hand before drawing them from memory with the right. This is one of the few studies to investigate the involvement of the primary visual cortex (V1) in non-visual memory. With detailed results of topographical brain mapping, V1 has been shown to operate as a "visual-spatial buffer, or 'sketchpad,' for working memory" (Likova, 2012, p. 1). The cognitive-kinesthetic, tactile-memory task may be used to explore plasticity rehabilitation of individuals with blindness and supports the sensory and kinesthetic approaches used by the art therapist as an effective method of enhancing neuroplasticity for therapeutic benefit.

Bolwerk et al., (2014) completed the first known study linking the neural effects of visual art production with psychological resilience in adulthood. Fourteen adult participants 65 years and older were divided into two groups for 10-week-long art interventions. One 'visual art production group' created art in an art class and one 'cognitive art evaluation group' evaluated art at a museum. The neural effects of each group were measured with fMRI before and after each week of participation to investigate the brain's default mode network (DMN). Analysis of the DMN was identified through a seed voxel correlation analysis (SCA) in the posterior cingulate cortex. The German equivalent of the Resilience Scale (RS-11) was used to relate the

covariance of fMRI results and psychological resilience. Results for the visual art production group versus the cognitive art evaluation group showed a greater spatial increase in functional connectivity of the posterior cingulate cortex to the frontal and parietal cortices. In the study, significance to psychological resilience was related to the visual art production group, indicating a stabilizing effect of art production and well-being, especially in older adults.

Art therapists rely on these stabilizing effects in clinical treatment and generating neuroscientific evidence to support otherwise trusted interventions has become crucial for the understanding and acceptance of the field in our current healthcare climate. Lusebrink (1990) understood the support of brain research on contemplating art production and stated that visual expression is processed on different levels of complexity. She wrote that "an expression through art media can also originate from complex cognitive activity involving decisions and internal imagery, thus activating the sensory channels and motor activity" (Lusebrink, 2004 p. 125). In other words, the brain makes use of visual, somatosensory, and motor information processing in conjunction to areas of emotional and memory processes.

Kagin and Lusebrink (1978) developed what perhaps remains the most utilized theory of intervention in the profession of art therapy called the Expressive Therapies Continuum (ETC), which was developed as a model of creative functioning through human development and information processing (Lusebrink, 1990). The vertical spine of creativity is balanced through hierarchical planes of the sensory-kinesthetic level, perceptual-affective level, and cognitive-symbolic level. According to theory, during art production, an individual's choice in media corresponds with levels of the ETC and reflects brain functions of the temporal, orbital, parietal, and frontal lobes (Hinz, 2009). This three-tier hierarchical structure provides for the variety of component functions involved in visual expression and suggests a commanding functional level. The materials and methods chosen by the art therapist in the development of specific therapeutic interventions for patients often emerge from these constructs.

Over the last decade art therapists have joined with neuroscientists to begin the exploration of artistic processes and brain activity by using EEG as a mechanism for inquiry. Belkofer and Konopka (2008) conducted a modified, single-subject design (N = 1) that used EEG to explore brain activity after 1 hour of art making. In order to study the effects of art making, two 22 minute EEG recordings were taken; the first acted as a baseline measure, and the second was taken immediately following the 1 hour art making process. They found that when comparing pre-and post-data, higher frequency bands of alpha and beta were present after drawing and painting. The results of this study show that activation occurred predominantly within the occipital, parietal, and temporal lobes (Belkofer & Konopka, 2008). While alpha and beta waves showed marked increases, delta and theta brainwaves decreased in the same brain regions. Parietal and occipital lobe activation is an indication that the participant had "increased visual processing demands" (p. 61) and it was believed that spiritual and emotional connections can be made in the temporal lobe based on evidence increased activity in this area.

In a later study, Belkofer et al. (2014) explored residual effects of a drawing in brain activity in a pre-post within-group study, using EEG as measurement and discussed results in terms of brain mapping. In this study participants were given more direction: "...for the next 20 minutes, use the materials to create an image. Your image can be representational (people, places, or things), abstract (shapes and lines), or both" (p. 63). Results indicated changes in the frontal areas of the non-artist group, which they attributed to the unfamiliarity of the tasks. By comparing these two groups, they also found that an increase in alpha frequency may play an important role in drawing. However, unlike the previous 2008 study, the results showed activity

in the spatial/visual regions of the cortex. These include the left parietal (P3), occipital (O1), and temporal (T5) lobes, as well as in the posterior central (Cz) and right parietal (P4) regions (Belkofer & Konopka, 2014).

Kruk et al. (2014) compared the brain activity during drawing and clay sculpting in fourteen female participants between the ages of 22 and 25. Participants completed a pre- and post-measure of state versus trait anxiety using the State-Trait Anxiety Inventory, STA1 Form Y1. Control readings required the participants to open and close their eyes and crumple tissue paper; readings were taken before and after five minutes of freely sculpting with clay and five minutes of drawing. Choosing two different tasks allowed for more specific investigation into how certain tasks, e.g. drawing and sculpting with clay, affect the brain. Results indicated the right medial parietal lobe increased in gamma power activation with the drawing and clay conditions. In comparison, the right medial frontal lobe showed a decrease in gamma power and an increase in theta power during the clay condition. These results also indicated that using a directive during the drawing task affected the frontoparietal network differently when compared to the non-directive art making using clay. The researchers stated that "drawing on paper in response to a directive likely would elicit a cognitive reaction and possibly a perceptual response" (Kruk et al., 2014, p. 54).

Malchiodi (2003) asserts that science will be central to understanding how art therapy works, will better define its effectiveness, and will improve the ability to develop more effective protocols to test art therapy interventions. Although there have only been a handful of neuroimaging studies in the field of art therapy, EEG has been a promising method to research art making, the distinctions in properties of art materials, and art processes (King & Kruk, 2016). This current project will contribute to the limited yet growing knowledge base on the subjects of art therapy and neuroscience.

2 Materials and Methods

This study was completed with adherence to the Human Subjects Guidelines of the Indiana University Institutional Revenue Board, (IRB approval # 1507398603, see Appendix M) with informed written consent obtained from every subject.

A convenience sample of ten participants was taken using a within-subjects comparison of EEG recordings with the intent to further establish and explore the links between creativity and neuroscience for the purpose of advancing the field of art therapy. EEG recordings were taken during a single session and compared baseline (eyes closed) recordings to post art making and subsequently post rote motor task recordings.

2.1 Participants

Participants were recruited using a convenience sample including graduate students from the Indiana University Purdue University Indianapolis campus, Indiana University School of Medicine faculty, and surrounding community members through the use of flyers, social media postings, and email notices. Criteria for participation included being 18 years or older, identified as a part of a normal non-patient population, and able to provide consent. Exclusion characteristics included having a prior history of major head injury, stroke, seizure disorder, or brain or skull surgery, or taking psychotropic or other medications, such as narcotics, that can affect EEG recording.

Prior to data collection, participants met with the graduate research assistants to read and sign an informed consent form and with the neuro technologist for a brief explanation of EEG recording processes and expectations. The informed consent form included information regarding the overall purpose of the study, participation procedures, risks and benefits of taking part in the study, how confidentiality would be maintained, and the voluntary nature of the study. Also included in the informed consent form was a release for their artistic production to be used in future publications and/or presentations pertaining to art therapy. Participants were asked to complete a short demographics form (see Appendix N) indicating handedness, level of artistic ability, age, and gender following the completion of the data collection.

2.2 Materials

The art making portion of this study required a 12 pack of chalk pastels and an 18'' x 24'' sheet of white paper with a pre-drawn mandala, or circle, at the center. The mandala, commonly used in art therapy practice and intervention, is essentially a circle outline, which can be used as a focal point within which to explore the self. The diameter of the pre-drawn mandala was 15". Chalk pastels were chosen because they are a diverse medium that can be used in a variety of ways (i.e. controlled clean lines or smeared/loose line quality) and are commonly found in a variety of art therapy settings. A Presidential $1 gold coin was chosen for the first motor task, coin flip, because is it larger (8.100 g and 26.49 mm) in diameter than the standard American quarter (5.67 g and 0.955 mm). A standard No. 2 pencil was also chosen for ease of availability for the second motor task.

2.3 Procedure

EEG equipment for recording and computerized technology for assessments were made available for the conduct of this study from the Indiana University Health Neuroscience Center. Data collection took place on two separate days with five participants scheduled per day. EEG recordings took place in a well lit EEG testing room within the Indiana University Health Neuroscience Center with a neuro technologist (R. EEG T.), neurophysiologist, and graduate research assistant present. Standard gold cup EEG surface electrodes were placed by the neuro technologist using the International 10-20 system of electrode placement, conductive paste, and sticky gauze squares. Recording electrodes were placed at (Fp1, Fp2, F3, F4, C3, C4, P3, P4, O1, O2, F7, F8, T3, T4, T5, T6, FZ, PZ, CZ). A ground electrode was placed on the forehead, A1 and A2 electrodes were placed behind the ears. Electrodes were also placed at the outer canthus of each eye, to help detect and eliminate eye movement artifacts, and an ECG electrode was placed to identify ECG artifacts. Electrode impedances were kept below 5 KOhms throughout all recordings. Every participant followed the same order of EEG data collection: (1) baseline, (2) art making, (3) post art making, (4) coin flip, (5) pencil rotation, (6) post motor tasks. The baseline, post art making, and post rote motor task intervals all followed the same 12 minute sequence; four 3 minute epochs of time, eyes open, eyes closed, eyes open, eyes closed.

After completion of the 12 minute baseline, the table holding the paper and chalk pastels was moved into reach of the participant with the following directive (see Appendix P for full script):

Use the 12 pack of chalk pastels and 18" x 24" sheet of white paper with the pre-drawn

> circle provided to explore how you feel using lines, shapes, and colors in the circle. You will have 12 minutes to complete this task, please continue to make art for the duration of this task. You will not be judged based on the artwork created, there is no right or wrong way to complete this task.

The study's art task (Appendix Q, Figure Q1) was taken from Cohen's (1988) Diagnostic Drawing Series (DDS), which originally was designed to provide a baseline assessment of participants using a three-part directive. This section of the DDS was chosen to promote abstract thinking. In addition, a pre-drawn mandala was included to provide structure, boundaries, containment, increase attention and reduce anxiety (Babouchkina & Robbins, 2015; Curry & Kasser, 2005; Fincher, 1991; Smitheman-Brown & Church, 1996; Roush, 2013). Reducing anxiety was especially relevant to the current study as Belkofer and Konopka (2014) suggested EEG procedures may be anxiety provoking.

Next, the post-art making data collection occurred. This consisted of four 3 minute epochs of time, eyes open, eyes closed, eyes open, eyes closed. Following this, the rote motor tasks were performed. In order to maintain attention and engagement throughout this segment of testing, two tasks were administered in 6 minute, consecutive intervals. The prompt read as follows:

> This intervention will be divided into two 6 minute tasks. For the first 6 minutes we will ask you to continually flip a coin. Next, we will ask that you rotate a pencil between your fingers using your dominant hand for the remaining 6 minutes.

The final phase of the EEG data collection was to complete the post motor task measure. Again, this consisted of four 3 minute epochs of time, eyes open, eyes closed, eyes open, eyes closed. For the preliminary data analysis, only the epochs of data identified as Epoch 1: Subsets 2 and 4, Epoch 3: Subsets 2 and 4, and Epoch 5: Subsets 2 and 4, as shown in Table R1 (see Appendix R) were utilized. All data will undergo analysis in future studies.

2.4 EEG Recording and Analysis

The EEG was recorded utilizing a Nihon Kohden, EEG-1200, with a low frequency filter of 0.16 seconds and a high frequency filter of 70 HZ. A bipolar, longitudinal montage was utilized for data collection, and the EEG was later reformatted to a Laplacian average reference montage for quantitative analysis. Prior to analysis of the data, raw EEG underwent visual inspection, with epochs of excessive artifact removed throughout all recording periods. Persyst 12, InsightII software was utilized to perform a Fast Fourier Transform (FFT) of the EEG, yielding numerical output of total power in sqrt(uV), at 2 HZ epochs of frequencies, ranging from 0-2 HZ to 30-32 HZ. The FFT was calculated with a sampling rate of 128 HZ, and non-overlapping epochs of 1 second duration. FFT was conducted on various "channel" groupings of electrodes as detailed in Table S1 (see Appendix S). For this preliminary data analysis, only the channel groupings of Left and Right Hemisphere were analyzed. All channel groupings will undergo analysis in future studies.

2.5 Self-Reports

The study participants were asked to complete a form that indicated a level of artistic ability. This single form included three options to rate experience, (1) no experience, (2) some experience, or (3) formal training. Of the ten individuals involved in the study, six indicated that they had no experience related to art making, three reporting having some experience with art, and one was formally trained in fine arts.

2.6 Statistical Analysis

To analyze the raw EEG data, we tested differences within individual subjects, across all subjects and within groups. More specifically, we compared three treatment levels within individual subjects, across all ten subjects and within three artistic experience groups using the EEG total power measurements for each frequency interval. The three levels of the considered treatments are baseline eyes closed, after art making eyes closed, and after rote motor task eyes closed, respectively. The EEG measurements are recorded in the form of square root of total Power v. Frequency (0-2 HZ, 2-4 HZ, …, 30-32 HZ) across specified time periods (around 400 time periods) and geographic locations (Left Hemisphere and Right Hemisphere). The analysis was done for each frequency level and each location thereby allowing for the detection of a greater number of variations in the data. ANOVA with repeated measure models are applied and PROC MIXED procedure in SAS is used to perform the analysis.

To compare individual subject differences in the data (i.e. compare the three treatment levels for Subject ARP001, etc.), we applied the model with Power as the response variable, Treatment as the factor and Time periods as the repeated measure for each subject. We first tested for the overall treatment effect using F test through type3 analysis. Then we performed a pairwise comparison using Tukey adjustment to do *t*-tests for the mean power difference between each pair of the three treatments. These pairwise comparison results are summarized in Table T1 (see Appendix T).

Next, we tested for the treatment effect while considering the subject variation. The same ANOVA model was applied, as above, but this time we included Subject as a random effect. We tested for the overall treatment effect using F test through type3 analysis and treatment effect is found to be highly significant ($p<0.001$) under almost all frequency intervals, except one case for Frequency 0-2 HZ at left Hemisphere. We then performed pairwise comparison to do *t*-tests for the mean power difference among the three treatments. These pairwise comparison results are summarized in Table U1 (see Appendix U). Then, we tested for the treatment effect within the three artistic experience groups. We applied the same ANOVA model as above and included Subject as the random effect and Artistic Experience as the between subject effect. We also evaluated the interaction between Treatment and Artistic Experience. First, we tested for the main effect of treatment and Artistic Experience and their interaction effect using F tests through type3 analysis. The main effect of treatment is found to be highly significant for all most all cases, while that of Artistic Experience is not significant ($p >0.05$), but there are highly significant interactions found between them under many frequency intervals. Then we used slice statement in Proc Mixed to perform pairwise comparisons between each pair of treatment levels sliced by each level of Artistic Experience using *t*-tests. These pairwise comparison results are summarized in Table V1 (see Appendix V). Additionally, we also performed a comparison of the two eyes closed baseline sessions (BaseEC1 and BaseEC2) which were both recorded prior to art

making or rote motor task, as an internal control, so that we could rule out any random variations that might affect the accuracy of our tests. By frequency and location, we applied ANOVA model with Power as the response, Treatment (two levels: BaseEC1 and BaseEC2) as the factor, Subject as the random effect, and Time as the repeated measure. We tested for the mean power difference between BaseEC1 and BaseEC2 using *t*-tests. The results are summarized in Table W1 (see Appendix W).

3 Results

Table X1 (see Appendix X) shows a demographic summary of our subjects, detailing age range, handedness, and artistic experience.

Table W1 (Baseline Difference Control) shows estimated mean differences of left and right hemisphere power by frequency and location, for the Baseline (Eyes Closed) epoch 1 subset 4 compared to the Baseline (Eyes Closed) epoch 1, subset 2 (see Table R. Procedure Time with Epoch Notation). These results show that the later epoch of time (epoch 1 subset 4) shows a general decrease of power in frequencies between 1-12 HZ, with a gradual trend upward in power from 12-32 HZ. In the left hemisphere, the decrease in power is statistically significant in the 8-12 HZ range, and the increase in power is statistically significant in the 22-32 HZ range. In the right hemisphere, the decrease in power is statistically significant in the 0-18 HZ range, and the increase in power is statistically significant in the 26-32 HZ range. Statistically significant estimated mean differences from both hemispheres ranged from -0.0424 to 0.02948. This shows that variation in brainwaves occurred over time, prior to interventions. To account for this in after intervention comparisons, a threshold line of estimated mean difference values was set at +/-0.045. This was established to identify after intervention findings that could potentially reflect random fluctuations in the EEG.

Table U1 (Pairwise Comparison by Frequency, Location) details a pairwise comparison by frequency and location, showing estimated mean differences of power 1) after art making task to the baseline, 2) after motor tasks to the baseline, and 3) after motor tasks to after art making task.

Results for after art making task compared to baseline showed a general increase in power throughout all frequencies, trending upward in power from 0-10 HZ, with a gradual trend downward from 10-30 HZ. In the left hemisphere, the increase in power is statistically significant from 2-32 HZ, and it exceeds the threshold lines of +/-0.045 (set to show potential random variance), from 6-14 HZ, and 30-32 HZ. In the right hemisphere, the increase in power is statistically significant from 0-32 HZ, and it exceeds the threshold of 0.045 from 6-16 HZ.

Results for after motor tasks compared to baseline showed a general increase in power throughout all frequencies, trending upward in power from 0-10 HZ, with a gradual trend downward from 10-32 HZ. In the left hemisphere, the increase in power is statistically significant from 2-32 HZ, and it exceeds the threshold of 0.045 from 6-14 HZ. In the right hemisphere, the increase in power is statistically significant from 0-32 HZ, and it exceeds the threshold of 0.045 from 6-16 HZ.

Results for after motor tasks compared to after art making task showed little to no change in power in the left hemisphere, with a more noticeable decrease in power from 8-24 HZ on the right. Statistically significant changes in mean power were seen on the left with increased power at 4-6 HZ and decreased power at 14-18 HZ, and on the right with decreased power from 14-24 HZ. No variances exceeded the +/-0.045 threshold lines set to show potential random variance.

Figure Y1 and Figures Y2 (see Appendix Y) shows a graph depicting the changes from

baseline that are seen after art making and after the motor tasks, detailed in Table T1, as compared to the baseline control (Table W1). Threshold lines at +/-0.045 estimated mean difference are drawn. Differences greater than those seen in the control are found in both hemispheres for both interventions (after art making compared to baseline and after motor tasks compared to baseline), from 6-14 HZ.

Table T1 (Pairwise Comparison by Subject, Frequency, Location) details a pairwise comparison by subject, frequency and location, showing estimated mean differences of power 1) after art making task to the baseline, 2) after motor tasks to the baseline, and 3) after motor tasks to after art making task for each subject. Results in this table did not significantly vary from those seen in Table U1.

Table V1 (Pairwise Comparison Slice by Artistic Experience by Frequency, Location) shows estimated mean differences of power divided until three (3) subsets of no experience, some experience, and formal training for the following: 1) after art making task to the baseline, 2) after motor tasks to the baseline, and 3) after motor tasks to after art making task.

Results for after art making task compared to baseline, by artistic experience showed a general increase in power throughout all frequencies, and artistic experience levels trending upward in power from 0-12 HZ, with a gradual trend downward from 12-32 HZ, with differences more pronounced in the left hemisphere over the right, for those having no or some experience. For those with formal training (N = 1), the trend was upward in power from 0-10 HZ on the left, and 0-8 HZ on the right, followed by a downward trend in power that became negative (less power than baseline) on the left at 12-18 HZ and on the right at 10-18 HZ.

In the left hemisphere, the increase in power is statistically significant and exceeds the threshold lines of +/-0.045 (set to show potential random variance), from 6-16 HZ for those having no or some experience, and from 6-8 HZ for those having formal training. In the right hemisphere, the increase in power is statistically significant from 0-32 HZ, and it exceeds the threshold of 0.045 from 6-16 HZ.

Figure Z1 and Figure Z2 (see Appendix Z) shows a graph depicting these changes, seen by artistic experience for after art making as compared to baseline, detailed in Table V1, as compared to the baseline control (Table W1).

Results for after motor tasks compared to baseline, by artistic experience showed a general increase in power throughout all frequencies, and artistic experience levels trending upward in power from 0-10 HZ, with a gradual trend downward from 10-32 HZ for those having no or some experience. For those with formal training (N = 1), the trend was upward in power from 0-10 HZ on the left and right, followed by a downward trend in power that became negative (less power than baseline) on the left from 14-18 HZ and on the right at 12-18 HZ.

In the left hemisphere, the increase in power is statistically significant and exceeds the threshold lines of +/-0.045 (set to show potential random variance), from 6-14 HZ for those having no experience, from 6-16 HZ for those with some experience, and from 6-10 HZ and 20-28 HZ for those having formal training.

In the right hemisphere, the increase in power is statistically significant and exceeds the threshold lines of +/-0.045 (set to show potential random variance), from 6-14 HZ for those having no experience, and from 2-16 HZ for those with some experience. No power differences met these criteria on the right for those having formal training.

Figure Z2 and Figure Z3 shows a graph depicting these changes, seen by artistic experience for after motor tasks as compared to baseline, detailed in Table V1, as compared to the baseline control (Table W1).

Results for after motor tasks compared to after art making task showed varying differences, with a general loss of power after 6-8 HZ for those having no to some experience, and variable positive and negative variance in power for those with formal training (N = 1) . No variances exceeded the +/-0.045 threshold lines set to show potential random variance, with the exception of those with formal experience showing a decrease in power from 1-4 HZ.

Figure Z5 and Figure Z6 shows a graph depicting these changes, seen by artistic experience for after motor tasks as compared to after art making, detailed in Table V1, as compared to the baseline control (Table W1).

Overall, the recordings post art making show a persistent neurophysiological change lasting at least 12 minutes, of significantly greater magnitude than the baseline variations ($p<0.001$). The recordings post rote motor tasks show a similar magnitude and length of persistent physiological change ($p<0.001$). Meaningful hemispheric differences were not detected, as similar changes were evident in the right and left hemisphere recordings. A trend in power changes as compared to level of artmaking experiences suggests that subjects with some art making experience appear to have greater increases in power after art making, than those with no experience. Those with formal training appear to experience less impact on EEG power with art making, and with motor tasks.

4 Discussion

Among the different approaches to research creativity, neuroimaging and neurophysiology hold strong potential and are complementary. Preliminary key findings and analysis in this study suggest that EEG is a meaningful biomarker for cortical activation and processing in creative arts expression. The use of EEG may be complementary to functional imaging (fMRI and PET) and <obile Brain Body Imaging (MoBI) as fundamental research tools in the study of the neuroscience of creative arts.

Changes in EEG due to baseline normal variation were identified and quantified so as to allow for determination of statistically meaningful effects from art making and rote motor tasking. It is essential for meaningful interpretation of serial measurements pre and post intervention to understand the magnitude of random variation in EEG measurements. This study established these baseline changes as obtained in serial baseline measurements from each subject. This quantification serves to best define the baseline variation in EEG measurements for comparing and interpreting post intervention changes. Future studies should further clarify the magnitude and characteristics of baseline variation so as to limit the risk of misinterpretation of post intervention changes. In the current study the post-intervention persistent cortical neurophysiological changes were of substantially greater magnitude than the baseline variations and thus suggest that art making and rote motor tasking were associated with a significant persistent neurophysiological change. This study reinforces the importance of establishing normal baseline variations in serial EEG records. A component of this study is the use of multiple measurements of baseline (pre-activity) EEG in all subjects. These data indicate the magnitude of EEG changes in a random or normal baseline state and provide important clarification of the degree of baseline variation necessary for optimal interpretation of post intervention EEG.

Persistent physiological changes were seen in both hemispheres following art making and also rote motor tasking. Therefore, our hypothesis that there is a statistically significant difference in the cortical activation pattern of art making compared with rote motor tasking is not proven. However, we recognize the impact of having a small number of subjects in this study as

well as a potential impact of the sequencing of interventions that should add caution to this interpretation. Also there are clear trends in our data suggesting a greater effect from art making than from rote motor tasks and justify further studies to clarify if there are meaningful changes specific to art making. Changes of similar magnitude were seen following art making as well as rote motor tasks. In this study, all patients were given the art making activity prior to the trials of rote motor tasking. We do not know the duration of the persistent EEG effect seen post art making. While this study indicates it is present for up to 12 minutes post art making we observed the same findings post rote motor. One explanation is the rote motor and creative art making induce a similar cortical activation and persistent physiologic effect. On the other hand, we cannot rule out that the effects from art making continued on through the rote motor activity and thus could be responsible in part for those similar findings. This issue can be clarified by repeating the protocol but reversing the order of art making and rote motor activity. Furthermore, these trends suggesting a greater effect from art making than rote motor may require further studies using a larger number of subjects and avoiding a type 2 error to clarify if there are any meaningful changes specific to art making.

Data from the current study show no compelling evidence for a right hemisphere versus left hemisphere localization for aspects of the art making process. This study shows promising results and ultimately provides a reproducible, measurable and quantitative methodology for evaluating cortical activity and brain function in the study of the neuroscientific basis of creative arts, neuroaesthetics, and art therapy. Our observation of a persistent neurophysiological change of meaningful direction and magnitude in the cerebral cortex generates several important questions. What is the underlying functional basis for this persistent change? Is this a cortical activation effect or is it a post activation exhaustion? How long does this persistent cortical effect last? And is the persistent EEG change correlated with or related to the degree, quality, impact of the therapeutic effect of a creative art therapy intervention. And if so, is there application for such EEG measurements to measure the impact or likely success of an intervention?

This study reinforces the importance of establishing normal baseline variations in serial EEG records. A component of this study is the use of multiple measurements of baseline (pre-activity) EEG in all subject. These data indicate the magnitude of EEG changes in a random or normal baseline state and provide important clarification of the degree of baseline variation necessary for optimal interpretation of post intervention EEG.

Observations regarding localization are as follows: Significant persistent EEG changes following art making were detected in both hemispheres. As the laterality and localization of creative brain function has been disputed for many years the data from this current study show no compelling evidence for a right hemisphere versus left hemisphere localization for aspects of the art making process. Further study should be conducted to confirm this observation including the study of larger numbers of subjects. To the degree that right hemisphere persistent changes are observed in art making, one related research question that can be answered using this methodology would include clarification of the variables involved with selective right hemispheric/cortical localization. In right handed individuals the right parietal lobe is largely responsible for spatial orientation and conducting a similar study using rote and non-creative tasks of spatial orientation (such as clock drawing) compared with novel creative drawing would clarify the variables responsible for the right hemisphere persistent EEG changes.

Our study subjects included six inexperienced, three partially experienced, and one with formal art training. Differences were observed with increased magnitude of persistent physiologic change in the six subjects with limited artistic training. While the numbers are small

the questions generated with this observation include the following: 1) What is the meaning of a greater persistent physiological change as seen in those with no artistic training; 2) Does this relate to enhanced use of cortical regions for a creative process or enhanced use of non-creative regions related to components of attention, effort, stress, or cognitive processing/interpretation; 3) In those with formal training and experience is the lesser magnitude of the persistent physiological change related to more efficient and learned processing of a creative task requiring less utilization of novel cognitive regions in order to process a creative work.

An analogy may be seen with a cognitive function such as language. For example, if one is fully fluent in the French language then the cortical "effort" to produce the French language efficiently and meaningfully is ostensibly far less than in an individual who is a novice and may struggle and require word by word processing in order to communicate in French. Such differences may relate to the degree and localization for cortical activation and may influence the degree of a prolonged neurophysiological cortical change in EEG. Further study including a larger cohort of formally trained artists using the current model will add clarity to the effect of such training on brain localization and function. Identifying more completely the cortical "effort" put forth in expediting an artistic task may provide implications for understanding art therapy clinical interventions in the future. For example, art therapists rely heavily on brain-based theoretical structures such as the Expressive Therapies Continuum (Kagin and Lusebrink, 1978) to develop intervention strategies using a range of art materials that influence the quality of self expression within the context of patient symptoms and goals for treatment. Clarifying the effect of formal artistic training may lead to studies that seek to explore the preparedness for art therapy interventions and eventually may influence an understanding of a candidate's readiness for treatment.

With respect to the question of hemispheric and cortical localization we note that all of the subjects in the current study were right handed and further evaluation of left handed individuals may provide additional insight into associations that may be related to handedness and cerebral dominance.

This system provides a reproducible, measurable, and quantitative methodology for evaluating cortical activity and brain function in the study of the neuroscientific basis of creative arts, neuroaesthetics, and art therapy. Although in early stages, these data point to the use of wearable technology (MoBI) to more fully investigate the links between brain activity and behavior during movement (Makeig et. al 2009), which provides accessible and promising methods to more fully identify the brain processes during therapeutic events that historically have been intuited. Simultaneously, experimental studies in clinical art therapy interventions may contribute to the exploration of motivated motor behavior and aspects of embodied cognition as assessed by MoBI. Clarifying the interactions between brain and body dynamics may lead to evidence of a biological model of cognition (Gramann et. al, 2010) and the exploration of artistic expression in the context of the therapeutic relationship may provide useful data to inform protocols that study neuroimaging.

5 Conclusion

This quantitative study explores the differences in cortical activation patterns when subjects create art versus when they engage in a rote motor task. Baseline control recordings showed minimal changes in EEG. Changes in EEG due to baseline normal variation were identified and quantified so as to allow for determination of statistically meaningful effects from art making and rote motor tasking.

Art making was associated with a persistent change from baseline of significant direction and amplitude involving both hemispheres, a change that was similar to the persistent change in EEG following rote motor tasks. The hypothesis that art making is associated with significant differences in cortical activation compared with rote motor tasks is not proven in the current study. However, trends in our data suggest a greater effect from art making than from rote motor tasks and justify further studies to clarify if there are meaningful changes specific to art making. These preliminary findings suggest that EEG may be a meaningful biomarker for cortical activation in the study of creative arts. This system provides a reproducible, measurable, and quantitative methodology for evaluating brain activity and function in the study of the neuroscientific basis of creative arts, neuroaesthetics, and art therapy.

Our study contributes to the much-needed empirical evidence that will validate the impact of art therapy assessment and intervention. Merging neuroscience and art therapy through scientific research offers evidence for how brain science and artistic processes inform one another to support the overall health and amelioration of disease for patients and their caregivers.

6 Ethics Statement

This study was completed with adherence to the Human Subjects Guidelines of the Indiana University Institutional Revenue Boards, (IRB approval #1507398603) with informed written consent obtained from every subject.

7 Authors Contributions

JK was the Principal Investigator and was responsible for the hypothesis, the design and conduct of the trial, KK was an art therapy graduate research assistant involved with the design, conduct and analysis, AS was an art therapy graduate research assistant involved with the design, conduct and analysis, FL was the statistician, DS was the neurologist EEG expert, RP was the neurologist involved with conduct and analysis, and LO was the neurophysiologist responsible for neurophysiology recordings, data extraction and interpretation. All individuals were involved with preparation of the manuscript.

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9 Conflict of Interest Statement

All authors attest that this research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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CHAPTER V

REFERENCES

Babouchkina, A., & Robbins, S. J. (2015). Reducing negative mood through mandala creation: A randomized controlled trial. *Art Therapy*, *32*(1), 34-39.

Bergeron, V. (2011). What should we expect from the new aesthetics sciences? *ASA Newsletter: American Society of Aesthetics, 31,* 11-15.

Belkofer, C. M., & Konopka, L. M. (2008). Conducting art therapy research using quantitative EEG measures. Art Therapy, 25(2), 56-63.

Belkofer, C.M., & Nolan, E. (2016). Practical applications of neuroscience in art therapy. In J. L. King (Eds.), *Art therapy, trauma, and neuroscience: Theoretical and practical perspectives* (157-172). New York, NY: Routledge.

Belkofer, C. M., Van Hecke, A. V., & Konopka, L. M. (2014). Effects of drawing on alpha activity: A quantitative EEG study with implications for art therapy. *Art Therapy: Journal of the American Art Therapy Association*, *31*(2), 61-68.

Bhattacharya, J., & Petsche, H. (2005). Drawing on mind's canvas: Differences in cortical integration patterns between artist and non-artists. *Human Brain Mapping, 26*(1), 1-14.

Bohanna, I., (2012, September 23). What is creativity? Art as a symptoms of brain disease. Retrieved from http://brainblogger.com/2012/09/23/what-is-creativity-art-as-a-symptom-of-brain-disease/

Bolwerk, A., Mack-Andrick, J., Lang, F. R., Dörfler, A., & Maihöfner, C. (2014). How art changes your brain: differential effects of visual art production and cognitive art evaluation on functional brain connectivity. *PloS one*, *9*(7), e101035.

Bonda, E., Petrides, M., Frey, S. & Evans, A. C. (1994). Frontal cortex involvement in organized

sequences of hand movements: Evidence from a positron emission tomography study. *Soc. Neurosci. Abstr.*, 152.6.

Brooke, S. L. (2004). *Tools of the Trade: A Therapist's Guide to Art Therapy Assessments*. Springfield, IL: Charles C Thomas, Publishers, LTD.

Campbell, A. W. (1905). *Histological studies on the localization of cerebral function*. Cambridge, MA: Cambridge University Press.

Carr, S. M. (2014). Revisioning self-identity: The role of portraits, neuroscience and the art therapist's 'third hand'. *International Journal of Art Therapy*, *19*(2), 54-70.

Chakravarty, A. (2012). The neural circuitry of visual artistic production and appreciation: A proposition. *The Official Journal of Indian Academy of Neurology, 15*(2), 71-75.

Chatterjee, A. (2004). The neuropsychology of visual artistic production *Neuropsychology, 41*(11), 1568-1582.

Chatterjee, A. (2006). The neuropsychology of visual art: Conferring capacity. *International Review of Neurobiology, 74*, 39-49.

Chatterjee, A., Widick, P., Sternschein, R., Smith, W. B., & Bromberger, B. (2010). The assessment of art attributes. *Empirical Studies of the Arts*, *28*(2), 207-222.

Chatterjee, A. (2011a). Neuroaesthetics: a coming of age story. *Journal of Cognitive Neuroscience*, *23*(1), 53-62.

Chatterjee, A. (2011b). Where there be dragons: Finding the edges of neuroaesthetics. *ASA Newsletter: American Society for Aesthetics, 31*, 8-11.

Chatterjee, A., & Vartanian, O. (2014). Neuroaesthetics. Trends In Cognitive Sciences, 18(7), 370-375.

Chatterjee, A. (2015). The neuropsychology of visual art. In J. P. Huston, M. Nadal, F. Mora, L.

F. Agnati, & C. J. Cela-Conde (Eds.), *Art aesthetics, and the brain* (341-356). Oxford: Oxford University Press.

Chilton, G. (2013). Art therapy and flow: A review of the literature and applications. *Art Therapy*, *30*(2), 64-70.

Cohen, B. M. (Ed.). (1985/2012). *The Diagnostic Drawing Series Handbook*. (Available from Barry M. Cohen, P.O. Box 9853, Alexandria, Virginia, USA 22304. Inquires at landmarc@cox.net)

Cohen, B. M., Hammer, J. S., & Singer, S. (1988). The diagnostic drawing series: A systematic approach to art therapy evaluation and research. *The Arts in Psychotherapy, 15*(1), 11-21.

Csikszentmihalyi, M. (1996). *Flow and the psychology of discovery and invention.* New York: Harper Collins.

Curry, N. A., & Kasser, T. (2005). Can coloring mandalas reduce anxiety?. *Art Therapy*, *22*(2), 81-85.

Damasio, A. R. (2001). Some notes on brain, imagination and creativity. *The origins of creativity*, 59-68.

de Renzi, E. (1982). *Disorders of Space Exploration and Cognition*. New, York, NY: Wiley.

Decety, J. (1996). Do imagined and executed actions share the same neural substrate? *Cognitive Brain Research, 3*(1996), 87-93.

Dietrich, A. (2004). The cognitive neuroscience of creativity. *Psychonomic Bulletin and Review, 11,* 1011-1026.

Dietrich, A., & Kanso, R. (2010). A review of EEG, ERP, and neuroimaging studies of creativity and insight. *Psychological Bulletin, 136*(5), 822-848.

Dietrich, A., & Haider, H. (2015). Human creativity, evolutionary algorithms, and predictive

representations: The mechanics of thought trials. *Psychonomic Bulletin & Review, 22,* 897-915.

Dissanayake, E. (2015). *What is art for?*. University of Washington Press.

Duncan, J. (1986). Disorganization of behaviour after frontal lobe damage. *Cogn. Psychol., 3*(1986), 271-290.

Dursteler, M. R., Wurtz, R. H., Newsome, W. T. (1987). Directional pursuit deficits following lesions of the foveal representation within the superior temporal sulcus of the macaque monkey. *Journal of Neurophysiology, 57*(5), 1262–87.

Elkis-Abuhoff, D., & Gaydos, M. (2016). Medical art therapy applied to the trauma experienced by those diagnosed with parkinson's disease. In J. L. King (Eds.), *Art therapy, trauma, and neuroscience: Theoretical and practical perspectives* (195-210). New York, NY: Routledge.

Ferber, S., Mraz, R., Baker, N., & Graham, S. J. (2007). Shared and differential neural substrates of copying versus drawing: a functional magnetic resonance imaging study. *Neuroreport*, *18*(11), 1089-1093.

Freedberg, D., and Gallese, V. (2007). Motion, emotion and empathy in esthetic experience. *Trends Cogn. Sci.* 11, 197–203.

Foki, T., Pirker, W., Klinger, N., Geissler, A., Rath, J., Steinkellner, T., & Pusswald, G. (2010). FMRI correlates of apraxia in Parkinson's disease patients OFF medication. *Experimental neurology*, *225*(2), 416-422.

Fuster, J. M. (1997). *The prefrontal cortex*. New York, NY: Raven Press.

Gallese, V., and Didio, C. (2012). "Neuroaesthetics: the body in esthetic experience," in *The Encyclopedia of Human Behavior, Vol. 2,* ed V.S. Ramachandran (Amsterdam: Elsevier

Academic Press), 687-693.

Gantt, L. (1998). A discussion of art therapy as a science. *Art Therapy: Journal of the American Art Therapy Association, 15*(1), 3-12.

Gebhardt, A., Vanbellingen, T., Baronti, F., Kersten, B., & Bohlhalter, S. (2008). Poor dopaminergic response of impaired dexterity in Parkinson's disease: Bradykinesia or limb kinetic apraxia? *Movement Disorders*, *23*(12), 1701-1706.

Gombrich, E. (1960). *Art and illusion*. Princeton: Princeton University Press.

Gombrich, E.H., (1973), 'Illusion and art,' in *Illusion in Nature and Art,* ed. R.L. Gregory and E.H. Gombrich New York: Charles Scribner's Sons.

Gooch, B. (2002). "Ramachandran and Hirstein's Neurological Theories of Aesthetic for Computer Graphics." Siggraph Course Notes, 2002, pp. 193–204.

Gramann, K., Gwin, J. T., Bigdely-Shamlo, N., Ferris, D. P., & Makeig, S. (2010). Visual evoked responses during standing and walking. *Frontiers in human neuroscience*, *4*, 202.

Gramann, K., Jung, T. P., Ferris, D. P., Lin, C. T., & Makeig, S. (2014). *Towards a new cognitive neuroscience: modeling natural brain dynamics*. Frontiers E-books.

Halstead, W. C. (1947). Brain and intelligence: A quantitative study of the frontal lobes.

Hass-Cohen, N., & Findlay, J. C. (2015). *Art therapy & the neuroscience of relationships, creativity, & resiliency: Skills and practices*. New York, NY: W. W. Norton & Company.

Hinz, L. D. (2009). *Expressive therapies continuum*. New York, NY: Taylor & Francis Group.

Huettel, S., Song, A. W., & McCarthy, G. (2009). *Functional Magnetic Resonance Imaging* (2nd ed.) Massachusetts: Sinauer.

Jacobsen, T., Schubotz, R. I., Höfel, L., & Cramon, D. Y. V. (2006). Brain correlates of aesthetic judgment of beauty. *Neuroimage*, *29*(1), 276-285.

Kagin, S. L., & Lusebrink, V. B. (1978). The expressive therapies continuum. *Art Psychotherapy, 5*(4), 171-180.

Kanwisher, N., McDermott, J., & Chun, M. M. (1997). The fusiform face area: A module in human extrastriate cortex specialized for face perception. *J Neurosci*. *17* (11), 4302–11.

Kapitan, L. (2010). The empathic imagination of art therapy: Good for the brain? *Art Therapy: Journal of the American Art Therapy Association, 27*(4), 158-159.

Kaplan, F. F. (2000). *Art, science, and art therapy*. New York, NY: Jessica Kingsley.

Kawabata, H., & Zeki, S. (2004). Neural correlates of beauty. *J Neurophys.* 91, 1699–1705.

Keysers, C., & Gazzola, V. (2009). Expanding the mirror: Vicarious activity for actions, emotions, and sensations. *Current Opinion in Neurobiology, 19*, 666-671.

King, J.L. (Ed.) (2016). *Art therapy, trauma, and neuroscience: Theoretical and practical perspectives* (211-221). New York, NY: Routledge.

King, J. L., & Kruk, K., (2016). Conclusion. In J.L. King (Eds.), *Art therapy, trauma, and neuroscience: Theoretical and practical perspectives* (211-221). New York, NY: Routledge.

Kirk, U., Skov, M., Hulme, O., Christensen, M. S., & Zeki, S. (2009). Modulation of aesthetic value by semantic context: An fMRI study. *Neuroimage, 44*(3), 1125-1132.

Kruk, K. A., Aravich, P. F., Deaver, S. P., & deBeus, R. (2014). Comparison of brain activity during drawing and clay sculpting: A preliminary qEEG study. *Art Therapy: Journal of the American Art Therapy Association, 31*(2), 52-60.

Likova, L. T. (2012). Drawing enhances cross-modal memory plasticity in the human brain: A case study in a totally blind adult. *Frontiers in Human Neuroscience*, *6*, 44.

Logothetis, N. K., Pauls, J., Auguth, M., Trinath, T., & Oeltermann, A. (2001). A

neurophysiological investigation of the basis of the BOLD signal in fMRI. *Nature*, *412*(6843), 150–157.

Lo, Y. T., & Zeki, S. (2014). Perceptual asynchrony for motion. *Frontiers in Human Neuroscience, 8*(108), 1-11.

Luck, S. J. (2012). Event-related potentials. In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf & K. J. Sher (Eds.), *APA Handbook of Research Methods in Psychology: Volume 1, Foundations, Planning, Measures, and Psychometrics*. Washington, DC: American Psychological Association.

Lusebrink, V. B. (1990). *Imagery and visual expression in therapy.* Plenum Press

Lusebrink, V. B. (2004). Art therapy and the brain: An attempt to understand the underlying processes of art expression in therapy. *Art Therapy: Journal of the American Art Therapy Association, 21*(3), 125-135.

Lusebrink, V. B. (2014). Art therapy and the neural basis of imagery: Another possible view. *Art Therapy Journal of the American Art Therapy Association, 31(*2), 87-90.

Lusebrink, V. B. & Hinz, L. (2016). The expressive therapies continuum as a framework in the treatment of trauma. In J.L. King (Eds.), *Art Therapy, Trauma, and Neuroscience: Theoretical and practical perspectives* (42-66). New York, NY: Routledge.

Makeig, S., Gramann, K., Jung, T. P., Sejnowski, T. J., & Poizner, H. (2009). Linking brain, mind and behavior. *International Journal of Psychophysiology*, *73*(2), 95-100.

Malchiodi, C. A. (2003). Art therapy and the brain. In C. A. Malchiodi (Ed.), *Handbook of art therapy* (pp. 16-24). New York, NY: Guilford Press.

McGregor, H. R., & Gribble, P. L. (2015). Changes in visual and sensory-motor resting-state functional connectivity support motor learning by observing. *Journal of Neurophysiology,*

114(7), 677-688.

McNamee, C. M. (2004). Using both sides of the brain: Experiences that integrate art and talk therapy through scribbles drawings. *Art Therapy: Journal of the American Art Therapy Association, 21*(3), 136-142.

MD-health (2016). *Lobes of the brain.* Retrieved from http://www.md-health.com/Lobes-Of-The-Brain.html

Mendoza, J. E., Apostolos, G. T., Humphreys, J. D., Hanna-Pladdy, B., & O'Bryant, S. E. (2009). Coin rotation task (CRT): A new test of motor dexterity. *Archives of Clinical Neuropsychology*, *24*(3), 287-292.

Miller, E.K., Freedman, D.J., & Wallis, J.D. (2002). The prefrontal cortex: Categories, concepts and cognition. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 357*(1424), 1123–36.

Mills, A., Cohen, B. A., & Meneses, J. Z. (1993). Reliability and validity tests of the diagnostic drawing series. *The Arts in Psychotherapy, 20*, 83-88.

Myin, E. (2000). Two sciences of perception and visual art. *Journal of Consciousness Studies, 7*(8-9), 43-55.

Nadal, M., Munar, E., Capo, M. A., Rossello, J., & Cela-Conde, C. J. (2008). Towards a framework for the study of the neural correlates of aesthetic preference. *Spat Vis* 21, 379–396.

Nadal, M., & Skov, M. (2015). Neuroesthetics. *International Encyclopedia of the Social & Behavioral Sciences, 2*(16), 656-663.

National Endowment of the Arts (2015). *How creativity work in the brain: Insights from a Santa Fe institute working group, cosponsored by the National Endowment for the Arts.*

Retrieved from https://www.arts.gov/sites/default/files/how-creativity-works-in-the-brain-report.pdf

National Institute of Neurological Disorders and Stroke (2015). *Brain basics: Know your brain*. Retrieved from http://www.ninds.nih.gov/disorders/brain_basics/know_your_brain.htm

Neuper, C., Scherer, R., Reiner, M., & Pfurtscheller, G. (2005). Imagery of motor actions: Differential effects of kinesthetics and visual-motor mode of imagery in single-trial EEG. *Cognitive Brain Research, 25*(2005), 668-677.

Nolte, J. (1999). *The human brain: An introduction to its functional anatomy* (4th ed.). St. Louis, MI: Mosby, Inc.

Oberman, L. M., Hubbard, E. M., McCleery, J. P., Altschuler, E. L., Ramachandran, V. S., & Pineda, J. A. (2005). EEG evidence for mirror neuron dysfunction in autism spectrum disorders. *Cognitive Brain Research, 24*(2005), 190-198.

Patestas, M. A., & Gartner, L. P. (2016). *A textbook of neuroanatomy* (2). Hoboken, US: Wiley-Blackwell. Retrieved from http://www.ebrary.com.proxy.ulib.uits.iu.edu

Paus, T. (2001). Primate anterior cingulate cortex: where motor control, drive and cognition interface. *Nature Reviews Neuroscience*, *2*(6), 417-424.

Pearce, M. T., Zaidel, D. W., Vartanian, O., Skov, M., Leder, H., Chatterjee, A., & Nadal, M. (2016). Neuroaesthetics The Cognitive neuroscience of aesthetic experience. *Perspectives on Psychological Science*, *11*(2), 265-279.

Pfurtscheller, G., Brunner, C., Schlögl, A. & Lopes de Silva, F. H. (2006). Mu rhythm (de)synchronization and EEG single-trial classification of different motor imagery tasks. *NeuroImage, 31*(2006), 153-159.

Posner, M. I., & Presti, D. E. (1987). Selective attention and cognitive control. *Trends Neurosci,*

10(1987), 13-17.

Quencer, K., Okun, M. S., Crucian, G., Fernandez, H. H., Skidmore, F., & Heilman, K. M. (2007). Limb-kinetic apraxia in Parkinson disease. *Neurology*, *68*(2), 150-151.

Ramachandran, V. S., & Hirstein, W. (1999). The science of art: A neurological theory of aesthetic experience. *J. Conscious. Stud.* 6, 15–51.

Ramachandran, V. S. (2000). Mirror neurons and imitation learning as the driving force behind "the great leap forward" in human evolution. *Edge, 6*(1), 1-7.

Ramachandran, V. S. (2011). *The tell-tale brain*. New York, NY.

Requin, J. (1991). Neural basis of movement representations. In J. Requin and G. E. Stelman (Eds.), *Tutorials in Motor Neurosciences, Nato ASI Series.* Dordrecht: Kluwer Academic Publisher.

Ribas, G. C. (2010). The cerebral sulci and gyri. *Neurosurg Focus, 56*(2), 1-24.

Riley, S. (2004). The creative mind. *Art therapy: Journal of the American Art Therapy Association, 21*(4), 184-1.

Rizzolatti, G., Fadiga, L., Gallese, V., & Fogassi, L. (1996). Premotor cortex and the recognition of motor actions. *Cognitive Brain Research, 3*(1996), 131-141.

Rizzolatti, G. Fadiga, L., Fogassi, L., & Gallese, V. (1999). Resonance behaviors and mirror neurons. *Archives Italiennes de Biologie, 137*, 85-100.

Roush, M. A. (2013). *The circle and the line: A transpersonal containment and integration process using the mandala and neuro-linguistic programming (nlp) with individuals who experience severe and persistent mental illness and who are in crisis* (Doctoral dissertation, Institute of Transpersonal Psychology).

Rubin, J. (2001). The creative mind. *Art Therapy: Journal of the American Art Therapy*

Association, 21(4), 184-190.

Schott, G. D. (2012). Pictures as a neurological tool: Lessons from enhanced and emergent artistry in brain disease. *Brain: A Journal of Neurology, 135*(6), 1947-63.

Seeley, W. P. (2011). What is the cognitive neuroscience of art...and why should we care? *ASA Newsletter: American Society for Aesthetics, 31*, 1-7.

Skov, M. & Vartanian, O. (2009). Introduction: What is neuroaesthetics? In M. Skov & O. Vartanian (Eds.), Neuroaesthetics. Amityville, NY: Baywood.

Smitheman-Brown, V., & Church, R. R. (1996). Mandala drawing: Facilitating creative growth in children with ADD or ADHD. *Art Therapy*, *13*(4), 252-260.

Snow, C. P. (1959). *The two cultures and the scientific revolution: The Rede Lecture, 1959*. University Press.

Solso, R. L. (1994). *Cognition and the visual arts*. Cambridge, MA: Massachusetts Institute of Technology

Solso, R. L. (2000). The cognitive neuroscience of art: A preliminary fMRI observation. *Journal of Consciousness Studies, 7*(8-9), 75-85.

Teplan, M. (2002). Fundamentals of EEG measurement. *Measurement Science Review, 2*(2), 1-11.

Umilta, M. A., Berchio, C., Sestito, M., Freedberg, D., & Gallese, V. (2012). Abstract art and cortical motor activation: An EEG study. *Frontiers in Human Neuroscience, 6*(311), 1-9.

Vanbellingen, T., Kersten, B., Bellion, M., Temperli, P., Baronti, F., Müri, R., & Bohlhalter, S. (2011). Impaired finger dexterity in Parkinson's disease is associated with praxis function. *Brain and cognition*, *77*(1), 48-52.

Vanderah, T. W., & Gould, D. J. (2016). *Nolte's the human brain: An introduction to its*

functional anatomy (7th ed.). Philadelphia, PA: Elsevier, Inc.

Vartanian O., & Goel, V., (2004). Neuroanatomical correlates of aesthetic preference for paintings. *NeuroReport,* 15, 893–897.

Watson, J. D., Myers, R., Frackowiak, R. S., Hajnal, J. V., Woods, R. P., Mazziotta, J. C., Shipp, S., Zeki, S., (1993). Area V5 of the human brain: Evidence from a combined study using positron emission tomography and magnetic resonance imaging. *Cereb Cortex 1993*, 3, 79—94.

Zaidel, D. W. (2005). *Neuropsychology of art: Neurological, cognitive, and evolutionary perspectives*. UK: Psychology Press.

Zaidel, D. W. (2009). Brain and art: Neuro-clues from intersection of disciplines. In M. Skov & O. Vartanian (Eds.), *Neuroaesthetics*, (pp. 153-170). Amityville, NY: Baywood

Zaidel, D.W. (2010). Art and brain: Insights from neuropsychology, biology and evolution. *Journal of Anatomy, 216,* 177-183.

Zaidel, D. W., Nadal, M., Flexas, A., & Munar, E. (2013). An evolutionary approach to art and aesthetic experience. *Psychology of Aesthetics, Creativity, and the Arts*, *7*(1), 100-109.

Zaidel, D. W. (2015). Neuroesthetics is not just about art. *Frontiers in human neuroscience, 9, 80.*

Zeki, S., & Lamb, M. (1994). The neurology of kinetic art. *Brain: A Journal f Neurology, 117*(3), 607-636.

Zeki, S. (1999a). Art and the brain. *Journal of Consciousness Studies, 6*(6-7), 76-96.

Zeki, S. (1999b). *Inner vision: An exploration of art and the brain*. New York, NY: Oxford University Press.

Zeki, S. (2001). Artistic Creativity and the Brain. *Science, 293*(5527), 51-52.

Zeki, S. Statement on neuroesthetics. *Institute of Neuroesthetics.* Retrieved from http://www.neuroesthetics.org

Zeller, J. S. (2013). EM innovations: New technologies you haven't heard of yet. *Medscape*. Retrieved 3 January 2017.

Appendix A

Triune Brain

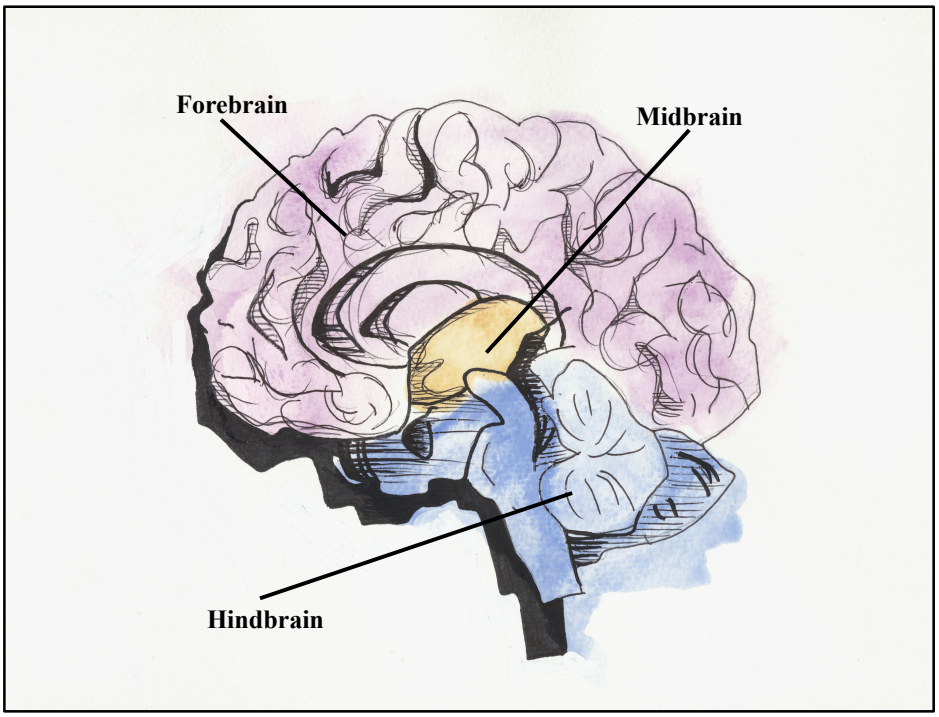

Figure A1. Lateral view of the human brain including the three major areas, the forebrain, midbrain, and hindbrain. Also known as the tribune brain made up of the neomamalian, paleomamalian, and reptilian brain.

Appendix B

Frontal Lobe

The frontal lobe, seen in Figure B1, operates with the help of its functional areas; the primary motor cortex, prefrontal cortex, the premotor area, and Broca's area (Vanderah & Gould, 2016). According to Carter et al. (2009), the following brain areas of the cortex relate to approximated functions: insula (gustation/taste faculty); occipital cortex and temporal cortex (vision); medial temporal lobe, posterior cingulate cortex (memory); medial temporal cortex (olfaction/smell faculty); temporal lobe (audition/sound); parietal lobe (body sensation); anterior cingulate and orbital cortex (emotion); and frontal lobe (motor).

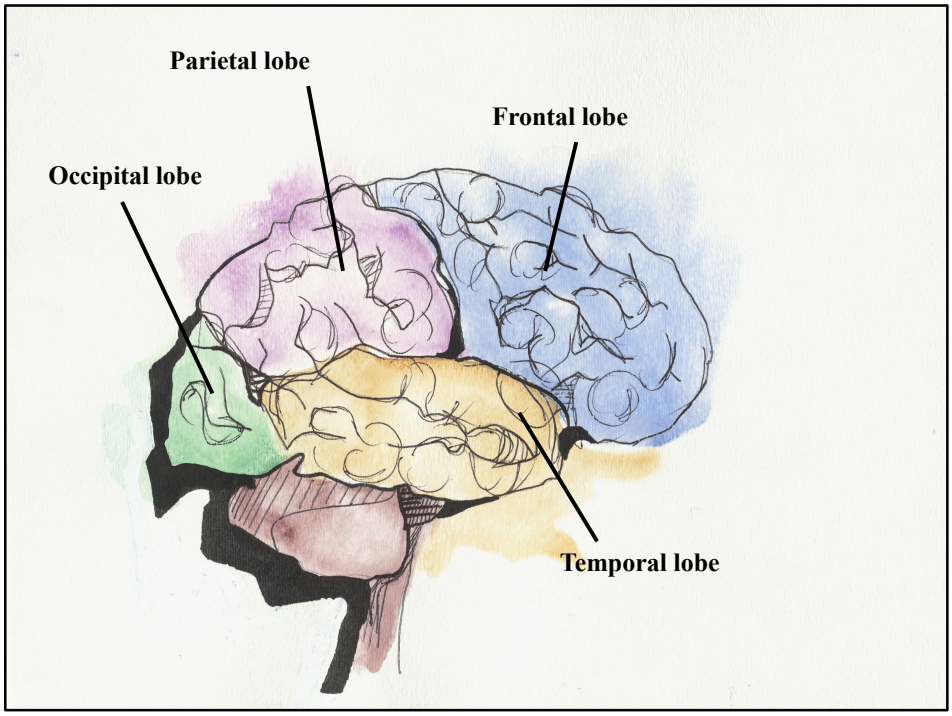

Figure B1. The four major lobes of the brain in lateral view. The four lobes make up the brain's cerebrum, or the largest portion of the human brain.

The frontal lobe, with its functional areas, contains several motor regions of the brain (Nolte, 1999). As the name suggests, the primary motor cortex, located in the dorsal portion of the frontal lobe, works in tandem with the premotor cortex during the preparation and execution of voluntary motor movements (Vanderah & Gould, 2016). Miller, Freedman, and Willis (2002) theorize that the prefrontal cortex participates in, "the ability to take charge of [these] actions and direct them toward future, unseen goals is called cognitive control" (p. 1134).

Several studies have also found that Broca's area (Figure A3) plays an important role in controlling movement (Bonda, Petrides, Frey, & Evans, 1994; Rizzolatti, Fadiga, Gallese, & Fogassi, 1996). It is possible that the frontal lobe and its motor areas will aid in our understanding of the creative process as we compare movements during the creation of art and manipulating objects with the hand. The purpose of the present study is to explore the differences in cortical function between art making and rote fine motor tasks using EEG. We hypothesize that between the tasks (rote fine motor and directive art making) there will be a statistically significant difference in cortical functions. Within our study, we consider that these distinctions in cortical activity patterns will lead to an increased scientific understanding of the creative process.

Appendix C

Parietal Lobe

Figure B1 shows that the parietal lobe sits directly behind the frontal lobe and rests atop the temporal and occipital lobes. According to Vanderah and Gould (2016), the parietal lobe has three major functions; (1) it encompasses the somatosensory cortex, which is "concerned with the initial cortical processing of tactile and proprioceptive information; more specifically, it deals with sensory localization" (p. 58), (2) language comprehension, and (3) the ability to direct attention to an object or subject as well as spatial orientation. This lobe of the brain includes the inferior parietal and superior parietal lobes, both of which take part in spatial awareness given the sensory information taken from places around the body.

Much like the temporal lobe, the parietal lobe is also separated into right and left sectors. In addition to more general functions like processing sensory information and the comprehension of language, more specific roles such as right-body tactile function, verbal, and reading intelligence takes place in the left subsection (Hass Cohen & Findlay, 2015). The third major function introduced by Vanderah and Gould (2016) is controlled by the right parietal lobe (Hass-Cohen & Findlay, 2015).

From studies regarding right parietal damage (de Renzi, 1982), researchers have found that there is a decrease in accuracy when depicting 3-dimensional objects as well as incompleteness on the left side of artistic productions. Zaidel (2013) reported that these symptoms were present in both artists and non-artist groups. Therefore, these findings do not add to our understanding of "artistic-specialized neural substrates" (p. 3).

Appendix D

Occipital Lobe

At the back of the forebrain, lies the occipital lobe (Figure B1), which contains visual areas of the brain, including the primary visual cortex (Nolte, 1999). The occipital lobe is made up of a several functional areas and visual pathways. There are two pathways, also known as the *What* and *Where* streams, which process visual imagery. Hass-Cohen and Findlay (2015) state that the *What* stream flows through the temporal lobe in order to determine image content, color, and texture. The *Where* stream, however, is involved with parts of the parietal lobe responsible for processing visuospatial environmental aspects. The dorsal stream, or *Where* stream, specifically focuses on motor actions.

Appendix E

Temporal Lobe

Beneath the parietal lobe, the temporal lobe, seen in Figure B1, collaborates with Wernicke's area for language comprehension, but is predominantly responsible for processing general exterior sensory input. This is processed, in part, within the primary auditory cortex, which is seated next to Wernicke's area. Hass-Cohen and Findlay (2015) specify that it is the left temporal lobe which specializes in language comprehension, as mentioned, as well as word retrieval and verbal memory. Within this lobe, nonverbal memory and sound comprehension are tasks managed on the right half of the temporal lobe. A recent review (Schott, 2012) reported by India Bohanna (2012), found that both the frontal and temporal lobes are involved in creativity. This study found that should the temporal lobe become damaged or naturally deteriorate as the result of a degenerative disease, the frontal lobe would be released from the temporal lobe's, "mutually inhibitory nature", (p. 1960) resulting in enhanced creativity.

Appendix F

Limbic System

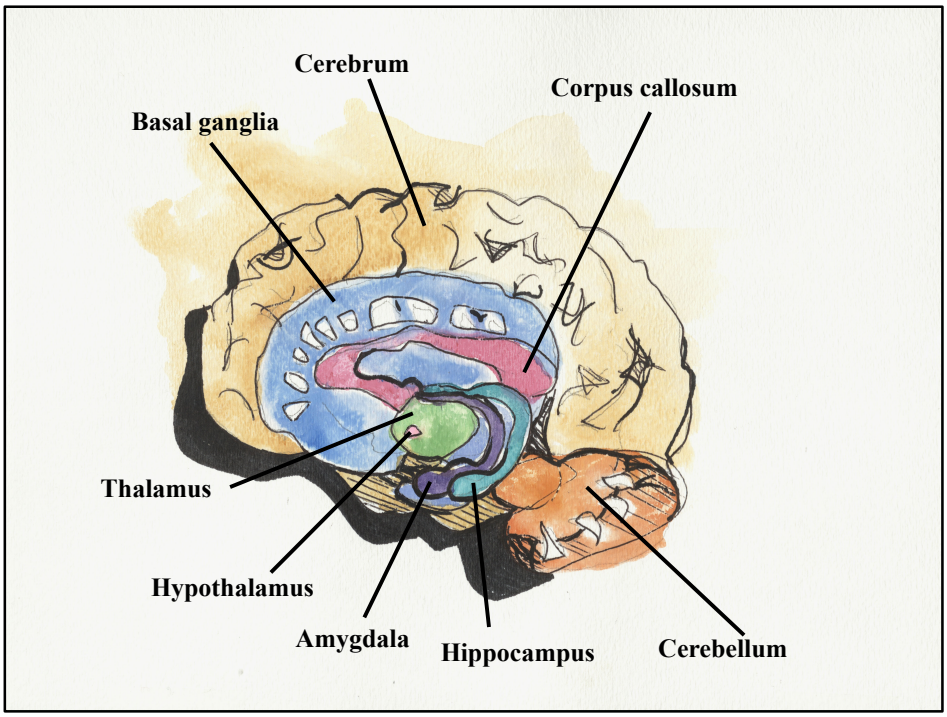

Figure F1. A portion of the limbic system in lateral view, which resides underneath the cerebrum.

Appendix G

Cortices of the Brain

Making sense of the world requires that the brain and environment interact through the body's somatosensory system via connections of light, sound waves, and pressure (Carter et al., 2009). External stimuli are transmitted as electrical signals to areas of the cerebral cortex, which is involved in the coordinated processing of sensations including, sight, sound, touch, smell, and taste (Carter et al., 2009). The sensory system processes external stimuli and internally create neural connections, related to memory, emotion, and other internal drivers (Sadock & Sadock, 2007). Association material from the sensory system provide a stimulus for actions to the motor system. While an abundance of sensory information enters the brain, only a small amount is made visible to conscious sensation. Some of this sensory information is immediately extinguished, the rest are considered to be unconscious sensations, which influence our behaviors (Carter et al., 2009).

According to Sadock and Sadock (2007), motor system information processing is modulated by cortical influence. The basal ganglia (Figure D1) makes up a portion of nerve-cell bodies, called nuclei, located in the midbrain, which are involved in motor control (Carter, Aldridge, Pager, & Parker, 2009). These nuclei oversee the smooth integration of sensory input and output responses. Involvement of the basal ganglia system includes planned movement and unconscious learned coordination with rapid response. Meaning that, the functional response of these intricate systems requires cooperation from each area, while any component that does not relay the circuitry signals impedes the motor response.

The motor system, central nervous system (CNS), and peripheral nervous system (PNS) are integrated and interdependent. According to Hass-Cohen and Findlay (2015), the

organization of the motor system could be considered a *three-tier schematic*. Tier one, the highest, includes the parietal, temporal, and frontal lobes of cortical association. In the middle, tier two, the motor cortex and subcortical structures are the thalamus, hypothalamus, and cerebellum. Lastly, the third tier incorporates the spinal cord and brainstem (Kalat, 2012). Reconsidering views that motor and sensory organization are separate means that, "...sensory pathways also carry copies of the motor instructions so that sensorimotor processing is unified throughout all levels of thalamocortical functions" (Sherman & Guillery, 2011, p. 1075). The higher association circuits receive information from the middle level; in particular, the basal ganglia support emotional regulation and the cerebellum (Hass-Cohen & Findley, 2015).

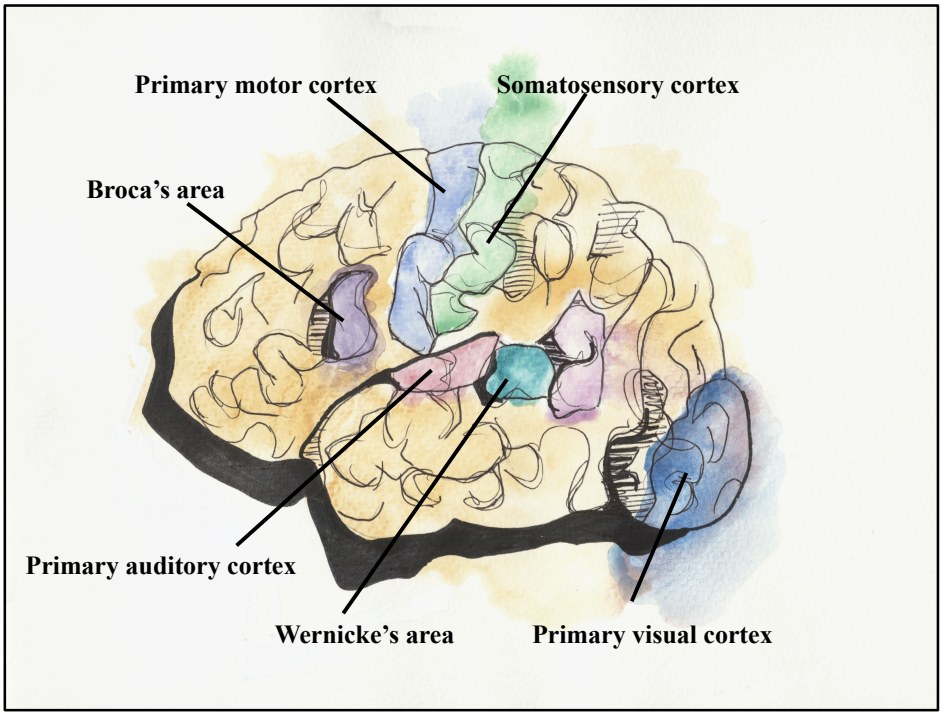

Figure G1. Cortices including the primary visual, somatosensory, primary auditory, primary motor, and two areas of the cerebral cortex, Broca's and Wernicke's area.

The cerebellum coordinates signals from the motor cortex to integrate the motor neurons (Carr et al., 2009), this process modulates movements with concern to precise timing. The cerebellum facilitates a variety of functions, such as retaining memories of fine motor sequences. This particular function is significant to our current study, evaluating cortical activity in relation to fine motor movements. Lower levels of the motor system transmit information to the middle level and receives commands from the higher levels (Hass-Cohen & Findlay, 2015). In relation to art making, this sequence begins when, "one picks a paintbrush, the motor cortex receives the information and, in turn, sends the appropriate messages to the hand. The hand's muscles adjust and balance fine motor actions, allowing one to fulfill the action and load the brush with paint, thus allowing art making to become an executed reality" (Hass-Cohen & Findlay, 2015, p. 62). This mind-body connection is integrated in the neuroscience of processing sensation, association, and movement.

Appendix H

Theoretical Motor Neuron Location

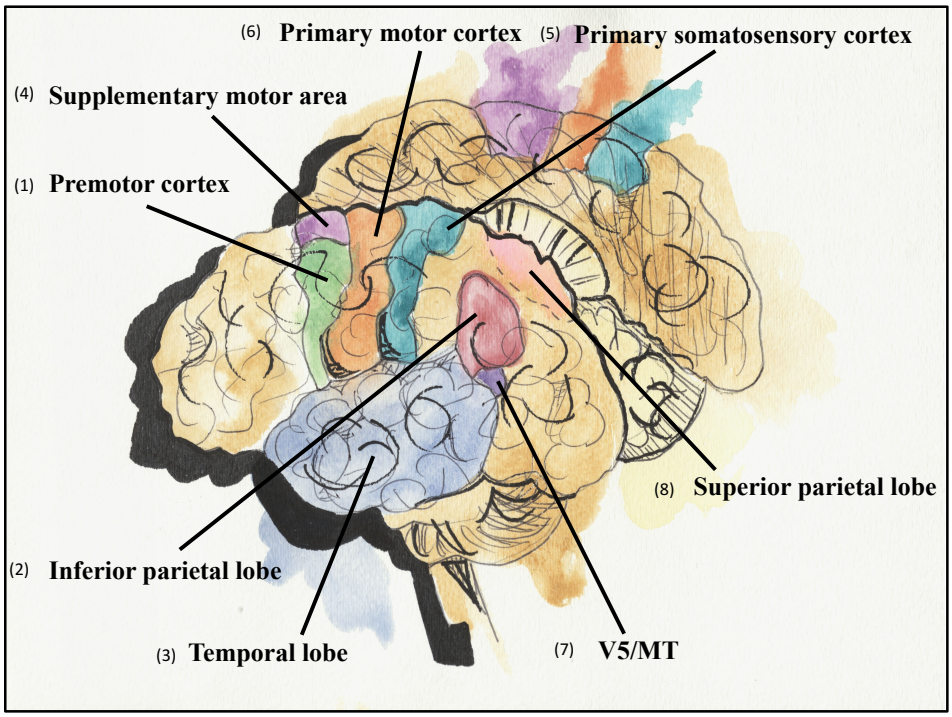

Figure H1. Keysers & Gazzola (2009) stated that mirror neurons can be found in the (1) premotor cortex, (2) inferior parietal lobe, (3) temporal lobe, and the (4) supplementary motor cortex. McGregor & Gribble's (2015) findings supported previous reports, but argued that mirror neurons are a part of an action observation network, which also include the (5) primary somatosensory cortices, (6) primary motor cortex, (7) the middle temporal visual area (V5/MT), and the (8) superior parietal lobe.

Appendix I

Visual Processing Systems of the Brain

This research concerns the cerebrum, which includes the frontal parietal, occipital, and temporal lobes, cortices, corpus callosum and their functional responses (Evans-Michaels, 2010). While those functions may be specified to a degree a contextual perspective accounts for the system of the brain's activities. Reducing the functions of the lobes and cortices does not provide an understanding of the brain's interactive and interconnect system. The nervous system is a complex network of neural activity that accounts for every aspect of life's basic and higher functions (Ashwell, 2012).

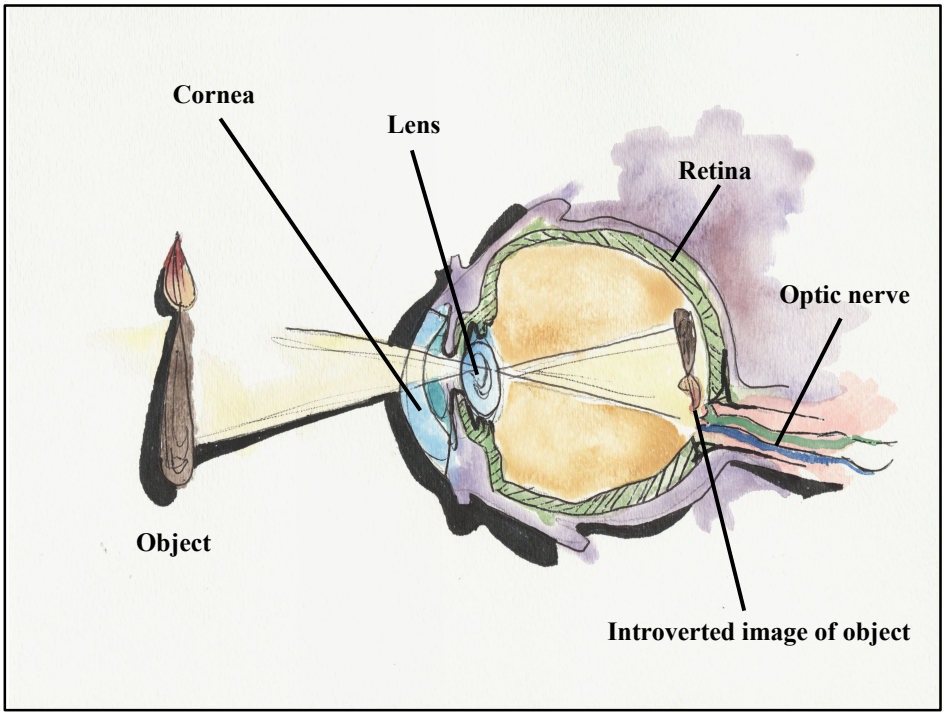

Figure I1. The translation of exterior visual stimuli within the visual processing system. Light enters through the cornea, working with the lens to light onto the retina at the back of the eye.

The nervous system is made up of the central nervous system, which includes the brain and spinal cord and the peripheral nervous system, which includes sympathetic nervous system (SNS) ganglia and peripheral nerves (Evans-Martin, 2010). The coordination and complexity of the nervous system cannot be replicated and function include a control center, central relay center, transduction, motor commands, homeostasis, stress response, and digestion (Evans-Martin, 2010). According to Telesford et al. (2011), networks do not need to be anatomically connected to influence functions, and this happens through a force of temporal correlations. Limitations of a reduced, independent approach of networks renders an incomplete study of the brain (Telesford et al., 2011). Using network science as a framework and approach to brain studies is crucial to value the complex system of the brain.

In an effort to better comprehend the field of neuroaesthetics, we must first understand the neuroanatomy behind viewing images. The sensation of sight is processed in the visual cortex, which is part of the brain's visual processing system; taking exterior information and distributing it to other cortices (Nolte, 1999). In the act of observing a piece of art, it is the visual processing system that translates visual details gleaned from the production into readable information. The lens and cornea (Figure I1) work together to refract photons (Nolte, 1999). This means an image can be created and then shone on the retina. In order for the photons to be understood as an image to other areas of the brain, the retina translates the visual information into pulses, which are then carried to the optic chiasm via the optic nerve (Nolte, 1999). Once these pulses reach the optic chiasm (Figure I2), the optic nerves decussate, or cross, making right become left (Vanderah & Gould, 2016).

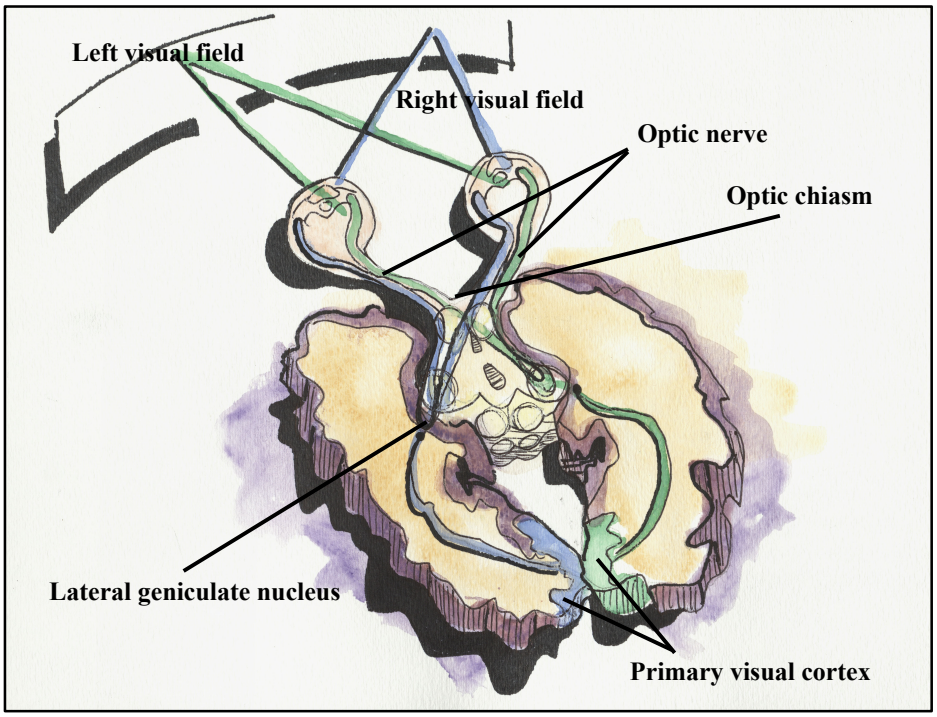

Figure I2. A cross section of the brain showing the visual processing system from exterior stimuli (within the left and right visual fields) through the optic nerve to the optic chiasm, lateral geniculate nucleus, and finally, the primary visual cortex.

Many of the optic nerve fibers end once they have reached the lateral geniculate nucleus, (LGN) which connects the optic nerve behind the eye to the occipital lobe and primary visual cortex, or V1, situated at the back of the brain (Figure I3). Within the visual processing system, the first visual area, V1, detects the edges of objects and assists in spatial organization. V2 aids in depth perception while V3 helps to understand the speed and directionality of the visual object. The fourth visual area, V4, is known as the color center, leaving V5, the motion center (Zeki, 1999a).

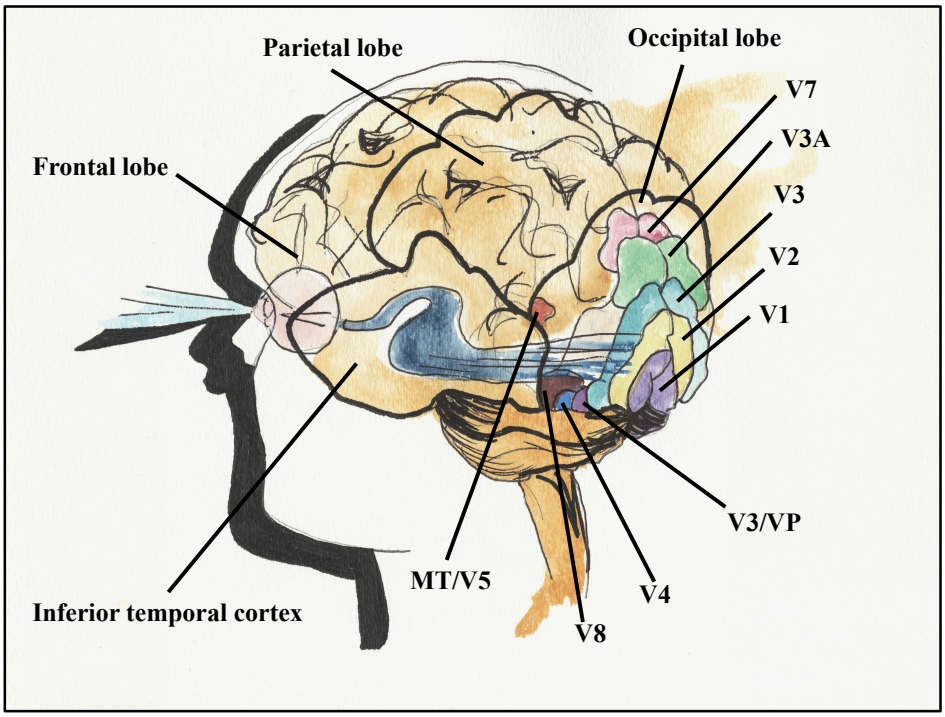

Figure I3. The human visual brain, areas V1-V8, or the functional subdivisions of the visual cortex.

The functional specialization of the visual cortex has been explored (Watson et al., 1993; Zeki et al., 1991) adding to previous literature supporting the claim that rCBF can be significantly affected following the presentation of a moving stimuli in more areas than the primary visual area. This increase in blood flow indicates that certain areas of the brain are being activated. However, V1 and V2 (Figure I3) have also been found to activate when participants view objects in motion (Zeki et al., 1991). The excitation of V1 is due to its role as primary receptor from the retina, while V2 becomes activated my motion after V1 distributes the visual signal through its site. Due to the acceptance and delegation of visual stimuli, both V1 and V2 are activated by all types of visual stimulations (Zeki et al., 1991). Research such as this helps better our understanding of the visual and motor cortices.

Appendix J

Eight Laws of Aesthetic Experience

Neuroaesthetic pioneer and theorist Ramachandran (1999) and his colleague Hirstein proposed the eight laws of the aesthetic experience in their text *The Science of Art: A Neurobiological Theory of Aesthetic Experience*. Ramachandran and Hirstein (1999) theorized that these eight laws (Figure J1) aid our understanding of design, visual art, and aesthetics.

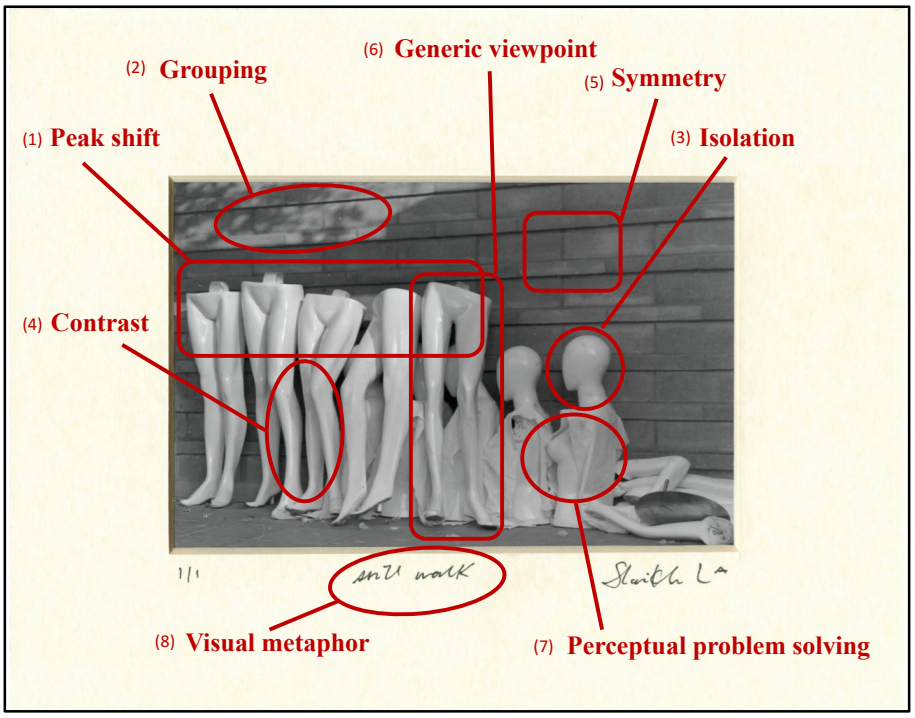

Figure J1. Eight laws of the aesthetic experience, by Ramachandran and fellow researcher, Hirstein (1999), outlined in one 35mm print photograph, *Still Walk*. The eight laws are, (1) peak shift experience, (2) grouping, (3) isolation, (4) contrast, (5) symmetry, (6) generic viewpoint, (7) perceptual problem solving, and (8) visual metaphor.

These laws are meant to convey a set of universal principles, a common denominator of art, which can be applied across cultures. The principles, or laws, of their essay suggest heuristics that artists either consciously or unconsciously create art to excite the visual areas of the brain (Ramachandran & Hirstein, 1999). While Ramachandran references photographs multiple items as an antagonist to support the eight laws, the inclusion in this essay is to broaden the semantics of these principles (Figure J2).

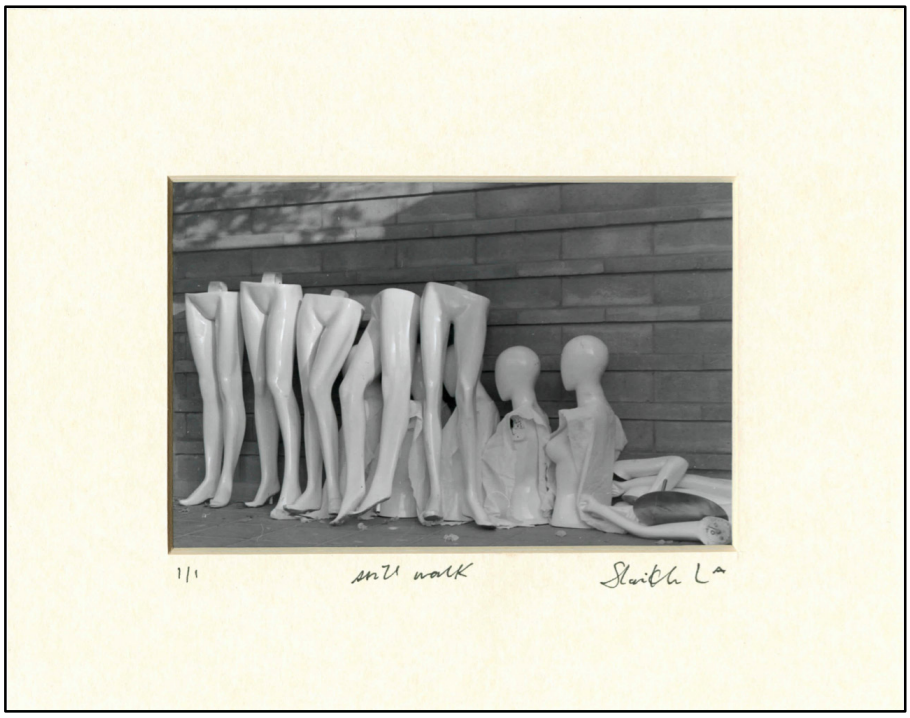

Figure J2. *Still Walk,* a 35mm film photograph printed in 2014, on 1M black and white variable contrast glossy paper.

The definition of art is considered ad nauseam, its visceral impact is accepted without question. Therefore, the survival value of art lies within the eight laws of aesthetic experience albeit as an aphorism. To begin with the (1) peak shift principle, is a psychological phenomenon

in discrimination learning. The first law stems from animal discrimination learning. Here, the peak shift effect relates to aesthetic preference and pattern recognition in humans by capturing the essence of an object to elicit an emotional response (Ramachandran & Hirstein, 1999). In animal studies, rats were trained to recognize a square and rectangle with an aspect ratio of 3:2, when a rectangle with a ratio of 4:1 was introduced the rats preferred the latter. It is perhaps the *rectangularity* of the shape that excited the preference (Ramachandran & Hirstein, 1999). The peak shift principle is important to the *evocativeness* of art where by what is essential becomes amplified and many times through characterization.

As a form, the feminine physique is characteristically more sensuous than the angular masculine physique (Ramachandran & Hirstein, 1999). In *Still Walk*, the area of peak shift is exhibited in the pelvis of the mannequin's feminine form. This amplification in the exaggerated female figure is represented in contrasting form, tone and compositional perspective. This choice has characterized an essence of the female pelvis. As Ramachandran and Hirstein (1999) point out, the image amplified in femininity on the female/male spectrum, results in "a 'super stimulus' in the domain of male/female differences" (Ramachandran & Hirstein, 1999, pg. 18). For comparison, a masculine mannequin form is unlikely to evoke the same degree of provocation. Men are constrained in various postures due to anatomical differences. In the view of Ramachandran & Hirstein (1999), this works "to subtract the male posture from the female posture to produce a caricature in 'posture space' thereby amplifying 'fem-inine posture' and producing a correspondingly high limbic activation" (p. 18). In 'still walk' the limbic activation and peak shift principle is pronounced in the pelvis of the mannequin's feminine form, as an area of essentiality.

The second law (2) grouping is a binding and reinforcing process that developed early in

the visual processing system (Ramachandran & Hirstein, 1999). Perceptual binding and grouping is explained as a reinforcing task for individuals. This law is essentially saying that the act of perceptual grouping, or separating a figure from its background, can be a pleasurable act.

In order to locate predators, the visual system has evolved to detect objects in the visual field. For example, by grouping foliage in the visual field and then the camouflaged lion from one another, binding of the two objects is alerted in the brain as a survival mechanism. In 'still walk' the area of contrasting shapes in the upper left hand corner is an example of grouping. An example is in problem solving that the area is a shadow stream through foliage from a tree outside the frame. Binding in the brain of the harmless leaves, without an alert of an additional predatory object, say a crow about to attack, decreases the limbic system activation.

The last main principle of the eight laws is (3) isolation. It refers to a single visual modality, which is relevant to the form and shape. Isolation, refers to the act of isolating a single module, or aspect of an object, prior to "allocating attention" (Ramachandran & Hirstein, 1999). Essentially, this principle can be explained by the use of outlines or sketches as an artistic product to direct the viewer's attention to one area, such as depth or form. Ramachandran and Hirstein (1999) theorize that because an individual can focus his/her attention more fully on one piece of the original image after being isolated, it can be considered more aesthetically appealing than an image of the original object. This is a process to extract what's critical and discard what is irrelevant or cluttered and then introduce peak shift as a degree of exaggeration (Ramachandra & Hirstein, 1999). An outline of the mannequin's bust from head to neck in 'still walk' demonstrates the principle of isolation. The focus here is on the salient areas of the profile and eliminating what's irrelevant. In this instance the form appeals to, less is more.

The next five principles of the eight laws of aesthetic experience are comparatively lucid

concepts. Similar to grouping in the action of extracting reinforced information, (4) contrast is a phenomenon in the visual system that responds to edges (step changes in luminance) of color and not homogenous surface tone (Ramachandran & Hirstein, 1999). The fourth law, contrast, eliminates extraneous detail and thereby focuses the viewer's attention. Researchers suggest that by formulating edges and creating contrast via changes in luminance, an image can become more pleasing (Ramachandran & Hirstein, 1999). Contrasts in the darkroom print 'still walk' exist in tonal changes of the exposure on light sensitive paper to create a photographic emulsion. Steps in tone contrast appear across the spectrum of white in the mannequin's leg, blackened tones in between and shades of grey off the fading wall.

(5) Symmetry is the fifth law of aesthetic experience. Ramachandran and Hirstein (1999) reference the work of evolutionary biologists, which concludes that human beings show a preference towards symmetry due to parasitic infestation, which previously led to asymmetrical growths. These results suggest that, "we have a build-in aesthetic preference for symmetry" (Ramachandran & Hirstein, 1999, p. 27). As a common aesthetic preference, symmetry is considered biologically relevant in mate selection as a mechanism to avoid disease (Ramachandran & Hirstein, 1999). In a more obvious instance symmetry may imply the solidity of a form. The structured background wall in 'still walk,' where the mannequin's loll is discernibly symmetrical. This is without coincidence since that wall is the exterior of an architecture college.

Aesthetics of vantage point, lie in the (6) generic viewpoint, which is favored by the visual system for not being suspiciously coincidental (Ramachandran & Hirstein, 1999). The law of generic viewpoint states that the human visual system has an aversion to interpretations that require a specific vantage point. The reason for this trust in generic viewpoints is the visual

system has a larger set of associations for this vantage point and therefore finds a unique vantage point as improbable and an occlusion (Ramachandran & Hirstein, 1999). In ‘still walk’ the generic viewpoint of the central mannequin’s legs are squared up in direct angle on the frame, which demonstrates this principle. The visual system is not fighting a unique vantage point, there are infinite sets of this eye level, frontal perspective in the visual system.

The seventh law proposed by Ramachandran and Hirstein (1999) introduces perceptual problem solving. They hypothesize that the brain can find aesthetic pleasure in deciphering ambiguous imagery and that “ambiguity itself can be a source of pleasure” (Gooch, 2002, p. 11). An example of (7) problem-solving in aesthetics relates to Ernst Gombrich’s (1973), question of the distaste of a completely bare nude in favor of the allure from a veiled nude. The idea in this instance is the visuals system’s interest in problem-solving what is extracted from the elements and imagined possibilities. The torso of the marked mannequin in ‘still walk’ has been loosely covered in fabric. In congruence with aesthetic problem-solving the covering is partially draped on the torso, with a profiled exposure of the mannequin's form, especially the side breast.

(8) Visual metaphors, more specifically art as metaphors, are discussed in the seventh law of aesthetic experience. Ramachandran (1999) states that a metaphor, “is a mental tunnel between two concepts or percepts that appear grossly dissimilar on the surface” (p. 31). And much like the pleasurable effect of grouping on a viewer, understanding a metaphor, or analogy, in art can be rewarding (Ramachandran & Hirstein, 1999). This is a rhetorical effect which illuminates a reference in art whether that is visual or otherwise. The visual metaphor in ‘still walk’ is between the disjointed immobile mannequin forms and the lively contrast of light, and composition. It then allows the eye to play within the frame to create a story of senses to activate the imagination. The title adds a context scaffold to view the photograph. ‘Still’, being a

motionless quiet and also adverb of timely action. ‘Walk’, is considered as the movement and in, around and out the frame while the senses create a story unique to the viewer. Together ‘still walk’ is the combination of visual movement in the static frame that creates a personal story of a dynamic time and place.

In the present study, our directive art making task, “make a picture of how you’re feeling, using lines, shapes, and colors”, employs this law of visual metaphor as participants make connections between internal emotional states and external art productions. These principles offer logical, biological, and neurophysiological foundations for considering aesthetics. C. P. Snow (1959) talked about two severed cultures of the sciences and humanities. Ramachandran and Hirstein (1999) propose that in the interface of the brain, and perhaps through art these two cultures do meet. Neuroaesthetics, a science of art, offers progressive integration, especially when implemented through the clinical field of art therapy.

Appendix K

Expressive Therapies Continuum

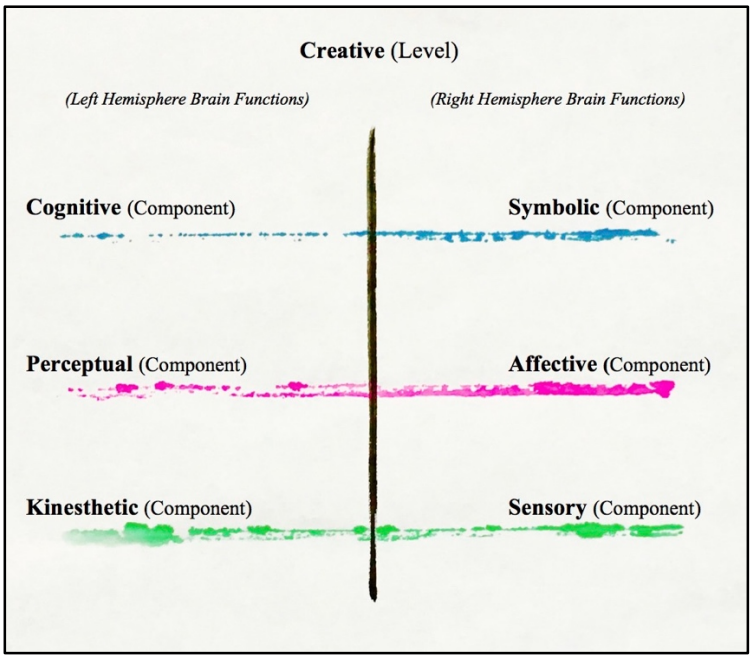

Figure K1. The Expressive Therapies Continuum (ETC) adapted from Hinz (2009). Each component pf the ETC lies on a continuum with the Creative Level integrated throughout each level.

Appendix L

Art, Movement, and EEG Flyer

Figure L1. This figure was distributed on a university campus and within the surrounding community of a capital city in the Midwest.

Appendix M

Art Therapy & Neuroscience Logo

Figure M1. This logo was created using subject ARP005's art making response to replicate common brain mapping imagery.

Appendix N

Indiana University Informed Consent Statement: IRB Approval #150739860

PROTOCOL TITLE: Cortical Activity Patterns in Art Making versus Fine Motor Movement as Measured by EEG

Sponsor: Juliet King, Dragos Sabau, Leisha Osburn

Principal Investigator: Juliet King, MA, ATR-BC, LPC

Research Site Address:	Neuroscience Center of Excellence 355 West 16th Street Indianapolis, IN 46202-2267
Daytime Telephone #:	317-963-7382
Emergency #:	317-944-5000 and ask the operator to page Dr. King. After business hours, ask the operator to page the neurologist on call.
Coordinator:	Sandy Guingrich, LPN, CCRC
Phone #:	317-963-7382
Emergency #:	317-312-1539; after the tone, enter your phone number & press the # key

You are invited to participate in a research study of the effects of art therapy in cortical function. We ask that you read this form and ask any questions you may have before agreeing to be in the study. The study is being conducted by Juliet King, Director of Art Therapy, Herron School of Art & Design, Dr. Dragos Sabau, Department of Neurology, Leisha Osburn, and graduate assistants Alex Shaikh and Kaitlin Knapp.

STUDY PURPOSE:

The purpose of this study is to explore the differences in cortical (cerebral cortex), the part of the brain that plays an important role in our consciousness, function between art making and rote fine motor tasks. Using the quantitative electroencephalogram (qEEG). Electroencephalography (EEG) is the measurement of electrical patterns at the surface of the scalp which reflect brain activity, and are commonly referred to as "brainwaves". Quantitative EEG (qEEG) is the analysis of the digitized EEG, and is sometimes called "Brain Mapping". The qEEG is an extension of the analysis of the visual EEG interpretation which may assist and aid our understanding of the EEG and brain function. This information will contribute to current literature on the neuroscience of art making and further provide a framework for the understanding and application of clinical art therapy interventions.

NUMBER OF PEOPLE TAKING PART IN THE STUDY:
If you agree to participate, you will be one of 10 subjects who will be participating in this research.

INCLUSION/ EXCLUSION CRITERIA

Participants must be 18 years or older and able to consent for themselves. If you have a prior history of major head injury, stroke, seizure disorder, brain or skull surgery or are taking psychotropic medications or other medications that can affect EEG recording, you will be excluded from participation in this study.

PROCEDURES FOR THE STUDY:

If you agree to be in the study, you will do the following things:

Electrical impulses in the brain are evaluated using an EEG. The test measures the electrical activity through several electrodes placed on your scalp. An electrode is a conductor through which an electric current can pass safely. The electrodes transfer information from your brain through wires to an amplifier and a machine that measures and records the data.
The test involves the following steps:

To obtain a baseline control, rest measurements will be taken by asking the participant to remain still, close their eyes, and open their eyes. Electrical impulses in the brain are evaluated using an EEG. The test measures the electrical activity through several electrodes placed on a participant's scalp. An electrode is a conductor through which an electric current can pass safely. The electrodes transfer information from the brain through wires to an amplifier and a machine that measures and records the data. The test involves the following steps:

- The participant will be asked to sit in a chair at a table
- The technician will measure the participant's head and use a pencil to mark where electrodes will be attached to the scalp. These spots are then scrubbed with a special cream that helps the electrodes get a high-quality reading.
- The technician will put a sticky gel adhesive on 16 to 25 electrodes and will place these electrodes at various spots on the scalp. The electrodes look like flat metal disks.

Once the test begins, the electrodes send electrical impulse data from the brain to the recording machine. This machine converts the electrical impulses into visual patterns that can be seen on a screen and are saved to a computer. On the screen, the electrical impulses look like wavy lines with peaks and valleys. The participants may be directed by the technician to do certain things while the test is in progress, such as remain still and to open or close your eyes. In this study, the technician will prepare the subject and either the PI or the graduate research assistants will provide the directives in the presence of the technician, who will consistently monitor to ensure ease of data collection and control for artifact. Artifact in EEG is electrical data gathered from areas other than the cerebral cortex such as from other body parts or elements in the environment. After the directives are complete, the technician will remove the electrodes. During the directives, very little electricity is passed between the electrodes and the participant's skin. The electrodes do not send any sensations, and the participants will feel little to no discomfort.
The directives include:

1. To sit still with electrodes on long enough to gather a baseline measure
2. To engage in a directive drawing task; for example: "Draw a picture of how you feel using lines, shapes and colors."
3. A rote motor task, such as flipping a coin and rotating a pen in hand.

*Note: It is not necessary to have artistic ability to participate!
Each task will be no longer than 15 minutes in duration, for a total of 1 hour and approximately 15 minutes to set up the electrodes and clean up afterwards for a total of 1.5 hours of time, at most.

RISKS OF TAKING PART IN THE STUDY:

You might experience some mild discomfort from the electrode adhesive, similar to a Band-Aid, but since the recording is passive, you will not experience any additional feeling or discomfort. There is a potential risk of loss of confidentiality.

BENEFITS OF TAKING PART IN THE STUDY:

There are no immediate benefits to you as an individual from taking part in this study. We anticipate that the information acquired from your participation (and that of other subjects) will provide foundational evidence for the further exploration of how, and why, art therapy is an effective form of therapy and will help to assess and refine the clinical treatment therein.

ALTERNATIVES TO TAKING PART IN THE STUDY:

Instead of being in this study, you have the option not to participate.

CONFIDENTIALITY:

Efforts will be made to keep your personal information confidential. We cannot guarantee absolute confidentiality. Your personal information may be disclosed if required by law. Your identity will be held in confidence in reports in which the study may be published and in databases in which the results may be stored.

Organizations that may inspect and/or copy your research records for quality assurance and data analysis include groups such as the study investigator and his/her research associates, the Indiana University Institutional Review Board or its designees, the study sponsors and (as allowed by law) state or federal agencies, specifically the Office for Human Research Protections (OHRP) who may need to access your medical and/or research records.

By signing this informed consent form, you will be giving permission for the following productions created during this session to be used for the purposes of scientific research. I understand that this consent may include possible references to my art and/or the process of art making in scientific publications and/or presentations pertaining to art therapy.

COSTS:

The costs of the study will be covered by the sponsor of the study. You and your insurance company will not be charged for the testing done as a part of this study.

PAYMENT:

You will not receive payment for taking part in this study.

CONTACTS FOR QUESTIONS OR PROBLEMS:

For questions about the study, contact the researcher Dr. King at (317) 963-7404 (the phone is answered 24 hours a day). This number may also be used in case of emergencies.

If you cannot reach the researcher during regular business hours (i.e. 8:00AM-5:00PM), please call the IU Human Subjects Office at (317) 278-3458.

For questions about your rights as a research participant or to discuss problems, complaints or concerns about a research study, or to obtain information, or offer input, contact the IU Human Subjects Office at (317) 278-3458 or (800) 696-2949.

VOLUNTARY NATURE OF STUDY:

Taking part in this study is voluntary. You may choose not to take part or may leave the study at any time. Leaving the study will not result in any penalty or loss of benefits to which you are entitled. Your decision whether or not to participate in this study will not affect your current or future relations with IU Health, Indiana University or Herron Art School & Design.

SUBJECT'S CONSENT:

In consideration of all of the above, I give my consent to participate in this research study.

I will be given a copy of this informed consent document to keep for my records. I agree to take part in this study.

Subject's Printed Name:_____

Subject's Signature: _____ **Date**: _____
(must be dated by the subject)

Printed Name of Person Obtaining Consent:_____

Signature of Person Obtaining Consent: _____**Date**:_____

Appendix O

Indiana University Demographics Survey

PROTOCOL TITLE: Cortical Activity Patterns in Art Making versus Fine Motor Movement as Measured by EEG

CONFIDENTIALITY NOTICE:

Efforts will be made to keep your personal information confidential. We cannot guarantee absolute confidentiality. Your personal information may be disclosed if required by law. Your identity will be held in confidence in reports in which the study may be published and in databases in which the results may be stored.

Organizations that may inspect and/or copy your research records for quality assurance and data analysis include groups such as the study investigator and his/her research associates, the Indiana University Institutional Review Board or its designees, the study sponsors and (as allowed by law) state or federal agencies, specifically the Office for Human Research Protections (OHRP) who may need to access your medical and/or research records.

Name:_____ **Subject ID**:_____

Age: _____ **Gender**: _____

Level of artistic training (please circle the one, which most applies):

No experience Some experience Formal training

By signing below, I certify that all information listed above is true and correct to the best of my knowledge.

Signature: _____ **Date**:_____

Appendix P

Script for Data Collection

Please have a seat. For the next 2 hours you will be participating in a study that helps us learn about brain function and art. First, we will have you read and sign the informed consent form. Please let either of the graduate research assistants know if you have any questions.

Next, Bonnie, the technician will place the EEG electrodes on your scalp. This process will take approximately 30 minutes. First, Bonnie will measure your head with a pencil to mark where electrodes will be placed. These spots will be scrubbed with a special cream, which helps the electrodes obtain a high-quality reading. Finally, she will apply a sticky gel adhesive on the electrodes and place them on the previously marked areas.

The electrodes will send electrical impulse data from your brain to the recording machine, which converts this data into visual patterns on a computer. We expect the data to change over time from the requested tasks you will be asked to complete. There should be no discomfort during the recording.

During the EEG recording, you will be asked to complete a baseline measure three times, which will last 12 minutes and take place between the each of our interventions. During the baseline measure, we will ask you to open and close your eyes for 3 minutes at a time.

Let's begin with the first baseline measure. We ask that you keep your eyes open for the next 3 minutes, please blink normally during this time. Now close your eyes. I'm going to ask that you open your eyes again. Now please close your eyes once more.

We will now begin the art making intervention. Use the 12 pack of chalk pastels and 12" x 18" sheet of white paper with the pre-drawn circle provided to explore "how you're feeling using lines, shapes, and colors in the circle." You will have 12 minutes to complete this task,

please continue to make art for the duration of this task. You will not be judged based on the artwork created, there is no right or wrong way to complete this task. This concludes the art making intervention.

We will now begin the second baseline measure. Again, we ask that you keep your eyes open for the next 3 minutes, please blink normally during this time. Now close your eyes. Please open your eyes. Once more, please close your eyes.

We will now begin the movement intervention. This intervention will be divided into two 6 minute tasks. For the first 6 minutes we will ask you to continually flip a coin. Next, we will ask that you rotate a pencil between your fingers using your dominate hand for the remaining 6 minutes. You may begin flipping the coin. Now you may begin rotating the pencil between your fingers using your dominate hand. This concludes the movement intervention.

We will now begin the last baseline measure. Again, we ask that you keep your eyes open for the next 3 minutes, please blink normally during this time. Now close your eyes. Please open your eyes. Once more, please close your eyes.

This concludes our study. Thank you for your participation. We will now begin removing the EEG electrodes.

Appendix Q

Subjects' Artwork

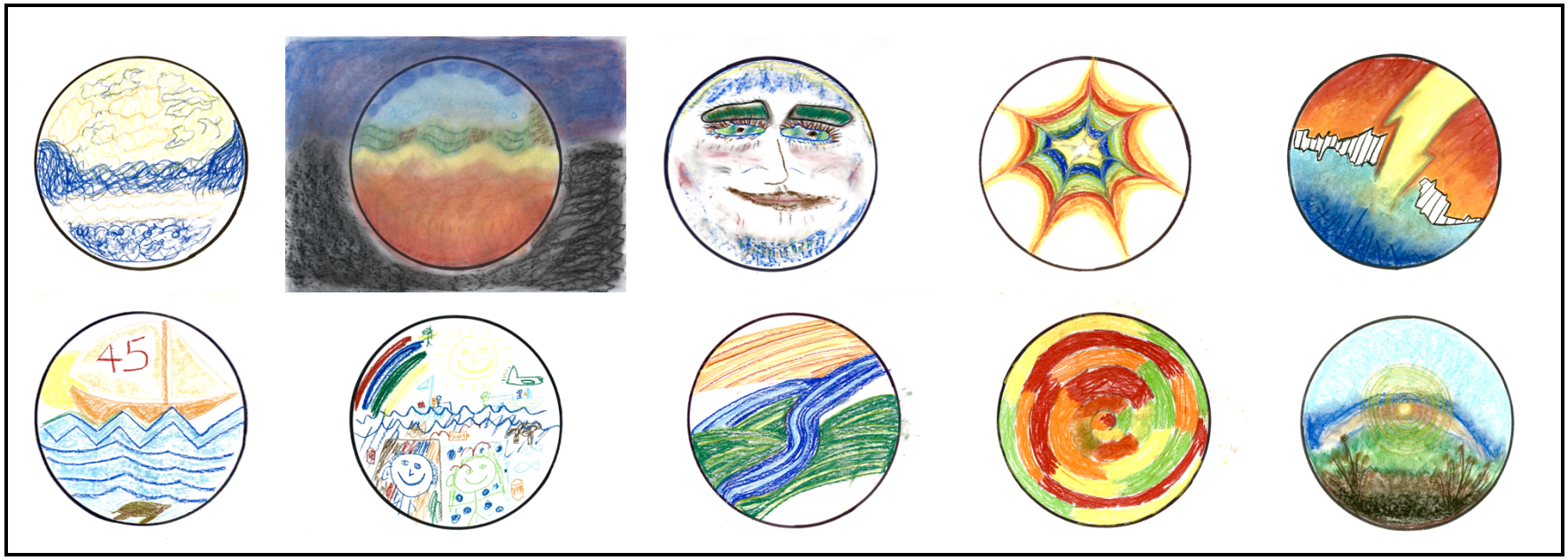

Figure Q1: Subjects' Artwork. Created with the directive, "explore how you feel using lines, shapes, and colors" within 12 minutes. Of the ten subjects, self-reported artistic experience: six no experience (NE), three some experience (SE), one formal training (FT). Top left to right, subject and self-reported level of artistic training: ARP001, NE; ARP002, SE; ARP003, NE; ARP004, NE; ARP005, FT; ARP006, NE; ARP007, NE; ARP008, SE; ARP009, NE; ARP010, SE.

Appendix R

Table R1: Procedure Time with Epoch Notation

Baseline				Art Making Task	After Art Making				Motor Tasks		After Motor Tasks			
3 min.	3 min.	3 min.	3 min.	12 min.	3 min.	3 min.	3 min.	3 min.	6 min.	6 min.	3 min.	3 min.	3 min.	3 min.
Eyes Open	Eyes Closed	Eyes Open	Eyes Closed	Art Directive	Eyes Open	Eyes Closed	Eyes Open	Eyes Closed	Coin Flip	Pencil Rotation	Eyes Open	Eyes Closed	Eyes Open	Eyes Closed
Subset 1	Subset 2	Subset 3	Subset 4		Subset 1	Subset 2	Subset 3	Subset 4	Subset 1	Subset 2	Subset 1	Subset 2	Subset 3	Subset 4
Epoch 1				Epoch 2	Epoch 3				Epoch 4		Epoch 5			

Table R1. Recordings of the EEG data were performed for epochs and subsets of time, as detailed here. Control data were obtained through comparison of Epoch 1 Subset 4 to Epoch 1 Subset 2. Epoch 1, Subsets 2 and 4 were combined to form the Baseline (Eyes Closed) data set. Epoch 3, Subsets 2 and 4 were combined to form the After Art Making (Eyes Closed) data set. Epoch 5, Subsets 2-4 were combined to form the After Motor Tasks (Eyes Closed) data set.

Appendix S

Table S1: Channel Groupings of Electrodes for Quantitative EEG Analysis

Left Hemisphere	F7-aF7, T3-aT3, T5-aT5, O1-aO1, F3-aF3, C3-aC3, P3-aP3	Right Hemisphere	F8-aF8, T4-aT4, T6-aT6, O2-aO2, F4-aF4, C4-aC4, P4-aP4
Left Frontal	F7-aF7, F3-aF3	Right Frontal	F8-aF8, F4-aF4
Left Temporal	T3-aT3, T5-aT5	Right Temporal	T4-aT4, T6-aT6
Left Central-Parietal	C3-aC3, P3-aP3	Right Central-Parietal	C4-aC4, P4-aP4
Left Posterior Temporal-Occipital	T5-aT5, O1-aO1	Right Posterior Temporal-Occipital	T6-aT6, O2-aO2

Table S1. Indicates the channel groupings used for the Quantitative EEG Analysis, separated into left and right hemispheres; left and right frontal regions; left and right temporal regions; left and right central-parietal regions; left and right temporal-occipital regions. For this preliminary data analysis, only the channel groupings of Left and Right Hemisphere were analyzed. All channel groupings will undergo analysis in future studies.

Appendix T

Table T1: Pairwise Comparison by Subject Frequency, Location

Subject ARP001 After Art Making Task to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.01422	0.02072	115	-0.69	0.494	Tukey-Kramer	0.772
2-4 HZ	-0.02298	0.02409	135	-0.95	0.3418	Tukey-Kramer	0.6073
4-6 HZ	-0.003183	0.01836	180	-0.17	0.8625	Tukey-Kramer	0.9836
6-8 HZ	0.05006**	0.0114	237	4.39	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.1082**	0.01664	181	6.5	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.1319**	0.02012	165	6.55	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.1167**	0.0166	166	7.03	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.08742**	0.01203	173	7.27	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.0506**	0.008826	122	5.73	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.02398*	0.009734	107	2.46	0.0153	Tukey-Kramer	0.0395
20-22 HZ	0.01424	0.01029	105	1.38	0.1691	Tukey-Kramer	0.3519
22-24 HZ	0.01125	0.01126	95.9	1	0.3204	Tukey-Kramer	0.5792
24-26 HZ	0.01265	0.01314	86.7	0.96	0.3384	Tukey-Kramer	0.6023
26-28 HZ	0.01676	0.01527	74.1	1.1	0.2759	Tukey-Kramer	0.5183
28-30 HZ	0.01908	0.01677	69.6	1.14	0.2591	Tukey-Kramer	0.4943
30-32 HZ	0.02076	0.01804	69.1	1.15	0.2538	Tukey-Kramer	0.487

Subject ARP001 After Art Making Task to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.004856	0.01942	159	-0.25	0.8029	Tukey-Kramer	0.9661
2-4 HZ	-0.02019	0.0237	156	-0.85	0.3955	Tukey-Kramer	0.6714
4-6 HZ	0.00879	0.01886	197	0.47	0.6416	Tukey-Kramer	0.8872
6-8 HZ	0.0527**	0.014	223	3.76	0.0002	Tukey-Kramer	0.0006
8-10 HZ	0.08614**	0.01687	181	5.11	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.09638**	0.01812	178	5.32	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.08963**	0.0154	167	5.82	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.06999**	0.01196	177	5.85	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.04505**	0.01011	194	4.46	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.02709*	0.01052	195	2.58	0.0107	Tukey-Kramer	0.0287
20-22 HZ	0.01424	0.01048	184	1.81	0.0727	Tukey-Kramer	0.1706
22-24 HZ	0.01125	0.01103	157	0.92	0.3571	Tukey-Kramer	0.6262
24-26 HZ	0.01265	0.01254	131	0.12	0.9079	Tukey-Kramer	0.9926
26-28 HZ	0.01676	0.01406	115	-0.02	0.9853	Tukey-Kramer	0.9998
28-30 HZ	0.01908	0.01505	107	0.05	0.9604	Tukey-Kramer	0.9986
30-32 HZ	0.02076	0.01612	102	-0.22	0.823	Tukey-Kramer	0.9727

Subject ARP001 After Motor Tasks to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.04274*	0.01285	169	-3.33	0.0011	Tukey-Kramer	0.0033
2-4 HZ	-0.0546**	0.0156	148	-3.5	0.0006	Tukey-Kramer	0.0018
4-6 HZ	-0.00797	0.01315	170	-0.61	0.5453	Tukey-Kramer	0.8171
6-8 HZ	0.09422**	0.01123	197	8.39	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.1658**	0.01713	174	9.68	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.179**	0.0206	165	8.69	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.151**	0.01693	166	8.92	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.1057**	0.01212	171	8.72	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.05589**	0.007913	149	7.06	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.02593*	0.00799	158	3.24	0.0014	Tukey-Kramer	0.0042
20-22 HZ	0.01564	0.008044	157	1.94	0.0536	Tukey-Kramer	0.1304
22-24 HZ	0.00696	0.008528	123	0.82	0.4162	Tukey-Kramer	0.6941
24-26 HZ	0.00076	0.01045	95.6	0.07	0.9424	Tukey-Kramer	0.9971
26-28 HZ	-0.000402	0.01298	82.4	-0.03	0.9754	Tukey-Kramer	0.9995
28-30 HZ	-0.003337	0.01527	65.6	-0.22	0.8278	Tukey-Kramer	0.974
30-32 HZ	-0.008416	0.01742	53.6	-0.48	0.631	Tukey-Kramer	0.8795

Subject ARP001 After Motor Tasks to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.03156	0.01382	177	-2.28	0.0235	Tukey-Kramer	0.061
2-4 HZ	-0.04364*	0.01687	164	-2.59	0.0106	Tukey-Kramer	0.0286
4-6 HZ	0.01535	0.01488	192	1.03	0.3036	Tukey-Kramer	0.558
6-8 HZ	0.1088**	0.01395	194	7.8	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.1562**	0.01686	177	9.26	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.1552**	0.01756	182	8.84	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.1341**	0.01503	169	8.92	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.09673**	0.01158	178	8.36	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.05942**	0.009563	200	6.21	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.03582*	0.009619	206	3.72	0.0003	Tukey-Kramer	0.0007
20-22 HZ	0.02303*	0.008966	190	2.57	0.011	Tukey-Kramer	0.0294
22-24 HZ	0.0081	0.008504	155	0.95	0.3422	Tukey-Kramer	0.6078
24-26 HZ	-0.005665	0.009099	122	-0.62	0.5347	Tukey-Kramer	0.808
26-28 HZ	-0.009912	0.009997	98.6	-0.99	0.3239	Tukey-Kramer	0.5838
28-30 HZ	-0.01374	0.01073	84.2	-1.28	0.2038	Tukey-Kramer	0.4092
30-32 HZ	-0.02296	0.01185	67	-1.94	0.0569	Tukey-Kramer	0.134

Subject ARP001 After Motor Tasks to After Art Making							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.02852	0.01787	70	-1.6	0.1149	Tukey-Kramer	0.2509
2-4 HZ	-0.03162	0.01986	73.7	-1.59	0.1156	Tukey-Kramer	0.2527
4-6 HZ	-0.004787	0.01497	106	-0.32	0.7498	Tukey-Kramer	0.9452
6-8 HZ	0.04416*	0.01182	196	3.74	0.0002	Tukey-Kramer	0.0007
8-10 HZ	0.0576**	0.01624	176	3.55	0.0005	Tukey-Kramer	0.0014
10-12 HZ	0.0471**	0.01894	168	2.49	0.0139	Tukey-Kramer	0.0368
12-14 HZ	0.03431	0.01575	164	2.18	0.0308	Tukey-Kramer	0.0778
14-16 HZ	0.01827	0.01241	159	1.47	0.1431	Tukey-Kramer	0.3071
16-18 HZ	0.00529	0.0099	141	0.53	0.5937	Tukey-Kramer	0.8544
18-20 HZ	0.00194	0.01051	124	0.18	0.8535	Tukey-Kramer	0.9813
20-22 HZ	0.0014	0.01032	106	0.14	0.8925	Tukey-Kramer	0.9899
22-24 HZ	-0.00429	0.01057	84.3	-0.41	0.6858	Tukey-Kramer	0.9132
24-26 HZ	-0.01189	0.01214	76.9	-0.98	0.3302	Tukey-Kramer	0.5914
26-28 HZ	-0.01716	0.01504	70.8	-1.14	0.2576	Tukey-Kramer	0.4918
28-30 HZ	-0.02242	0.01749	66.9	-1.28	0.2043	Tukey-Kramer	0.4102
30-32 HZ	-0.02918	0.01912	62.5	-1.53	0.1321	Tukey-Kramer	0.2862

Subject ARP001 After Motor Tasks to After Art Making							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.0267	0.01611	95.2	-1.66	0.1007	Tukey-Kramer	0.2249
2-4 HZ	-0.02345	0.0192	87.2	-1.22	0.2251	Tukey-Kramer	0.4424
4-6 HZ	0.00656	0.01553	132	0.42	0.6735	Tukey-Kramer	0.9065
6-8 HZ	0.05613**	0.01459	188	3.85	0.0002	Tukey-Kramer	0.0005
8-10 HZ	0.07005**	0.01731	169	4.05	<.0001	Tukey-Kramer	0.0002
10-12 HZ	0.05886**	0.01708	178	3.45	0.0007	Tukey-Kramer	0.002
12-14 HZ	0.04442*	0.01364	184	3.26	0.0013	Tukey-Kramer	0.0038
14-16 HZ	0.02674*	0.01049	198	2.55	0.0116	Tukey-Kramer	0.0311
16-18 HZ	0.01437	0.009399	207	1.53	0.1278	Tukey-Kramer	0.2795
18-20 HZ	0.00872	0.01012	204	0.86	0.3899	Tukey-Kramer	0.665
20-22 HZ	0.0041	0.009711	180	0.42	0.6733	Tukey-Kramer	0.9064
22-24 HZ	-0.002086	0.009879	134	-0.21	0.8331	Tukey-Kramer	0.9757
24-26 HZ	-0.007118	0.01116	106	-0.64	0.525	Tukey-Kramer	0.7996
26-28 HZ	-0.009652	0.01247	94.1	-0.77	0.441	Tukey-Kramer	0.7199
28-30 HZ	-0.01449	0.01331	91.4	-1.09	0.2793	Tukey-Kramer	0.5235
30-32 HZ	-0.01934	0.01387	93.2	-1.39	0.1667	Tukey-Kramer	0.3483

Subject ARP002 After Art Making Task to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.01508	0.01535	221	0.98	0.3269	Tukey-Kramer	0.5886
2-4 HZ	0.03785	0.01684	199	2.25	0.0257	Tukey-Kramer	0.0661
4-6 HZ	0.04196*	0.01447	204	2.9	0.0042	Tukey-Kramer	0.0116
6-8 HZ	0.05372**	0.01457	173	3.69	0.0003	Tukey-Kramer	0.0009
8-10 HZ	0.06952**	0.01792	186	3.88	0.0001	Tukey-Kramer	0.0004
10-12 HZ	0.0657**	0.01789	201	3.67	0.0003	Tukey-Kramer	0.0009
12-14 HZ	0.05096**	0.01447	207	3.52	0.0005	Tukey-Kramer	0.0015
14-16 HZ	0.04209*	0.01194	199	3.53	0.0005	Tukey-Kramer	0.0015
16-18 HZ	0.03175*	0.01026	171	3.1	0.0023	Tukey-Kramer	0.0063
18-20 HZ	0.03547*	0.01033	189	3.43	0.0007	Tukey-Kramer	0.002
20-22 HZ	0.03311*	0.00953	202	3.47	0.0006	Tukey-Kramer	0.0018
22-24 HZ	0.02483*	0.008748	184	2.84	0.005	Tukey-Kramer	0.0137
24-26 HZ	0.02031*	0.008563	171	2.37	0.0188	Tukey-Kramer	0.0487
26-28 HZ	0.01988*	0.008211	168	2.42	0.0165	Tukey-Kramer	0.0431
28-30 HZ	0.02138*	0.007857	166	2.72	0.0072	Tukey-Kramer	0.0193
30-32 HZ	0.02281*	0.008063	155	2.83	0.0053	Tukey-Kramer	0.0143

Subject ARP002 After Art Making Task to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.00823	0.01635	208	0.5	0.6153	Tukey-Kramer	0.8698
2-4 HZ	0.03107	0.019	178	1.63	0.1039	Tukey-Kramer	0.2335
4-6 HZ	0.03249	0.0167	172	1.95	0.0533	Tukey-Kramer	0.1288
6-8 HZ	0.05923**	0.01615	188	3.67	0.0003	Tukey-Kramer	0.0009
8-10 HZ	0.0923**	0.02071	190	4.46	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.08612**	0.02036	194	4.23	<.0001	Tukey-Kramer	0.0001
12-14 HZ	0.06453**	0.01616	182	3.99	<.0001	Tukey-Kramer	0.0003
14-16 HZ	0.04181*	0.01229	187	3.4	0.0008	Tukey-Kramer	0.0023
16-18 HZ	0.01821	0.009176	197	1.98	0.0486	Tukey-Kramer	0.1188
18-20 HZ	0.01887	0.009448	206	2	0.0471	Tukey-Kramer	0.1153
20-22 HZ	0.02917*	0.008676	224	3.36	0.0009	Tukey-Kramer	0.0026
22-24 HZ	0.02667*	0.007503	219	3.55	0.0005	Tukey-Kramer	0.0013
24-26 HZ	0.01813*	0.006628	195	2.74	0.0068	Tukey-Kramer	0.0184
26-28 HZ	0.0118	0.006431	174	1.83	0.0683	Tukey-Kramer	0.161
28-30 HZ	0.00658	0.006453	178	1.02	0.3095	Tukey-Kramer	0.5657
30-32 HZ	0.00288	0.006436	181	0.45	0.6556	Tukey-Kramer	0.8959

Subject ARP002 After Motor Tasks to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.04627**	0.01589	198	2.91	0.004	Tukey-Kramer	0.011
2-4 HZ	0.06492**	0.01825	173	3.56	0.0005	Tukey-Kramer	0.0014
4-6 HZ	0.06699**	0.01598	173	4.19	<.0001	Tukey-Kramer	0.0001
6-8 HZ	0.07985**	0.01606	183	4.97	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.08533**	0.01905	191	4.48	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.07205**	0.0185	200	3.89	0.0001	Tukey-Kramer	0.0004
12-14 HZ	0.05594**	0.01505	200	3.72	0.0003	Tukey-Kramer	0.0008
14-16 HZ	0.0436*	0.01219	192	3.58	0.0004	Tukey-Kramer	0.0013
16-18 HZ	0.03047*	0.009392	201	3.24	0.0014	Tukey-Kramer	0.0039
18-20 HZ	0.02957*	0.009702	222	3.05	0.0026	Tukey-Kramer	0.0073
20-22 HZ	0.03173*	0.009112	219	3.48	0.0006	Tukey-Kramer	0.0017
22-24 HZ	0.0277*	0.008772	181	3.16	0.0019	Tukey-Kramer	0.0052
24-26 HZ	0.02604*	0.009516	158	2.74	0.0069	Tukey-Kramer	0.0185
26-28 HZ	0.02777*	0.01031	149	2.69	0.0079	Tukey-Kramer	0.0209
28-30 HZ	0.02954*	0.01066	145	2.77	0.0063	Tukey-Kramer	0.0168
30-32 HZ	0.02785*	0.01065	141	2.62	0.0099	Tukey-Kramer	0.026

Subject ARP002 After Motor Tasks to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.06058**	0.01783	221	3.4	0.0008	Tukey-Kramer	0.0023
2-4 HZ	0.06441**	0.01913	192	3.37	0.0009	Tukey-Kramer	0.0026
4-6 HZ	0.05991**	0.01631	185	3.67	0.0003	Tukey-Kramer	0.0009
6-8 HZ	0.07499**	0.01599	202	4.69	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.08413**	0.02038	199	4.13	<.0001	Tukey-Kramer	0.0002
10-12 HZ	0.06616**	0.02009	198	3.29	0.0012	Tukey-Kramer	0.0033
12-14 HZ	0.04828**	0.0162	184	2.98	0.0033	Tukey-Kramer	0.009
14-16 HZ	0.02918	0.01253	186	2.33	0.0209	Tukey-Kramer	0.0541
16-18 HZ	0.01106	0.009686	193	1.14	0.2551	Tukey-Kramer	0.4897
18-20 HZ	0.01399	0.00929	224	1.51	0.1336	Tukey-Kramer	0.2903
20-22 HZ	0.02162*	0.008895	238	2.43	0.0158	Tukey-Kramer	0.0417
22-24 HZ	0.0231*	0.007746	232	2.98	0.0032	Tukey-Kramer	0.0089
24-26 HZ	0.0154	0.006946	211	2.22	0.0277	Tukey-Kramer	0.0706
26-28 HZ	0.01035	0.006964	192	1.49	0.1388	Tukey-Kramer	0.2995
28-30 HZ	0.00922	0.007426	177	1.24	0.2161	Tukey-Kramer	0.4303
30-32 HZ	0.00915	0.00767	166	1.19	0.2344	Tukey-Kramer	0.4585

Subject ARP002 After Motor Tasks to After Art Making							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.03119	0.01764	215	1.77	0.0785	Tukey-Kramer	0.1828
2-4 HZ	0.02707	0.01943	188	1.39	0.1651	Tukey-Kramer	0.3463
4-6 HZ	0.02503	0.01654	184	1.51	0.1318	Tukey-Kramer	0.2868
6-8 HZ	0.02613	0.01442	199	1.81	0.0714	Tukey-Kramer	0.1682
8-10 HZ	0.01581	0.01775	206	0.89	0.3742	Tukey-Kramer	0.6469
10-12 HZ	0.00635	0.01818	206	0.35	0.7272	Tukey-Kramer	0.935
12-14 HZ	0.00498	0.01529	205	0.33	0.7448	Tukey-Kramer	0.9432
14-16 HZ	0.00152	0.01298	204	0.12	0.9072	Tukey-Kramer	0.9925
16-18 HZ	-0.001283	0.01133	206	-0.11	0.91	Tukey-Kramer	0.993
18-20 HZ	-0.005899	0.01159	227	-0.51	0.6112	Tukey-Kramer	0.867
20-22 HZ	-0.00138	0.01076	238	-0.13	0.8981	Tukey-Kramer	0.991
22-24 HZ	0.00286	0.01076	232	0.27	0.7903	Tukey-Kramer	0.9617
24-26 HZ	0.00573	0.01151	224	0.5	0.6191	Tukey-Kramer	0.8724
26-28 HZ	0.00789	0.01211	216	0.65	0.5153	Tukey-Kramer	0.7917
28-30 HZ	0.00816	0.01231	210	0.66	0.5081	Tukey-Kramer	0.7852
30-32 HZ	0.00505	0.01254	213	0.4	0.6876	Tukey-Kramer	0.9146

Subject ARP002 After Motor Tasks to After Art Making							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.05235**	0.01693	227	3.09	0.0022	Tukey-Kramer	0.0063
2-4 HZ	0.03334	0.0184	205	1.81	0.0714	Tukey-Kramer	0.1682
4-6 HZ	0.02742	0.01562	199	1.76	0.0807	Tukey-Kramer	0.1876
6-8 HZ	0.01576	0.01626	207	0.97	0.3336	Tukey-Kramer	0.5972
8-10 HZ	-0.008166	0.02045	211	-0.4	0.69	Tukey-Kramer	0.9159
10-12 HZ	-0.01996	0.01952	222	-1.02	0.3075	Tukey-Kramer	0.5632
12-14 HZ	-0.01624	0.0151	226	-1.08	0.2831	Tukey-Kramer	0.5301
14-16 HZ	-0.01263	0.01165	220	-1.08	0.2794	Tukey-Kramer	0.5249
16-18 HZ	-0.007148	0.009202	208	-0.78	0.4382	Tukey-Kramer	0.7177
18-20 HZ	-0.004882	0.009404	225	-0.52	0.6042	Tukey-Kramer	0.8621
20-22 HZ	-0.00755	0.009022	241	-0.84	0.4035	Tukey-Kramer	0.6805
22-24 HZ	-0.003571	0.008173	234	-0.44	0.6626	Tukey-Kramer	0.9002
24-26 HZ	-0.002733	0.007765	223	-0.35	0.7252	Tukey-Kramer	0.934
26-28 HZ	-0.001446	0.008016	217	-0.18	0.857	Tukey-Kramer	0.9822
28-30 HZ	0.00264	0.008318	207	0.32	0.7512	Tukey-Kramer	0.946
30-32 HZ	0.00628	0.008394	192	0.75	0.4553	Tukey-Kramer	0.7352

Subject ARP003 After Art Making Task to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.006485	0.01425	198	-0.46	0.6496	Tukey-Kramer	0.8922
2-4 HZ	-0.004946	0.01352	192	-0.37	0.7149	Tukey-Kramer	0.9289
4-6 HZ	0.015	0.01478	152	1.03	0.3055	Tukey-Kramer	0.5602
6-8 HZ	0.1155**	0.02662	90.3	4.34	<.0001	Tukey-Kramer	0.0001
8-10 HZ	0.1641**	0.03883	64.5	4.23	<.0001	Tukey-Kramer	0.0002
10-12 HZ	0.1452**	0.04025	58.5	3.61	0.0006	Tukey-Kramer	0.0017
12-14 HZ	0.1051**	0.03221	60.3	3.26	0.0018	Tukey-Kramer	0.0049
14-16 HZ	0.07708**	0.02568	55.2	3	0.004	Tukey-Kramer	0.0104
16-18 HZ	0.04439*	0.01717	71.4	2.59	0.0118	Tukey-Kramer	0.0303
18-20 HZ	0.04427*	0.01497	137	2.96	0.0036	Tukey-Kramer	0.0103
20-22 HZ	0.04711**	0.01555	114	3.03	0.003	Tukey-Kramer	0.0085
22-24 HZ	0.03734*	0.0144	93.9	2.59	0.011	Tukey-Kramer	0.0292
24-26 HZ	0.02275	0.01163	90.4	1.96	0.0536	Tukey-Kramer	0.1286
26-28 HZ	0.01765	0.009252	96.6	1.91	0.0595	Tukey-Kramer	0.1413
28-30 HZ	0.02106*	0.00805	96	2.62	0.0103	Tukey-Kramer	0.027
30-32 HZ	0.02423*	0.007405	95.2	3.27	0.0015	Tukey-Kramer	0.004

Subject ARP003 After Art Making Task to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.00903	0.01181	214	0.76	0.4453	Tukey-Kramer	0.7251
2-4 HZ	0.02178	0.01139	208	1.91	0.0573	Tukey-Kramer	0.1378
4-6 HZ	0.03797*	0.01187	168	3.2	0.0016	Tukey-Kramer	0.0046
6-8 HZ	0.1151**	0.02338	85.8	4.92	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.1505**	0.03652	56.6	4.12	0.0001	Tukey-Kramer	0.0003
10-12 HZ	0.1272**	0.03891	52.3	3.27	0.0019	Tukey-Kramer	0.0049
12-14 HZ	0.09071**	0.03083	56.5	2.94	0.0047	Tukey-Kramer	0.0123
14-16 HZ	0.06762**	0.02442	53.9	2.77	0.0077	Tukey-Kramer	0.0195
16-18 HZ	0.04551**	0.01595	66.6	2.85	0.0058	Tukey-Kramer	0.0148
18-20 HZ	0.04675**	0.01352	129	3.46	0.0007	Tukey-Kramer	0.0021
20-22 HZ	0.0488**	0.01424	111	3.43	0.0009	Tukey-Kramer	0.0024
22-24 HZ	0.0402*	0.01362	81.4	2.95	0.0041	Tukey-Kramer	0.0109
24-26 HZ	0.02991*	0.01093	81	2.74	0.0076	Tukey-Kramer	0.0198
26-28 HZ	0.02588*	0.008216	106	3.15	0.0021	Tukey-Kramer	0.0058
28-30 HZ	0.02541*	0.007421	116	3.42	0.0009	Tukey-Kramer	0.0024
30-32 HZ	0.02564*	0.006961	97.6	3.68	0.0004	Tukey-Kramer	0.001

Subject ARP003 After Motor Tasks to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.00151	0.0145	202	-0.1	0.9169	Tukey-Kramer	0.994
2-4 HZ	0.02315	0.01392	194	-1.66	0.0979	Tukey-Kramer	0.2221
4-6 HZ	0.0494**	0.01622	155	-3.05	0.0027	Tukey-Kramer	0.0076
6-8 HZ	0.0842**	0.03464	96.5	-2.43	0.0169	Tukey-Kramer	0.0443
8-10 HZ	0.06444	0.05345	77.6	-1.21	0.2316	Tukey-Kramer	0.4539
10-12 HZ	0.02887	0.054	81.1	-0.53	0.5943	Tukey-Kramer	0.8546
12-14 HZ	0.00707	0.04406	81.4	-0.16	0.8729	Tukey-Kramer	0.9859
14-16 HZ	0.00194	0.03421	84.2	-0.06	0.9549	Tukey-Kramer	0.9982
16-18 HZ	0.00784	0.02241	101	-0.35	0.727	Tukey-Kramer	0.9347
18-20 HZ	0.04055	0.01931	115	-2.1	0.0379	Tukey-Kramer	0.0939
20-22 HZ	0.04322	0.01997	107	-2.16	0.0327	Tukey-Kramer	0.082
22-24 HZ	0.02719	0.01837	104	-1.48	0.1418	Tukey-Kramer	0.3047
24-26 HZ	0.0126	0.01453	109	-0.87	0.3879	Tukey-Kramer	0.6624
26-28 HZ	0.0066	0.0112	117	-0.59	0.557	Tukey-Kramer	0.8263
28-30 HZ	0.00919	0.009617	119	-0.96	0.3413	Tukey-Kramer	0.6064
30-32 HZ	0.01537	0.008734	120	-1.76	0.0811	Tukey-Kramer	0.1878

Subject ARP003 After Motor Tasks to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.01043	0.01299	219	0.8	0.4228	Tukey-Kramer	0.7015
2-4 HZ	0.02822	0.01233	208	2.29	0.0231	Tukey-Kramer	0.0596
4-6 HZ	0.05019**	0.01282	168	3.92	0.0001	Tukey-Kramer	0.0004
6-8 HZ	0.09146**	0.03047	92.8	3	0.0034	Tukey-Kramer	0.0096
8-10 HZ	0.07359	0.04968	76.9	1.48	0.1426	Tukey-Kramer	0.3066
10-12 HZ	0.03078	0.05097	80.4	0.6	0.5476	Tukey-Kramer	0.8185
12-14 HZ	0.00473	0.0406	84.1	0.12	0.9076	Tukey-Kramer	0.9926
14-16 HZ	-0.005411	0.03115	84.8	-0.17	0.8625	Tukey-Kramer	0.9835
16-18 HZ	-0.006135	0.02001	97.9	-0.31	0.7598	Tukey-Kramer	0.9495
18-20 HZ	0.0209	0.01659	128	1.26	0.2099	Tukey-Kramer	0.4202
20-22 HZ	0.02123	0.01717	120	1.24	0.2189	Tukey-Kramer	0.4344
22-24 HZ	0.00847	0.01619	105	0.52	0.6019	Tukey-Kramer	0.8601
24-26 HZ	-0.001264	0.01292	107	-0.1	0.9223	Tukey-Kramer	0.9947
26-28 HZ	0.0001	0.009757	124	0.01	0.9915	Tukey-Kramer	0.9999
28-30 HZ	0.00564	0.008326	126	0.68	0.4993	Tukey-Kramer	0.777
30-32 HZ	0.00822	0.007901	115	1.04	0.3001	Tukey-Kramer	0.5526

Subject ARP003 After Motor Tasks to After Art Making							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.008	0.01277	227	0.63	0.5317	Tukey-Kramer	0.8058
2-4 HZ	0.0281	0.01244	199	2.26	0.025	Tukey-Kramer	0.0642
4-6 HZ	0.03421*	0.0143	152	2.39	0.018	Tukey-Kramer	0.0469
6-8 HZ	-0.03132	0.02926	71.9	-1.07	0.2879	Tukey-Kramer	0.5345
8-10 HZ	-0.09963	0.04306	48	-2.31	0.025	Tukey-Kramer	0.0606
10-12 HZ	-0.1163**	0.04158	48.7	-2.8	0.0074	Tukey-Kramer	0.0182
12-14 HZ	-0.098**	0.03406	46.6	-2.88	0.006	Tukey-Kramer	0.0147
14-16 HZ	-0.07514**	0.02546	49.2	-2.95	0.0048	Tukey-Kramer	0.012
16-18 HZ	-0.03655	0.01736	69	-2.11	0.0388	Tukey-Kramer	0.0945
18-20 HZ	-0.003713	0.01726	92.9	-0.22	0.8301	Tukey-Kramer	0.9748
20-22 HZ	-0.003892	0.01743	84	-0.22	0.8239	Tukey-Kramer	0.9729
22-24 HZ	-0.01014	0.01538	78.9	-0.66	0.5115	Tukey-Kramer	0.7875
24-26 HZ	-0.01015	0.01181	84	-0.86	0.3924	Tukey-Kramer	0.6668
26-28 HZ	-0.01105	0.009043	99.5	-1.22	0.2246	Tukey-Kramer	0.4427
28-30 HZ	-0.01187	0.007718	108	-1.54	0.1271	Tukey-Kramer	0.2772
30-32 HZ	-0.008866	0.006893	112	-1.29	0.201	Tukey-Kramer	0.4057

Subject ARP003 After Motor Tasks to After Art Making							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.0014	0.01151	213	0.12	0.9034	Tukey-Kramer	0.9919
2-4 HZ	0.00644	0.01092	208	0.59	0.5557	Tukey-Kramer	0.8256
4-6 HZ	0.01222	0.01149	169	1.06	0.2891	Tukey-Kramer	0.538
6-8 HZ	-0.02366	0.02565	68.8	-0.92	0.3596	Tukey-Kramer	0.6276
8-10 HZ	-0.0769	0.0385	45.2	-2	0.0518	Tukey-Kramer	0.1211
10-12 HZ	-0.09642**	0.03733	47.5	-2.58	0.0129	Tukey-Kramer	0.032
12-14 HZ	-0.08598**	0.03006	49.2	-2.86	0.0062	Tukey-Kramer	0.0154
14-16 HZ	-0.07303**	0.02242	54.8	-3.26	0.0019	Tukey-Kramer	0.0049
16-18 HZ	-0.05164**	0.01517	75.2	-3.4	0.0011	Tukey-Kramer	0.0029
18-20 HZ	-0.02584	0.01462	113	-1.77	0.0798	Tukey-Kramer	0.1845
20-22 HZ	-0.02757	0.01462	105	-1.89	0.0621	Tukey-Kramer	0.1473
22-24 HZ	-0.03172*	0.01257	93.7	-2.52	0.0133	Tukey-Kramer	0.0349
24-26 HZ	-0.03118*	0.009824	96.2	-3.17	0.002	Tukey-Kramer	0.0056
26-28 HZ	-0.02578*	0.007936	109	-3.25	0.0015	Tukey-Kramer	0.0043
28-30 HZ	-0.01977*	0.007097	131	-2.79	0.0061	Tukey-Kramer	0.0168
30-32 HZ	-0.01741*	0.006443	123	-2.7	0.0078	Tukey-Kramer	0.0213

Subject ARP004 After Art Making Task to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.01362	0.01556	153	-0.88	0.3827	Tukey-Kramer	0.6566
2-4 HZ	-0.003763	0.01893	140	-0.2	0.8427	Tukey-Kramer	0.9784
4-6 HZ	-0.004468	0.01858	128	-0.24	0.8104	Tukey-Kramer	0.9686
6-8 HZ	-0.004143	0.01951	126	-0.21	0.8322	Tukey-Kramer	0.9755
8-10 HZ	0.01038	0.02284	124	0.45	0.6503	Tukey-Kramer	0.8925
10-12 HZ	0.03671	0.02497	120	1.47	0.1441	Tukey-Kramer	0.3089
12-14 HZ	0.05015	0.02296	114	2.18	0.031	Tukey-Kramer	0.0783
14-16 HZ	0.05935**	0.02072	118	2.86	0.0049	Tukey-Kramer	0.0137
16-18 HZ	0.05834**	0.01796	117	3.25	0.0015	Tukey-Kramer	0.0044
18-20 HZ	0.03768*	0.01507	129	2.5	0.0137	Tukey-Kramer	0.0366
20-22 HZ	0.01872	0.01359	137	1.38	0.1707	Tukey-Kramer	0.356
22-24 HZ	0.00965	0.01246	132	0.77	0.44	Tukey-Kramer	0.7194
24-26 HZ	0.00595	0.01097	131	0.54	0.5885	Tukey-Kramer	0.8506
26-28 HZ	0.00364	0.009015	142	0.4	0.6868	Tukey-Kramer	0.914
28-30 HZ	0.00276	0.007092	154	0.39	0.6975	Tukey-Kramer	0.9198
30-32 HZ	0.0013	0.005389	169	0.24	0.8102	Tukey-Kramer	0.9686

Subject ARP004 After Art Making Task to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.007724	0.01241	213	-0.62	0.5342	Tukey-Kramer	0.8079
2-4 HZ	-0.006074	0.01551	163	-0.39	0.6958	Tukey-Kramer	0.919
4-6 HZ	-0.006658	0.01504	140	-0.44	0.6587	Tukey-Kramer	0.8977
6-8 HZ	-0.001374	0.01528	133	-0.09	0.9285	Tukey-Kramer	0.9956
8-10 HZ	0.02302	0.0196	139	1.17	0.2422	Tukey-Kramer	0.4704
10-12 HZ	0.05081	0.02405	134	2.11	0.0365	Tukey-Kramer	0.0913
12-14 HZ	0.05215	0.02271	129	2.3	0.0233	Tukey-Kramer	0.0602
14-16 HZ	0.0495	0.02149	122	2.3	0.023	Tukey-Kramer	0.0594
16-18 HZ	0.03515	0.0189	111	1.86	0.0656	Tukey-Kramer	0.1556
18-20 HZ	0.01014	0.01598	117	0.63	0.527	Tukey-Kramer	0.8014
20-22 HZ	-0.006668	0.01422	123	-0.47	0.6399	Tukey-Kramer	0.8859
22-24 HZ	-0.01187	0.01235	123	-0.96	0.3386	Tukey-Kramer	0.6031
24-26 HZ	-0.01611	0.01045	128	-1.54	0.1254	Tukey-Kramer	0.2751
26-28 HZ	-0.01973	0.008433	143	-2.34	0.0207	Tukey-Kramer	0.0543
28-30 HZ	-0.01848*	0.006579	152	-2.81	0.0056	Tukey-Kramer	0.0157
30-32 HZ	-0.01471*	0.00498	149	-2.95	0.0036	Tukey-Kramer	0.0102

Subject ARP004 After Motor Tasks to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.02517	0.01732	167	1.45	0.1479	Tukey-Kramer	0.3159
2-4 HZ	0.04139	0.01842	153	2.25	0.0261	Tukey-Kramer	0.0668
4-6 HZ	0.02666	0.01719	143	1.55	0.1232	Tukey-Kramer	0.2708
6-8 HZ	0.00202	0.01956	137	0.1	0.9178	Tukey-Kramer	0.9941
8-10 HZ	0.00102	0.024	123	0.04	0.9661	Tukey-Kramer	0.999
10-12 HZ	0.01754	0.02605	114	0.67	0.5021	Tukey-Kramer	0.7794
12-14 HZ	0.02048	0.02455	101	0.83	0.4061	Tukey-Kramer	0.6826
14-16 HZ	0.02356	0.02283	99.8	1.03	0.3046	Tukey-Kramer	0.5583
16-18 HZ	0.01682	0.02092	102	0.8	0.4234	Tukey-Kramer	0.7014
18-20 HZ	0.00086	0.01856	106	0.05	0.9631	Tukey-Kramer	0.9988
20-22 HZ	-0.009853	0.01645	109	-0.6	0.5504	Tukey-Kramer	0.8209
22-24 HZ	-0.01345	0.01457	108	-0.92	0.3582	Tukey-Kramer	0.6271
24-26 HZ	-0.01176	0.01269	105	-0.93	0.3561	Tukey-Kramer	0.6244
26-28 HZ	-0.008423	0.0107	103	-0.79	0.4329	Tukey-Kramer	0.7116
28-30 HZ	-0.004946	0.008796	101	-0.56	0.5752	Tukey-Kramer	0.8404
30-32 HZ	-0.00185	0.006911	97.4	-0.27	0.7895	Tukey-Kramer	0.9613

Subject ARP004 After Motor Tasks to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.02909	0.01295	217	2.25	0.0257	Tukey-Kramer	0.066
2-4 HZ	0.02809	0.01456	197	1.93	0.055	Tukey-Kramer	0.1333
4-6 HZ	0.02089	0.01398	167	1.49	0.1371	Tukey-Kramer	0.2967
6-8 HZ	0.01338	0.01607	137	0.83	0.4066	Tukey-Kramer	0.6836
8-10 HZ	0.02912	0.02151	125	1.35	0.1782	Tukey-Kramer	0.3681
10-12 HZ	0.04888	0.02617	117	1.87	0.0642	Tukey-Kramer	0.1522
12-14 HZ	0.04094	0.02513	109	1.63	0.1062	Tukey-Kramer	0.2374
14-16 HZ	0.03052	0.02356	108	1.3	0.198	Tukey-Kramer	0.4008
16-18 HZ	0.00966	0.02065	107	0.47	0.641	Tukey-Kramer	0.8866
18-20 HZ	-0.0122	0.01736	116	-0.7	0.4837	Tukey-Kramer	0.7624
20-22 HZ	-0.01863	0.01554	121	-1.2	0.2328	Tukey-Kramer	0.4559
22-24 HZ	-0.02011	0.01409	115	-1.43	0.1563	Tukey-Kramer	0.3303
24-26 HZ	-0.0244	0.01225	107	-1.99	0.049	Tukey-Kramer	0.1189
26-28 HZ	-0.02852*	0.01002	100	-2.85	0.0054	Tukey-Kramer	0.0144
28-30 HZ	-0.0272*	0.00762	109	-3.57	0.0005	Tukey-Kramer	0.0014
30-32 HZ	-0.02104*	0.005399	135	-3.9	0.0002	Tukey-Kramer	0.0004

Subject ARP004 After Motor Tasks to After Art Making							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.0388*	0.01525	178	2.54	0.0118	Tukey-Kramer	0.0316
2-4 HZ	0.04515**	0.01785	155	2.53	0.0124	Tukey-Kramer	0.0332
4-6 HZ	0.03113	0.01702	132	1.83	0.0696	Tukey-Kramer	0.164
6-8 HZ	0.00617	0.01981	127	0.31	0.7561	Tukey-Kramer	0.948
8-10 HZ	-0.009357	0.02547	120	-0.37	0.714	Tukey-Kramer	0.9284
10-12 HZ	-0.01916	0.02864	118	-0.67	0.5048	Tukey-Kramer	0.7819
12-14 HZ	-0.02967	0.02705	109	-1.1	0.275	Tukey-Kramer	0.5178
14-16 HZ	-0.03578	0.02403	106	-1.49	0.1395	Tukey-Kramer	0.3001
16-18 HZ	-0.04152	0.0201	98.9	-2.07	0.0415	Tukey-Kramer	0.1019
18-20 HZ	-0.03682	0.01716	93.2	-2.15	0.0345	Tukey-Kramer	0.0853
20-22 HZ	-0.02858	0.01548	98.2	-1.85	0.0679	Tukey-Kramer	0.1592
22-24 HZ	-0.0231	0.01397	101	-1.65	0.1013	Tukey-Kramer	0.2275
24-26 HZ	-0.01771	0.01239	102	-1.43	0.1558	Tukey-Kramer	0.3289
26-28 HZ	-0.01206	0.01065	103	-1.13	0.2598	Tukey-Kramer	0.4957
28-30 HZ	-0.007708	0.008838	101	-0.87	0.3852	Tukey-Kramer	0.6588
30-32 HZ	-0.003147	0.007073	102	-0.44	0.6573	Tukey-Kramer	0.8967

Subject ARP004 After Motor Tasks to After Art Making							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.03682*	0.01303	206	2.83	0.0052	Tukey-Kramer	0.0142
2-4 HZ	0.03417	0.01537	167	2.22	0.0275	Tukey-Kramer	0.0701
4-6 HZ	0.02755	0.01462	145	1.88	0.0616	Tukey-Kramer	0.1469
6-8 HZ	0.01475	0.01675	130	0.88	0.3802	Tukey-Kramer	0.6535
8-10 HZ	0.0061	0.02279	129	0.27	0.7895	Tukey-Kramer	0.9613
10-12 HZ	-0.001929	0.02773	124	-0.07	0.9446	Tukey-Kramer	0.9973
12-14 HZ	-0.0112	0.02636	116	-0.42	0.6716	Tukey-Kramer	0.9053
14-16 HZ	-0.01898	0.02394	112	-0.79	0.4295	Tukey-Kramer	0.7082
16-18 HZ	-0.02549	0.01986	109	-1.28	0.2021	Tukey-Kramer	0.4076
18-20 HZ	-0.02234	0.01637	116	-1.36	0.1752	Tukey-Kramer	0.3631
20-22 HZ	-0.01196	0.01454	120	-0.82	0.4122	Tukey-Kramer	0.6896
22-24 HZ	-0.008239	0.01309	108	-0.63	0.5305	Tukey-Kramer	0.8043
24-26 HZ	-0.00829	0.01171	99.8	-0.71	0.4807	Tukey-Kramer	0.7593
26-28 HZ	-0.008784	0.01009	99.8	-0.87	0.386	Tukey-Kramer	0.6598
28-30 HZ	-0.008724	0.0079	114	-1.1	0.2718	Tukey-Kramer	0.5132
30-32 HZ	-0.006329	0.00579	136	-1.09	0.2762	Tukey-Kramer	0.5198

Subject ARP005 After Art Making Task to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.00679	0.01287	225	0.53	0.5981	Tukey-Kramer	0.8578
2-4 HZ	0.01149	0.01279	191	0.9	0.3701	Tukey-Kramer	0.6419
4-6 HZ	0.02634	0.01465	178	1.8	0.0739	Tukey-Kramer	0.1733
6-8 HZ	0.04931**	0.01955	162	2.52	0.0126	Tukey-Kramer	0.0336
8-10 HZ	0.04973	0.0215	176	2.31	0.0219	Tukey-Kramer	0.0566
10-12 HZ	0.01262	0.0216	197	0.58	0.5598	Tukey-Kramer	0.8288
12-14 HZ	-0.009267	0.01822	199	-0.51	0.6115	Tukey-Kramer	0.8672
14-16 HZ	-0.02123	0.01475	206	-1.44	0.1515	Tukey-Kramer	0.3224
16-18 HZ	-0.01603	0.01047	225	-1.53	0.1274	Tukey-Kramer	0.2788
18-20 HZ	0.0179	0.01084	217	1.65	0.1002	Tukey-Kramer	0.2267
20-22 HZ	0.04024*	0.01154	211	3.49	0.0006	Tukey-Kramer	0.0017
22-24 HZ	0.03567*	0.009836	194	3.63	0.0004	Tukey-Kramer	0.0011
24-26 HZ	0.03071*	0.008305	186	3.7	0.0003	Tukey-Kramer	0.0008
26-28 HZ	0.03287*	0.007061	187	4.66	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.03108*	0.005871	205	5.29	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.02429*	0.004794	217	5.07	<.0001	Tukey-Kramer	<.0001

Subject ARP005 After Art Making Task to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.01651	0.01303	238	1.27	0.2063	Tukey-Kramer	0.415
2-4 HZ	0.022	0.01363	198	1.61	0.1081	Tukey-Kramer	0.2419
4-6 HZ	0.03469*	0.01309	200	2.65	0.0087	Tukey-Kramer	0.0236
6-8 HZ	0.04798**	0.01526	190	3.14	0.0019	Tukey-Kramer	0.0055
8-10 HZ	0.031	0.01844	191	1.7	0.0901	Tukey-Kramer	0.2065
10-12 HZ	-0.007335	0.01945	220	-0.38	0.7064	Tukey-Kramer	0.9246
12-14 HZ	-0.02267	0.01629	226	-1.39	0.1653	Tukey-Kramer	0.3468
14-16 HZ	-0.02644	0.01328	229	-1.99	0.0476	Tukey-Kramer	0.1166
16-18 HZ	-0.01115	0.009658	228	-1.15	0.2496	Tukey-Kramer	0.4819
18-20 HZ	0.02888*	0.009819	228	2.94	0.0036	Tukey-Kramer	0.0101
20-22 HZ	0.04162*	0.01044	220	3.99	<.0001	Tukey-Kramer	0.0003
22-24 HZ	0.03031*	0.0087	226	3.48	0.0006	Tukey-Kramer	0.0017
24-26 HZ	0.01939*	0.007078	217	2.74	0.0067	Tukey-Kramer	0.0182
26-28 HZ	0.01748*	0.005847	215	2.99	0.0031	Tukey-Kramer	0.0087
28-30 HZ	0.01764*	0.004995	214	3.53	0.0005	Tukey-Kramer	0.0015
30-32 HZ	0.01692*	0.004529	215	3.74	0.0002	Tukey-Kramer	0.0007

Subject ARP005 After Motor Tasks to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.01281	0.01298	232	-0.99	0.3249	Tukey-Kramer	0.5861
2-4 HZ	-0.00628	0.01317	209	-0.48	0.6334	Tukey-Kramer	0.8819
4-6 HZ	0.03323	0.01593	166	2.09	0.0385	Tukey-Kramer	0.0957
6-8 HZ	0.07733**	0.02066	145	3.74	0.0003	Tukey-Kramer	0.0007
8-10 HZ	0.07526**	0.02164	172	3.48	0.0006	Tukey-Kramer	0.0018
10-12 HZ	0.03732	0.02134	197	1.75	0.0819	Tukey-Kramer	0.1898
12-14 HZ	0.01488	0.01791	199	0.83	0.407	Tukey-Kramer	0.6843
14-16 HZ	-0.001406	0.01456	206	-0.1	0.9232	Tukey-Kramer	0.9949
16-18 HZ	-0.000232	0.01076	224	-0.02	0.9828	Tukey-Kramer	0.9997
18-20 HZ	0.03663*	0.0114	197	3.21	0.0015	Tukey-Kramer	0.0043
20-22 HZ	0.07213**	0.01161	207	6.21	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.07281**	0.009857	191	7.39	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.06325**	0.008072	192	7.84	<.0001	Tukey-Kramer	<.0001
26-28 HZ	0.04934**	0.006657	188	7.41	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.03163*	0.00529	199	5.98	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.02008*	0.004364	226	4.6	<.0001	Tukey-Kramer	<.0001

Subject ARP005 After Motor Tasks to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.0289	0.01276	236	-2.27	0.0242	Tukey-Kramer	0.0623
2-4 HZ	-0.02644	0.01314	210	-2.01	0.0455	Tukey-Kramer	0.1118
4-6 HZ	-0.001965	0.0139	191	-0.14	0.8877	Tukey-Kramer	0.989
6-8 HZ	0.03222	0.01646	161	1.96	0.052	Tukey-Kramer	0.1258
8-10 HZ	0.0321	0.01833	194	1.75	0.0814	Tukey-Kramer	0.1888
10-12 HZ	0.00638	0.01872	230	0.34	0.7336	Tukey-Kramer	0.938
12-14 HZ	-0.008123	0.01545	233	-0.53	0.5995	Tukey-Kramer	0.8588
14-16 HZ	-0.01548	0.01263	231	-1.23	0.2216	Tukey-Kramer	0.4393
16-18 HZ	-0.01059	0.009574	231	-1.11	0.27	Tukey-Kramer	0.5115
18-20 HZ	0.01973	0.01042	215	1.89	0.0596	Tukey-Kramer	0.1429
20-22 HZ	0.04101*	0.01073	206	3.82	0.0002	Tukey-Kramer	0.0005
22-24 HZ	0.03232*	0.008661	219	3.73	0.0002	Tukey-Kramer	0.0007
24-26 HZ	0.02008*	0.007076	215	2.84	0.005	Tukey-Kramer	0.0137
26-28 HZ	0.01522*	0.006	211	2.54	0.0119	Tukey-Kramer	0.0319
28-30 HZ	0.0147*	0.005272	209	2.79	0.0058	Tukey-Kramer	0.0159
30-32 HZ	0.01808*	0.004929	197	3.67	0.0003	Tukey-Kramer	0.0009

Subject ARP005 After Motor Tasks to After Art Making							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.0196	0.01251	240	-1.57	0.1185	Tukey-Kramer	0.2621
2-4 HZ	-0.01778	0.01326	194	-1.34	0.1816	Tukey-Kramer	0.3744
4-6 HZ	0.00689	0.01657	168	0.42	0.6781	Tukey-Kramer	0.9092
6-8 HZ	0.02802	0.02238	153	1.25	0.2125	Tukey-Kramer	0.4245
8-10 HZ	0.02553	0.02232	166	1.14	0.2543	Tukey-Kramer	0.4885
10-12 HZ	0.0247	0.01953	217	1.26	0.2073	Tukey-Kramer	0.4167
12-14 HZ	0.02415	0.01593	232	1.52	0.1308	Tukey-Kramer	0.2853
14-16 HZ	0.01982	0.0128	246	1.55	0.1226	Tukey-Kramer	0.27
16-18 HZ	0.0158	0.0104	226	1.52	0.1301	Tukey-Kramer	0.2839
18-20 HZ	0.01873	0.01195	198	1.57	0.1184	Tukey-Kramer	0.2617
20-22 HZ	0.03189*	0.012	198	2.66	0.0085	Tukey-Kramer	0.023
22-24 HZ	0.03714*	0.0105	186	3.54	0.0005	Tukey-Kramer	0.0015
24-26 HZ	0.03254*	0.008485	187	3.84	0.0002	Tukey-Kramer	0.0005
26-28 HZ	0.01647*	0.00653	204	2.52	0.0124	Tukey-Kramer	0.0332
28-30 HZ	0.00055	0.005314	213	0.1	0.9175	Tukey-Kramer	0.9941
30-32 HZ	-0.004208	0.004547	221	-0.93	0.3557	Tukey-Kramer	0.6248

Subject ARP005 After Motor Tasks to After Art Making							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.04546**	0.01262	245	-3.6	0.0004	Tukey-Kramer	0.0011
2-4 HZ	-0.04844**	0.0132	212	-3.67	0.0003	Tukey-Kramer	0.0009
4-6 HZ	-0.03666*	0.01368	196	-2.68	0.008	Tukey-Kramer	0.0217
6-8 HZ	-0.01576	0.0169	168	-0.93	0.3524	Tukey-Kramer	0.6205
8-10 HZ	0.0007	0.01959	184	0.04	0.9715	Tukey-Kramer	0.9993
10-12 HZ	0.01371	0.01923	214	0.71	0.4765	Tukey-Kramer	0.7559
12-14 HZ	0.01455	0.01545	224	0.94	0.3473	Tukey-Kramer	0.6144
14-16 HZ	0.01097	0.01234	233	0.89	0.375	Tukey-Kramer	0.6478
16-18 HZ	0.00056	0.00956	230	0.06	0.9533	Tukey-Kramer	0.9981
18-20 HZ	-0.009149	0.01047	216	-0.87	0.3833	Tukey-Kramer	0.6575
20-22 HZ	-0.000615	0.0105	214	-0.06	0.9533	Tukey-Kramer	0.9981
22-24 HZ	0.002	0.008797	221	0.23	0.8202	Tukey-Kramer	0.9719
24-26 HZ	0.00069	0.007339	210	0.09	0.9254	Tukey-Kramer	0.9952
26-28 HZ	-0.002264	0.00591	210	-0.38	0.702	Tukey-Kramer	0.9223
28-30 HZ	-0.002942	0.005038	214	-0.58	0.5599	Tukey-Kramer	0.8289
30-32 HZ	0.00116	0.004797	198	0.24	0.8098	Tukey-Kramer	0.9685

Subject ARP006 After Art Making Task to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.04105*	0.01023	229	4.01	<.0001	Tukey-Kramer	0.0002
2-4 HZ	0.04399*	0.011	201	4	<.0001	Tukey-Kramer	0.0003
4-6 HZ	0.07113**	0.01077	190	6.61	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.1211**	0.01252	189	9.68	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.1365**	0.01593	166	8.57	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.113**	0.01696	152	6.66	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.0891**	0.0139	154	6.41	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.06479**	0.01127	154	5.75	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.04231*	0.009388	169	4.51	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.03989*	0.009279	164	4.3	<.0001	Tukey-Kramer	<.0001
20-22 HZ	0.03732*	0.008049	166	4.64	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.03028*	0.006819	169	4.44	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.02477*	0.005816	172	4.26	<.0001	Tukey-Kramer	<.0001
26-28 HZ	0.02128*	0.004977	171	4.28	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.01719*	0.004386	172	3.92	0.0001	Tukey-Kramer	0.0004
30-32 HZ	0.01323*	0.00402	157	3.29	0.0012	Tukey-Kramer	0.0034

Subject ARP006 After Art Making Task to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.04844**	0.01146	195	4.23	<.0001	Tukey-Kramer	0.0001
2-4 HZ	0.04599**	0.01421	161	3.24	0.0015	Tukey-Kramer	0.0041
4-6 HZ	0.06418**	0.01307	159	4.91	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.1028**	0.01237	173	8.31	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.1165**	0.01407	161	8.28	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.09392**	0.01402	149	6.7	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.07496**	0.01178	152	6.36	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.05117**	0.00953	165	5.37	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.03616*	0.008498	187	4.26	<.0001	Tukey-Kramer	0.0001
18-20 HZ	0.03678*	0.00781	192	4.71	<.0001	Tukey-Kramer	<.0001
20-22 HZ	0.0367*	0.006678	187	5.5	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.03241*	0.005718	186	5.67	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.02788*	0.004928	202	5.66	<.0001	Tukey-Kramer	<.0001
26-28 HZ	0.02486*	0.00423	215	5.88	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.02105*	0.003872	193	5.44	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.01794*	0.003688	171	4.87	<.0001	Tukey-Kramer	<.0001

Subject ARP006 After Motor Tasks to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.02839*	0.01074	218	2.64	0.0088	Tukey-Kramer	0.0238
2-4 HZ	0.04674**	0.01276	193	3.66	0.0003	Tukey-Kramer	0.0009
4-6 HZ	0.06875**	0.01216	191	5.66	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.0968**	0.01319	180	7.34	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.08004**	0.01753	144	4.57	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.03594	0.02058	107	1.75	0.0836	Tukey-Kramer	0.192
12-14 HZ	0.01784	0.01817	87.5	0.98	0.3288	Tukey-Kramer	0.5897
14-16 HZ	-0.002109	0.0165	68	-0.13	0.8987	Tukey-Kramer	0.991
16-18 HZ	-0.009285	0.01218	95.5	-0.76	0.4477	Tukey-Kramer	0.7267
18-20 HZ	0.00088	0.01033	131	0.08	0.9325	Tukey-Kramer	0.996
20-22 HZ	0.00718	0.008849	142	0.81	0.4187	Tukey-Kramer	0.6968
22-24 HZ	0.0086	0.007513	152	1.14	0.2543	Tukey-Kramer	0.4883
24-26 HZ	0.01225	0.006425	167	1.91	0.0583	Tukey-Kramer	0.1398
26-28 HZ	0.01582*	0.005575	176	2.84	0.0051	Tukey-Kramer	0.014
28-30 HZ	0.01706*	0.004975	180	3.43	0.0008	Tukey-Kramer	0.0022
30-32 HZ	0.01636*	0.004615	177	3.54	0.0005	Tukey-Kramer	0.0015

Subject ARP006 After Motor Tasks to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.04071*	0.01073	224	3.79	0.0002	Tukey-Kramer	0.0006
2-4 HZ	0.05294**	0.01433	179	3.7	0.0003	Tukey-Kramer	0.0009
4-6 HZ	0.06725**	0.01305	170	5.15	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.08616**	0.01233	179	6.99	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.07726**	0.0153	141	5.05	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.04462*	0.01635	113	2.73	0.0074	Tukey-Kramer	0.0196
12-14 HZ	0.02834	0.01465	102	1.93	0.0559	Tukey-Kramer	0.1333
14-16 HZ	0.00587	0.0127	97.9	0.46	0.6447	Tukey-Kramer	0.8889
16-18 HZ	-0.002943	0.01044	129	-0.28	0.7784	Tukey-Kramer	0.9571
18-20 HZ	0.00358	0.008872	149	0.4	0.6868	Tukey-Kramer	0.914
20-22 HZ	0.00959	0.007593	144	1.26	0.2086	Tukey-Kramer	0.4182
22-24 HZ	0.01311	0.006498	146	2.02	0.0454	Tukey-Kramer	0.1111
24-26 HZ	0.0151*	0.005558	159	2.72	0.0073	Tukey-Kramer	0.0197
26-28 HZ	0.01656*	0.00495	165	3.35	0.001	Tukey-Kramer	0.0029
28-30 HZ	0.01823*	0.004506	171	4.05	<.0001	Tukey-Kramer	0.0002
30-32 HZ	0.01823*	0.004104	177	5.03	<.0001	Tukey-Kramer	<.0001

Subject ARP006 After Motor Tasks to After Art Making							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.01266	0.01102	221	-1.15	0.2519	Tukey-Kramer	0.4852
2-4 HZ	0.00275	0.01238	194	0.22	0.8244	Tukey-Kramer	0.9732
4-6 HZ	-0.002377	0.01157	196	-0.21	0.8374	Tukey-Kramer	0.977
6-8 HZ	-0.02433	0.01323	183	-1.84	0.0676	Tukey-Kramer	0.1599
8-10 HZ	-0.05649**	0.01796	148	-3.14	0.002	Tukey-Kramer	0.0056
10-12 HZ	-0.07702**	0.02069	108	-3.72	0.0003	Tukey-Kramer	0.0009
12-14 HZ	-0.07126**	0.01835	89.3	-3.88	0.0002	Tukey-Kramer	0.0005
14-16 HZ	-0.0669**	0.01635	65.9	-4.09	0.0001	Tukey-Kramer	0.0003
16-18 HZ	-0.0516**	0.01258	102	-4.1	<.0001	Tukey-Kramer	0.0002
18-20 HZ	-0.03902*	0.01077	133	-3.62	0.0004	Tukey-Kramer	0.0012
20-22 HZ	-0.03014*	0.008756	136	-3.44	0.0008	Tukey-Kramer	0.0021
22-24 HZ	-0.02168*	0.007138	150	-3.04	0.0028	Tukey-Kramer	0.0078
24-26 HZ	-0.01252	0.005815	171	-2.15	0.0327	Tukey-Kramer	0.0824
26-28 HZ	-0.005462	0.004838	177	-1.13	0.2604	Tukey-Kramer	0.4975
28-30 HZ	-0.000131	0.004225	170	-0.03	0.9753	Tukey-Kramer	0.9995
30-32 HZ	0.00313	0.003783	164	0.83	0.4097	Tukey-Kramer	0.6871

Subject ARP006 After Motor Tasks to After Art Making							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.007734	0.01175	202	-0.66	0.5113	Tukey-Kramer	0.788
2-4 HZ	0.00695	0.01363	190	0.51	0.6106	Tukey-Kramer	0.8666
4-6 HZ	0.00308	0.01215	191	0.25	0.8004	Tukey-Kramer	0.9653
6-8 HZ	-0.01664	0.01252	177	-1.33	0.1854	Tukey-Kramer	0.3807
8-10 HZ	-0.03919*	0.01611	145	-2.43	0.0162	Tukey-Kramer	0.0424
10-12 HZ	-0.04931**	0.01738	123	-2.84	0.0053	Tukey-Kramer	0.0145
12-14 HZ	-0.04662**	0.01528	110	-3.05	0.0029	Tukey-Kramer	0.0078
14-16 HZ	-0.0453**	0.01291	101	-3.51	0.0007	Tukey-Kramer	0.0018
16-18 HZ	-0.03911*	0.01042	128	-3.75	0.0003	Tukey-Kramer	0.0007
18-20 HZ	-0.03319*	0.008918	147	-3.72	0.0003	Tukey-Kramer	0.0008
20-22 HZ	-0.02711*	0.007637	141	-3.55	0.0005	Tukey-Kramer	0.0015
22-24 HZ	-0.0193*	0.006534	142	-2.95	0.0037	Tukey-Kramer	0.0101
24-26 HZ	-0.01278	0.005631	157	-2.27	0.0246	Tukey-Kramer	0.0628
26-28 HZ	-0.008299	0.00484	157	-1.71	0.0884	Tukey-Kramer	0.2024
28-30 HZ	-0.002817	0.004231	158	-0.67	0.5065	Tukey-Kramer	0.7836
30-32 HZ	0.00271	0.003731	173	0.73	0.4692	Tukey-Kramer	0.7488

Subject ARP007 After Art Making Task to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.01496	0.009725	230	1.54	0.1254	Tukey-Kramer	0.275
2-4 HZ	0.01876	0.009641	216	1.95	0.053	Tukey-Kramer	0.1285
4-6 HZ	0.02387*	0.009912	208	2.41	0.0169	Tukey-Kramer	0.0443
6-8 HZ	0.02275	0.01401	171	1.62	0.1062	Tukey-Kramer	0.238
8-10 HZ	0.02891	0.01863	181	1.55	0.1225	Tukey-Kramer	0.2691
10-12 HZ	0.03052	0.01961	204	1.56	0.1212	Tukey-Kramer	0.2669
12-14 HZ	0.02712	0.01627	211	1.67	0.0971	Tukey-Kramer	0.2203
14-16 HZ	0.02462	0.01261	220	1.95	0.0522	Tukey-Kramer	0.1266
16-18 HZ	0.03178*	0.008396	219	3.79	0.0002	Tukey-Kramer	0.0006
18-20 HZ	0.02209*	0.008626	211	2.56	0.0111	Tukey-Kramer	0.0297
20-22 HZ	0.01879*	0.007805	196	2.41	0.017	Tukey-Kramer	0.0443
22-24 HZ	0.02048*	0.005799	230	3.53	0.0005	Tukey-Kramer	0.0014
24-26 HZ	0.01617*	0.004502	224	3.59	0.0004	Tukey	0.0012
26-28 HZ	0.01178*	0.003922	213	3	0.003	Tukey-Kramer	0.0083
28-30 HZ	0.00851	0.003868	213	2.2	0.0289	Tukey-Kramer	0.0734
30-32 HZ	0.00875*	0.003502	213	2.5	0.0132	Tukey-Kramer	0.0351

Subject ARP007 After Art Making Task to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.01724	0.008921	219	1.93	0.0545	Tukey-Kramer	0.1319
2-4 HZ	0.01507	0.008634	206	1.75	0.0825	Tukey-Kramer	0.191
4-6 HZ	0.01903	0.00913	189	2.08	0.0384	Tukey-Kramer	0.0955
6-8 HZ	0.02341	0.01344	166	1.74	0.0834	Tukey-Kramer	0.1924
8-10 HZ	0.02616	0.01826	182	1.43	0.1536	Tukey-Kramer	0.3259
10-12 HZ	0.02577	0.01967	208	1.31	0.1916	Tukey-Kramer	0.3911
12-14 HZ	0.02309	0.01654	216	1.4	0.164	Tukey-Kramer	0.3444
14-16 HZ	0.02091	0.01329	226	1.57	0.117	Tukey-Kramer	0.2592
16-18 HZ	0.02889*	0.008763	214	3.3	0.0011	Tukey-Kramer	0.0033
18-20 HZ	0.02199*	0.008	215	2.75	0.0065	Tukey-Kramer	0.0178
20-22 HZ	0.02894*	0.007509	208	3.85	0.0002	Tukey-Kramer	0.0004
22-24 HZ	0.0279*	0.006271	216	4.45	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.02346*	0.004944	219	4.75	<.0001	Tukey-Kramer	<.0001
26-28 HZ	0.01715*	0.004088	214	4.2	<.0001	Tukey-Kramer	0.0001
28-30 HZ	0.01222*	0.003805	208	3.21	0.0015	Tukey-Kramer	0.0043
30-32 HZ	0.01158*	0.003388	216	3.42	0.0008	Tukey	0.0022

Subject ARP007 After Motor Tasks to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.02712*	0.009738	232	2.78	0.0058	Tukey-Kramer	0.0159
2-4 HZ	0.03491*	0.009511	219	3.67	0.0003	Tukey-Kramer	0.0009
4-6 HZ	0.05418**	0.009858	218	5.5	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.0658**	0.01442	179	4.56	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.06617**	0.01901	185	3.48	0.0006	Tukey-Kramer	0.0018
10-12 HZ	0.05705**	0.01993	204	2.86	0.0046	Tukey-Kramer	0.0127
12-14 HZ	0.04761**	0.01654	210	2.88	0.0044	Tukey-Kramer	0.0121
14-16 HZ	0.03692*	0.01278	216	2.89	0.0043	Tukey-Kramer	0.0117
16-18 HZ	0.03813*	0.008582	213	4.44	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.03459*	0.007731	254	4.47	<.0001	Tukey-Kramer	<.0001
20-22 HZ	0.03547*	0.007037	255	5.04	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.03243*	0.005587	238	5.8	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.02573*	0.004351	220	5.91	<.0001	Tukey	<.0001
26-28 HZ	0.01988*	0.003812	212	5.22	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.01826*	0.003794	214	4.81	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.01984*	0.003536	212	5.61	<.0001	Tukey-Kramer	<.0001

Subject ARP007 After Motor Tasks to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.03099*	0.008388	232	3.7	0.0003	Tukey-Kramer	0.0008
2-4 HZ	0.03351*	0.008908	207	3.76	0.0002	Tukey-Kramer	0.0006
4-6 HZ	0.04859**	0.00921	197	5.28	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.0698**	0.01326	163	5.27	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.07154**	0.0175	167	4.09	<.0001	Tukey-Kramer	0.0002
10-12 HZ	0.06131**	0.01896	196	3.23	0.0014	Tukey-Kramer	0.004
12-14 HZ	0.05138**	0.01581	203	3.25	0.0014	Tukey-Kramer	0.0038
14-16 HZ	0.03974*	0.0126	215	3.15	0.0018	Tukey-Kramer	0.0052
16-18 HZ	0.03495*	0.008435	212	4.14	<.0001	Tukey-Kramer	0.0001
18-20 HZ	0.02891*	0.008162	219	3.54	0.0005	Tukey-Kramer	0.0014
20-22 HZ	0.03398*	0.007334	225	4.63	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.03747*	0.005869	230	6.38	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.03309*	0.004652	228	7.11	<.0001	Tukey-Kramer	<.0001
26-28 HZ	0.0309*	0.003916	214	7.89	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.03061*	0.003723	203	8.22	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.03142*	0.003437	212	9.14	<.0001	Tukey	<.0001

Subject ARP007 After Motor Tasks to After Art Making							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.01216	0.009509	235	1.28	0.2023	Tukey-Kramer	0.4087
2-4 HZ	0.01615	0.00962	219	1.68	0.0946	Tukey-Kramer	0.2156
4-6 HZ	0.03031*	0.009751	218	3.11	0.0021	Tukey-Kramer	0.006
6-8 HZ	0.04305*	0.01228	223	3.51	0.0005	Tukey-Kramer	0.0016
8-10 HZ	0.03726*	0.01572	234	2.37	0.0186	Tukey-Kramer	0.0488
10-12 HZ	0.02653	0.01714	239	1.55	0.123	Tukey-Kramer	0.2707
12-14 HZ	0.0205	0.01453	238	1.41	0.1597	Tukey-Kramer	0.3373
14-16 HZ	0.0123	0.01159	238	1.06	0.2894	Tukey-Kramer	0.5388
16-18 HZ	0.00635	0.007971	239	0.8	0.4263	Tukey-Kramer	0.7053
18-20 HZ	0.0125	0.008567	224	1.46	0.146	Tukey-Kramer	0.3128
20-22 HZ	0.01668	0.008113	213	2.06	0.041	Tukey-Kramer	0.1015
22-24 HZ	0.01195	0.005719	236	2.09	0.0377	Tukey-Kramer	0.0942
24-26 HZ	0.00956	0.004414	224	2.17	0.0313	Tukey	0.0792
26-28 HZ	0.0081	0.003729	228	2.17	0.0309	Tukey-Kramer	0.0783
28-30 HZ	0.00975*	0.003695	232	2.64	0.0089	Tukey-Kramer	0.0241
30-32 HZ	0.01109*	0.003339	237	3.32	0.001	Tukey-Kramer	0.003

Subject ARP007 After Motor Tasks to After Art Making							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.01375	0.00865	221	1.59	0.1133	Tukey-Kramer	0.2521
2-4 HZ	0.01844	0.008838	216	2.09	0.0381	Tukey-Kramer	0.095
4-6 HZ	0.02956*	0.008615	223	3.43	0.0007	Tukey-Kramer	0.0021
6-8 HZ	0.04639**	0.01093	226	4.25	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.04538**	0.01444	231	3.14	0.0019	Tukey-Kramer	0.0054
10-12 HZ	0.03554	0.01665	236	2.13	0.0338	Tukey-Kramer	0.0853
12-14 HZ	0.02828	0.01423	236	1.99	0.0481	Tukey-Kramer	0.1178
14-16 HZ	0.01883	0.01188	232	1.58	0.1145	Tukey-Kramer	0.2545
16-18 HZ	0.00606	0.008311	216	0.73	0.467	Tukey-Kramer	0.7468
18-20 HZ	0.00692	0.008619	224	0.8	0.4229	Tukey-Kramer	0.7016
20-22 HZ	0.00504	0.00789	216	0.64	0.524	Tukey-Kramer	0.7992
22-24 HZ	0.00956	0.006207	212	1.54	0.1248	Tukey-Kramer	0.2739
24-26 HZ	0.00962	0.004852	213	1.98	0.0486	Tukey-Kramer	0.1187
26-28 HZ	0.01375*	0.003922	220	3.51	0.0006	Tukey-Kramer	0.0016
28-30 HZ	0.01839*	0.003571	237	5.15	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.01984*	0.003322	228	5.97	<.0001	Tukey	<.0001

Subject ARP008 After Art Making Task to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.01349	0.009765	211	-1.38	0.1686	Tukey-Kramer	0.3524
2-4 HZ	-0.0252	0.01161	176	-2.17	0.0312	Tukey-Kramer	0.0789
4-6 HZ	0.00637	0.01073	183	0.59	0.5537	Tukey-Kramer	0.8239
6-8 HZ	0.07631**	0.01795	132	4.25	<.0001	Tukey-Kramer	0.0001
8-10 HZ	0.102**	0.02589	121	3.94	0.0001	Tukey-Kramer	0.0004
10-12 HZ	0.08651**	0.02757	110	3.14	0.0022	Tukey-Kramer	0.0061
12-14 HZ	0.06716**	0.02301	108	2.92	0.0043	Tukey-Kramer	0.0118
14-16 HZ	0.03855	0.01723	109	2.24	0.0273	Tukey-Kramer	0.0696
16-18 HZ	0.01405	0.008926	159	1.57	0.1175	Tukey-Kramer	0.26
18-20 HZ	0.033*	0.007157	173	4.61	<.0001	Tukey-Kramer	<.0001
20-22 HZ	0.03595*	0.007327	163	4.91	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.02577*	0.007458	132	3.45	0.0007	Tukey-Kramer	0.0022
24-26 HZ	0.01269	0.005723	145	2.22	0.0281	Tukey-Kramer	0.0717
26-28 HZ	0.00563	0.004061	182	1.39	0.1677	Tukey-Kramer	0.3508
28-30 HZ	0.00508	0.003409	202	1.49	0.1375	Tukey-Kramer	0.2972
30-32 HZ	0.00487	0.003101	199	1.57	0.1177	Tukey	0.2603

Subject ARP008 After Art Making Task to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.02425	0.01173	192	-2.07	0.0401	Tukey-Kramer	0.0995
2-4 HZ	-0.03126	0.01373	162	-2.28	0.0241	Tukey-Kramer	0.0619
4-6 HZ	-0.000529	0.01206	169	-0.04	0.9651	Tukey-Kramer	0.9989
6-8 HZ	0.06308**	0.01697	132	3.72	0.0003	Tukey-Kramer	0.0008
8-10 HZ	0.09325**	0.02272	123	4.1	<.0001	Tukey-Kramer	0.0002
10-12 HZ	0.08504**	0.02355	116	3.61	0.0005	Tukey-Kramer	0.0013
12-14 HZ	0.06696**	0.01967	114	3.4	0.0009	Tukey-Kramer	0.0026
14-16 HZ	0.04079*	0.01476	113	2.76	0.0067	Tukey-Kramer	0.0182
16-18 HZ	0.01311	0.007541	159	1.74	0.084	Tukey-Kramer	0.194
18-20 HZ	0.01978*	0.006001	189	3.3	0.0012	Tukey-Kramer	0.0033
20-22 HZ	0.02723*	0.006158	164	4.42	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.0202*	0.005901	143	3.42	0.0008	Tukey-Kramer	0.0024
24-26 HZ	0.00918	0.004535	153	2.02	0.0447	Tukey-Kramer	0.1101
26-28 HZ	0.00435	0.003493	173	1.25	0.2143	Tukey	0.4275
28-30 HZ	0.00559	0.003241	183	1.73	0.0861	Tukey	0.1983
30-32 HZ	0.0072	0.003289	172	2.19	0.03	Tukey	0.0759

Subject ARP008 After Motor Tasks to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.01403	0.009454	206	-1.48	0.1395	Tukey-Kramer	0.3008
2-4 HZ	-0.02755*	0.01079	183	-2.55	0.0115	Tukey-Kramer	0.0308
4-6 HZ	-0.002488	0.01014	190	-0.25	0.8065	Tukey-Kramer	0.9674
6-8 HZ	0.06742**	0.01651	150	4.08	<.0001	Tukey-Kramer	0.0002
8-10 HZ	0.1002**	0.02504	125	4	0.0001	Tukey-Kramer	0.0003
10-12 HZ	0.09142**	0.02777	109	3.29	0.0013	Tukey-Kramer	0.0038
12-14 HZ	0.0727**	0.02338	107	3.11	0.0024	Tukey-Kramer	0.0067
14-16 HZ	0.04666**	0.01795	105	2.6	0.0107	Tukey-Kramer	0.0285
16-18 HZ	0.01818	0.008868	157	2.05	0.042	Tukey-Kramer	0.1038
18-20 HZ	0.03419*	0.006987	186	4.89	<.0001	Tukey-Kramer	<.0001
20-22 HZ	0.03578*	0.008354	122	4.28	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.02715*	0.008335	109	3.26	0.0015	Tukey-Kramer	0.0041
24-26 HZ	0.01687*	0.006192	131	2.72	0.0073	Tukey-Kramer	0.0198
26-28 HZ	0.01126*	0.00436	174	2.58	0.0106	Tukey-Kramer	0.0285
28-30 HZ	0.01088*	0.003746	200	2.9	0.0041	Tukey-Kramer	0.0114
30-32 HZ	0.01121*	0.003324	212	3.37	0.0009	Tukey	0.0025

Subject ARP008 After Motor Tasks to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.01917	0.01066	215	-1.8	0.0736	Tukey-Kramer	0.1729
2-4 HZ	-0.0159	0.01267	169	-1.25	0.2113	Tukey-Kramer	0.4229
4-6 HZ	-0.000278	0.01064	192	-0.03	0.9792	Tukey-Kramer	0.9996
6-8 HZ	0.04657**	0.01522	155	3.06	0.0026	Tukey-Kramer	0.0074
8-10 HZ	0.07887**	0.02124	132	3.71	0.0003	Tukey-Kramer	0.0009
10-12 HZ	0.07762**	0.0228	115	3.4	0.0009	Tukey-Kramer	0.0026
12-14 HZ	0.06226**	0.0192	112	3.24	0.0016	Tukey-Kramer	0.0044
14-16 HZ	0.04087*	0.01447	109	2.82	0.0056	Tukey-Kramer	0.0154
16-18 HZ	0.01313	0.00747	154	1.76	0.0809	Tukey-Kramer	0.1875
18-20 HZ	0.0097	0.00608	184	1.6	0.1123	Tukey-Kramer	0.25
20-22 HZ	0.01962*	0.006508	147	3.01	0.003	Tukey-Kramer	0.0084
22-24 HZ	0.01749*	0.00639	126	2.74	0.0071	Tukey-Kramer	0.0192
24-26 HZ	0.01145*	0.00483	146	2.37	0.0191	Tukey-Kramer	0.0498
26-28 HZ	0.00913*	0.003581	178	2.55	0.0116	Tukey	0.0312
28-30 HZ	0.00981*	0.003276	191	3	0.0031	Tukey	0.0087
30-32 HZ	0.00928*	0.003262	186	2.84	0.005	Tukey	0.0137

Subject ARP008 After Motor Tasks to After Art Making							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.000537	0.008868	241	-0.06	0.9517	Tukey-Kramer	0.998
2-4 HZ	-0.00235	0.01082	172	-0.22	0.8284	Tukey-Kramer	0.9743
4-6 HZ	-0.008854	0.01079	185	-0.82	0.4127	Tukey-Kramer	0.6905
6-8 HZ	-0.008882	0.01906	141	-0.47	0.6419	Tukey-Kramer	0.8873
8-10 HZ	-0.001798	0.02581	125	-0.07	0.9446	Tukey-Kramer	0.9973
10-12 HZ	0.00491	0.02608	117	0.19	0.8511	Tukey-Kramer	0.9807
12-14 HZ	0.00554	0.02175	115	0.25	0.7993	Tukey-Kramer	0.9649
14-16 HZ	0.00811	0.01643	108	0.49	0.6226	Tukey-Kramer	0.8745
16-18 HZ	0.00413	0.008822	154	0.47	0.64	Tukey-Kramer	0.8861
18-20 HZ	0.0012	0.008105	189	0.15	0.8828	Tukey-Kramer	0.9881
20-22 HZ	-0.000173	0.008957	138	-0.02	0.9846	Tukey-Kramer	0.9998
22-24 HZ	0.00139	0.008454	112	0.16	0.8701	Tukey-Kramer	0.9853
24-26 HZ	0.00418	0.006163	130	0.68	0.4993	Tukey-Kramer	0.777
26-28 HZ	0.00564	0.004233	176	1.33	0.1848	Tukey-Kramer	0.3797
28-30 HZ	0.0058	0.00362	201	1.6	0.1109	Tukey-Kramer	0.2474
30-32 HZ	0.00633	0.003188	216	1.99	0.0482	Tukey	0.1179

Subject ARP008 After Motor Tasks to After Art Making							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.00508	0.01153	175	0.44	0.66	Tukey-Kramer	0.8986
2-4 HZ	0.01537	0.01406	152	1.09	0.276	Tukey-Kramer	0.5196
4-6 HZ	0.00025	0.01217	167	0.02	0.9836	Tukey-Kramer	0.9998
6-8 HZ	-0.0165	0.01774	138	-0.93	0.3537	Tukey-Kramer	0.6219
8-10 HZ	-0.01438	0.02307	122	-0.62	0.5341	Tukey-Kramer	0.8075
10-12 HZ	-0.00742	0.02296	116	-0.32	0.7472	Tukey-Kramer	0.9441
12-14 HZ	-0.004702	0.01913	115	-0.25	0.8063	Tukey-Kramer	0.9673
14-16 HZ	0.00008	0.01416	115	0.01	0.9957	Tukey-Kramer	1
16-18 HZ	0.00001	0.00757	160	0	0.9986	Tukey-Kramer	1
18-20 HZ	-0.01007	0.006492	196	-1.55	0.1223	Tukey-Kramer	0.2693
20-22 HZ	-0.007606	0.006817	156	-1.12	0.2662	Tukey-Kramer	0.5058
22-24 HZ	-0.002713	0.006399	129	-0.42	0.6724	Tukey-Kramer	0.9058
24-26 HZ	0.00227	0.004755	143	0.48	0.6342	Tukey-Kramer	0.8823
26-28 HZ	0.00477	0.00362	169	1.32	0.1891	Tukey	0.3868
28-30 HZ	0.00422	0.003318	184	1.27	0.2049	Tukey	0.4127
30-32 HZ	0.00208	0.003275	182	0.64	0.5259	Tukey	0.8008

Subject ARP009 After Art Making Task to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.00735	0.0164	197	0.45	0.6545	Tukey-Kramer	0.8952
2-4 HZ	0.01272	0.01771	198	0.72	0.4733	Tukey-Kramer	0.7528
4-6 HZ	0.01505	0.01499	197	1	0.3164	Tukey-Kramer	0.5749
6-8 HZ	0.04038*	0.01463	188	2.76	0.0063	Tukey-Kramer	0.0172
8-10 HZ	0.06858**	0.02004	196	3.42	0.0008	Tukey-Kramer	0.0022
10-12 HZ	0.07819**	0.02144	199	3.65	0.0003	Tukey-Kramer	0.001
12-14 HZ	0.06489**	0.01787	199	3.63	0.0004	Tukey-Kramer	0.001
14-16 HZ	0.04824**	0.01423	195	3.39	0.0008	Tukey-Kramer	0.0024
16-18 HZ	0.01653	0.009833	191	1.68	0.0945	Tukey-Kramer	0.2151
18-20 HZ	-0.005707	0.008027	225	-0.71	0.4779	Tukey-Kramer	0.7573
20-22 HZ	-0.004017	0.007369	227	-0.55	0.5862	Tukey-Kramer	0.8491
22-24 HZ	0.00183	0.006438	217	0.28	0.7767	Tukey-Kramer	0.9565
24-26 HZ	0.00196	0.005465	203	0.36	0.72	Tukey-Kramer	0.9315
26-28 HZ	0.00161	0.004774	189	0.34	0.7368	Tukey-Kramer	0.9395
28-30 HZ	0.00411	0.004207	195	0.98	0.3298	Tukey-Kramer	0.5923
30-32 HZ	0.00643	0.00382	209	1.68	0.0941	Tukey-Kramer	0.2144

Subject ARP009 After Art Making Task to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.00517	0.01589	198	0.33	0.7453	Tukey-Kramer	0.9434
2-4 HZ	0.02776	0.01812	196	1.53	0.1272	Tukey-Kramer	0.2782
4-6 HZ	0.03028	0.01623	190	1.87	0.0635	Tukey-Kramer	0.1512
6-8 HZ	0.03069	0.01617	173	1.9	0.0594	Tukey-Kramer	0.1423
8-10 HZ	0.02914	0.01907	186	1.53	0.1282	Tukey-Kramer	0.2803
10-12 HZ	0.01939	0.01914	195	1.01	0.3124	Tukey-Kramer	0.5698
12-14 HZ	0.00995	0.01594	195	0.62	0.5332	Tukey-Kramer	0.807
14-16 HZ	-2.3206	0.01277	191	0	0.9999	Tukey-Kramer	1
16-18 HZ	-0.01107	0.009201	191	-1.2	0.2305	Tukey-Kramer	0.4528
18-20 HZ	-0.009259	0.007286	224	-1.27	0.2051	Tukey-Kramer	0.4131
20-22 HZ	0.00331	0.006285	226	0.53	0.5989	Tukey-Kramer	0.8583
22-24 HZ	0.0079	0.005484	210	1.44	0.151	Tukey-Kramer	0.3216
24-26 HZ	0.00434	0.004628	207	0.94	0.35	Tukey-Kramer	0.6177
26-28 HZ	0.00493	0.003937	205	1.25	0.2117	Tukey-Kramer	0.4236
28-30 HZ	0.0081	0.003571	213	2.27	0.0242	Tukey-Kramer	0.0624
30-32 HZ	0.01252*	0.003494	206	3.58	0.0004	Tukey-Kramer	0.0012

Subject ARP009 After Motor Tasks to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.01764	0.01627	208	-1.08	0.2794	Tukey-Kramer	0.5248
2-4 HZ	-0.008248	0.01729	208	-0.48	0.6338	Tukey-Kramer	0.8822
4-6 HZ	0.00771	0.01493	209	0.52	0.6063	Tukey-Kramer	0.8635
6-8 HZ	0.04012*	0.01449	215	2.77	0.0061	Tukey-Kramer	0.0168
8-10 HZ	0.07379**	0.02052	201	3.6	0.0004	Tukey-Kramer	0.0012
10-12 HZ	0.08831**	0.02242	195	3.94	0.0001	Tukey-Kramer	0.0003
12-14 HZ	0.0773**	0.01853	201	4.17	<.0001	Tukey-Kramer	0.0001
14-16 HZ	0.06059**	0.01447	208	4.19	<.0001	Tukey-Kramer	0.0001
16-18 HZ	0.02621*	0.009392	229	2.79	0.0057	Tukey-Kramer	0.0158
18-20 HZ	-0.0064	0.007797	251	-0.83	0.4092	Tukey-Kramer	0.6868
20-22 HZ	-0.004134	0.007012	256	-0.59	0.556	Tukey-Kramer	0.8258
22-24 HZ	0.00157	0.006597	234	0.24	0.8124	Tukey-Kramer	0.9694
24-26 HZ	0.0014	0.005276	228	0.26	0.7913	Tukey-Kramer	0.962
26-28 HZ	-0.001637	0.004167	235	-0.39	0.6949	Tukey-Kramer	0.9185
28-30 HZ	-0.003653	0.003713	246	-0.98	0.3261	Tukey-Kramer	0.5878
30-32 HZ	-0.00374	0.003644	229	-1.03	0.3058	Tukey-Kramer	0.561

Subject ARP009 After Motor Tasks to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.003577	0.01415	231	-0.25	0.8006	Tukey-Kramer	0.9654
2-4 HZ	0.0121	0.01624	215	0.74	0.4572	Tukey-Kramer	0.7371
4-6 HZ	0.02223	0.01482	210	1.5	0.135	Tukey-Kramer	0.293
6-8 HZ	0.03364	0.01628	181	2.07	0.0402	Tukey-Kramer	0.0998
8-10 HZ	0.04495	0.02097	168	2.14	0.0335	Tukey-Kramer	0.0841
10-12 HZ	0.04821	0.02121	173	2.27	0.0243	Tukey-Kramer	0.0622
12-14 HZ	0.03915	0.01748	175	2.24	0.0264	Tukey-Kramer	0.0674
14-16 HZ	0.02823	0.01332	191	2.12	0.0354	Tukey-Kramer	0.0888
16-18 HZ	0.00841	0.008667	210	0.97	0.3331	Tukey-Kramer	0.5966
18-20 HZ	-0.004515	0.006955	249	-0.65	0.5168	Tukey-Kramer	0.793
20-22 HZ	0.00513	0.006563	222	0.78	0.4356	Tukey-Kramer	0.715
22-24 HZ	0.00981	0.005625	224	1.74	0.0824	Tukey-Kramer	0.191
24-26 HZ	0.00906	0.004504	217	2.01	0.0455	Tukey-Kramer	0.1119
26-28 HZ	0.00844	0.003875	207	2.18	0.0306	Tukey-Kramer	0.0775
28-30 HZ	0.01033*	0.00369	209	2.8	0.0056	Tukey-Kramer	0.0154
30-32 HZ	0.0127*	0.003629	205	3.5	0.0006	Tukey-Kramer	0.0017

Subject ARP009 After Motor Tasks to After Art Making							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.02499	0.0152	231	-1.64	0.1015	Tukey-Kramer	0.2295
2-4 HZ	-0.02097	0.01703	211	-1.23	0.2195	Tukey-Kramer	0.436
4-6 HZ	-0.007342	0.01479	213	-0.5	0.62	Tukey-Kramer	0.8731
6-8 HZ	-0.000263	0.01515	201	-0.02	0.9861	Tukey-Kramer	0.9998
8-10 HZ	0.00522	0.02158	199	0.24	0.8092	Tukey-Kramer	0.9683
10-12 HZ	0.01012	0.02318	195	0.44	0.663	Tukey-Kramer	0.9004
12-14 HZ	0.01241	0.01907	198	0.65	0.516	Tukey-Kramer	0.7922
14-16 HZ	0.01236	0.01481	201	0.83	0.405	Tukey-Kramer	0.682
16-18 HZ	0.00968	0.00975	206	0.99	0.3218	Tukey-Kramer	0.582
18-20 HZ	-0.00074	0.008149	241	-0.09	0.9278	Tukey-Kramer	0.9955
20-22 HZ	-0.000117	0.007323	240	-0.02	0.9873	Tukey-Kramer	0.9999
22-24 HZ	-0.000261	0.006618	226	-0.04	0.9686	Tukey-Kramer	0.9991
24-26 HZ	-0.000564	0.005268	212	-0.11	0.9149	Tukey-Kramer	0.9937
26-28 HZ	-0.003243	0.004481	178	-0.72	0.4701	Tukey-Kramer	0.7497
28-30 HZ	-0.007763	0.004024	188	-1.93	0.0552	Tukey-Kramer	0.133
30-32 HZ	-0.01017*	0.003638	216	-2.79	0.0057	Tukey-Kramer	0.0156

Subject ARP009 After Motor Tasks to After Art Making							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.008746	0.01608	202	-0.54	0.5871	Tukey-Kramer	0.8497
2-4 HZ	-0.01566	0.01777	190	-0.88	0.3792	Tukey-Kramer	0.6526
4-6 HZ	0.00025	0.01615	184	-0.5	0.6184	Tukey-Kramer	0.8719
6-8 HZ	-0.0165	0.01739	169	0.17	0.8655	Tukey-Kramer	0.9843
8-10 HZ	-0.01438	0.02139	165	0.74	0.4607	Tukey-Kramer	0.7404
10-12 HZ	0.02882	0.02144	169	1.34	0.1807	Tukey-Kramer	0.3726
12-14 HZ	0.0292	0.01762	171	1.66	0.0993	Tukey-Kramer	0.2246
14-16 HZ	0.02823	0.01341	183	2.11	0.0366	Tukey-Kramer	0.0914
16-18 HZ	0.01948	0.008866	196	2.2	0.0292	Tukey-Kramer	0.0742
18-20 HZ	0.00474	0.007451	229	0.64	0.525	Tukey-Kramer	0.8001
20-22 HZ	0.00182	0.007078	223	0.26	0.7977	Tukey-Kramer	0.9644
22-24 HZ	0.00191	0.005853	209	0.33	0.7445	Tukey-Kramer	0.943
24-26 HZ	0.00472	0.004368	216	1.08	0.2808	Tukey-Kramer	0.5268
26-28 HZ	0.0035	0.00362	220	0.97	0.3342	Tukey-Kramer	0.598
28-30 HZ	0.00223	0.0035	206	0.64	0.5248	Tukey-Kramer	0.7999
30-32 HZ	0.00018	0.003437	197	0.05	0.9588	Tukey-Kramer	0.9985

Subject ARP010 After Art Making Task to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.06202**	0.01007	197	6.16	<.0001	Tukey-Kramer	<.0001
2-4 HZ	0.07657**	0.01082	125	7.07	<.0001	Tukey-Kramer	<.0001
4-6 HZ	0.06787**	0.009333	133	7.27	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.08454**	0.01084	99	7.8	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.1457**	0.02185	64.4	6.67	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.1693**	0.02719	72.2	6.23	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.1454**	0.02272	80.8	6.4	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.1228**	0.01722	94.5	7.13	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.08853**	0.009986	135	8.87	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.07159**	0.007898	152	9.06	<.0001	Tukey-Kramer	<.0001
20-22 HZ	0.07417**	0.008068	129	9.19	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.06738**	0.007315	136	9.21	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.04909**	0.006039	162	8.13	<.0001	Tukey-Kramer	<.0001
26-28 HZ	0.03136*	0.004614	184	6.8	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.02556*	0.003635	202	7.03	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.02871*	0.003402	190	8.44	<.0001	Tukey-Kramer	<.0001

Subject ARP010 After Art Making Task to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.07849**	0.009914	214	7.92	<.0001	Tukey-Kramer	<.0001
2-4 HZ	0.0868**	0.00989	159	8.78	<.0001	Tukey-Kramer	<.0001
4-6 HZ	0.08066**	0.0088	163	9.17	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.1169**	0.01264	84.6	9.25	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.2149**	0.02547	67	8.44	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.2558**	0.0305	79.1	8.39	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.2286**	0.02538	89.8	9.01	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.1997**	0.01984	105	10.06	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.1543**	0.0135	137	11.43	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.1217**	0.01098	180	11.09	<.0001	Tukey-Kramer	<.0001
20-22 HZ	0.1139**	0.009884	178	11.53	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.09781**	0.008671	171	11.28	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.06802**	0.007349	173	9.26	<.0001	Tukey-Kramer	<.0001
26-28 HZ	0.04484*	0.005512	180	8.13	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.03724*	0.004594	152	8.11	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.04144*	0.004213	145	9.84	<.0001	Tukey-Kramer	<.0001

Subject ARP010 After Motor Tasks to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.05307**	0.009558	198	5.55	<.0001	Tukey-Kramer	<.0001
2-4 HZ	0.06925**	0.008407	167	8.24	<.0001	Tukey-Kramer	<.0001
4-6 HZ	0.07308**	0.008115	139	9.01	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.09624**	0.009982	107	9.64	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.1262**	0.01933	71	6.53	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.1177**	0.02596	67.4	4.53	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.09578**	0.02172	75.5	4.41	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.07593**	0.01655	91.7	4.59	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.0567**	0.009444	155	6	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.06018**	0.007923	153	7.6	<.0001	Tukey-Kramer	<.0001
20-22 HZ	0.06618**	0.007958	143	8.32	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.06192**	0.007407	143	8.36	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.05238**	0.006047	165	8.66	<.0001	Tukey-Kramer	<.0001
26-28 HZ	0.04308*	0.0047	175	9.17	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.03835*	0.003686	196	10.4	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.03624*	0.00331	207	10.95	<.0001	Tukey-Kramer	<.0001

Subject ARP010 After Motor Tasks to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.07092**	0.01011	189	7.02	<.0001	Tukey-Kramer	<.0001
2-4 HZ	0.09257**	0.009668	148	9.58	<.0001	Tukey-Kramer	<.0001
4-6 HZ	0.1027**	0.009254	135	11.1	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.1327**	0.01174	88.8	11.3	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.1651**	0.0234	61.5	7.06	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.1596**	0.03001	63.3	5.32	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.1353**	0.02477	74.9	5.46	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.1104**	0.02017	84.6	5.47	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.08831**	0.0145	109	6.09	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.08897**	0.01288	120	6.91	<.0001	Tukey-Kramer	<.0001
20-22 HZ	0.09226**	0.01217	111	7.58	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.08601**	0.01042	110	8.26	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.07176**	0.007359	154	9.75	<.0001	Tukey-Kramer	<.0001
26-28 HZ	0.05633**	0.004739	206	11.89	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.04716**	0.003604	215	13.08	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.04362*	0.003658	189	11.92	<.0001	Tukey-Kramer	<.0001

Subject ARP010 After Motor Tasks to After Art Making							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.008945	0.01097	208	-0.82	0.4159	Tukey-Kramer	0.694
2-4 HZ	-0.007318	0.01192	155	-0.61	0.54	Tukey-Kramer	0.8126
4-6 HZ	0.0052	0.01081	166	0.48	0.6309	Tukey-Kramer	0.8802
6-8 HZ	0.0117	0.01336	142	0.88	0.3826	Tukey-Kramer	0.6565
8-10 HZ	-0.01949	0.02714	100	-0.72	0.4744	Tukey-Kramer	0.7535
10-12 HZ	-0.05157	0.03413	97.5	-1.51	0.134	Tukey-Kramer	0.2908
12-14 HZ	-0.04959	0.02801	103	-1.77	0.0796	Tukey-Kramer	0.1851
14-16 HZ	-0.04683	0.02069	112	-2.26	0.0256	Tukey-Kramer	0.0655
16-18 HZ	-0.03183*	0.01123	151	-2.83	0.0052	Tukey-Kramer	0.0144
18-20 HZ	-0.0114	0.009531	178	-1.2	0.2332	Tukey-Kramer	0.457
20-22 HZ	-0.007987	0.009815	164	-0.81	0.4169	Tukey-Kramer	0.6951
22-24 HZ	-0.005455	0.008791	159	-0.62	0.5358	Tukey-Kramer	0.8091
24-26 HZ	0.00329	0.006719	165	0.49	0.6248	Tukey-Kramer	0.8762
26-28 HZ	0.01172*	0.004852	176	2.42	0.0167	Tukey-Kramer	0.0438
28-30 HZ	0.01278*	0.003777	198	3.38	0.0009	Tukey-Kramer	0.0025
30-32 HZ	0.00754	0.00351	197	2.15	0.033	Tukey-Kramer	0.0832

Subject ARP010 After Motor Tasks to After Art Making							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.007572	0.01092	208	-0.69	0.489	Tukey-Kramer	0.7677
2-4 HZ	0.00577	0.01154	172	0.5	0.6173	Tukey-Kramer	0.8711
4-6 HZ	0.02207	0.01073	166	2.06	0.0412	Tukey-Kramer	0.1019
6-8 HZ	0.01579	0.01605	131	0.98	0.3269	Tukey-Kramer	0.5885
8-10 HZ	-0.04979	0.03244	101	-1.53	0.128	Tukey-Kramer	0.2802
10-12 HZ	-0.09629**	0.0391	101	-2.46	0.0155	Tukey-Kramer	0.0413
12-14 HZ	-0.09335**	0.03175	109	-2.94	0.004	Tukey-Kramer	0.0113
14-16 HZ	-0.08927**	0.02469	115	-3.62	0.0004	Tukey-Kramer	0.0013
16-18 HZ	-0.06602**	0.01651	131	-4	0.0001	Tukey-Kramer	0.0003
18-20 HZ	-0.03272	0.01398	143	-2.34	0.0207	Tukey-Kramer	0.0534
20-22 HZ	-0.02168	0.0132	134	-1.64	0.1028	Tukey-Kramer	0.231
22-24 HZ	-0.0118	0.01135	133	-1.04	0.3005	Tukey-Kramer	0.5532
24-26 HZ	0.00373	0.008293	173	0.45	0.6531	Tukey-Kramer	0.8943
26-28 HZ	0.01149	0.005592	185	2.05	0.0413	Tukey-Kramer	0.1021
28-30 HZ	0.00992	0.004763	163	2.08	0.0388	Tukey-Kramer	0.0961
30-32 HZ	0.00217	0.004559	164	0.48	0.6341	Tukey-Kramer	0.8823

Table T1. This table details a pairwise comparison by subject, frequency and location, showing estimated mean differences of power after art making task to the baseline, after motor tasks to the baseline, and after motor tasks to after art making task for each subject. Cells with * indicate $p < 0.05$; cells with ** indicate $p < 0.05$ and have an estimated mean difference above 0.045 threshold.

Appendix U

Table U1: Pairwise Comparison by Frequency, Location

After Art Making Task to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.009165	0.004378	11,000	2.09	0.0364	Tukey-Kramer	0.0913
2-4 HZ	0.01339*	0.004889	11,000	2.74	0.0062	Tukey-Kramer	0.017
4-6 HZ	0.02539*	0.004458	11,000	5.69	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.06125**	0.005253	11,000	11.66	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.08797**	0.007447	11,000	0.7	0.4842	Tukey-Kramer	0.7637
10-12 HZ	0.07179**	0.007514	11,000	11.71	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.05492**	0.006592	11,000	2.26	0.0236	Tukey-Kramer	0.0611
14-16 HZ	0.03642*	0.004994	11,000	11	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.03194*	0.003589	11,000	10.15	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.03137*	0.003293	11,000	9.7	<.0001	Tukey-Kramer	<.0001
20-22 HZ	0.02628*	0.003209	11,000	9.78	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.01953*	0.00293	11,000	8.97	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.01606*	0.002622	11,000	7.45	<.0001	Tukey-Kramer	<.0001
26-28 HZ	0.01535*	0.002367	11,000	6.78	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.01526*	0.002208	11,000	6.95	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.08927**	0.00215	11,000	7.1	<.0001	Tukey-Kramer	<.0001

After Art Making Task to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.01404*	0.004294	11,000	3.27	0.0011	Tukey-Kramer	0.0031
2-4 HZ	0.01834*	0.004948	11,000	3.71	0.0002	Tukey-Kramer	0.0006
4-6 HZ	0.02974*	0.004433	11,000	6.71	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.06128**	0.004985	11,000	12.29	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.08676**	0.007194	11,000	0.82	0.4103	Tukey-Kramer	0.6885
10-12 HZ	0.08376**	0.007301	11,000	11.47	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.06853**	0.006367	11,000	2.3	0.0215	Tukey-Kramer	0.0559
14-16 HZ	0.05182**	0.005014	11,000	10.33	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.03558*	0.003722	11,000	9.56	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.03221*	0.003291	11,000	9.79	<.0001	Tukey-Kramer	<.0001
20-22 HZ	0.03391*	0.00314	11,000	10.8	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.02779*	0.00284	11,000	9.78	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.01822*	0.002511	11,000	7.26	<.0001	Tukey-Kramer	<.0001
26-28 HZ	0.01286*	0.002251	11,000	5.71	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.01133*	0.002138	11,000	5.3	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.01139*	0.002112	11,000	5.4	<.0001	Tukey-Kramer	<.0001

After Motor Tasks to Baseline							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.008729	0.00428	11,000	2.04	0.0415	Tukey-Kramer	0.103
2-4 HZ	0.01742*	0.004682	11,000	3.72	0.0002	Tukey-Kramer	0.0006
4-6 HZ	0.03621*	0.00443	11,000	8.17	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.07003**	0.00565	11,000	12.39	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.08406**	0.007784	11,000	10.8	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.0732**	0.008285	11,000	8.84	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.05687**	0.006951	11,000	8.18	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.03951*	0.005552	11,000	7.12	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.02404*	0.003931	11,000	6.11	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.02503*	0.003519	11,000	7.11	<.0001	Tukey-Kramer	<.0001
20-22 HZ	0.02849*	0.003428	11,000	8.31	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.0246*	0.003161	11,000	7.78	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.01939*	0.002773	11,000	6.99	<.0001	Tukey-Kramer	<.0001
26-28 HZ	0.01582*	0.002483	11,000	6.37	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.01385*	0.002322	11,000	5.97	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.01294*	0.002235	11,000	5.79	<.0001	Tukey-Kramer	<.0001

After Motor Tasks to Baseline							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.01537*	0.00414	11,000	3.71	0.0002	Tukey-Kramer	0.0006
2-4 HZ	0.02167*	0.004637	11,000	4.67	<.0001	Tukey-Kramer	<.0001
4-6 HZ	0.03795*	0.004254	11,000	8.92	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.06836**	0.00526	11,000	13	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.08083**	0.00731	11,000	11.06	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.06971**	0.007799	11,000	8.94	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.05388**	0.00659	11,000	8.18	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.03951*	0.005336	11,000	6.76	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.02404*	0.003942	11,000	5.18	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.02503*	0.003482	11,000	5.75	<.0001	Tukey-Kramer	<.0001
20-22 HZ	0.02849*	0.003335	11,000	7.26	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.0246*	0.002975	11,000	7.03	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.01939*	0.002524	11,000	5.51	<.0001	Tukey-Kramer	<.0001
26-28 HZ	0.01582*	0.002171	11,000	4.79	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.01385*	0.002002	11,000	5.04	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.01294*	0.001955	11,000	5.38	<.0001	Tukey-Kramer	<.0001

After Motor Tasks to After Art Making Task							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.000436	0.00426	11,000	-0.1	0.9184	Tukey-Kramer	0.9942
2-4 HZ	0.00402	0.004889	11,000	2.74	0.0062	Tukey-Kramer	0.017
4-6 HZ	0.01082*	0.004433	11,000	2.44	0.0147	Tukey-Kramer	0.039
6-8 HZ	0.00879	0.005546	11,000	1.58	0.1132	Tukey-Kramer	0.2526
8-10 HZ	-0.00521	0.007447	11,000	-0.7	0.4842	Tukey-Kramer	0.7637
10-12 HZ	-0.01477	0.007828	11,000	-1.89	0.0592	Tukey-Kramer	0.1425
12-14 HZ	-0.01492	0.006592	11,000	-2.26	0.0236	Tukey-Kramer	0.0611
14-16 HZ	-0.01542*	0.005245	11,000	-2.94	0.0033	Tukey-Kramer	0.0092
16-18 HZ	-0.01238*	0.00383	11,000	-3.23	0.0012	Tukey-Kramer	0.0035
18-20 HZ	-0.006909	0.00361	11,000	-1.91	0.0557	Tukey-Kramer	0.1348
20-22 HZ	-0.002875	0.003469	11,000	-0.83	0.4073	Tukey-Kramer	0.6852
22-24 HZ	-0.001679	0.003135	11,000	-0.54	0.5924	Tukey-Kramer	0.8539
24-26 HZ	-0.000142	0.002731	11,000	-0.05	0.9584	Tukey-Kramer	0.9985
26-28 HZ	-0.000243	0.002464	11,000	-0.1	0.9214	Tukey-Kramer	0.9946
28-30 HZ	-0.0015	0.002352	11,000	-0.64	0.5237	Tukey-Kramer	0.7993
30-32 HZ	-0.002316	0.0023	11,000	-1.01	0.3139	Tukey-Kramer	0.5723

After Motor Tasks to After Art Making Task							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.00134	0.004193	11,000	0.32	0.7496	Tukey-Kramer	0.9454
2-4 HZ	0.00333	0.004948	11,000	3.71	0.0002	Tukey-Kramer	0.0006
4-6 HZ	0.00821	0.004231	11,000	1.94	0.0523	Tukey-Kramer	0.1274
6-8 HZ	0.00708	0.005267	11,000	1.34	0.1788	Tukey-Kramer	0.3705
8-10 HZ	-0.005924	0.007194	11,000	-0.82	0.4103	Tukey-Kramer	0.6885
10-12 HZ	-0.01405	0.007595	11,000	-1.85	0.0644	Tukey-Kramer	0.1537
12-14 HZ	-0.01464	0.006367	11,000	-2.3	0.0215	Tukey-Kramer	0.0559
14-16 HZ	-0.01577*	0.00511	11,000	-3.09	0.002	Tukey-Kramer	0.0058
16-18 HZ	-0.01517*	0.003771	11,000	-4.02	<.0001	Tukey-Kramer	0.0002
18-20 HZ	-0.0122*	0.003429	11,000	-3.56	0.0004	Tukey-Kramer	0.0011
20-22 HZ	-0.009699*	0.003249	11,000	-2.98	0.0028	Tukey-Kramer	0.008
22-24 HZ	-0.006883*	0.002854	11,000	-2.41	0.0159	Tukey-Kramer	0.0421
24-26 HZ	-0.004314	0.002466	11,000	-1.75	0.0803	Tukey-Kramer	0.1871
26-28 HZ	-0.002448	0.002208	11,000	-1.11	0.2677	Tukey-Kramer	0.5088
28-30 HZ	-0.001228	0.002096	11,000	-0.59	0.5579	Tukey-Kramer	0.8276
30-32 HZ	-0.000867	0.002035	11,000	-0.43	0.67	Tukey-Kramer	0.9048

Table U1. This table details a pairwise comparison by frequency and location, showing estimated mean differences of power after art making task to the baseline, after motor tasks to the baseline, and after motor tasks to after art making task. Cells with * indicate $p < 0.05$; cells with ** indicate $p < 0.05$ and have an estimated mean difference above the 0.045 threshold or below the -0.45 threshold.

Appendix V

Table V1: Pairwise Comparison Slice by Artistic Experience by Frequency, Location

After Art Making Task to Baseline - No Experience							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.00409	0.005608	11054	0.73	0.4653	Tukey-Kramer	0.7456
2-4 HZ	0.00625	0.006263	11054	1	0.3183	Tukey-Kramer	0.5781
4-6 HZ	0.01913*	0.005713	11054	3.35	0.0008	Tukey-Kramer	0.0023
6-8 HZ	0.05835**	0.006731	11054	8.67	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.08771**	0.009014	11054	9.73	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.09097**	0.00959	11054	9.49	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.0774**	0.007989	11051	9.69	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.06121**	0.006345	11054	9.65	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.04111*	0.004569	11054	9	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.02731*	0.004214	11054	6.48	<.0001	Tukey-Kramer	<.0001
20-22 HZ	0.02219*	0.004095	11054	5.42	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.01857*	0.003735	11054	4.97	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.01409*	0.003342	11054	4.22	<.0001	Tukey-Kramer	<.0001
26-28 HZ	0.01212*	0.00302	11054	4.01	<.0001	Tukey-Kramer	0.0002
28-30 HZ	0.01201*	0.002823	11054	4.25	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.01226*	0.002754	11054	4.45	<.0001	Tukey-Kramer	<.0001

After Art Making Task to Baseline - No Experience							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.01071	0.005496	11054	1.95	0.0514	Tukey-Kramer	0.1255
2-4 HZ	0.013	0.006329	11054	2.05	0.0399	Tukey-Kramer	0.0995
4-6 HZ	0.02529*	0.005673	11054	4.46	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.05455**	0.006381	11054	8.55	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.07322**	0.008644	11054	8.47	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.07035**	0.009252	11054	7.6	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.05854**	0.007798	11053	7.51	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.04425*	0.006331	11054	6.99	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.0306*	0.004722	11054	6.48	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.02262*	0.004199	11051	5.39	<.0001	Tukey-Kramer	<.0001
20-22 HZ	0.02179*	0.003994	11054	5.46	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.01768*	0.00361	11054	4.9	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.01162*	0.003201	11054	3.63	0.0003	Tukey-Kramer	0.0008
26-28 HZ	0.00859*	0.002879	11054	2.99	0.0028	Tukey-Kramer	0.008
28-30 HZ	0.00788*	0.002738	11054	2.88	0.004	Tukey-Kramer	0.0112
30-32 HZ	0.00777*	0.002703	11054	2.88	0.004	Tukey-Kramer	0.0113

After Art Making Task to Baseline - Some Experience							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.02082*	0.008111	11054	2.57	0.0103	Tukey-Kramer	0.0277
2-4 HZ	0.02888*	0.009052	11054	3.19	0.0014	Tukey-Kramer	0.0041
4-6 HZ	0.03815*	0.00826	11054	4.62	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.07169**	0.009743	11054	7.36	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.1064**	0.01307	11054	8.14	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.1078**	0.01391	11054	7.75	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.08816**	0.01159	11051	7.61	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.06813**	0.009205	11054	7.4	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.04482*	0.006617	11054	6.77	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.04678**	0.006084	11054	7.69	<.0001	Tukey-Kramer	<.0001
20-22 HZ	0.04789**	0.005402	11054	7.32	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.03951*	0.004835	11054	5.68	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.02744*	0.004367	11054	4.33	<.0001	Tukey-Kramer	<.0001
26-28 HZ	0.01891*	0.004078	11054	4.23	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.01723*	0.003975	11054	4.68	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.01862*	0.005402	11054	7.32	<.0001	Tukey-Kramer	<.0001

After Art Making Task to Baseline - Some Experience							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.02031*	0.007943	11054	2.56	0.0106	Tukey-Kramer	0.0285
2-4 HZ	0.02825*	0.009151	11054	3.09	0.002	Tukey-Kramer	0.0057
4-6 HZ	0.03717*	0.008206	11054	4.53	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.07982**	0.009225	11054	8.65	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.134**	0.01251	11054	10.71	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.1429**	0.0134	11054	10.67	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.1207**	0.01129	11053	10.69	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.09456**	0.009174	11054	10.31	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.06216**	0.006844	11054	9.08	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.0536**	0.006076	11051	8.82	<.0001	Tukey-Kramer	<.0001
20-22 HZ	0.05691**	0.005782	11054	9.84	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.04832**	0.00523	11054	9.24	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.03187*	0.004633	11054	6.88	<.0001	Tukey-Kramer	<.0001
26-28 HZ	0.02042*	0.004159	11054	4.91	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.01655*	0.00395	11054	4.19	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.01725*	0.003902	11054	4.42	<.0001	Tukey-Kramer	<.0001

After Art Making Task to Baseline - Formal Training							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.00692	0.01382	11054	0.5	0.6164	Tukey-Kramer	0.8708
2-4 HZ	0.0121	0.01543	11054	0.78	0.4329	Tukey-Kramer	0.7128
4-6 HZ	0.02645	0.01408	11054	1.88	0.0602	Tukey-Kramer	0.1447
6-8 HZ	0.04935**	0.0166	11054	2.97	0.003	Tukey-Kramer	0.0083
8-10 HZ	0.05026	0.02225	11054	2.26	0.0239	Tukey-Kramer	0.0619
10-12 HZ	0.01313	0.02369	11054	0.55	0.5794	Tukey-Kramer	0.8443
12-14 HZ	-0.009123	0.01973	11051	-0.46	0.6438	Tukey-Kramer	0.8888
14-16 HZ	-0.02119	0.01567	11054	-1.35	0.1764	Tukey-Kramer	0.3664
16-18 HZ	-0.01597	0.01127	11054	-1.42	0.1564	Tukey-Kramer	0.332
18-20 HZ	0.01794	0.01037	11054	1.73	0.0837	Tukey-Kramer	0.194
20-22 HZ	0.04041*	0.01008	11054	4.01	<.0001	Tukey-Kramer	0.0002
22-24 HZ	0.03609*	0.009204	11054	3.92	<.0001	Tukey-Kramer	0.0003
24-26 HZ	0.03108*	0.008238	11054	3.77	0.0002	Tukey-Kramer	0.0005
26-28 HZ	0.03309*	0.007442	11054	4.45	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.03131*	0.00695	11054	4.5	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.02452*	0.006775	11054	3.62	0.0003	Tukey-Kramer	0.0009

After Art Making Task to Baseline - Formal Training							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.01663	0.01354	11054	1.23	0.2191	Tukey-Kramer	0.4361
2-4 HZ	0.02265	0.01559	11054	1.45	0.1464	Tukey-Kramer	0.3142
4-6 HZ	0.03525*	0.01398	11054	2.52	0.0117	Tukey-Kramer	0.0315
6-8 HZ	0.0482**	0.01572	11054	3.07	0.0022	Tukey-Kramer	0.0062
8-10 HZ	0.03171	0.02131	11054	1.49	0.1369	Tukey-Kramer	0.2969
10-12 HZ	-0.007091	0.02282	11054	-0.31	0.756	Tukey-Kramer	0.9482
12-14 HZ	-0.02263	0.01924	11053	-1.18	0.2396	Tukey-Kramer	0.4675
14-16 HZ	-0.02649	0.01563	11054	-1.69	0.0901	Tukey-Kramer	0.2071
16-18 HZ	-0.01113	0.01166	11054	-0.95	0.3396	Tukey-Kramer	0.6054
18-20 HZ	0.02899*	0.01035	11051	2.8	0.0051	Tukey-Kramer	0.0141
20-22 HZ	0.04184*	0.00985	11054	4.25	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.03084*	0.008909	11054	3.46	0.0005	Tukey-Kramer	0.0016
24-26 HZ	0.01995*	0.007894	11054	2.53	0.0115	Tukey-Kramer	0.0309
26-28 HZ	0.01791*	0.007089	11054	2.53	0.0116	Tukey-Kramer	0.031
28-30 HZ	-0.01803*	0.006734	11054	2.68	0.0074	Tukey-Kramer	0.0204
30-32 HZ	-0.01726*	0.006651	11054	2.59	0.0095	Tukey-Kramer	0.0257

After Motor Tasks to Baseline - No Experience							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.00311	0.005452	11054	0.57	0.5678	Tukey-Kramer	0.8354
2-4 HZ	0.01317	0.005964	11054	2.21	0.0273	Tukey-Kramer	0.0699
4-6 HZ	0.0325*	0.005653	11054	5.75	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.06357**	0.007213	11054	8.81	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.07598**	0.009932	11054	7.65	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.06904**	0.01056	11054	6.54	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.05503**	0.008848	11051	6.22	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.0384*	0.007059	11054	5.44	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.02265*	0.005003	11054	4.53	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.01551*	0.004479	11054	3.46	0.0005	Tukey-Kramer	0.0016
20-22 HZ	0.01397*	0.004334	11054	3.22	0.0013	Tukey-Kramer	0.0036
22-24 HZ	0.01009*	0.003981	11054	2.54	0.0113	Tukey-Kramer	0.0302
24-26 HZ	0.00649	0.003491	11054	1.86	0.063	Tukey-Kramer	0.1507
26-28 HZ	0.00502	0.003136	11054	1.6	0.1094	Tukey-Kramer	0.2453
28-30 HZ	0.00521	0.002945	11054	1.77	0.0771	Tukey-Kramer	0.1805
30-32 HZ	0.00614	0.002842	11054	2.16	0.0307	Tukey-Kramer	0.078

After Motor Tasks to Baseline - No Experience							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.01229	0.005261	11054	2.34	0.0195	Tukey-Kramer	0.051
2-4 HZ	0.01777*	0.005888	11054	3.02	0.0026	Tukey-Kramer	0.0072
4-6 HZ	0.03692*	0.005411	11054	6.82	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.06662**	0.006703	11054	9.94	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.0755**	0.009302	11054	8.12	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.06534**	0.009903	11054	6.6	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.05073**	0.008354	11053	6.07	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.033*	0.006757	11054	4.88	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.0173*	0.005004	11054	3.46	0.0005	Tukey-Kramer	0.0016
18-20 HZ	0.01188*	0.004431	11051	2.68	0.0073	Tukey-Kramer	0.0201
20-22 HZ	0.01214*	0.00423	11054	2.87	0.0041	Tukey-Kramer	0.0114
22-24 HZ	0.00918*	0.003767	11054	2.44	0.0148	Tukey-Kramer	0.0393
24-26 HZ	0.01229	0.003196	11054	1.27	0.2036	Tukey-Kramer	0.4113
26-28 HZ	0.01777*	0.002754	11054	0.98	0.328	Tukey-Kramer	0.5907
28-30 HZ	0.03692*	0.002543	11054	1.48	0.1392	Tukey-Kramer	0.3012
30-32 HZ	0.06662**	0.002484	11054	1.84	0.0664	Tukey-Kramer	0.1581

After Motor Tasks to Baseline - Some Experience							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.0282*	0.007977	11054	3.54	0.0004	Tukey-Kramer	0.0012
2-4 HZ	0.03482*	0.008728	11054	3.99	<.0001	Tukey-Kramer	0.0002
4-6 HZ	0.04534*	0.008265	11054	5.48	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.08131**	0.01053	11054	7.72	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.1043**	0.0145	11054	7.19	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.09438**	0.01543	11054	6.12	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.07527**	0.01292	11051	5.82	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.05591**	0.01031	11054	5.42	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.03533*	0.007303	11054	4.84	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.04145*	0.006533	11054	6.34	<.0001	Tukey-Kramer	<.0001
20-22 HZ	0.04463*	0.006324	11054	7.06	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.039*	0.005811	11054	6.71	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.03177*	0.005099	11054	6.23	<.0001	Tukey-Kramer	<.0001
26-28 HZ	0.02728*	0.00458	11054	5.96	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.02614*	0.004299	11054	6.08	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.02496*	0.004147	11054	6.02	<.0001	Tukey-Kramer	<.0001

After Motor Tasks to Baseline - Some Experience							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.03717*	0.007697	11054	4.83	<.0001	Tukey-Kramer	<.0001
2-4 HZ	0.04657**	0.008625	11054	5.4	<.0001	Tukey-Kramer	<.0001
4-6 HZ	0.05394**	0.007921	11054	6.81	<.0001	Tukey-Kramer	<.0001
6-8 HZ	0.08468**	0.009787	11054	8.65	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.1096**	0.01358	11054	8.07	<.0001	Tukey-Kramer	<.0001
10-12 HZ	0.1016**	0.01446	11054	7.02	<.0001	Tukey-Kramer	<.0001
12-14 HZ	0.08256**	0.0122	11053	6.77	<.0001	Tukey-Kramer	<.0001
14-16 HZ	0.06074**	0.009873	11054	6.15	<.0001	Tukey-Kramer	<.0001
16-18 HZ	0.03795*	0.007312	11054	5.19	<.0001	Tukey-Kramer	<.0001
18-20 HZ	0.03769*	0.006472	11051	5.82	<.0001	Tukey-Kramer	<.0001
20-22 HZ	0.04446*	0.006179	11054	7.2	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.04215*	0.005506	11054	7.66	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.03717*	0.004675	11054	7.01	<.0001	Tukey-Kramer	<.0001
26-28 HZ	0.04657**	0.004028	11054	6.25	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.05394**	0.003719	11054	5.92	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.08468**	0.003635	11054	5.69	<.0001	Tukey-Kramer	<.0001

After Motor Tasks to Baseline - Formal Training							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.01282	0.01361	11054	-0.94	0.3462	Tukey-Kramer	0.6136
2-4 HZ	-0.006364	0.01489	11054	-0.43	0.6691	Tukey-Kramer	0.9043
4-6 HZ	0.03321*	0.01411	11054	2.35	0.0186	Tukey-Kramer	0.0488
6-8 HZ	0.07753**	0.01799	11054	4.31	<.0001	Tukey-Kramer	<.0001
8-10 HZ	0.07544**	0.02478	11054	3.04	0.0023	Tukey-Kramer	0.0066
10-12 HZ	0.03731	0.02635	11054	1.42	0.1568	Tukey-Kramer	0.3326
12-14 HZ	0.01451	0.02207	11051	0.66	0.5109	Tukey-Kramer	0.7882
14-16 HZ	-0.001836	0.01761	11054	-0.1	0.917	Tukey-Kramer	0.994
16-18 HZ	-0.0005	0.01248	11054	-0.04	0.9681	Tukey-Kramer	0.9991
18-20 HZ	0.03651*	0.01117	11054	3.27	0.0011	Tukey-Kramer	0.0031
20-22 HZ	0.0721**	0.01081	11054	6.67	<.0001	Tukey-Kramer	<.0001
22-24 HZ	0.07301**	0.00993	11054	7.35	<.0001	Tukey-Kramer	<.0001
24-26 HZ	0.06345**	0.008709	11054	7.29	<.0001	Tukey-Kramer	<.0001
26-28 HZ	0.04935**	0.007823	11054	6.31	<.0001	Tukey-Kramer	<.0001
28-30 HZ	0.03162*	0.007346	11054	4.3	<.0001	Tukey-Kramer	<.0001
30-32 HZ	0.02007*	0.007087	11054	2.83	0.0046	Tukey-Kramer	0.0129

After Motor Tasks to Baseline - Formal Training							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.029	0.01313	11054	-2.21	0.0273	Tukey-Kramer	0.0699
2-4 HZ	-0.02645	0.01471	11054	-1.8	0.0722	Tukey-Kramer	0.1703
4-6 HZ	-0.001998	0.01351	11054	-0.15	0.8824	Tukey-Kramer	0.988
6-8 HZ	0.03223	0.01672	11054	1.93	0.0539	Tukey-Kramer	0.1309
8-10 HZ	0.03168	0.0232	11054	1.37	0.1721	Tukey-Kramer	0.3592
10-12 HZ	0.00574	0.02471	11054	0.23	0.8164	Tukey-Kramer	0.9707
12-14 HZ	-0.008654	0.02084	11053	-0.42	0.678	Tukey-Kramer	0.9094
14-16 HZ	-0.01583	0.01686	11054	-0.94	0.348	Tukey-Kramer	0.6158
16-18 HZ	-0.01067	0.01249	11054	-0.85	0.3928	Tukey-Kramer	0.6689
18-20 HZ	0.01975	0.01105	11051	1.79	0.074	Tukey-Kramer	0.1741
20-22 HZ	0.04102*	0.01055	11054	3.89	0.0001	Tukey-Kramer	0.0003
22-24 HZ	0.03248*	0.009401	11054	3.45	0.0006	Tukey-Kramer	0.0016
24-26 HZ	0.0204*	0.007979	11054	2.56	0.0106	Tukey-Kramer	0.0285
26-28 HZ	0.01544	0.006875	11054	2.25	0.0247	Tukey-Kramer	0.0637
28-30 HZ	0.01485	0.006348	11054	2.34	0.0193	Tukey-Kramer	0.0506
30-32 HZ	0.0182*	0.006203	11054	2.93	0.0033	Tukey-Kramer	0.0094

After Motor Tasks to After Art Making Task - No Experience							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.00098	0.005484	11054	-0.18	0.8582	Tukey-Kramer	0.9825
2-4 HZ	0.00692	0.0061	11054	1.13	0.2567	Tukey-Kramer	0.493
4-6 HZ	0.01337	0.005711	11054	2.34	0.0193	Tukey-Kramer	0.0505
6-8 HZ	0.00522	0.007139	11054	0.73	0.4643	Tukey-Kramer	0.7446
8-10 HZ	-0.01174	0.009579	11054	-1.23	0.2205	Tukey-Kramer	0.4381
10-12 HZ	-0.02193	0.01007	11054	-2.18	0.0294	Tukey-Kramer	0.0748
12-14 HZ	-0.02237*	0.008468	11051	-2.64	0.0083	Tukey-Kramer	0.0225
14-16 HZ	-0.02281*	0.006733	11054	-3.39	0.0007	Tukey-Kramer	0.002
16-18 HZ	-0.01846*	0.004916	11054	-3.75	0.0002	Tukey-Kramer	0.0005
18-20 HZ	-0.0118*	0.004636	11054	-2.55	0.0109	Tukey-Kramer	0.0294
20-22 HZ	-0.008226	0.004437	11054	-1.85	0.0638	Tukey-Kramer	0.1524
22-24 HZ	-0.00848	0.003997	11054	-2.12	0.0339	Tukey-Kramer	0.0855
24-26 HZ	-0.0076	0.003484	11054	-2.18	0.0292	Tukey-Kramer	0.0744
26-28 HZ	-0.007099	0.003154	11054	-2.25	0.0244	Tukey-Kramer	0.063
28-30 HZ	-0.006803	0.003017	11054	-2.26	0.0241	Tukey-Kramer	0.0623
30-32 HZ	-0.006122	0.002955	11054	-2.07	0.0383	Tukey-Kramer	0.0957

After Motor Tasks to After Art Making Task - No Experience							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.00159	0.005382	11054	0.29	0.7683	Tukey-Kramer	0.9533
2-4 HZ	0.00476	0.005977	11054	0.8	0.4256	Tukey-Kramer	0.705
4-6 HZ	0.01163	0.005436	11054	2.14	0.0324	Tukey-Kramer	0.0819
6-8 HZ	0.01207	0.006774	11054	1.78	0.0747	Tukey-Kramer	0.1755
8-10 HZ	0.00228	0.009243	11054	0.25	0.805	Tukey-Kramer	0.967
10-12 HZ	-0.005012	0.009741	11054	-0.51	0.6069	Tukey-Kramer	0.8643
12-14 HZ	-0.007814	0.008161	11053	-0.96	0.3383	Tukey-Kramer	0.6038
14-16 HZ	-0.01125	0.00655	11054	-1.72	0.0859	Tukey-Kramer	0.1985
16-18 HZ	-0.0133*	0.004844	11054	-2.75	0.0061	Tukey-Kramer	0.0167
18-20 HZ	-0.01073*	0.00441	11051	-2.43	0.015	Tukey-Kramer	0.0397
20-22 HZ	-0.009645	0.004173	11054	-2.31	0.0208	Tukey-Kramer	0.0543
22-24 HZ	-0.008495	0.003665	11054	-2.32	0.0205	Tukey-Kramer	0.0534
24-26 HZ	-0.007557*	0.003168	11054	-2.39	0.0171	Tukey-Kramer	0.045
26-28 HZ	-0.005901	0.00284	11054	-2.08	0.0377	Tukey-Kramer	0.0944
28-30 HZ	-0.004118	0.002697	11054	-1.53	0.1268	Tukey-Kramer	0.2783
30-32 HZ	-0.003214	0.00262	11054	-1.23	0.22	Tukey-Kramer	0.4375

After Motor Tasks to After Art Making Task - Some Experience							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.00738	0.007818	11054	0.94	0.3451	Tukey-Kramer	0.6123
2-4 HZ	0.00594	0.008692	11054	0.68	0.4945	Tukey-Kramer	0.7733
4-6 HZ	0.00718	0.008145	11054	0.88	0.3778	Tukey-Kramer	0.6517
6-8 HZ	0.00962	0.0102	11054	0.94	0.3457	Tukey-Kramer	0.613
8-10 HZ	-0.002066	0.01369	11054	-0.15	0.8801	Tukey-Kramer	0.9875
10-12 HZ	-0.01338	0.01439	11054	-0.93	0.3526	Tukey-Kramer	0.6215
12-14 HZ	-0.01289	0.01211	11051	-1.06	0.287	Tukey-Kramer	0.536
14-16 HZ	-0.01222	0.009629	11054	-1.27	0.2043	Tukey-Kramer	0.4126
16-18 HZ	-0.009494	0.007028	11054	-1.35	0.1767	Tukey-Kramer	0.367
18-20 HZ	-0.00533	0.006622	11054	-0.8	0.4209	Tukey-Kramer	0.7
20-22 HZ	-0.003262	0.006337	11054	-0.51	0.6067	Tukey-Kramer	0.8641
22-24 HZ	-0.000519	0.00571	11054	-0.09	0.9276	Tukey-Kramer	0.9955
24-26 HZ	0.00433	0.004974	11054	0.87	0.3843	Tukey-Kramer	0.6593
26-28 HZ	0.00837	0.004503	11054	1.86	0.0629	Tukey-Kramer	0.1506
28-30 HZ	0.00891	0.004307	11054	2.07	0.0387	Tukey-Kramer	0.0966
30-32 HZ	0.00634	0.004218	11054	1.5	0.1328	Tukey-Kramer	0.2894

After Motor Tasks to After Art Making Task - Some Experience							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	0.01686	0.00767	11054	2.2	0.0279	Tukey-Kramer	0.0715
2-4 HZ	0.01833	0.008511	11054	2.15	0.0313	Tukey-Kramer	0.0795
4-6 HZ	0.01677	0.007745	11054	2.16	0.0304	Tukey-Kramer	0.0774
6-8 HZ	0.00485	0.009674	11054	0.5	0.6159	Tukey-Kramer	0.8705
8-10 HZ	-0.02441	0.01321	11054	-1.85	0.0645	Tukey-Kramer	0.154
10-12 HZ	-0.04138*	0.01392	11054	-2.97	0.003	Tukey-Kramer	0.0083
12-14 HZ	-0.03813*	0.01166	11053	-3.27	0.0011	Tukey-Kramer	0.0031
14-16 HZ	-0.03382*	0.009358	11054	-3.61	0.0003	Tukey-Kramer	0.0009
16-18 HZ	-0.02421*	0.006919	11054	-3.5	0.0005	Tukey-Kramer	0.0014
18-20 HZ	-0.01591*	0.006299	11051	-2.53	0.0116	Tukey-Kramer	0.0311
20-22 HZ	-0.01244	0.00596	11054	-2.09	0.0368	Tukey-Kramer	0.0924
22-24 HZ	-0.006171	0.005233	11054	-1.18	0.2383	Tukey-Kramer	0.4656
24-26 HZ	0.00091	0.004519	11054	0.2	0.8406	Tukey-Kramer	0.978
26-28 HZ	0.00476	0.004047	11054	1.18	0.2399	Tukey-Kramer	0.468
28-30 HZ	0.00546	0.003842	11054	1.42	0.1555	Tukey-Kramer	0.3304
30-32 HZ	0.00343	0.003731	11054	0.92	0.3582	Tukey-Kramer	0.6283

After Motor Tasks to After Art Making Task - Formal Training							
Left Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.01975	0.01342	11054	-1.47	0.1411	Tukey-Kramer	0.3046
2-4 HZ	-0.01846	0.01492	11054	-1.24	0.2159	Tukey-Kramer	0.431
4-6 HZ	0.00675	0.01398	11054	0.48	0.6291	Tukey-Kramer	0.8793
6-8 HZ	0.02818	0.01751	11054	1.61	0.1076	Tukey-Kramer	0.2417
8-10 HZ	0.02518	0.02352	11054	1.07	0.2843	Tukey-Kramer	0.5323
10-12 HZ	0.02418	0.02471	11054	0.98	0.3279	Tukey-Kramer	0.5905
12-14 HZ	0.02363	0.0208	11051	1.14	0.2558	Tukey-Kramer	0.4916
14-16 HZ	0.01936	0.01654	11054	1.17	0.2418	Tukey-Kramer	0.4708
16-18 HZ	0.01547	0.01207	11054	1.28	0.1998	Tukey-Kramer	0.4053
18-20 HZ	0.01857	0.01137	11054	1.63	0.1024	Tukey-Kramer	0.2316
20-22 HZ	0.03168*	0.01088	11054	2.91	0.0036	Tukey-Kramer	0.0101
22-24 HZ	0.03692*	0.009805	11054	3.77	0.0002	Tukey-Kramer	0.0005
24-26 HZ	0.03237*	0.008541	11054	3.79	0.0002	Tukey-Kramer	0.0004
26-28 HZ	0.01627	0.007731	11054	2.1	0.0354	Tukey-Kramer	0.0891
28-30 HZ	0.00032	0.007395	11054	0.04	0.9657	Tukey-Kramer	0.999
30-32 HZ	-0.004455	0.007242	11054	-0.62	0.5384	Tukey-Kramer	0.8118

After Motor Tasks to After Art Making Task - Formal Training							
Right Hemisphere							
Frequency	Estimate	StdErr	DF	t-value	Probt	Adjustment	Adjp
0-2 HZ	-0.04563**	0.01316	11054	-3.47	0.0005	Tukey-Kramer	0.0015
2-4 HZ	-0.04909**	0.01461	11054	-3.36	0.0008	Tukey-Kramer	0.0022
4-6 HZ	-0.03725	0.01329	11054	-2.8	0.0051	Tukey-Kramer	0.0141
6-8 HZ	-0.01597	0.01661	11054	-0.96	0.3363	Tukey-Kramer	0.6012
8-10 HZ	-0.000021	0.02268	11054	0	0.9993	Tukey-Kramer	1
10-12 HZ	0.01283	0.0239	11054	-0.54	0.5914	Tukey-Kramer	0.8532
12-14 HZ	0.01397	0.02002	11053	0.7	0.4853	Tukey-Kramer	0.7648
14-16 HZ	0.01066	0.01607	11054	0.66	0.5071	Tukey-Kramer	0.7848
16-18 HZ	0.00046	0.01188	11054	0.04	0.9692	Tukey-Kramer	0.9992
18-20 HZ	-0.009241	0.01081	11051	-0.85	0.3929	Tukey-Kramer	0.6691
20-22 HZ	-0.00082	0.01023	11054	-0.08	0.9362	Tukey-Kramer	0.9965
22-24 HZ	0.00164	0.008985	11054	0.18	0.8551	Tukey-Kramer	0.9818
24-26 HZ	0.00045	0.007758	11054	0.06	0.954	Tukey-Kramer	0.9982
26-28 HZ	-0.002463	0.006945	11054	-0.35	0.7229	Tukey-Kramer	0.9331
28-30 HZ	-0.003177	0.006593	11054	-0.48	0.6299	Tukey-Kramer	0.8799
30-32 HZ	0.00095	0.006402	11054	0.15	0.8825	Tukey-Kramer	0.988

Table V1. Cells with * indicate $p < 0.05$; cells with ** indicate $p < 0.05$ and have an estimated mean difference above 0.045 threshold. This represents a pairwise comparison slice by level of artistic experience (no experience, some experience, and formal training).

Appendix W

Table W1: Baseline Difference Control

Left Hemisphere						Right Hemisphere					
Frequency	Estimate	StdErr	DF	t-value	P-value	Frequency	Estimate	StdErr	DF	t-value	P-value
0-2 HZ	0.00649	0.006313	3796	1.03	0.3038	0-2 HZ	-0.01535**	0.005569	3612	-2.76	0.0059
2-4 HZ	-0.01155	0.006347	3612	-1.82	0.0689	2-4 HZ	-0.01966**	0.006039	3612	-3.26	0.0011
4-6 HZ	-0.005217	0.006204	3428	-0.84	0.4004	4-6 HZ	-0.01845***	0.005375	3612	-3.43	0.0006
6-8 HZ	-0.009725	0.007295	3612	-1.33	0.1826	6-8 HZ	-0.02005**	0.006567	3612	-3.05	0.0023
8-10 HZ	-0.02402*	0.01004	3612	-2.39	0.0168	8-10 HZ	-0.03291***	0.009169	3612	-3.59	0.0003
10-12 HZ	-0.02767**	0.01068	3612	-2.59	0.0096	10-12 HZ	-0.04024***	0.009805	3612	-4.1	<.0001
12-14 HZ	-0.01482	0.008898	3612	-1.67	0.096	12-14 HZ	-0.03125***	0.008057	3612	-3.88	0.0001
14-16 HZ	-0.006377	0.006897	3612	-0.92	0.3552	14-16 HZ	-0.02402***	0.006333	3612	-3.79	0.0002
16-18 HZ	0.00406	0.004874	3612	0.83	0.4048	16-18 HZ	-0.01154*	0.004797	3612	-2.41	0.0162
18-20 HZ	0.00773	0.004643	3612	1.66	0.0961	18-20 HZ	-0.002711	0.004788	3612	-0.57	0.5713
20-22 HZ	0.0062	0.004811	3612	1.29	0.1974	20-22 HZ	-0.001147	0.004928	3612	-0.23	0.816
22-24 HZ	0.0117*	0.005221	3612	2.24	0.025	22-24 HZ	0.00269	0.004984	3612	0.54	0.5888
24-26 HZ	0.02055***	0.006174	3612	3.33	0.0009	24-26 HZ	0.00924	0.004726	3612	1.95	0.0507
26-28 HZ	0.026***	0.00663	3612	3.92	<.0001	26-28 HZ	0.01326**	0.004357	3612	3.04	0.0024
28-30 HZ	0.02734***	0.005893	3612	4.64	<.0001	28-30 HZ	0.01452***	0.004273	3612	3.4	0.0007
30-32 HZ	0.02948***	0.006113	3612	4.82	<.0001	30-32 HZ	0.01617***	0.004351	3612	3.72	0.0002

Table W1. This table shows estimated mean differences of left and right hemisphere power by frequency and location, for the Baseline (Eyes Closed) epoch 1 subset 4 compared to the Baseline (Eyes Closed) epoch 1, subset 2 (see Table 1. Procedure Time with Epoch Notation). Cells with * indicate $p < 0.05$; cells with ** indicate $p < 0.01$; cells with *** indicate $p < 0.001$.

Appendix X

Table X1: Demographics

Subject Identification Number	Age Range	Handedness	Artistic Experience
ARP001	56-65	Right	No Experience
ARP002	16-25	Right	Some Experience
ARP003	56-65	Right	No Experience
ARP004	56-65	Right	No Experience
ARP005	16-25	Right	Formal Training
ARP006	66-75	Right	No Experience
ARP007	46-55	Right	No Experience
ARP008	36-45	Right	Some Experience
ARP009	16-25	Right	No Experience
ARP010	26-35	Right	Some Experience

Table X1. Shows de-identified demographic information for all 10 subjects, handedness, and artistic experience (self-report of no experience, some experience, or formal training).

Appendix Y

Pairwise Comparison by Frequency, Location

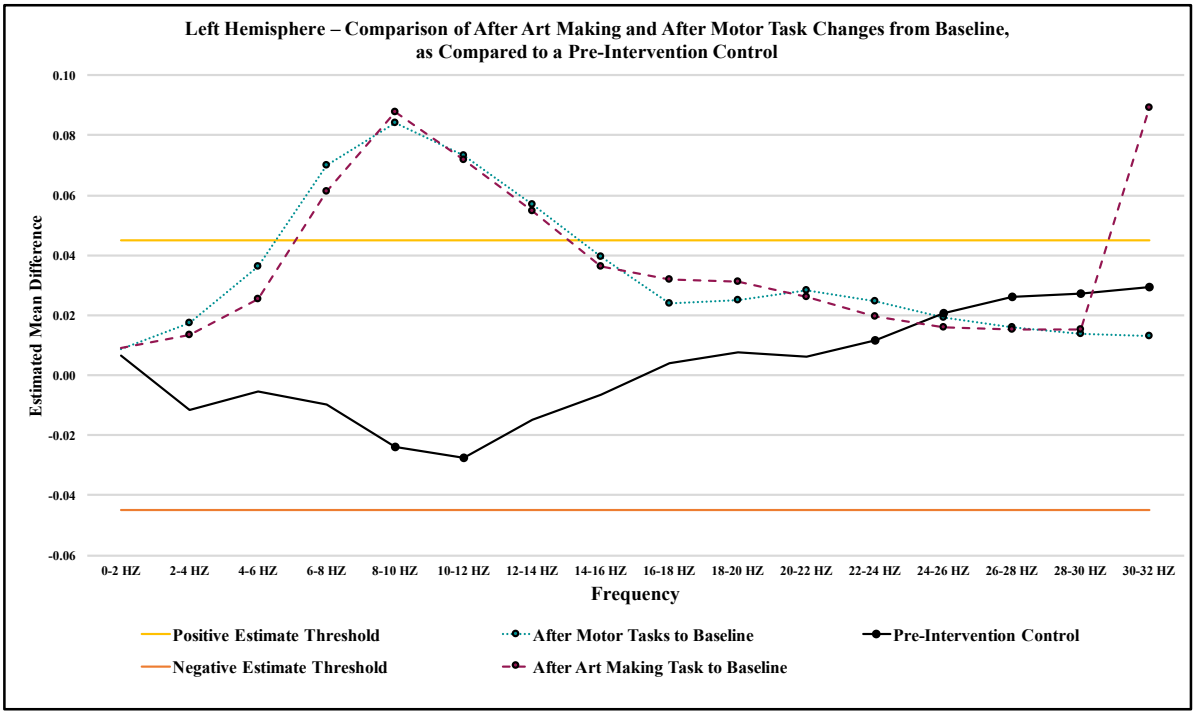

Figure Y1. Shows a pairwise comparison of the EEG power for After Art Making to Baseline, and After Motor Tasks to Baseline, by frequency for the left hemisphere. Additionally, comparison of 2 separate pre-intervention data collections, is shown as Pre-Intervention Control, demonstrating variation in power that has been used to establish an estimated mean difference threshold of 0.045 and -0.045. Each data point from frequencies 0-2 HZ through 28-32 HZ is indicated. Points with a circle show that the estimated mean difference for that frequency was statistically significant ($p < 0.05$).

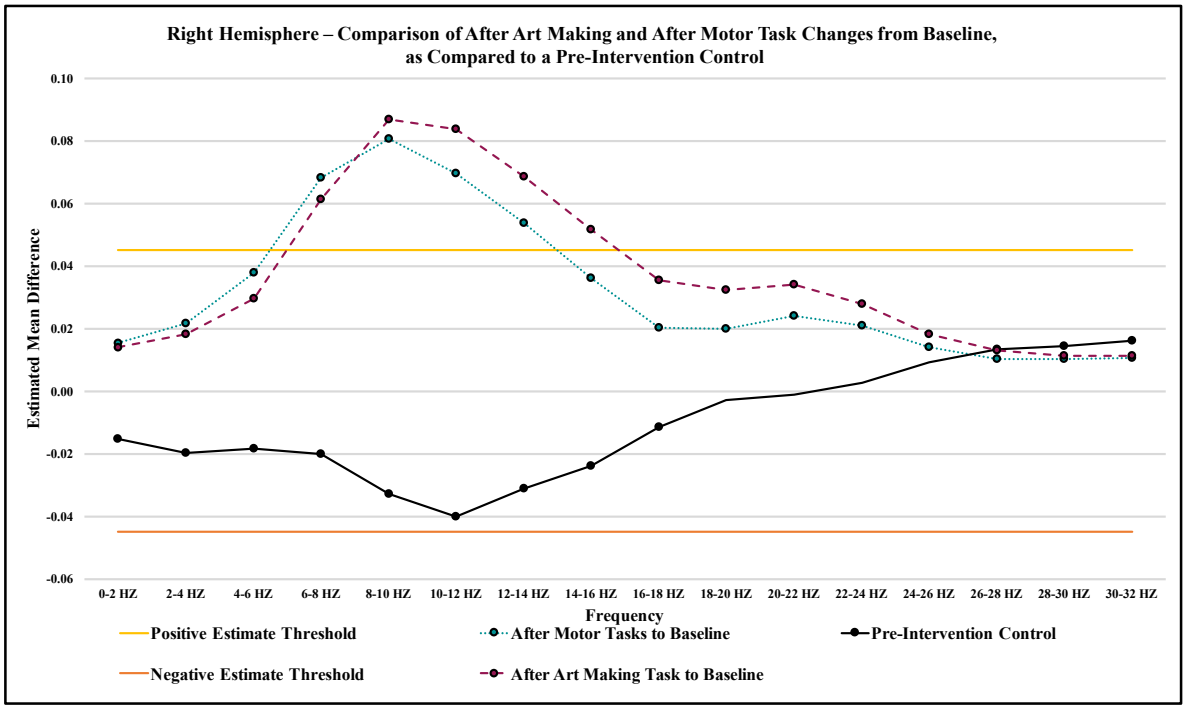

Figure Y2. Shows a pairwise comparison of the EEG power for After Art Making to Baseline, and After Motor Tasks to Baseline, by frequency for the right hemisphere. Additionally, comparison of 2 separate pre-intervention data collections, is shown as Pre-Intervention Control, demonstrating variation in power that has been used to establish an estimated mean difference threshold of 0.045 and -0.045. Each data point from frequencies 0-2 HZ through 28-32 HZ is indicated. Points with a circle show that the estimated mean difference for that frequency was statistically significant ($p < 0.05$).

Appendix Z

Pairwise Comparison Slice by Artistic Experience Frequency, Location

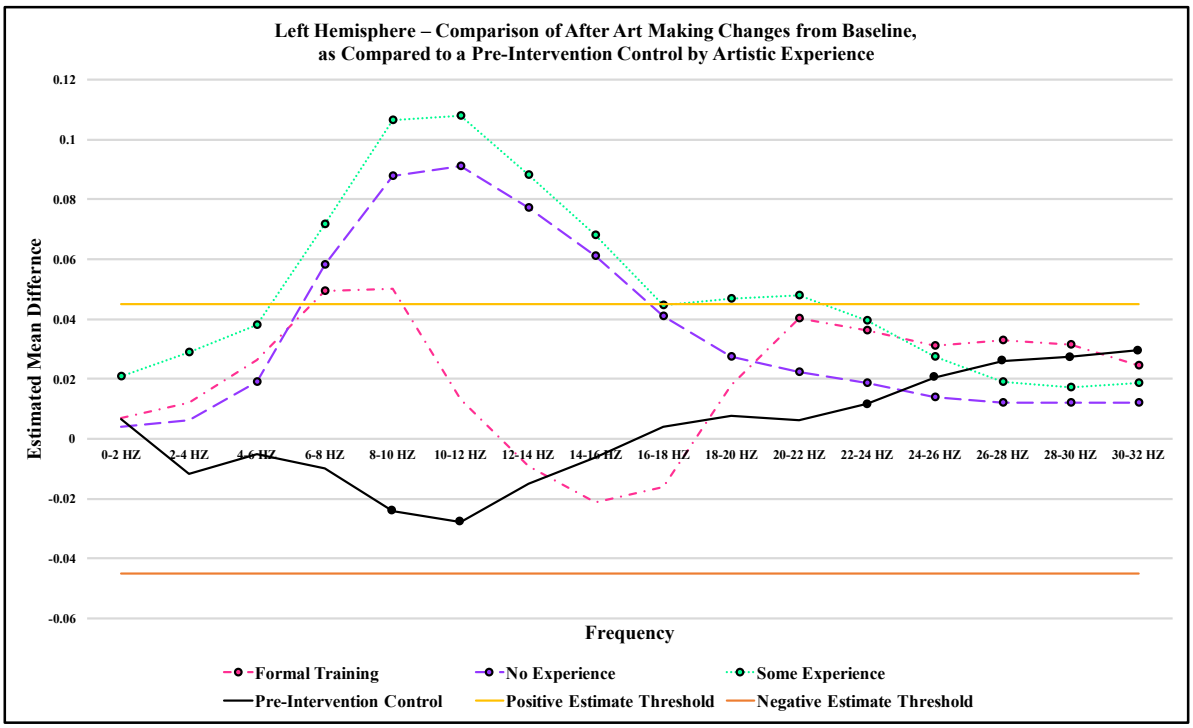

Figure Z1. Shows a pairwise comparison of the EEG power for After Art Making Tasks to Baseline by frequency for artistic experience (no experience, some experience, and formal training) in the left hemisphere. Additionally, comparison of 2 separate pre-intervention data collections, is shown as Pre-Intervention Control, demonstrating variation in power that has been used to establish an estimated mean difference threshold of 0.045 and -0.045. Each data point from frequencies 0-2 HZ through 28-32 HZ is indicated. Points with a circle show that the estimated mean difference for that frequency was statistically significant ($p < 0.05$).

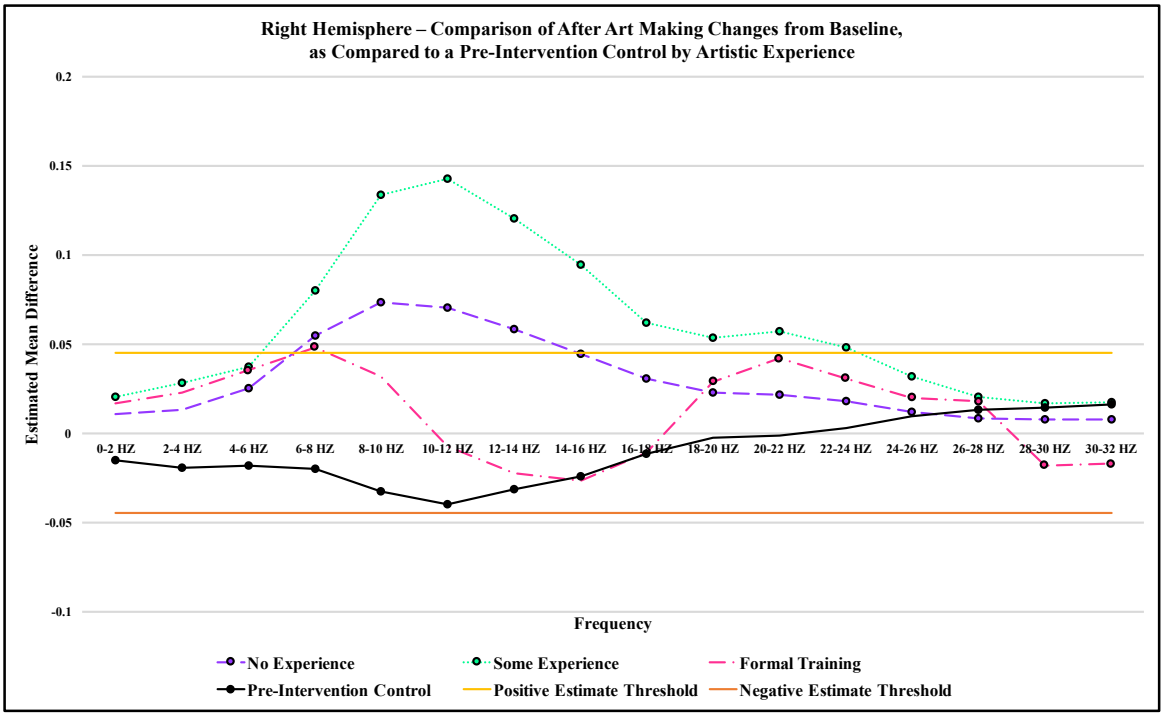

Figure Z2. Shows a pairwise comparison of the EEG power for After Art Making Tasks to Baseline by frequency for artistic experience (no experience, some experience, and formal training) in the right hemisphere. Additionally, comparison of 2 separate pre-intervention data collections, is shown as Pre-Intervention Control, demonstrating variation in power that has been used to establish an estimated mean difference threshold of 0.045 and -0.045. Each data point from frequencies 0-2 HZ through 28-32 HZ is indicated. Points with a circle show that the estimated mean difference for that frequency was statistically significant ($p < 0.05$).

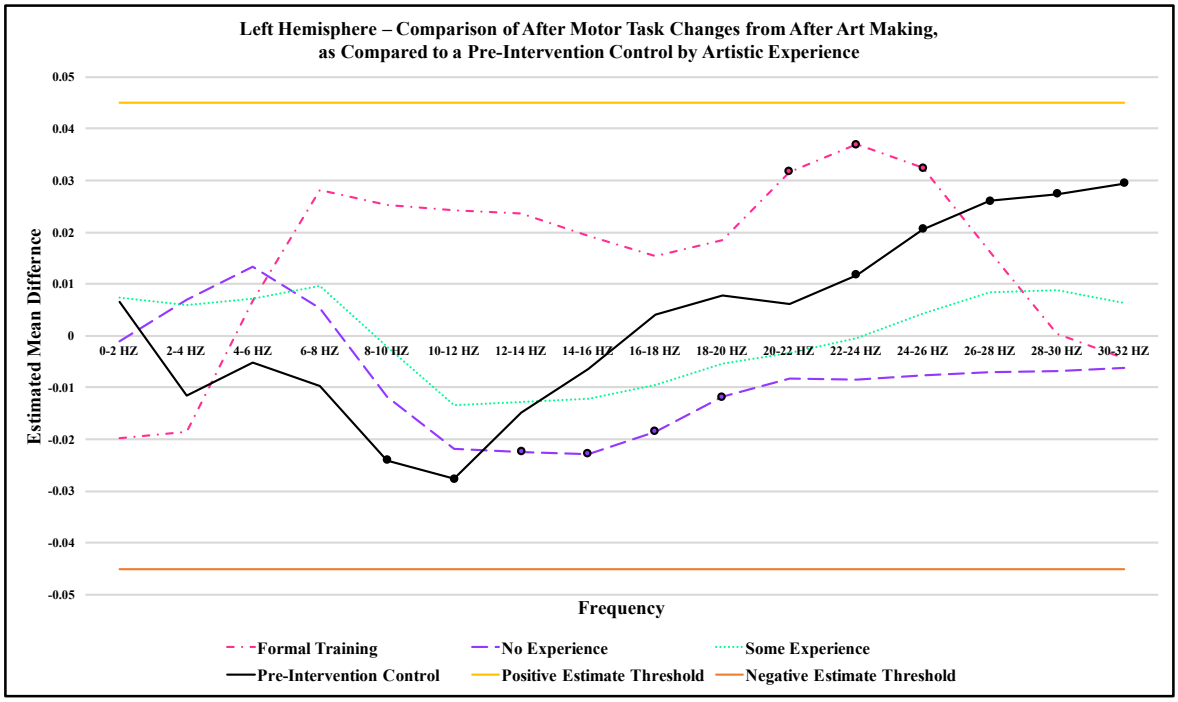

Figure Z3. Shows a pairwise comparison of the EEG power for After Motor Tasks to Baseline by frequency for artistic experience (no experience, some experience, and formal training) in the left hemisphere. Additionally, comparison of 2 separate pre-intervention data collections, is shown as Pre-Intervention Control, demonstrating variation in power that has been used to establish an estimated mean difference threshold of 0.045 and -0.045. Each data point from frequencies 0-2 HZ through 28-32 HZ is indicated. Points with a circle show that the estimated mean difference for that frequency was statistically significant ($p < 0.05$).

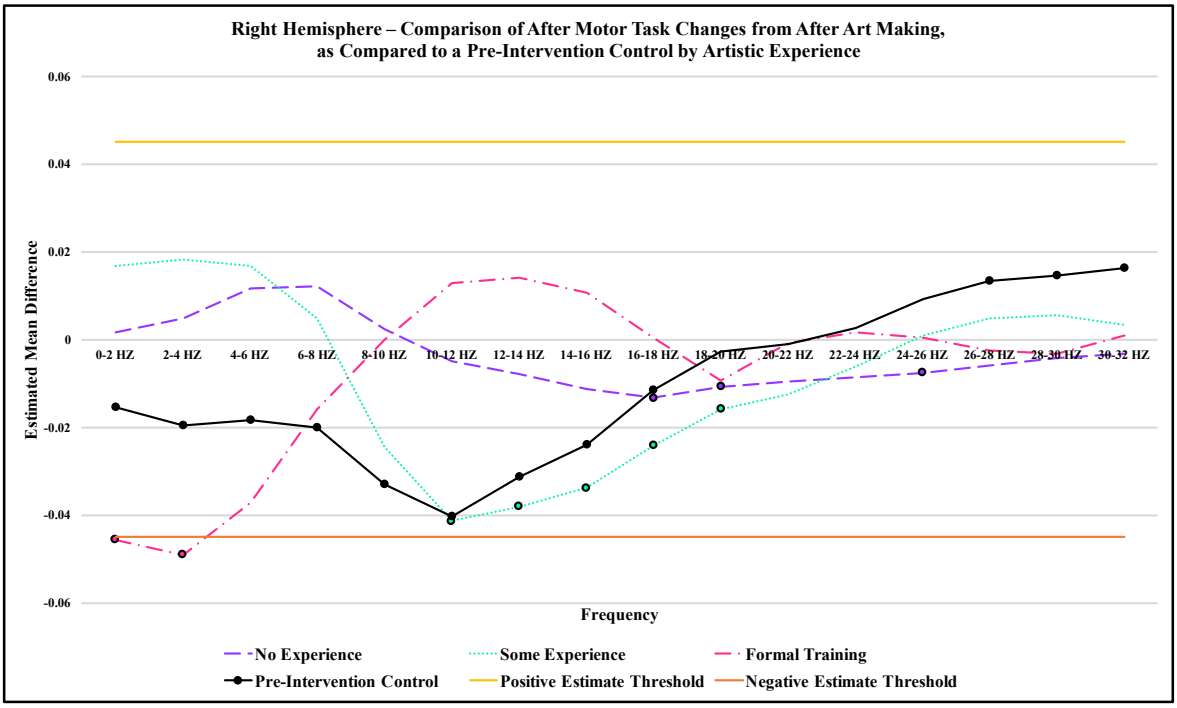

Figure Z4. Shows a pairwise comparison of the EEG power for After Motor Tasks to Baseline by frequency for artistic experience (no experience, some experience, and formal training) in the right hemisphere. Additionally, comparison of 2 separate pre-intervention data collections, is shown as Pre-Intervention Control, demonstrating variation in power that has been used to establish an estimated mean difference threshold of 0.045 and -0.045. Each data point from frequencies 0-2 HZ through 28-32 HZ is indicated. Points with a circle show that the estimated mean difference for that frequency was statistically significant ($p < 0.05$).

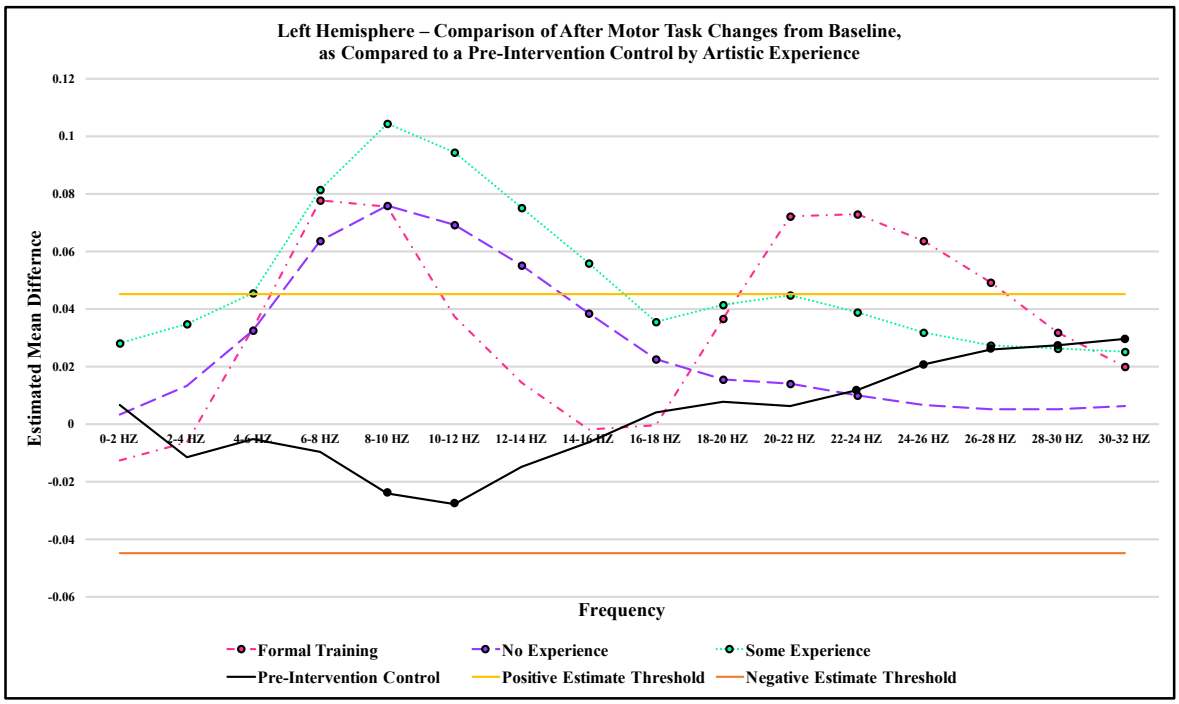

Figure Z5. Shows a pairwise comparison of the EEG power for After Motor Tasks to the After Art Making Task by frequency for artistic experience (no experience, some experience, and formal training) in the left hemisphere. Additionally, comparison of 2 separate pre-intervention data collections, is shown as Pre-Intervention Control, demonstrating variation in power that has been used to establish an estimated mean difference threshold of 0.045 and -0.045. Each data point from frequencies 0-2 HZ through 28-32 HZ is indicated. Points with a circle show that the estimated mean difference for that frequency was statistically significant ($p < 0.05$).

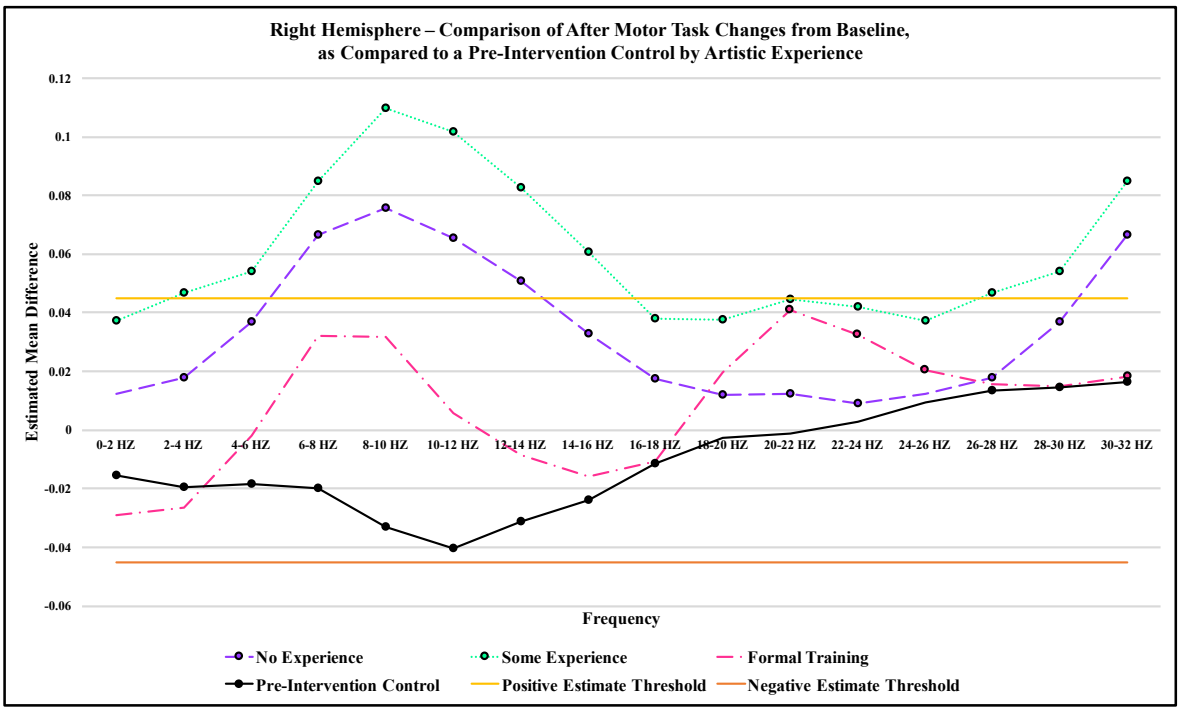

Figure Z6. Shows a pairwise comparison of the EEG power for After Motor Tasks to the After Art Making Task by frequency for artistic experience (no experience, some experience, and formal training) in the right hemisphere. Additionally, comparison of 2 separate pre-intervention data collections, is shown as Pre-Intervention Control, demonstrating variation in power that has been used to establish an estimated mean difference threshold of 0.045 and -0.045. Each data point from frequencies 0-2 HZ through 28-32 HZ is indicated. Points with a circle show that the estimated mean difference for that frequency was statistically significant ($p < 0.05$).