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Impulsivity and Performance on a Music-Based Cognitive Rehabilitation Protocol in Persons with Alcohol Dependence

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IMPULSIVITY AND PERFORMANCE ON A MUSIC-BASED COGNITIVE REHABILITATION PROTOCOL IN PERSONS WITH ALCOHOL DEPENDENCE

By

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The purpose of this study was to examine the performance of individuals with alcohol dependence on a music-based cognitive rehabilitation protocol (MBCR), and to examine the relationship between degree of impulsivity and performance on the MBCR. Twenty adults with a primary diagnosis of alcohol dependence or polysubstance dependence participated in the study. Each participant first completed a 14-minute computerized assessment of impulsivity and then took part in one, 25-minute individual music session during which they completed four different MBCR exercises. Included in the MBCR were a Five-Finger exercise, Bordun exercise, Rhythm Repetition exercise, and Song Playing exercise. Participants' performances on each of the MBCR exercises were scored using a rubric which included 1 (poor), 2 (fair), 3 (good), or 4 (excellent), for a total possible score of 16.

Results indicated that participants' impulsivity, as measured by Perseverations and Hit Reaction Time (Hit RT) on the Continuous Performance Test (Conners, 2007) as well as a Total Impulsivity composite score, was significantly greater than a normative group. In regards to performance on the MBCR, participants scored the highest on the Song Playing exercise, and performed most poorly on the Bordun exercise. A repeated measures ANOVA revealed that participants' performance on the Song Playing exercise

was significantly better than on the Five-Finger, Bordun, and Rhythm Repetition exercises.

Bivariate correlation was used to examine relationships between scores of CPT impulsivity measures, Total Impulsivity, the rubric scores for the four MBCR exercises, and a composite Total Rubric score. Significantly negative correlations were found between Hit RT and Commission Errors, Perseverations and Total Impulsivity, Perseverations and the Rhythm Repetition exercise, and Total Impulsivity and the Rhythm Repetition exercise. Significantly positive correlations were found between Hit RT and the Song Playing exercise, Commission Errors and the Bordun exercise, the Five-finger exercise and Total Rubric, and the Rhythm Repetition exercise and Total Rubric score.

Because all of the MBCR exercises required different types of attentional control, analysis of the relationships between participants' impulsivity (as measured by Hit RT, Commission Errors, Perseverations, and Total Impulsivity) and performance on the MBCR implicate attention deficits as being related to impulsivity in individuals with alcohol dependence. Despite the presence of attention deficits, all participants were able to complete the entire MBCR protocol with scores of 2, 3, or 4 on all exercises. Therefore, music may be able to prime attention in individuals with alcohol dependence, which may be useful in addressing impulsivity in therapeutic treatment environments.

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Chapter 1

Introduction

Statement of the Problem

Impairment of cognitive skills is frequently seen in individuals diagnosed with alcohol dependence (AD). Cognitive impairments associated with AD are often manifested as problems with a number of higher-level cognitive skills, such as working memory, cognitive flexibility, attention control, response inhibition, abstract reasoning, and complex visuospatial and visuomotor skills (Bates, Bowden, & Barry, 2002). Known collectively as executive function, these cognitive skills are involved in the ability to plan, monitor, activate, switch, or inhibit lower-level, automatic cognitive functions (Cicerone, Levin, Malec, Stuss, & Whyte, 2006). Deficits of executive function may contribute to a number of behaviors associated with substance dependence, such as continued substance use despite negative consequences and relapse (Allen, Goldstein, & Seaton, 1997; Volkow & Fowler, 2000).

Impulsivity, the tendency to act quickly without regard to negative consequences (Moeller & Dougherty, 2002) is a cognitive deficit related to both continued substance use and relapse in alcohol dependence. Heightened impulsivity in AD indicates difficulties with response inhibition, an aspect of executive function responsible for controlling automatic or impulsive responses at appropriate times (Verdejo-Garcia & Pérez-Garcia, 2007). Impulsivity is often observed in individuals prior to initiation of substance use and contributes to substance-seeking behavior following initial experimentation with substances (Bechara, 2005). Conversely, repeated use of substances

causes changes to the brain which result in impulsive behavior and can lead to long-term substance use (Moeller & Dougherty, 2002).

An examination of the neurobiological mechanisms responsible for impulsivity related to AD provides a comprehensive view of this concept. Bechara (2005) proposes that lack of impulse control which contributes to substance dependence is due to the dysfunction of two interacting neural systems: the impulsive system and the reflective system. The neuroanatomy of the impulsive system consists of the amgydala and its interaction with other subcortical structures such as the hypothalamus, autonomic brainstem nuclei, striatum, and periaqueductal gray matter. This neural interaction is responsible for producing emotional responses to immediate outcomes based on environmental events. The reflective system primarily includes neural structures in the prefrontal cortex which are responsible for regulating emotional responses associated with long-term outcomes based on memories or knowledge. Neuroanatomically, this system consists of the ventromedial prefrontal cortex, dorsolateral prefrontal cortex, insula and hippocampus. Individuals are predisposed to substance addiction when the reflective system is not strong enough to override the powerful urges to use substances produced by an overactive impulsive system (Bechara, 2005).

A number of studies elucidate the presence of heightened impulsivity in individuals who abuse alcohol, regardless of whether they have received treatment for alcohol dependence. In one study, heavy drinkers who had never received treatment for alcohol dependence performed significantly poorer than healthy controls on three behavioral measures of impulsivity and showed significantly heightened impulsivity on three self-report measures (Rubio et al., 2008). In addition, individuals with AD receiving

outpatient treatment had significantly higher levels of impulsivity than healthy controls as measured by both self-report and a behavioral measure of response inhibition (Lawrence, Luty, Bogdan, Sahakian, & Clark, 2009).

Cognitive deficits associated with alcohol dependence can be addressed through intensive, targeted interventions. Recent studies examining rehabilitation of substance-related cognitive deficits have reported positive outcomes from computer-based programming to improve cognitive skills such as memory, visual-motor coordination, visual-spatial skills, and attention (Fals-Stewart & Lucente, 1994; Fals-Stewart & Lam, 2010; Grohman & Fals-Stewart, 2003). Although not directly targeting impulsivity, a number of studies have demonstrated the effect of cognitive behavioral therapy on interpersonal problem-solving in patients with substance dependence (Appel & Kaestner, 1979; Intagliata, 1978). Addressing cognitive deficits, such as problems with executive functioning, is considered a priority treatment area because it promotes relapse prevention (Bates, Bowden, & Barry, 2002; Lesiuk, 2010).

While a number of studies suggest that music is an effective tool in addressing the emotional, interpersonal, and motivational needs of individuals with substance dependence, there is a paucity of research examining the cognitive outcomes of music therapy with this population. One music therapy research study found that participants in a residential treatment facility for substance dependence self-reported that music therapy decreased their impulsivity more consistently than other treatment groups (Silverman, 2003). However, no intervention was investigated to specifically target impulsivity. Additionally, the study did not explore reasons why participants felt music therapy

reduced their impulsivity, thus it is difficult to ascertain if and to what degree music therapy interventions affect problems with impulsivity.

Research theory suggests that music-based interventions can be an effective medium for addressing cognitive deficits associated with addictive disorders and in different diagnoses with similar deficits (Lesiuk, 2010). Studies involving individuals with traumatic brain injury, dementia, and schizophrenia have reported positive outcomes for a variety of cognitive skills (e.g., attention, working memory, planning, and cognitive flexibility) following participation in music-based interventions (Bruer, Spitznagel, & Cloninger, 2007; Ceccato, Caneva, & Lamonaca, 2006; Thaut, et al., 2009). While not specific to impulsivity, these studies provide support that cognitive skills, as understood to be mediated by frontal lobe activation, can be affected through music.

Only one music therapy study has specifically addressed impulsivity in a clinical population. Rickson (2006) compared the effectiveness of participation in instructional- and improvisational-based music therapy groups on impulsivity in adolescents with Attention Deficit Hyperactivity Disorder (ADHD). The instructional intervention consisted of practicing highly-structured rhythmic tasks which culminated in the performance of a percussion ensemble. The improvisational intervention consisted of group improvisation on a variety of percussion instruments based on a chosen mood, theme, or musical style. Participants demonstrated significantly improved accuracy on a measure of impulsivity (i.e., a tapping task) following both types of music therapy interventions. Additionally, subjective observations by classroom teachers and social workers indicated that participants showed reduction of ADHD symptoms throughout the course of participation in music therapy. The author suggests that these findings may be

due improvement in participants' ability to sustain attention, concentration, and self-control as the study intervention progressed.

Because of the lack of research examining potential relationships between music and impulsivity, and potential uses of music to address impulsivity, theories regarding the usefulness of music in improving impulse control must be investigated. Crews and Boettiger (2009) suggest that because impulsivity reflects poor executive function, activation of frontal-cortical structures during therapy can help to reduce impulsivity in individuals with AD. A number of brain imaging studies demonstrate the role of the frontal lobe during both music perception and production tasks (Green, Bærentsen, Stødkilde-Jørgensen, Wallentin, Roepstorff, & Vuust, 2008; Kringelbach & Rolls, 2004; Limb & Braun, 2008; Nan, Knösche, Zysset, & Friederici, 2007; Sridharan, Levitin, Chafe, Berger, & Menon, 2007; Tramo, 2001) thus suggesting an overlap of function of this brain structure during music experiences and impulse control. Therefore, music may have an effect on impulsivity in individuals with AD by activating the frontal lobe during intensive music-based exercises which focus on executive functions, such as attention and memory (Lesiuk, 2010). By examining the performances of individuals with AD on music-based tasks addressing cognitive skills, relationships between music and impulse control may emerge which will help inform future research and development of clinical interventions.

Definition of Terms

Alcohol dependence. For purposes of this study, alcohol dependence is defined based on the diagnostic criteria set forth by the American Psychiatric Association (2000) which includes continued use of alcohol despite significant cognitive, behavioral, and

physiological symptoms. In order to be diagnosed with AD, an individual must experience "clinically significant impairment or distress" (p.197) in at least three or more areas of functioning at the same time during a one year period, such as increased tolerance, withdrawal symptoms, and use of alcohol despite knowledge of negative consequences.

The term alcohol dependence is often used synonymously in the literature with related terms such as alcohol addiction, substance addiction, alcohol abuse, and substance abuse. The researcher will not change the terminology in regard to substance dependence used by authors cited in the related literature.

Impulsivity. Impulsivity is the tendency to act quickly without regard to negative consequences (Moeller & Dougherty, 2002) and is the result of a deficit in the ability to control or inhibit automatic responses when necessary (Verdejo-Garcia & Pérez-Garcia, 2007).

Executive function. Executive function refers to a number of higher-level cognitive processes (e.g., working memory, cognitive flexibility, attention control, response inhibition, abstract reasoning, and complex visuospatial and visuomotor skills) which are necessary to plan, monitor, activate, switch, or inhibit lower-level, automatic cognitive functions (Bates, Bowden, & Barry, 2002; Cicerone, Levin, Malec, Stuss, & Whyte, 2006).

Need for the Study

Theoretical relevance. This research will provide insight into the presence of impulsivity in individuals with AD and into how individuals with heightened impulsivity related to AD respond to music-based cognitive intervention. Specifically, this study will

provide knowledge about the potential relationships between impulsivity and performance on a number of different music tasks assumed to address cognitive skills such as attention and memory. Findings from the present study may inform future research regarding the mediating effect of music on impulsivity and contribute to the development of music therapy interventions to address impulse control in individuals receiving treatment for AD.

Practical relevance. To date, the focus of music therapy researching examining the treatment of substance dependence has been limited to social, intrapersonal, and emotional goals, and has traditionally been implemented in group settings. The present study focuses on an area that has yet to be addressed in the literature: the performance of individuals with AD, who have heightened impulsivity, on a number of music-based tasks administered on an individual basis. If the outcome of the study shows that impulsivity is correlated with music-based attention tasks, researchers in the field of music therapy will be able to use this knowledge to design future research protocols to specifically examine the effect of music on impulse control and other executive functions. Music therapy clients could benefit from evidence-based interventions to promote treatment adherence and prevent relapse by strengthening their ability to remain abstinent in the community. Therefore, treatment programs could see a reduction in recidivism if music therapists incorporate cognitive remediation strategies into sessions.

Purpose of the Study

The purpose of this study was to investigate the performance on a music-based cognitive rehabilitation protocol by individuals with AD. Further, this study also

examined the relationship between degree of impulsivity and performance on the music-based cognitive rehabilitation protocol.

Chapter 2

Related Literature

This chapter will review research literature relevant to understanding impulsivity related to alcohol dependence (AD), cognitive rehabilitation in the treatment of AD, and uses of music in the treatment of cognitive deficits in individuals with AD and other substance use disorders. The first section of the chapter will define impulsivity, identify the neuroanatomic structures and processes linked to impulsivity in AD, and summarize the presence of and problems caused by impulsivity in individuals with AD. Next, present-day cognitive rehabilitation techniques used in the treatment of AD will be discussed. The final section of the chapter will examine trends of music therapy in the treatment of AD and related disorders, and related music-based cognitive rehabilitation techniques used with similar cognitive deficits, but different diagnoses. This literature review will provide a rationale for the use of music-based cognitive rehabilitation, specifically addressing impulsivity, in the treatment of adults with alcohol dependence.

Impulsivity

Impulsivity is a construct that does not have one single agreed-upon definition in the literature, and may involve a number of different components. Researchers define and study impulsivity through either behavioral and personality approaches, which view impulsivity as either individual, observable behaviors; or as a persisting personality trait that contributes to long-term patterns of behavior (Whiteside & Lynam, 2009). While a single definition is elusive, synthesis of current literature relates the following concepts to impulsivity: 1) acting quickly without regard for potential outcomes or consequences, including decreased sensitivity to negative consequences (Moeller, Barratt, Dougherty,

Schmitz, & Swann, 2001); 2) preference for rewards which are smaller but immediate instead of larger rewards received later (Kalenscher, Ohmann, & Güntürkün, 2006); and 3) response urgency and sensation seeking (Whiteside & Lynam, 2009). This study will emphasize the definition of impulsivity in which individuals act quickly without regard to negative consequences (Moeller & Dougherty, 2002).

While impulsive behavior is seen in most typical people, heightened impulsiveness is associated with a number of pathologies, such as attention-deficit hyperactivity disorder (ADHD) and substance addiction (Kalenscher, Ohmann, & Gunturkun, 2006). A recent study found that childhood ADHD, both diagnosed and undiagnosed, is a significant risk factor for developing co-morbid AD or multi-substance addiction (Ohlmeier et al., 2008). Researchers administered a battery of tests, including a retrospective assessment of ADHD and a variety of other assessments measuring ADHD symptoms, to participants with alcohol dependence or multi-substance dependence. Results indicated that between 20 to 23% of participants with AD likely experienced ADHD as a child regardless of formal diagnosis, and that 33% of these participants continued to experience persistent ADHD symptoms as adults. These results point to the critical role that impulsivity related to ADHD may play in the development and persistence of AD throughout the lifespan.

Neuroanatomy of impulsivity. An examination of the neurobiological mechanisms responsible for impulsivity provides a comprehensive view of concept. The neuropsychological construct known as executive function includes a variety of higher-level cognitive skills (e.g., attention or mental flexibility) involved in the ability to plan, monitor, activate, switch, or inhibit lower-level, automatic cognitive functions (Cicerone,

Levin, Malec, Stuss, & Whyte, 2006). When executive function is exerted in healthy individuals, they are able to self-regulate behavior due to the delay period provided by intact behavioral inhibition (Barkley, 1997).

Behavioral inhibition (also known as response inhibition) is an aspect of executive function responsible for controlling automatic or impulsive responses at appropriate times (Verdejo-Garcia & Pérez-Garcia, 2007). A number of cognitive and behavioral processes are involved in response inhibition, such as the ability to discontinue responding in a way that has been learned through reinforcement over time (Barkley, 1997). Additionally, response inhibition necessitates the ability to control potentially distracting events or stimuli from interfering with responses. Behavioral or response disinhibition is manifested behaviorally as heightened impulsivity and has been linked to frontal lobe dysfunction in a number of clinical populations, including individuals with AD (Verdejo-Garcia & Pérez-Garcia, 2007).

Lack of impulse control to resist using substances such as alcohol can be explained through the interaction and deregulation of two separate neuroanatomical systems – the impulsive system and reflective systems (Bechara, 2005). When functioning in a typical fashion, the interaction of these systems assists individuals in exercising free will by consciously integrating past experiences into current decision-making opportunities. However, damage to these systems due to genetic or environmental factors (or a combination of both) can affect an individual's ability to make decisions according to long-term outcomes. In the case of compulsive substance use, deregulation of these systems cause individuals to act on strong urges to use

substances because they are unable to inhibit their behavior based on potential consequences.

Neuroanatomically, the impulsive system includes the amgydala and its interaction with other subcortical structures such as the hypothalamus, autonomic brainstem nuclei, striatum, and periaqueductal gray matter (Bechara, 2005). The interaction of these neuroanatomical structures produces rapid emotional responses to immediate outcomes in response to perceived affective properties of environmental events or stimuli. The valence of emotional responses is due to individuals linking the stimuli to its positive or negative features. However, the affective properties of certain stimuli, such as money or drugs are associated through learning over time.

The reflective system consists of neural structures in the prefrontal cortex (PFC) that control affective responses to stimuli according to long-term outcomes in response to memories or knowledge (Bechara, 2005). The reflective system is synonymous with the term executive system (Bickel et al., 2006) because it is also associated with executive functions, such as memory, attention, mental flexibility, response inhibition, and learning (Barkley, 1997; Bates, Bowden, & Barry, 2002). Neuroanatomically, this system consists of the ventromedial prefrontal cortex (VMPF), dorsolateral prefrontal cortex (DLPC), insula, and hippocampus. This system is responsible for creating "affective state patterns" (Bechara, 2005, p. 1459) based on previous positive or negative experiences with substances. When an individual is faced with a previously-experienced situation involving substance use (or recalls memories of one), the affective state pattern associated with that event is activated. Affective state patterns are also created in response to learned social rules about the consequences of certain behaviors, such as

excessive alcohol use, without actually having to participate in them. Thus, an individual who has never tried illicit drugs or alcohol may still experience anxiety or fear by just imagining their consequences, because these responses have been learned or reinforced over time.

Individuals are predisposed to substance addiction when the reflective system is not strong enough to override the powerful urges to use substances produced by an overactive impulsive system (Bechara, 2005). This deregulation is thought to be present in individuals prior to drug use and may cause initial substance experimentation leading to long-term use. The resulting substance dependence occurs because the executive system's ability to recall affective state patterns is damaged and the impulsive system causes the individual to yield to impulses to use substances despite their consequences.

Additional brain imaging studies have pinpointed other neuroanatomical sites of cognitive impairment in individuals with substance dependence. Bechara (2005) synthesized brain imaging research focusing on impaired decision-making in individuals with alcohol, cannabis, cocaine, opioid, or methamphetamine dependence, noting that abnormalities in the ventromedial prefrontal cortext (VMPC) often seen in individuals with substance dependence, are manifested behaviorally through impaired decision-making and denial (Damasio, 1994). Additionally, research suggests that decision-making ability is impaired prior to substance use and dependence and is exacerbated by experimenting with and becoming addicted to substances (Bechara & Damasio, 2005). In another review of brain imaging research, Volkow and Fowler (2000) also found that substance dependence causes deregulation of the dopamine system through the orbitofrontal cortex, impairing the inhibition of behavior, such as drug-seeking

(Schoenbaum, Roesch, & Stalnaker, 2006). Specifically, substance use causes increased dopamine in areas of the brain responsible for reward, such as the amygdala, and in turn, reinforces the positive effect of substances, making it difficult for individuals to inhibit powerful urges to use.

Prevalence and Problems of Impulsivity in Alcohol Dependence

Numerous studies have identified impulsivity as a cognitive deficit seen in individual who abuse alcohol regardless of whether or not they had received previous treatment. In one study, heavy drinkers who had never received treatment for alcohol dependence performed significantly poorer than healthy controls on three behavioral measures of impulsivity and showed significantly heightened impulsivity on three self-report measures (Rubio et al., 2008). In another study, individuals in treatment for AD displayed significant impairments in inhibition as measured by a battery of neuropsychological tests when compared to healthy controls (Gourdriaan, Oosterlaan, de Beurs, & van den Brink, 2006). Additionally, individuals with AD receiving outpatient treatment had significantly higher levels of impulsivity than healthy controls as measured by both self-report and a behavioral measure of response inhibition (Lawrence, Luty, Bogdan, Sahakian, & Clark, 2009).

Poor decision-making in individuals with alcohol dependence is linked to deficits in response inhibition (Nöel, Bechara, Dan, Hanak, & Verbanck, 2007). Researchers administered a battery of neuropsychological tests to a group of participants with alcohol dependence and a healthy control group. Analysis of results indicated that the performance of nearly half of the participants with AD indicated impaired decision making and other executive functions, such as manipulation of working memory. The

authors relate this result to deficits in response inhibition, which causes individuals to continuously engage in risky behavior despite knowledge of potential negative outcomes.

Cognitive rehabilitation of impulsivity in alcohol dependence. No research has been located by the author that examines interventions to specifically target impulsivity in individuals with AD. However, Crews and Boettiger (2009) suggest that strengthening executive function processes through activation of frontal lobe structures during therapy can help to reduce impulsivity and addictive behaviors. Thus, studies focusing on remediation of executive control dysfunction and related cognitive impairment related to substance dependence are relevant in examining how to decrease impulsivity and increase conscious decision-making processes.

A number of recent studies have shown promising outcomes in the remediation of cognitive dysfunction related to AD. Specifically, computer-based programming has been used to address a variety of cognitive impairments in individuals receiving treatment for substance dependence. Fals-Stewart and Lucente (1994) compared the effects of two computer-based programs, as well as progressive muscle relaxation and no treatment on the neuropsychological status of patients with cognitive impairments involved in treatment for substance abuse. One of the computer conditions was a cognitive rehabilitation program consisting of exercises to practice a variety of cognitive skills, such as attention, planning ability, pattern detection, memory, and problem solving. The other computer condition consisted of training on how to type on a computer keyboard. All treatment conditions were facilitated twice-weekly for 50 minutes over the course of 6 months. Participants underwent a battery of neuropsychological tests at admission to the treatment program and on a monthly basis.

Results indicated that participants assigned to the computer-assisted cognitive rehabilitation condition had a significantly faster rate of cognitive recovery during the first 2 months of treatment than individuals in the other conditions. Additionally, these participants had more efficient cognitive functioning through the fourth month of treatment than those individuals assigned to the other conditions. In addition, staff ratings indicated that participants involved in the cognitive rehabilitation exercises were more positive and participatory during treatment.

The authors suggest that improved cognitive functioning can positively affect treatment response and outcome. A follow-up to this study found that individuals who participate in a computer-assisted rehabilitation program do indeed experience improvements in length of treatment stay and graduation from treatment programs (Grohman and Fals-Stewart, 2003). Specifically, individuals who received computer-based cognitive rehabilitation had a longer length of stay in the treatment program and were more likely to successfully graduate when compared to individuals receiving typing instruction or no treatment condition.

A second follow-up to the original study (Fals-Stewart and Lam, 2010) confirmed that staff rated individuals who participated in computer-assisted cognitive rehabilitation as significantly more engaged in treatment. Additionally, individuals who participated in the computer-assisted cognitive rehabilitation program remained in the treatment program longer than individuals who received typing instruction. An additional finding was that these individuals also had better long-term recovery outcomes, as they spent more days abstinent in the community during the 12 months following treatment graduation. This finding is important because it illustrates not only that cognitive deficits

can be remediated in a treatment setting, but the effects of remediation have a functional effect on recovery following treatment by preventing relapse.

The authors attribute the promising results of the above-mentioned studies to the computer program training addressing the underlying cognitive skills involved in higher-level, executive processes. The active nature of the computer-assisted cognitive rehabilitation probably improved attention and concentration. Attention and concentration are two skills involved in a variety of other cognitive processes necessary in everyday life situations (Fals-Stewart and Lucente, 1994). The positive effect of the computer training on treatment engagement and time to graduate had a direct effect on individuals' ability to maintain long-term abstinence in the community (Fals-Stewart and Lam, 2010). Thus, remediation of cognitive impairments through targeted interventions will contribute to relapse prevention by promoting long-term abstinence following treatment (Bates, Bowden, & Barry, 2002; Lesiuk, 2010).

Summary of Impulsivity

Impulsivity is a construct which involves quick and unplanned responses to stimuli without the consideration of potential negative outcomes (Moeller & Dougherty, 2002). Neuroanatomically, impulsivity is the result of an overactive impulsive system, regulated by the amygdala, which exerts power over a weakened reflective system, regulated by the PFC (Bechara, 2005). This deregulation, thought to be caused by a combination of environmental and genetic factors, causes individuals with AD to act on strong urges to use substances despite learned knowledge that potential negative consequences could occur.

Individuals with AD experience deficits in impulse control, which are thought to be present prior to substance use and are then exacerbated through prolonged consumption of alcohol (Bechara, 2005; Moeller & Dougherty, 2002). Presently, no research literature exists which examines the effect of specific interventions on impulsivity in individuals with AD. However, a number of studies have shown that computer-based cognitive rehabilitation programming is effective in addressing substance-related cognitive deficits, such as memory and attention (Fals-Stewart & Lucente, 1994; Fals-Stewart & Lam, 2010; Grohman & Fals-Stewart, 2003). Because attention and memory are skills thought to be at least partially regulated by the PFC, these studies provide evidence that cognitive deficits can be affected through interventions which activate and strengthen frontal-cortical structures. By strengthening executive function processes through activation of frontal lobe structures during therapy, individuals with AD should demonstrate a decrease in impulsivity and addictive behaviors (Crews and Boettiger, 2009).

Music and Impulsivity

This section will provide a rationale for the use of music-based interventions in addressing heightened impulsivity in individuals diagnosed with AD. First, the neuroanatomy of music perception and production will be reviewed with a focus on structures of the PFC. Review of these structures will build a rationale for the use of music in remediating impulsivity via activation of frontal lobe structures implicated in both impulsivity and activities which include music perception and production.

Next, this section this section will review previous music therapy literature related to the treatment of substance dependence and addictions. Additionally, this section will

discuss the use of music therapy in addressing cognitive deficits with a variety of clinical populations, such as traumatic brain injury and dementia. Finally, one study directly examining the use of music to address impulsivity in a clinical population, children with attention-deficit hyperactivity disorder (ADHD), will be examined.

Neuroanatomy of Music Perception and Production

A review of literature identifies the PFC as a key neural area involved in high-level cognitive skills present in both music perception and production (Levitin & Tirovolas, 2009). In regard to music perception, this region is responsible for generating expectations during music listening, and detecting violations of those expectations (Tramo, 2001). In addition, a recent brain imaging study implicated the left medial PFC as one of several brain structures involved in differentiating major and minor tonalities in music, as they relate to perceived sadness versus happiness (Green et al., 2008). The right ventro-medial PFC is also activated when processing melodies involving one's culturally-familiar, native music (Nan et al., 2007). The PFC also contributes to detecting phrase boundaries in music through maintenance of attention and updating working memory during music listening (Sridharan et al., 2007).

Level of PFC activation during music depends on the amount of higher-level, executive functions of music needed to complete the task. For example, a recent brain imaging study found that areas of the lateral PFC were deactivated in jazz musicians during piano improvisation, while the medial PFC was activated during the same task (Limb & Braun, 2008). The study elucidates the role of the lateral PFC in executive functions such as attention, inhibitory control, and other behaviors which require self-monitoring (Kringelbach & Rolls, 2004). The results of these studies involving music

perception and production provide support that music activates key areas of the reflective system, which needs to be strengthened in order to overcome impulsivity associated with AD.

Music Therapy in the Treatment of Substance Dependence

To date, music therapy has been used to address the social, emotional, and interpersonal needs of individuals receiving treatment for substance dependence (Lesiuk, 2010). Silverman (2003) conducted a review of literature consisting of 23 music therapy-related articles published between 1961 and 2002 and identified goals and interventions linked to the use of music in addictions treatment. Treatment goals identified through this review varied, touching on areas such as communication skills, mood/emotional expression, management of stress and anxiety, and issues relating to spirituality and recovery. Interventions most frequently reported in these articles included relaxation training, songwriting, and lyric analysis. None of the reported outcomes were related to cognitive functioning of participants or clients and none of the included studies evaluated treatment effectiveness of frequently-used music therapy interventions.

Based on findings from his literature review, Silverman (2003) conducted a two-part pilot study with women receiving long-term, residential substance abuse treatment to compare participants' perceptions of music therapy with other group interventions. The first portion of the study consisted of assessing perceived therapeutic benefit following weekly music therapy sessions. Four music therapy group types were presented twice each: music games, relaxation training, lyric analysis, and songwriting. During the second portion of the study, the author collected data related to participants' perceptions of which group (out of 19 possible treatment groups the participants attended) best

addressed a certain treatment aspect. Results indicated that participants felt that when compared to the other group treatment types, music therapy was the most therapeutic, enjoyable, relaxing, and energizing. Participants also rated music therapy as the group which best decreased their impulsivity.

The findings of the above-mentioned study have several important limitations. With the exception of relaxation training, the author does not identify which interventions facilitated, if any, were meant to specifically address any of the participants' self-reported benefits. For example, although participants felt that music therapy decreased their impulsiveness, the author does not report which of the four interventions were used to specifically target impulsivity, or if he actually intended to target impulsivity. Furthermore, the study did not explore reasons why participants felt that music therapy was most therapeutic, energetic, relaxing, energizing, and reduced their impulsivity. Based on this limitation, the results do not describe if and to what degree music therapy interventions influence the goal areas participants felt music therapy affected. Specific to impulsivity, the author hypothesizes that a link may exist between relaxation experienced in music therapy and the ability to consider consequences of past impulsive behavior related to substance use.

Several recent studies explore the use of different music therapy interventions to address the needs of individuals receiving treatment for substance dependence. Cevasco, Kennedy, and Generally (2007) compared the effect of group movement-to-music, rhythm activities, and competitive music-based games on depression, stress, anxiety, and anger of females in a substance abuse rehabilitation setting. The entire treatment cycle was 6 weeks long, with each intervention conducted twice a week for an hour over 2

weeks. Measures included inventories to assess anxiety and anger prior to each 2-week treatment period and after the final treatment condition, as well as participants' self-reported emotional states reported before and after each individual treatment session.

Overall, results of this study did not yield significant differences for the various music therapy interventions on participants' anxiety, depression, stress, and anger. However, analysis of individual participants' daily scores did indicate a decrease in all dependent variables immediately following music therapy sessions. In addition to daily scores, positive comments written in daily journals by participants also indicated that they felt music therapy was effective in helping reduce depression, stress, anxiety, and anger. The authors report that several clients showed consistent decreases in all dependent measures, while others responded more favorably to certain music therapy interventions than others. Based on these results, the authors emphasize the important role of assessment in identifying appropriate interventions, rather than utilizing a one-size-fits-all approach to therapy.

In another study comparing music therapy intervention types, Jones (2005) examined the effects of songwriting and lyric analysis on evoking emotional change in a single session with individuals with chemical dependency. Participants were individuals on a short-term chemical detoxification unit who attended a single music therapy session consisting of a warm-up activity and either a songwriting or lyric analysis intervention. Prior to and after the session, participants rated their mood on a scale from 0 (not at all) to 100 (extreme feelings) in 11 different mood areas, such as anger/rage/hostility, joy/happiness/enjoyment, and loneliness. Following discharge, participants also

completed a questionnaire related to self-perceived significant events that occurred during their time receiving treatment at the facility.

Results indicated no statistically significant differences in participants' moods prior to and after participant in the music session between songwriting and lyric analysis. However, comparison of pretest and posttest change scores indicated that songwriting produced greater changes in mood for 10 out of the 11 mood areas, including those related to joy, sadness, fearfulness, acceptance, surprise, anxiety, shame, guilt, frustration, and loneliness. Additionally, the majority of participants identified music therapy as a significant tool or step in their recovery.

The researcher suggests that the cognitive processes involved in thinking about and planning for the future during the songwriting process strengthened the emotional response during this intervention type. Additionally, an increase in "positive" emotions and a decrease in "negative" emotions during both treatment conditions, while not statistically significant, was observed and suggests that music therapy can evoke immediate changes in emotion during treatment for substance abuse. Thus, an effective treatment should address both cognitive and emotional issues.

A recent study by Baker, Gleadhill, and Dingle (2007) further explored the effect of a single music therapy session on altering emotions in clients in substance abuse treatment. Patients participated in at least one music therapy session and completed a post-test questionnaire related to enjoyment of music therapy, personal history of music use to alter mood, identification of mood experienced during music therapy, and intensity of moods experienced during music therapy.

Music therapy interventions used included lyric analysis, songwriting, improvisation, and song singing/listening. Results indicated that the majority of participants already used music to alter their moods, and that music frequently elicited a positive mood change. In addition, the majority of participants reported that the music therapy sessions were enjoyable or extremely enjoyable. While the majority of participants also reported experiencing a positive mood during music therapy, some negative emotions, such as feeling sad and upset, were also reported. More than half of the patients felt that participation in music therapy helped them to explore emotions. The authors conclude that music therapy allows clients to experience a wide range of emotions in a safe context, that is, without the use of substances.

In addition to emotional exploration, a study by Dingle, Gleadhill, and Baker (2008) found that music therapy which utilizes a cognitive-behavioral therapy (CBT) approach is an effective medium for engaging clients receiving treatment for substance dependence. CBT typically includes identifying and analyzing behaviors related to the substance use, such as reasons for and consequences of use, followed by learning and practicing new ways to cope with high-risk situations which may trigger substance use. In this study, participants who were either receiving inpatient or outpatient treatment for substance addiction took part in at least one music therapy session and completed a post-session survey. The music therapy sessions focused on topics also being addressed in participants' CBT-based verbal counseling sessions and included interventions such as lyric analysis, songwriting, improvisation, and song singing/listening. The post-session survey consisted of questions related to motivation, enjoyment, and desire to continue

participation in music therapy. In addition, a question was included related to participants' perception of the benefits received through music therapy participation.

Results revealed uniformly high ratings on all areas of the post-session survey, including enjoyment and motivation to participate. Nearly half of all participants reported that participation in music therapy "will help me feel part of the group" (p. 194), and music therapy was able to engage patients regardless of age or substance of choice. The researchers suggest that participation in music therapy facilitated strong emotional reactions in participants who displayed minimal emotional responses in verbal-based group CBT and cite its ability to engage clients of all ages as an important contribution to group substance abuse treatment. However, despite the use of a CBT-based model of music therapy in this study, no cognitive outcomes were actually measured.

The contribution of music therapy in addressing the affective-motivational needs of individuals receiving treatment, as noted in the above-mentioned research studies, has relevance to the current study. Because intense, impulsive urges to act often occur when individuals are in a negative mood (Bechara, 2005), using music in a therapeutic setting to induce a positive mood, such as through use of the iso principal or relaxation training interventions, may have an impact on impulsivity. In fact, Thaut (2002) suggests that affect modification through the various processes involved in music perception is a precursor to behavioral change. Specific to the cognitive domain, affect modification through music may improve attention and concentration, as well as insight into one's own behavior. Thus, music therapy interventions which include an affect modification component may emotionally and physiologically prepare a client to work on cognitive

skills. For treatment to be effective, both cognitive and emotional issues should be addressed during music therapy with individuals with AD.

Music-Based Cognitive Remediation in Related Clinical Populations

The uses of music-based cognitive rehabilitation have been explored in several adult clinical populations, such as adults with brain injuries, older adults with dementia, healthy older adults, and individuals with schizophrenia. These studies are relevant to the current study involving alcohol dependence and impulsivity because they provide evidence that music has a mediating effect on a number of cognitive functions, including executive function, memory, and attention. In addition, these studies identify specific music elements and/or music therapy interventions which are responsible for the mediating effects of music on cognitive skills, which can help researchers and clinicians test and design scientifically-validated music-based protocols with other clinical populations.

In a recent study, Thaut et al. (2009) examined the immediate effects of neurologic music therapy (NMT) on executive function and emotional adjustment in brain-injured individuals. NMT techniques are based on scientific knowledge regarding the effect of music on cognition, affect, and sensorimotor functioning and are designed to transfer to functional, nonmusical behaviors outside of the therapy session. Treatment participants took part in four, group music therapy sessions that employed an NMT technique specific to attention, memory, executive function, or emotional adjustment. The attentional control exercises consisted of participants synchronizing their percussion playing to rhythms produced by the therapist or another participant. During memory training, music was used as a mnemonic device to teach lists of words to participants.

Executive functioning training included group improvisation to exercise skills such as decision making and problem solving. Emotional adjustment exercises included structured group singing using songs portraying positive emotions.

Participants were administered pre- and post-tests consisting of neuropsychological measures related to each individual treatment variable. The pre-test was also administered to a control group after which they rested for 30 minutes and then took the post-test. Results indicated that overall emotional adjustment and one aspect of executive function, mental flexibility, were significantly improved after one, 30-minute NMT session. A large effect size for mental flexibility in the treatment group (d=1.21) also suggests clinical significance.

Music therapy has also been used to treat older adults with cognitive impairments associated with age-related dementias. Bruer, Spitznagel, and Cloninger (2007) examined the effect of group music therapy on cognitive impairment in elderly adults with dementia or dementia-like symptoms. Additionally, the authors sought to examine the duration of cognitive improvements following participation in music therapy. The authors predicted that music therapy would produce a measurable short-term cognitive improvement which would extend up to a week following participation in music therapy.

Participants were randomly assigned to treatment or control groups, and then acted as their own controls for 8 weeks (i.e., each group participated in either group music therapy or watched an age-appropriate movie on opposite weeks). Music therapy groups consisted of singing patient-preferred music and included socialization, humor, sensory stimulation, and song learning. An assessment of cognitive functioning was

administered to each participant prior to each intervention session, and at 2 points afterward.

Results indicated that an participating in group music therapy significantly improved cognitive functioning the day after treatment when compared with the video condition. However, the effects of music therapy appear to be short-lived, as tests carried out a week after each treatment session indicated that cognitive improvements seen the day after a session were no longer present. The authors hypothesize that music is effective in diminishing the short-term anxiety associated with age-related dementia and/or age-related cognitive decline.

Music instruction is another method for affecting executive functioning in older adults. Bugos, Perlstein, McCrae, Brophy, and Bedenbaugh (2006) examined the effect of individualized piano instruction (IPI) on age-related cognitive decline in older adults. Participants were assigned to treatment or untreated control groups and completed a battery of tests measuring general cognitive functioning and musical aptitude pre-training, following intervention, and three months later. The treatment group participated in one, 30 minute IPI session per week with three hours of independent practice for six consecutive months. The IPI sessions consisted of basic music theory training; practice of scales, triads, and dexterity exercises; and learning piano repertoire based on progress in sessions.

Results showed significant improvement over time in treatment participants' scores on two tests which measured attention, concentration, planning, memory, perceptual speech, and visoscanning following IPI sessions. Participants assigned to the treatment condition did not show significant improvements over time on the tests. Most

improvements were sustained three months after the end of treatment and generalized to non-musical, general cognitive skills. The researchers believe that the IPI's ability to exercise both cognitive and motor domains through high-level, concurrent spatial and temporal processing contributes to an overall improvement in cognitive abilities in older adults. Additionally, practice is necessary to maintain maximum cognitive benefits over time in older adults experiencing typical, age-related cognitive decline.

Cognitive impairment is also commonly seen in patients with schizophrenia. Ceccato, Caneva, and Lamonaca (2006) studied the effect of a Sound Training for Attention and Memory (STAM) procedure on attention, working memory, and life skills of individuals with schizophrenia. Participants assigned to the treatment group participated in the STAM protocol once a week for 16 weeks, with each session lasting 55 minutes. The STAM protocol consisted of 4 separate music-based movement exercises performed to pre-recorded sound tracks meant to exercise different aspects of attention and memory. For example, during one STAM exercise, participants worked on shifting attention by clapping their hands when they heard a drum, but inhibiting their response when they heard a cymbal. Control participants also participated in music therapy, although a less structured, improvisatory-based approach was utilized. Both groups were evaluated using a battery of tests to measure attention, memory, and social disability, such as self-care, calmness, social contact, communication, and responsibility, before and after music interventions

Results indicated that individuals in both groups significantly improved their life skills following participation in their respective music interventions. However, the individuals who participated in the STAM protocol also showed significant

improvements in working memory. Regarding the findings related to life skills, the authors conclude that participation in music therapy can improve global functioning in individuals with schizophrenia. Interestingly, neither group showed significant improvement on measures of attention. The authors do not offer substantial explanations for their findings, but believe their study should be used to stimulate more research on the effect of music therapy on specific cognitive impairments in individuals with schizophrenia.

Music therapy and impulse control. Presently, the author has located only one study specifically examining the use of music to affect impulsivity in a clinical population. Rickson (2006) compared the effects of instructional and improvisational rhythm-based group interventions on impulsivity in adolescent males with Attention-Deficit Hyperactivity Disorder (ADHD). Impulsivity is a characteristic common to individuals with ADHD as well as substance dependence, lending preliminary support to the consideration of interventions examined by Rickson.

Participants were assigned to instructional, improvisational, or control groups and their impulsivity was measured via a computerized, synchronized tapping task (STT) before and after each music session. Two treatment groups met during two "phases", each lasting for 10 weeks, where each group received either instruction or improvisation-based group sessions 8 times for 45 minutes each before switching to the other treatment type. The control group met for one phase following collection of experimental data from the treatment groups, and participated in group music therapy which incorporated positive findings from the two treatment groups.

Analysis of baseline data indicated no difference between groups prior to participation in experimental procedures. Following the second phase of treatment, both experimental groups showed statistically significant reductions in errors on the STT when compared to baseline scores. Both experimental groups made slightly more progress during the instruction-based treatment phases than the improvisation phases, though statistical significance was not reached. An additional measure of impulsivity used by teachers, social workers, and parents to subjectively rate participants' changes in classroom impulsive behavior following treatments also illustrated greater improvement following instruction.

The author points to the role of motivation to participate in music therapy in influencing the outcome of this study. Additionally, the researcher reported that results may be due to the fact that participants were able to better sustain attention, concentration, and self-control through participation in both music-based interventions, but does not explain how or why music may facilitate these behaviors. While this subjective report provides a basic hypothesis regarding the potential reasons that music can affect impulsivity, more detailed information is needed to ascertain how specific music experiences or elements may relate to impulsivity in clinical populations.

Summary of Music and Impulsivity

There is a paucity of research investigating the effect of music therapy on addressing impulse control in both typical and clinical populations. However, neurological evidence exists suggesting that music can activate key areas of the reflective or executive system which need to be strengthened in order to decrease impulsivity related to AD. Specifically, the PFC is a key neural area implicated in tasks involving

music perception and production, with activation or de-activation of PFC structures being task-dependent (Green et al., 2008; Kringelbach & Rolls, 2004; Limb & Braun, 2008; Nan et al., 2007; Sridharan et al., 2007; Tramo, 2001). In addition to music perception and production, the PFC is also involved in a number of cognitive skills thought to be mediated by the frontal lobe, such as impulse control. Research shows that participation in music-based interventions can positively affect attention, working memory, planning, and cognitive flexibility in individuals with traumatic brain injury, dementia, and schizophrenia, attention, working memory, planning, and cognitive flexibility (Bruer, Spitznagel, & Cloninger, 2007; Ceccato, Caneva, & Lamonaca, 2006; Thaut et al., 2009). These studies support the design and testing of music-based interventions to examine the relationship between music and cognitive skills, such as impulse control, which are thought to be mediated by the frontal lobe.

To date, music therapy research in addictions treatment has focused on social, emotional, and interpersonal outcomes, with outcomes based on participants' self-reports of perceived benefits of participation in music therapy (Lesiuk, 2010; Silverman, 2003). None of the studies in this area reported outcomes in the cognitive domain, nor did they provide a scientific rationale for why or how the music produced positive changes in participants. For this reason, it is difficult to ascertain exactly how music therapy actually influenced the reported outcomes.

One published music therapy study has specifically focused on reducing impulsivity in a clinical population. Rickson (2006) found that participation in improvisational and instructional modes of group music therapy decreased errors on a tapping task in children with ADHD. Because impulsivity is seen in both ADHD and

alcohol dependence, Rickson's study provides preliminary evidence of the usefulness of music in addressing impulse control in clinical populations. However, it is still difficult to understand exactly how music produced a positive outcome in this study.

Research Questions

The following research questions were addressed in this study:

1. How do individuals diagnosed with alcohol dependence perform on a music-based cognitive rehabilitation protocol?
2. What is the relationship between degree of impulsivity and performance on a music-based cognitive rehabilitation protocol in individuals diagnosed with alcohol dependence?

Chapter 3

Method

Participants

Twenty adults ages 25 to 60 years with a primary diagnosis of Alcohol Dependence (AD) or polysubstance dependence including alcohol (PSA) participated in this study. Participants were recruited from the inpatient drug and alcohol detoxification unit of the Health and Recovery Center at Jackson Memorial Hospital's Mental Health Hospital in Miami, Florida. Participants were admitted to this unit for medically-supervised detoxification which included administration of medication and optional participation in psychoeducational, therapeutic, recreational, and spiritually-based group activities. On average, participants remained on the detoxification unit for three to seven days, depending on severity of symptoms and the availability of more intensive rehabilitation services in the community.

All participants met the diagnostic criteria for AD or PSA according to the American Psychiatric Association (2000) as determined by the attending psychiatrist. Participants were excluded from this study if they had a dual diagnosis of a psychiatric disorder with psychotic features (e.g., schizophrenia) and/or attention-deficit hyperactivity disorder (ADHD). Additionally, individuals with a history of formal music instruction were excluded from participating in this study.

Participants were English speaking and able to understand verbal cues as well as read in English. In regard to motor functioning, participants were able to independently move all five fingers of their dominant hand, comparable to typing on a typewriter.

Design and Variables

A correlational design (Gravetter & Wallnau, 2011) was utilized to examine the relationship between the independent variables of Hit Reaction Time (Hit RT), Perseverations, Commission Errors, and Total Impulsivity, and the dependent variable of performance on the four exercises of the Music-Based Cognitive Rehabilitation Protocol (MBCR) and the Total Rubric score.

Measures

Demographics. Participant demographics were collected using a two-part researcher-generated information form which took approximately one minute to administer (see Appendix A). The first part of the information form contained demographic information, such as age, sex, and ethnicity. The second part of the information form contained questions related to the participant's history of alcohol use and treatment, such as number of years the participant's alcohol intake has been excessive, weekly and daily alcohol consumption amounts, and number of times the participant has received inpatient or outpatient treatment for alcohol-related issues.

Continuous performance test. The Continuous Performance Test-II, version 5 (CPT) (Conners, 2007), a 14-minute computerized assessment of attention, vigilance, and impulsivity, was used to collect data related to participants' impulsivity. The test can be used as a screening tool, to monitor treatment/medication effectiveness, or for research purposes, and helps to identify potential problems of executive function in clinical populations, such as adults with ADHD or neurological impairments. Although the CPT was originally tested with adults with ADHD or non-specified neurological impairment, and typically-functioning adults, it has been used in a number of studies to investigate the

neurobehavioral performance of individuals with substance dependence disorders (Rubio et al., 2007; Rubio et al., 2008).

During the CPT administration, participants press the keyboard spacebar every time any letter besides the target letter 'X' appears on the screen. The CPT includes inter-stimulus intervals (ISIs) of 1, 2, and 4 seconds. Letters, displayed for 250 milliseconds each, are presented in varying orders over six blocks throughout the course of the test. Each block contains 3 sub-blocks with 20 letter presentations. Following administration of the CPT, a score report is generated which contains three measures related to impulsivity, including Commission Errors, Hit Reaction Time (Hit RT), and Perseverations. A commission error is made by the participant when he or she has an incorrect response (i.e., presses the keyboard spacebar) to the letter "X". Hit RT refers to the mean response time, in milliseconds, for all target or correct responses. Perseverations refer to any responses that occur less than 100 milliseconds following the display of a stimulus on the computer monitor.

Impulsivity measures included in the CPT are converted to T-scores which compare the participant to individuals in the normative group of the same gender and age range. A T-score of 50 represents the mean score for the normative group, and all T-scores have a standard deviation of 10. For example, a T-score of 40 is 1 standard deviation below average.

Two of the three impulsivity measures on the CPT, Hit RT and Commissions, were included in the original standardization sample (Conners & MHS Staff, 2004) with the authors reporting split-half reliabilities of .95 and .83, respectively. The test-retest reliability of the third impulsivity measure, Perseverations, is reported at .43 and is

considered adequate considering the unusual distribution of this measure (i.e., some individuals did not make any perseverations during both the test and re-test).

Rubric. Each participant's performance during all four exercises of the music protocol (described in the section label "Procedure" below) was graded using a researcher-designed rubric (see Appendix B). For each of the four exercises, the participant could receive a score of 1 to 4 depending on performance on the exercise. A score of "1" indicates a poor performance on the exercise, while a score of "4" indicates an excellent performance on the exercise. The total possible score for the Rubric was 16.

Equipment

The following materials were used to conduct the research study: Dell Vostro 1510 laptop computer, Yamaha electronic keyboard, orange Post-it Flags, keyboard set-up diagrams (see Appendix C), rhythm recall sheet music (see Appendix D), and song playing numbered notation sheets (see Appendix E).

Procedure

The study received approval from the Institutional Review Board of the University of Miami and the Clinical Research Review Board of Jackson Memorial Hospital (Protocol number 20100763). Participants were recruited from the inpatient detoxification unit of the Health and Recovery Center at Jackson Memorial Hospital's Mental Health Hospital. The researcher explained the study to adults enrolled on the unit and invited each adult who met the requirements for the study to participate. If the adult chose to participate in the study, he or she signed an informed consent form (see Appendix F). A copy of the signed informed consent form was also sent to Jackson Memorial Hospital's Clinical Trials Office.

After signing the informed consent form, each adult participated in the study, which took place in a small group therapy room on the inpatient detoxification unit of the Health and Recovery Center at Jackson Memorial Hospital's Mental Health Hospital. All participants completed the participant information form and took the CPT prior to completing the researcher-developed MBCR. Each participant met with the researcher once for approximately 25 minutes. Four different music exercises were performed, including a Five-Finger exercise, Rhythm Repetition exercise, Bordun exercise, and a Song Playing exercise. The researcher evaluated the participant's performance on each exercise of the MBCR using the Rubric. Following the MBCR, the participant was encouraged to discuss their performance and/or provide feedback about the protocol.

Five-Finger exercise. The Five-Finger exercise was developed as a warm-up and is based on a portion of the protocol utilized in a previous study (Bugos et al., 2007) investigating the effect of individualized piano lessons on the executive function of healthy, older adults. During this exercise, the participant independently used all five fingers of his or her dominant hand to play up and down the first 5 notes of the C Major scale, including C, D, E, F, and G, on the keyboard in time with a metronome (see Appendix G). The Five-Finger exercise was assumed to address sustained attention.

The researcher began by placing orange stickers, labeled 1, 2, 3, 4, and 5, on the keys used for this exercise. Next, the researcher set the keyboard's internal metronome to 60 beats per minute (BPM), said "watch and listen," and demonstrated the exercise. The participant was then instructed to play the exercise using his or her dominant hand in time with the metronome as modeled by the researcher. If the participant was able to complete the exercise in time with the metronome, the researcher increased the metronome by 5%

(i.e., 3 BPM) and prompted the participant to repeat the exercise at the new tempo. This process continued for 5 minutes, or until the participant was not longer able to complete the exercise in time with the metronome after 3 attempts.

Bordun. The Bordun exercise was developed to address selective attention and is a modified version of the group Neurologic Music Therapy (NMT) technique suggested for addressing selective attention for cognitive rehabilitation (Thaut, 2005). During this exercise, the participant used two fingers from his or her dominant hand to play two notes on the keyboard simultaneously in time with a metronome while the research improvised a melody. Four different rhythmic patterns were played for one minute each by the participant: four quarter notes; two quarter notes and one half note; two half notes; and one whole note. The researcher began by placing orange stickers, labeled 1 and 2, on the keys used in this exercise (see Appendix C for keyboard set-up). The researcher told the participant that he or she would be sustaining a rhythm for one minute, while the researcher improvised a melody that was different from what the participant was playing. The participant was instructed to continue to sustain the rhythm no matter what the researcher played.

Next, the researcher set the keyboard's internal metronome to 60 beats per minute (BPM), told the participant to watch and listen, and demonstrated the exercise. The participant was then instructed to play the exercise using his or her dominant hand in time with the metronome as modeled by the researcher. Once the participant sustained the rhythm for 3 measures, the researcher began to improvise a melody for one minute. If the participant began to play out of tempo, the researcher would provide verbal cues to attempt to help the participant play correctly in-time with the metronome.

Rhythm Repetition. The Rhythm Repetition exercise was developed to address working memory and is based on theoretical principals related to the use of NMT in the cognitive remediation of memory in clinical populations (Gardiner, 2005). During this exercise, the participant listened to a rhythm played on the piano by the researcher, and repeated the rhythm back by playing it on piano. A total of 26 rhythms were presented (Solomon, 1998) (see Appendix D). The piano was programmed to sound like a variety of percussion instruments, and the rhythms were presented on a keyboard key which sounded like a wood block.

To begin, the participant was asked to choose a key to play for this exercise. The researcher then said, "listen to my rhythm, and then play it back on your key. Please tell me if you need to hear the rhythm played more than once." The researcher presented the rhythm and then said, "your turn." If the participant played the rhythm correctly, the researcher moved on to the next rhythm. The researcher repeated the same rhythm if requested by the participant, or if the participant played the rhythm back incorrectly, up to three times before moving on to the next rhythm.

Song Playing. The Song Playing exercise was assumed to address alternating attention and is based on the work of Bugos et al. (2007) who investigated the effect of individualized piano lessons on the executive function of healthy, older adults over several months. Because the MBCR protocol was conducted over one, 25-minute session, the Song Playing exercise was designed to ensure participant success within a few minutes. During this exercise, the participant chose from a list of three songs and independently used fingers from his or her dominant hand to play the melody of the song on the keyboard using numbered notation sheets and numbered stickers. The numbered

notation sheets (see Appendix E) included printed words to one verse and one chorus of the chosen song along with numbers over each word which corresponded to numbered stickers placed on the keyboard. Participants chose from the following songs: “Lean On Me” by Bill Withers, “Amazing Grace” (traditional religious), or “Eight Days a Week” by The Beatles. The researcher presumed these songs would be familiar to the majority of participants and were chosen for this reason.

The researcher began by telling the participant to play through the first line of the song slowly. Once the participant played the first line correctly, he or she was encouraged to play it over again several more times. The researcher then encouraged the participant to play through the second line of the song slowly. Once the participant played the second line correctly, he or she was encouraged to play it over again several more times. Then, the researcher encouraged the participant to play the two lines together slowly. Once the participant played the second line correctly, he or she was encouraged to play it over again several more times. This “chaining” technique was utilized throughout the song playing exercise until the entire song had been learned. Although not instructed to sing during this exercise, many participants chose to do so. Following the music session, the participant was encouraged to discuss their performance and/or provide feedback about the protocol.

Chapter 4

Results

This chapter will discuss the statistical analysis of the data. A correlational design was implemented in this study to examine the performance of individuals with alcohol dependence (AD) on a music-based cognitive rehabilitation protocol (MBCR), and to examine the relationship between degree of impulsivity and performance on the MBCR protocol. The independent variables relating to impulsivity were Perseverations, Hit Reaction Time (Hit RT), Commission Errors, and Total Impulsivity and were measured on a continuous scale with *T*-scores ranging from 0 to 100. The dependent variable was MBCR performance as measured on a rubric from 1 to 4 for each individual exercise, as well as a Total Rubric score with a possible total of 16.

In this chapter, the results of the descriptive analyses will be reported first, followed by results of inferential statistics, organized by research question. Descriptive results describe the participants' demographic information, and compare their mean scores on the three impulsivity measures and Total Impulsivity to normative data. Following the descriptive results, participants' performances on the four exercises will be compared in a repeated measures analysis of variance (ANOVA) to determine if significant differences exist between performance on the four MBCR exercises. Correlations between the means of the three impulsivity measures, Total Impulsivity, each exercise of the MBCR, and Total Rubric Score will then be examined.

Descriptive Results

In this section, participants' demographic information and responses to the alcohol-use questions on the Participant Questionnaire will be described. Additionally,

participants' scores on three impulsivity measures, as well as Total Impulsivity, will be described and compared with a normative group. Participants' performance on the MBCR protocol will also be included.

Participants. A total of 20 adults with alcohol dependence (AD) or polysubstance dependence including alcohol participated in this study. Of the 20 adults, 14 were male and six were female; 15 participants were diagnosed with AD and five were diagnosed with polysusbstance dependence. The mean age of participants was 44.8 years with participants ranging in age from 25 to 60. Of the 20 participants, nine were White non-Hispanic, nine were Hispanic, one was Asian, and one was Multi-racial. Detailed demographic information is listed in Table 1.

The descriptive results, shown in Table 2, include means, standard deviations, and ranges of participants' responses to alcohol-use questions on the Participant Questionnaire. The mean number of years of excessive alcohol use for participants was 17.1. The mean time per week participants drank alcohol was 6 days, with a mean of 20.1 drinks at any one time. The mean of prior inpatient treatment enrollments for AD for treatment participants (not including the present hospitalization) was three times. The mean of outpatient treatment enrollments for AD for treatment participants was 0.45 times. None of the participants were currently enrolled in an outpatient program.

Table 1

Frequency of Participant Demographics

Demographic Variables	Frequency
Gender	
Male	14
Female	6
Age (in years)	
25	1
32	1
34	1
35	2
41	2
43	1
45	1
46	3
47	1
48	1
50	1
53	1
54	1
56	1
59	1
60	1
Ethnicity	
White, non-Hispanic	9
Hispanic	9
Asian	1
Multi-racial	1
Diagnosis	
Alcohol Dependence	15
Polysubstance Dependence	5

Impulsivity Results

The descriptive results, shown in Table 3, include the overall means and standard deviations of participants' *T*-scores for all three measures of impulsivity as well as the mean and standard deviation of the Total Impulsivity *T*-score.

Possible scores for all measures of impulsivity and Total Impulsivity ranged from 0 to 100. The Total Impulsivity score consists of the mean of all three impulsivity *T*-scores together. The mean *T*-score for Commissions Errors for all participants was 50.70. The mean *T*-score for Hit Reaction Time (Hit RT) for all participants was 66.61. The mean *T*-score for Perseverations for all participants was 77.47.

The mean *T*-score for Total Impulsivity for all participants was 64.93. The mean *T*-score for all impulsivity scores for participants and the normative group are also depicted in the form of a bar graph in Figure 1.

Table 2

Means, Standard Deviations, and Ranges of Participants' Responses to the Participant Questionnaire

	M	*SD*	Range
Years of excessive alcohol use	17.1	13.50	40
Days per week drinking alcohol	6	1.97	6
Number of drinks at one time	20.1	11.23	41
*Number of inpatient treatments for AD	3	4.59	18
Number of outpatient treatments for AD	0.45	3	3

* Inpatient treatment does not include current hospitalization.

Table 3

Means and Standard Deviations of Measures of Impulsivity for Participants with AD or Polysubstance Dependence (N=20)

	M	*SD*
Commission Errors	50.70*	10.70
Hit RT***	66.61**	16.99
Perseverations	77.47**	37.00
Total Impulsivity	64.93**	12.56

Note. * indicates performance within the average range when compared to normative group according to Continuous Performance Test (CPT) guidelines for interpreting T-scores (Conners, 2004). ** indicates performance is markedly atypical when compared to normative group according to CPT guidelines for interpreting T-scores (Conners, 2004). ***For Hit RT, high *T*-scores indicate slow reaction times and potential attentional difficulties, while low *T*-scores indicate fast reaction times and potential impulsivity (Conners, 2004).

Four separate *t*-tests were conducted to determine if participants' *T*-scores for Perseverations, Hit RT, Commission Errors, and Total Impulsivity significantly differed from the normative group value of $t = 50$. A significant effect emerged for Perseverations, $t(19) = 3.319$, $p = .004$, with participants making substantially more perseverations than the normative group. A significant effect for Hit RT also emerged, $t(19) = 4.372$, $p < .001$, with participants' reaction time being slower than the normative group. No significant effect was observed for Commission Errors, $t(19) = .293)$, $p = .772$. A significant effect for Total Impulsivity emerged, $t(19) = 5.316$, $p < .001$, with participants receiving higher means than the normative group indicating significantly heightened impulsivity.

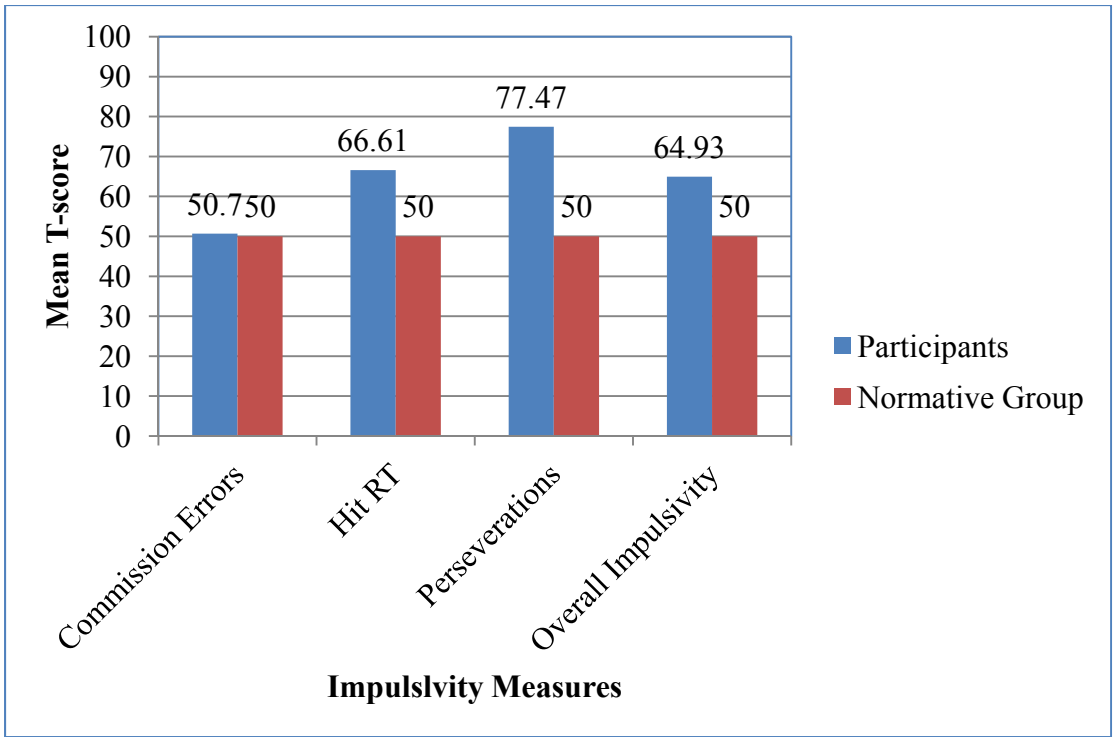

Figure 1. Means of impulsivity measures for participants with alcohol dependence or polysubstance dependence and a normative group. A *T*-score of 50 represents the mean for the non-clinical normative group (Conners and MHS Staff, 2004).

A Clinical Confidence Interval (CCI) score, generated by the computerized assessment utilized in this study, indicates that the participants' performance on the measure is related to a clinically significant attention and/or impulsivity problem. While the computerized assessment measures attention in addition to impulsivity, results of the participants' scores on the attention measures are not being utilized for this study. However, the means of the CCI score is being included in this chapter as they will be discussed in the following chapter with regard to theoretical and practical implications related to participants' impulsivity and attention, as well as implications for future research.

The CCI score is expressed as a percentage from 0 to 100 that indicates the likelihood that the participant matches a clinical versus non-clinical profile, with a score

of 50% providing no decision. As scores increase from 50%, the likelihood that a clinically significant attention or impulsivity problem exists also increases, especially when paired with elevated *T*-scores on the other CPT measures. Out of 20 participants, 13 received CCI scores at or above 50%, indicating that a clinically significant attention and/or impulsivity problem exists. The mean CCI score was 70.08% and the standard deviation was 25.44. The distribution of CCI scores is depicted in the form of a histogram in Figure 2.

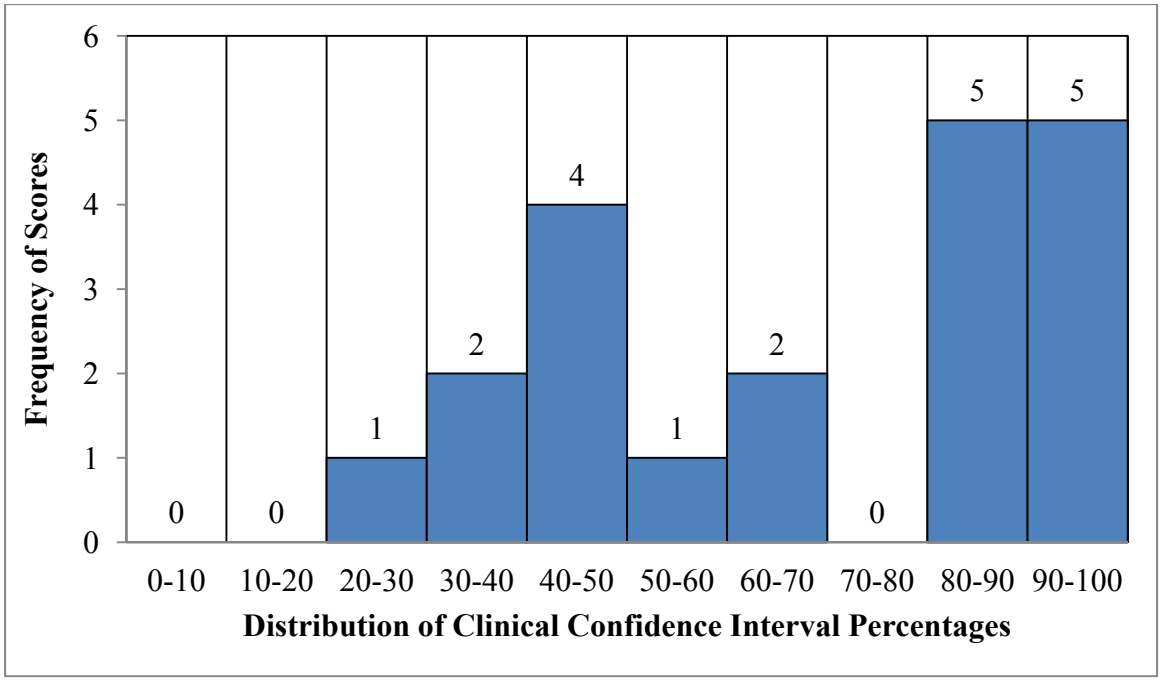

Figure 2. Distribution of Clinical Confidence Interval (CCI) scores. CCI values, reported as percentages, are used to help classify individuals, based on their performance on the CPT, as fitting a clinical or a non-clinical profile. CCI values over 50% indicate that an individual is a closer match for a clinical profile, with scores above 60% (paired with elevated *T*-scores on the other impulsivity measures) offering strong evidence of a clinical classification (Conners and MHS Staff, 2004).

Music-Based Cognitive Rehabilitation Protocol

Table 4 contains descriptive results related to frequencies of scores on each exercise of the Music-Based Cognitive Rehabilitation Protocol (MBCR). For each

exercise, participants could receive a score ranging from 1 to 4, with 1 indicating a poor performance and 4 indicating an excellent performance. For all exercises, no participants received a score of 1. On the Five-Finger exercise, six participants received a score of 2, nine participants received a score of 3, and five participants received a score of 4. The mean score for the Five-finger exercise was 2.95, and the standard deviation was .76. On the Bordun exercise, ten participants received a score of 2, seven participants received a score of 3, and three participants received a score of 4. The mean score for the Bordun exercise was 2.65, and the standard deviation was .75. On the Rhythm Repetition exercise, eight participants received a score of 2, eight participants received a score of 3, and four participants received a score of 4. The mean score for the Rhythm Repetition exercise was 2.8, and the standard deviation was .77. On the Song Playing exercise, no participants received a score of 1, no participants received a score of 2, eight participants received a score of 3, and 12 participants received a score of 4. The mean score for the Song Playing exercise was 3.6, and the standard deviation was .50. These results are also depicted in the form of a bar graph in Figure 3.

For Total Rubric score, no participants received a score below 9, and no participants received a score of 16. The mean Total Rubric score was 12 out of a possible score of 16, and the standard deviation was 1.65. The distribution of Total Rubric scores is depicted in the form of a bar graph in Figure 4.

Table 4

Frequencies, Means, and Standard Deviations of Scores for MBCR Exercises

Exercise	N	Frequency (N, %) 1	2	3	4	*M*	*SD*
1. Five-Finger	20	0 0%	6 30%	9 45%	5 25%	2.95	.76
2. Bordun	20	0 0%	10 50%	7 35%	3 15%	2.65	.75
3. Rhythm Repetition	20	0 0%	8 40%	8 40%	4 20%	2.8	.77
4. Song Playing	20	0 0%	0 0%	8 40%	12 60%	3.6	.50

Note. The scores can be interpreted as follows: 1=poor performance, 2=fair performance, 3=good performance, 4=excellent performance

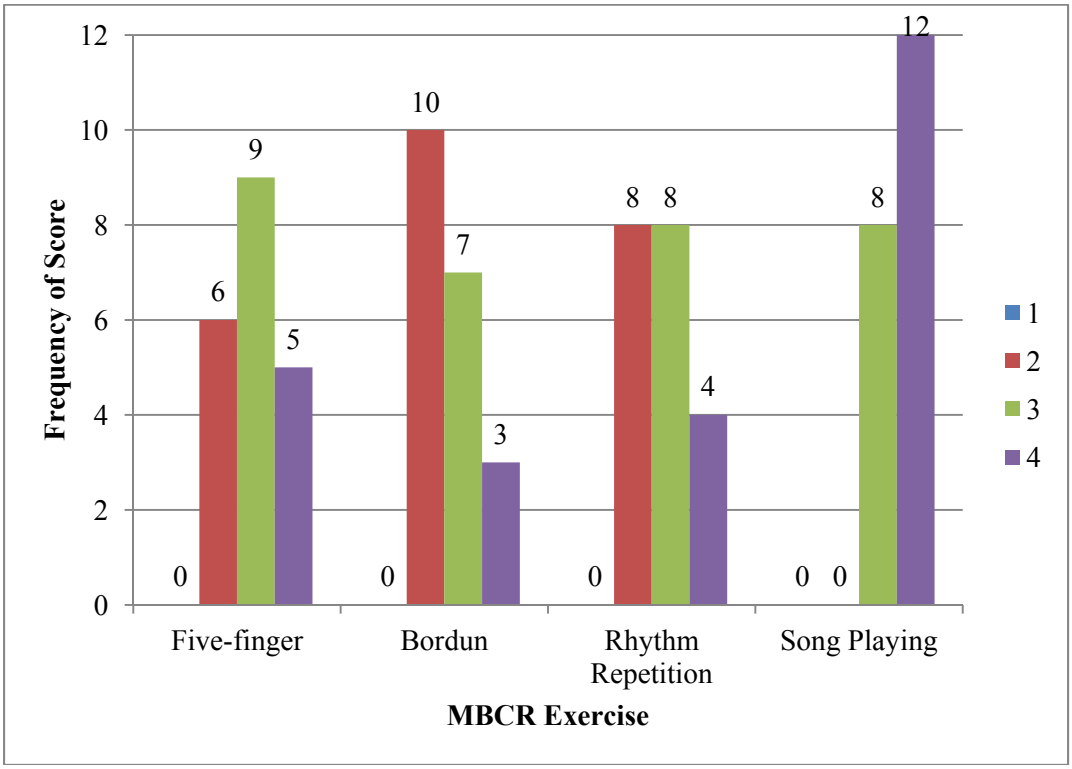

Figure 3. Frequencies of scores for MBCR exercises.

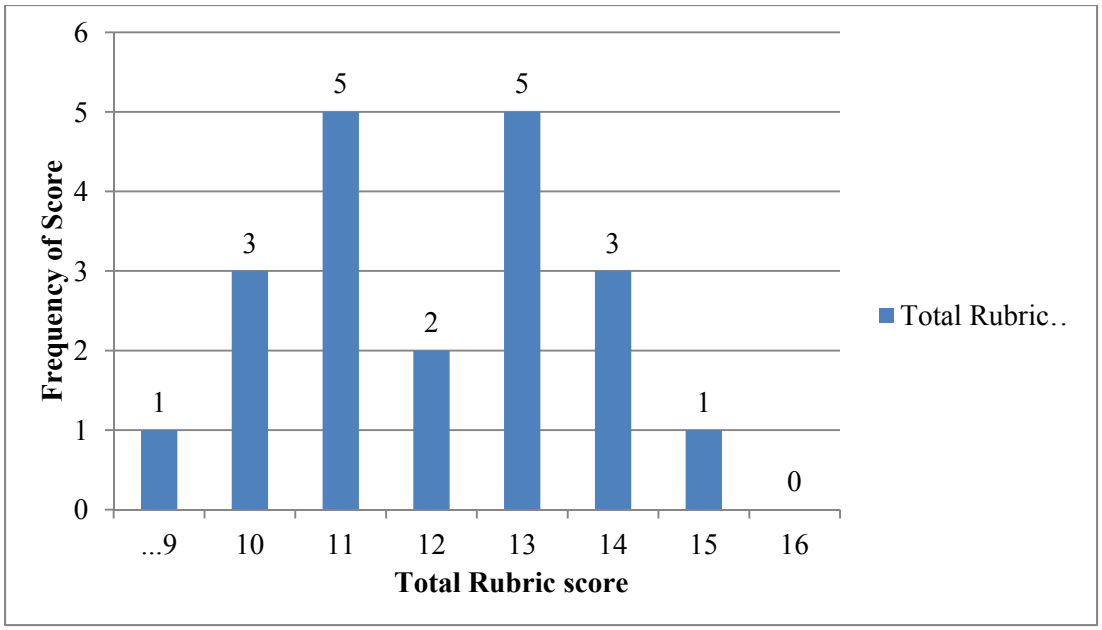

Figure 4. Distribution of Total Rubric scores.

Inferential Results

In this section, differences between the four exercises included in the MBCR protocol will be examined. Relationships between the three impulsivity measures, Total Impulsivity, rubric scores for the four MBCR exercises, and Total Rubric will be described.

A repeated measures ANOVA was used to determine significant differences between performance scores on the four exercises of the MBCR ($F(3,57) = 8.14$, $p <$ .001). This researcher checked for two assumptions of repeated measures ANOVA before implementing the model to test for differences between the four types of exercises. The assumption of sphericity was met ($x^2(5) = .92$, $p = .969$). The assumption of normality was not met due to the small range of possible scores. Table 5 shows the results of the repeated measures ANOVA.

Table 5

Repeated Measures Analysis of Variance (ANOVA)

Source	*SS*	*df*	*MS*	*F*	*p*
Exercise	10.5	3	3.5	8.143	.001
Error (exercise)	24.5	57	0.43		

To determine the location of differences between scores, a Bonferroni post-hoc analysis was used to examine pairwise comparisons. The post-hoc analysis showed that scores for the Five-Finger, Bordun, and Rhythm Repetition exercises were not significantly different from each other. However, scores for these three exercises were all significantly different than scores for the Song Playing exercise. The Bonferroni test revealed that scores for the Song Playing exercise were significantly better (i.e., higher) than the Five-Finger exercise (M_D=-.650, p = .022), Bordun exercise (M_D=.800, p = .200), and the Rhythm Repetition exercise (M_D=.950, p = .211).

Bivariate correlation was then used to examine relationships between the three impulsivity measures, Total Impulsivity, the rubric scores for the four MBCR exercises, and the Total Rubric score. The possible range for the impulsivity measures of Hit RT, Commission Errors, Perseverations, and Total Impulsivity were *T*-scores from 0-100, with higher scores indicating increasingly atypical performance. The possible range of scores for the Five-Finger, Bordun, Rhythm Repetition, and Song Playing exercises was 1 to 4, with a score of 1 indicating a poor performance and a score of 4 indicating an excellent performance.

Results indicated a highly significant, negative correlation between Hit RT and Commission errors, r = -.772, p < .001. A significant, negative correlation was also found between Hit RT and Song Playing, r = -.471, p = .036. A significant, negative

correlation was found between Commission Errors and the Bordun, $r = -.528$, $p = .017$. The positive correlation between Perseverations and Total Impulsivity was highly significant, $r = .956$, $p < .001$. The negative correlation between Perseverations and Rhythm Repetition was significant, $r = -.453$, $p = .045$. The negative correlation between Total Impulsivity and Rhythm Repetition was significant, $r = -.481$, $p = .032$. The positive correlation between Five-Finger exercise and the Total Rubric score was significant, $r = .671$, $p = .001$. The positive correlation between Bordun and Total was significant, $r = .555$, $p = .011$. The positive correlation of Rhythm Repetition and Total Rubric was highly significant, $r = .746$, $p < .001$. Table 6 displays the correlation matrix.

Table 6

Intercorrelations between Impulsivity Measures, Total Impulsivity, MBCR Exercises, and MBCR Total Rubric

	Hit RT	Commission Errors	Perseverations	Total Impulsivity	Five-finger	Bordun	Rhythm Repeition	Song Playing	Total Rubric
Hit RT		-.772**	-.093	.140	.086	.166	.101	-.471*	.018
Commission Errors			.055	-.009	-.153	-.528*	-.287	.394	-.321
Perseverations				.956**	-.354	.072	-.453*	.036	-.330
Total Impulsivity					-.352	-.005	-.481*	-.066	-.407
Five-finger						.060	.343	.083	.671**
Bordun							.239	-.112	.555*
Rhythm Repetition								.055	.746**
Song Playing									.316
Total Rubric									

Note. * indicates correlation is significant at the 0.05 level. ** indicates correlation is significant at the 0.01 level

Chapter 5

Discussion

The purpose of the study was to examine the performance of individuals with alcohol dependence (AD) on a music-based cognitive rehabilitation protocol (MBCR), as well as to examine the relationship between degree of impulsivity and performance on the MBCR. Participants completed a computerized assessment of impulsivity and then took part in a 25-minute individualized piano session which implemented the MBCR. The independent variables included the impulsivity measures of Commission Errors, Hit Reaction Time (Hit RT), Perseverations, and Total Impulsivity. To review, Commission Errors refers to the number of times the participant responded to the nontarget cue "X" during administration of the Continous Peformance Test (CPT) (Conners, 2007). Hit RT refers to the mean reaction time for all target (i.e., non-"X") responses for the duration of the entire CPT. Perseverations refers to responses made less than 100 milliseconds (ms) following any stimulus displayed on the CPT. The dependent variables were performance scores on each of four music exercises included in the MBCR as measured on a four-point rubric, as well as Total Rubric score.

Data were analyzed to determine participants' impulsivity scores, performance on the MBCR, and to examine intercorrelations between measures of impulsivity, Total Impulsivity, rubric scores on each exercise of the MBCR, and the Total Rubric score.

In this chapter, interpretation of the statistical analyses will be discussed in detail. Practical and theoretical implications, as well as study limitations and recommendations for future research will be identified.

Discussion of the Research Questions

The performance of individuals with AD on the MBCR protocol. The first research question examined the performance of individuals with AD on the MBCR. The results of the study revealed that all participants were able to complete the protocol with rubric scores on each exercise indicating fair, good, or excellent performances (i.e., scores of 2, 3 or 4). No participants received a rubric score of 1 (indicating a poor performance) on any of the MBCR exercises.

Additional descriptive analysis helped to elucidate differences in participants' performance on the four MBCR exercises. Specifically, participants performed the best on the Song Playing exercise, followed by the Five-Finger exercise and the Rhythm Repetition exercise, respectively. Participants performed most poorly on the Bordun Exercise. When compared to the other exercises, participants performed significantly better on the Song Playing exercise, with all participants receiving a good or excellent rating (i.e., a score of 3 or 4 on the rubric).

A number of reasons may explain the participants' significantly better performance on the Song Playing exercise than the other exercises. This exercise, which involved using numbered notation and lyrics along with numbered stickers placed on a keyboard to play a familiar melody, was designed by the researcher to address alternating attention. Participants may simply not have had significant deficits related to alternating attention, which involves shifting focusing between at least two different stimuli (Gardiner, 2005). In this case, participants were able to shift their attention between the numbered notation and the numbered stickers on the keyboard with good or excellent performance.

Further, specific directions were given by the researcher to participants for the Song Playing exercise, but participants were able to work through the exercise at their own pace. Specifically, the researcher gave general instructions, telling participants to match the number on the notation with the numbered stickers on the keyboard to play the melody of their chosen song. The researcher encouraged the participant to play through one line of the notation at a time and practice it several times before moving on to the next line of notation. The researcher encouraged this "chaining" technique until the participant could perform the song in its entirety. The approach allowed the participant to work through the exercise at their own pace and using the method of their own choosing. For example, some participants worked through the exercise at a slow pace, while others performed the exercise much more quickly. Additionally, several participants seemed to be able to memorize where the numbered stickers were placed on the keyboard which minimized the amount of times eye gaze had to be directed back-and-forth between the keyboard and numbered notation.

The Song Playing exercise did not require the participant to perform the exercise with any additional external sensory input, whereas the other three exercises did include simultaneous sensory input in the form of an external, auditory metronome and/or simultaneous keyboard playing by the researcher. This lack of additional sensory input may have contributed to better concentration by the participant. Likewise, the novelty of being able to play a familiar melody on the keyboard without formal music training may have contributed to better concentration on this particular exercise. The immediate feedback of hearing the familiar melody played correctly may also have increased attention and motivation.

Comments made during and after performing this exercise also indicated that most participants enjoyed Song Playing the most out of the four exercises of the MBCR. Affect change in response to music, such as improved mood or increased relaxation, may contribute to cognitive change in therapeutic contexts (Thaut, 2002). Therefore, participants' enjoyment of the Song Playing exercise may have contributed to increased concentration and/or attention, and thus, good or excellent performance on the exercise.

Participants seemed most challenged by the Bordun exercise, which involved sustaining a rhythmic pattern on the keyboard in time to a metronome while the researcher simultaneously improvised a melody. Specifically, the Bordun exercise was designed by the researcher to address selective attention, which involves maintaining focus on one stimulus in the presence of other, competing stimuli (Gardiner, 2005). Participants in this study may have had deficits related to selective attention, making it difficult to selectively attend to the rhythmic pattern they were playing in the presence of both an external, auditory metronome and the melody played by the researcher. When asked for comments regarding this particular exercise, the majority of participants noted that it was the most difficult for them of all four exercises of the MBCR. Additionally, many participants felt they had trouble focusing on maintaining a steady beat with the metronome while the researcher played a competing melody.

No significant relationships emerged between the four MBCR exercises. Because each exercise was designed to address a specific cognitive skill, the lack of relationships may indicate that each exercise targeted a discrete cognitive skill, including sustained attention, selective attention, working memory, and divided attention.

The relationship between degree of impulsivity and performance on the MBCR protocol. The second research question examined the relationship between degree of impulsivity and performance on the MBCR. The results of the study indicate that participants had significantly heightened impulsivity when compared to a normative group, as measured by Hit Reaction Time (Hit RT), Perseverations, and Total Impulsivity. Participants' impulslvity, as measured by Commission Errors, was not significantly different from the normative group and is considered within the normal range (Conners & MHS Staff, 2004).

The presence of heightened impulsivity in the sample of participants used in this study is similar to results of at least three previous studies examining impulsivity in individuals with alcohol dependence (AD) (Gourdriaan et al., 2006; Rubio et al., 2008; Lawrence et al., 2009). In these studies, individuals with AD had significantly higher degrees of impulsivity than healthy controls as measured by both behavioral and self-report measures of impulsivity.

According to the CPT manual (Conners and MHS Staff, 2004), a large number of Commission Errors (i.e., responses to the nontarget "X") combined with slow Hit RT (high *T*-scores) may indicate inattentiveness, and combined with fast Hit RT (low *T*-scores) may indicate impulsivity. While participants' Hit RT was markedly atypical from the normative group (i.e., their reaction time was significantly slower), their Commission Errors were not different from the normative group. Given participants' performance on Commission Errors and Hit RT together, these two measures do not provide conclusive evidence regarding the presence of heightened impulsivity or attention deficits in the sample of participants utilized in this study.

The definition of impulsivity adopted for this study involves quick and automatic responses to stimuli without regard for consequences (Moeller & Doughterty, 2002) indicating a deficit of response inhibition (Verdejo-Garcia & Pérez-Garcia, 2007). Based on this definition, participants' Perseverations may be the best indication of heightened impulsivity out of the three impulsivity measures. Participants' Perseverations were significantly different from the normative group, and their performance is considered to be markedly atypical. Given the physiological expectations for perceiving and responding to stimuli, participants' quick responses to stimuli on the CPT were largely anticipatory, and likely indicate heightened impulsivity (Conners and MHS Staff, 2004).

Although the present study is focused specifically on impulsivity, the CPT also measures attention and vigilance (i.e., sustained attention). Over half of the participants received high Clinical Confidence Interval (CCI) Scores, indicating that their overall performance on the CPT more closely matched a clinical profile than a non-clinical profile in regard to impulsivity and attention. Based on these results, at least some of the participants are extremely likely to have significant attention problems in addition to heightened impulsivity.

Participants' deficits in attention and impulsivity may be related to their alcohol/substance use, or may have been present prior to substance use and dependence. Recent research elucidates the relationship between co-morbid childhood attention-deficit hyperactivity disorder (ADHD) with symptoms persisting into adulthood and the development of alcohol or multi-substance abuse later on in life (Ohlmeier et al., 2008). Therefore, high CCI scores in more than half of participants likely indicate the presence of ADHD or related disorders which include heightened impulsivity as a key symptom.

However, due to privacy of protected health information during data collection, the researcher was not able to access patients' medical records to collect information about co-morbid diagnoses.

Results of the study revealed a number of significant intercorrelations between degree of impulsivity and performance on the MBCR. As Hit RT went up (indicating slower reaction time), performance on the Song Playing exercise went down. The Song Playing exercise required a certain degree of working memory, which involves holding onto and being able to manipulate information as necessary (Mateer et al., 1987). In this case, participants had to read a line of the numbered music notation, remember the numbers, and then retrieve that information to press the corresponding keys on the keyboard. Because participants had a slow reaction time, they may not have been able to maintain the information gathered from reading the music notation long enough to play the correct keyboard notes without errors.

As Commission Errors went up, participants' performance on the Bordun exercise went down. Selective attention, a skill being explicitly targeted by the Bordun exercise, is also required in order to inhibit responses to the nontarget "X" during an administration of the CPT. Thus, it is likely that some participants experienced deficits in selective attention while performing the Bordun exercise which made it difficult to maintain their rhythmic pattern while faced with competing stimuli.

As participants' Perseverations and Total Impulsivity scores increased, performance on the Rhythm Repetition exercise decreased. This exercise was designed by the researcher to address working memory. This researcher noted that nearly all participants began playing at least of one of the rhythmic patterns before the researcher

was finished presenting it at least once during the performance of this exercise, with the majority of participants doing so multiple times. Considering that Perseverations indicate anticipatory responses related to impulsivity, participants likely had difficulty inhibiting their responses during the Rhythm Repetition which caused them to make more errors. Specifically, the urge to respond quickly may have caused an inattentive state in participants, leading them to respond prior to hearing the full rhythm presented by the researcher and resulting in errors in repeating the rhythms.

Performance on the Five-Finger exercise, which was designed to target sustained attention, was not significantly affected by participants' heightened impulsivity. The Five-finger exercise was presented first in the MBCR protocol, when the novelty of playing the keyboard likely held participants' immediate attention. Additionally, this exercise was highly repetitive, requiring less mental flexibility than the other exercises.

Significant correlations between two different CPT impulsivity measures also emerged. The significant, negative correlation between Hit RT and Commission Errors indicates that as Hit RT scores increased (indicating slower reaction times), participants made less errors in pressing the computer keyboard when they saw the letter "X". Therefore, participants who reacted slower responded in a less impulsive way to stimuli presented during administration of the CPT. The significant, positive correlation between Perseverations and Total Impulsivity indicates that as individuals made more Perseverations (i.e., responses occurring less than 100 milliseconds following the presentation of stimuli on the computer screen), the Total Impulsivity score also increased. Because participants' scores for Perseverations was the highest of the three

impulsivity measures included on the CPT, this measure also had the greatest impact on the Total Impulsivity measure.

In summary, participants' increased impulsivity as measured by Hit RT had a negative influence on performance on the Song Playing exercise of the MBCR. Participant's increased impulsivity as measured by Perseverations and Total Impulsivity had a negative effect on performance on the Rhythm Repetition exercise of the MBCR. Although participants' Commission Errors were not significantly different from the normative group, these errors did seem to impair the Bordun performance. Performance on the Five-Finger exercise was not affected by any of the impulsivity measures.

Participant Feedback

Informal interviews conducted with participants following completion of the MBCR indicate that in general, participants enjoyed participating in the protocol. The majority of participants spontaneously reported improved mood or relaxation as a result of their participation in the study. Although the researcher explained during the informed consent process that this was research and not therapy, a number of participants also felt that their participation was beneficial to them as they received treatment on the detoxification unit. Specifically, one participant commented that he felt more "awake" and was more motivated to attend treatment activities. Three participants also commented that they felt motivated to pursue music lessons as a leisure activity or hobby upon discharge from the hospital.

In general, participants noted that some elements of the MBCR were easier for them to complete than others. In general, participants reported that the Five-Finger exercise was easiest and that the Bordun exercise was the most difficult. This subjective

feedback is aligns well with the results of this study, which showed that participants performed well on the Five-finger exercise, but did not perform well on the Bordun exercise.

Limitations of the Study

A number of limitations exist for this study. First, a small sample size was utilized for data collection, and the sample included individuals with a wide range of differences in their alcohol-use histories, such as number of years of excessive alcohol use. Additionally, the sample of participants included diagnoses of both alcohol dependence and polysubstance dependence including alcohol. Because of the small sample size and wide variation in participants' alcohol use, generalizing the results of the study to the population is difficult.

The researcher was unable to access participants' medical records to uncover potential co-morbid diagnoses which could affect the outcome of this study, such as ADHD or history of a brain injury. While nurses on the detoxification unit were able to help the researcher screen participants based on exclusion criteria (which excluded individuals with a formal diagnosis of ADHD), participants may have had a number of symptoms related to ADHD or another attention disorder, despite lack of a formal diagnosis. Considering that over half of the participants had a CCI score higher than 50, a number of participants may indeed have clinically significant attention problems related to their substance use, another disorder, or a brain injury.

Another limitation of this study is that the design did not include a normative or control group. The addition of a control group would have allowed the researcher to consider typical participants' impulsivity and their performance on the MBCR, and

compare these factors with the participants with AD. By comparing participants with and without AD, the research may have been able to draw more specific conclusions about how heightened impulsivity may be related to performance on the MBCR.

Lack of at least one other individual other than the researcher scoring the participants' performance on the MBCR is another limitation. Due to privacy restrictions associated with the data collection site, sessions were not recorded for additional, more detailed scoring. The addition of audio recording each MBCR session may have allowed for more specific analysis of performance using a more sensitive measurement tool than the researcher-created rubric. Additionally, the addition of at least one other person to rate participants using the rubric would have allowed the researcher to ascertain a greater degree of reliability in the scoring process and reduce potential bias in scoring.

An additional study limitation included environmental elements which may have interfered with participants' performance during the admission of the CPT and/or performance during the MBCR protocol. Although every effort was made to minimize environmental noise during data collection, the detoxification unit did have a certain level of ambient noise which could have been distracting to some participants. For example, at times, a television on the unit could be heard slightly in the room the researcher used to collect data. Additionally, the room used for data collection was not locked, and staff or patients occasionally opened the door during data collection. Environmental noise from surrounding rooms, such as a toilet flushing, or door closing, could also occasionally be heard in the data collection room. In the future, researchers conducting research on this or similar units should attempt to find a quieter space to collect data.

A final limitation of this study includes the interference of participants' medications on their attention, impulsivity, or overall energy level. Most participants were administered medications several times over the course of a day, many of which may have had side effects such as decreased arousal. Due to patient privacy, the researcher was unable to collect data about participants' specific medications and potential side effects.

Theoretical Implications

Given that all of the MBCR exercises required at least one type of attention, the results of this study also bring to light the potential relationship between attention and impulse control. Unlike conscious decision-making processes, impulsive behaviors which occur quickly and automatically may not require attention (Crews and Boetigger, 2009). Future research needs to be done to determine if music can act as mediating mechanism to affect impulsivity in individuals with alcohol dependence, and the relationship between music, impulsivity and attention is a starting point for future inquiry. Specifically, this study provides preliminary evidence of the arousal potential of music which appears to be useful in circumventing impulsivity and attention deficits in individuals with alcohol dependence during participation in music-based experiences.

Practical Implications

This study provides evidence of heightened impulsivity in individuals with alcohol dependence, and the relationship between impulsivity and performance on a number of music-based tasks which exercise cognitive skills such as attention and memory. Overall, individuals with impulsivity are able to complete these music-based tasks, with their performance on several of the tasks influenced by level of impulsivity.

Specifically, participants performed the best on the music-based task that required alternating attention, and performed the poorest on the music-based task that required selective attention.

The results of the present study also provide evidence that impulsivity is indeed present in individuals with alcohol dependence and appears to be related to performance on a number of music tasks involving cognitive processes such as attention. Given that impulsivity is linked to relapse in individuals with alcohol dependence, improving impulse control should be considered an important goal area for music therapists working with this population. Because the results showed attentional deficits in the presence of heightened impulsivity, improving attention should be considered another priority area for music therapists to address when working with individuals with alcohol dependence. Both impulse control and attention should be addressed by in future music therapy studies in order to develop and test interventions which may be appropriate for addressing these skills in individuals with AD.

Recommendations for Future Research

Future research should continue to explore the potential therapeutic applications of music to address problems of impulsivity in individuals with alcohol dependence. Studies should include larger sample sizes, and could potentially compare groups of participants with different types of substance dependence besides just alcohol. Future research could explore how participants progress on the MBCR after receiving several sessions, and could include the administration of both a pre- and post-test to examine the effects of the protocol on impulsivity over time.

Summary and Conclusions

The purpose of this study was to examine how individuals with alcohol dependence performed on a music-based cognitive rehabilitation protocol, and to examine relationships between impulsivity and performance on the protocol. Participants completed a computerized assessment of impulsivity and took part in one, 25-minute individual MBCR session.

Analysis of data revealed that participants' impulsivity, as measured by Hit Reaction Time, Perseverations, and Total Impulsivity, was both statistically and clinically significant when compared to a normative group. Participants were able to complete each of four exercises in the MBCR will different degrees of performance, ranging from fair to excellent. Specifically, participants performed the best on the Song Playing exercise, which targeted alternating attention. Participants performed the poorest on the Bordun exercise, which focused on selective attention.

A number of significant interrcorrelations between the four measures of impulsivity and each exercise of the MBCR were revealed. When reaction time (as measured by Hit RT) decreased, so did performance on the Song Playing exercise. As Commission Errors increased, performance on the Bordun exercise decreased. As Perseverations and Total Impulsivity increased, performance on the Rhythm Repetition decreased. Because all of the exercises on the MBCR required different degrees and types of attention, these results implicate attention deficits in the maintenance and/or development of impulsivity in individuals with alcohol dependence. Despite the given limitations, music-based exercises meant to address cognitive skills, such as the MBCR

protocol examined in this study, may offer an effective means of cognitive rehabilitation for adults with alcohol dependence. Specifically, the arousal potential of music appears to be useful in addressing impulsivity in individuals with alcohol dependence by priming attention.

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Appendix A

Participant Information Form

Participant:
Date of Completion:

Section I: Personal Information

1. Age: ___

2. Sex: Male ____ Female ____

3. Ethnicity (check all that apply):

    ___ Hispanic or Latino (regardless of race)
    ___ Not Hispanic or Latino:
        ___ American Indian or Alaska Native
        ___ Asian
        ___ Black or African-American
        ___ Native Hawaiian or other Pacific Islander
        ___ White

Section II: Alcohol Use and Treatment

4. Do you consider your alcohol intake to be excessive? ___
    a. If yes, for how many years has your alcohol intake been excessive? ___

5. Prior to enrolling in this treatment program, how many times in a typical week did you drink alcohol? ___

6. How many alcoholic drinks (can of beer, glass or wine/wine cooler, shot of hard liquor, or mixed drink) do you typically have at one time? ___

7. Not including your current treatment, how many times have you received treatment for alcohol dependence in the following settings:

    a. Inpatient/residential? ___
    b. Outpatient? ___

Appendix B

Music-Based Cognitive Rehabilitation Protocol Scoring Rubric

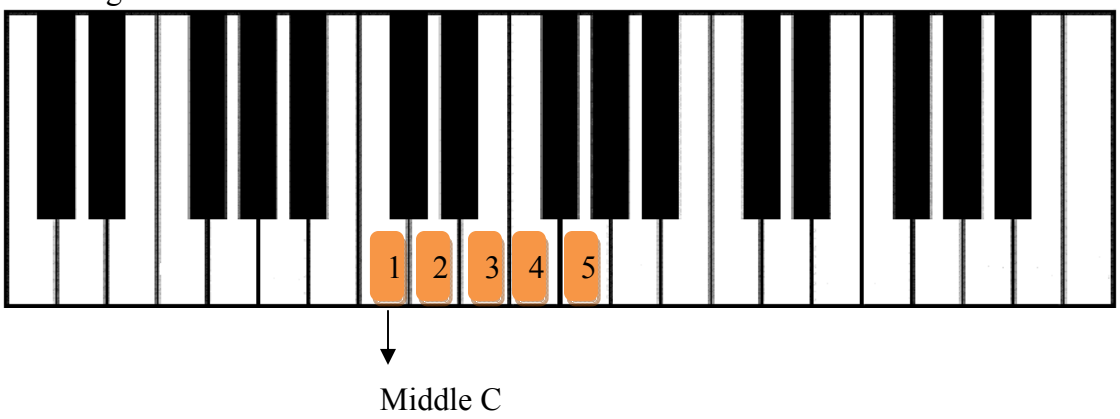
Exercise: Five-Finger	**Score (circle one):**
	Excellent (4) Participant plays all exercises accurately and in tempo.
	Good (3) Participant plays most exercises accurately and in tempo, but makes a few errors.
	Fair (2) Participant plays some exercises accurately and in tempo, but makes significant errors.
	Poor (1) Participant does not play exercises accurately and in tempo.
Exercise: Bordun	**Score (circle one):**
	Excellent (4) Participant sustains all music patterns in tempo for duration of exercise.
	Good (3) Participant sustains most music patterns in tempo for duration of exercise, but makes a few errors and/or stops playing a few times.
	Fair (2) Participant sustains some music patterns in tempo for duration of exercise, but makes significant errors and/or stops playing many times.
	Poor (1) Participant does not sustain music patterns in tempo for duration of exercise.
Exercise: Rhythm Repetition	**Score (circle one):**
	Excellent (4) Participant plays 22-26 out of 26 exercises correctly within 3 trials.
	Good (3) Participant plays 15-21 out of 26 exercises correctly within 3 trials.
	Fair (2) Participant plays 8-14 out of 26 exercises correctly within 3 trials.
	Poor (1) Participant plays 7 or less out of 26 exercises correctly within 3 trials.
Exercise: Song Playing	**Score (circle one):**
	Excellent (4) Participant plays melody accurately with no errors and minimal pauses.
	Good (3) Participant plays melody accurately with a few errors and pauses.
	Fair (2) Participant plays melody with significant errors and pauses.
	Poor (1) Participant does not play melody accurately.

Total Rubric Score: _____/16

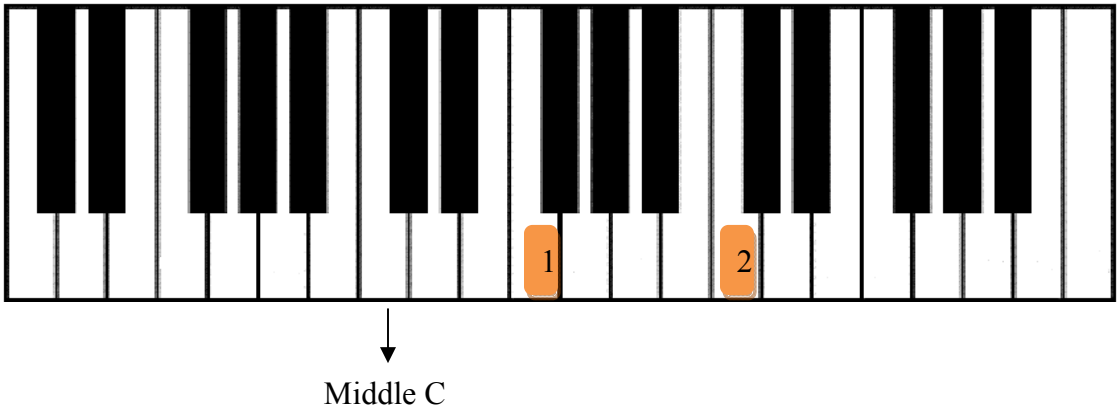
Appendix C

MBCR Keyboard Set-Up for Five-Finger Exercise and Bordun Exercise

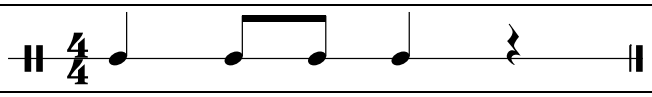
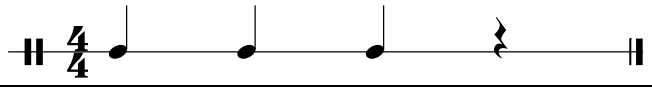
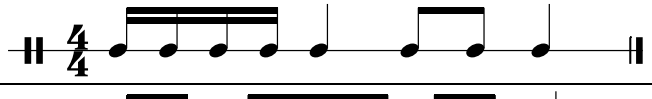
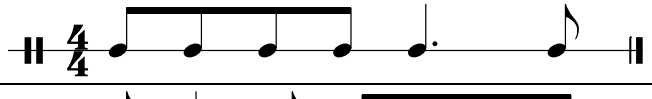
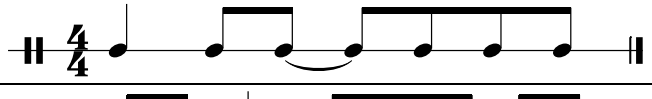
Five-Finger Exercise

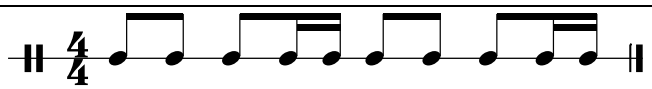
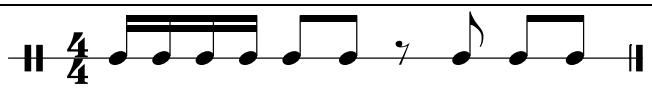
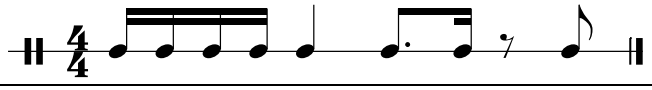


Bordun Exercise



Appendix D
Rhythms Included in MBCR Rhythm Repetition Exercise

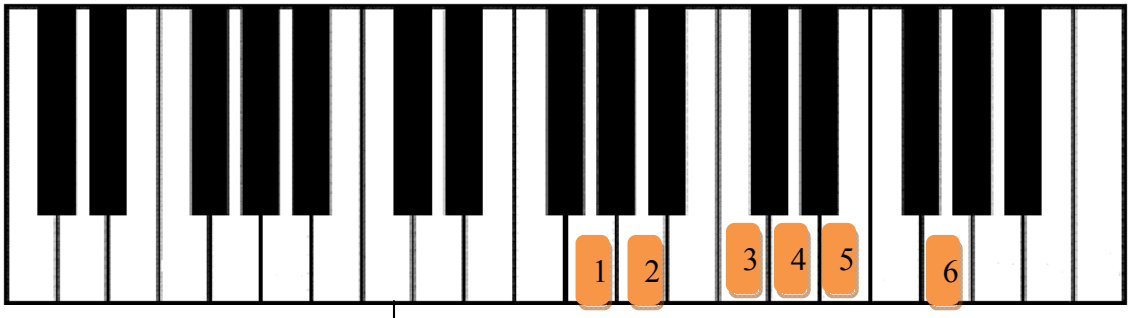
Rhythm 1	
Rhythm 2	
Rhythm 3	
Rhythm 4	
Rhythm 5	
Rhythm 6	
Rhythm 7	
Rhythm 8	
Rhythm 9	
Rhythm 10	
Rhythm 11	
Rhythm 12	
Rhythm 13	
Rhythm 14	
Rhythm 15	
Rhythm 16	
Rhythm 17	
Rhythm 18	

Rhythm 19	
Rhythm 20	
Rhythm 21	
Rhythm 22	
Rhythm 23	
Rhythm 24	
Rhythm 25	
Rhythm 26	

Appendix E

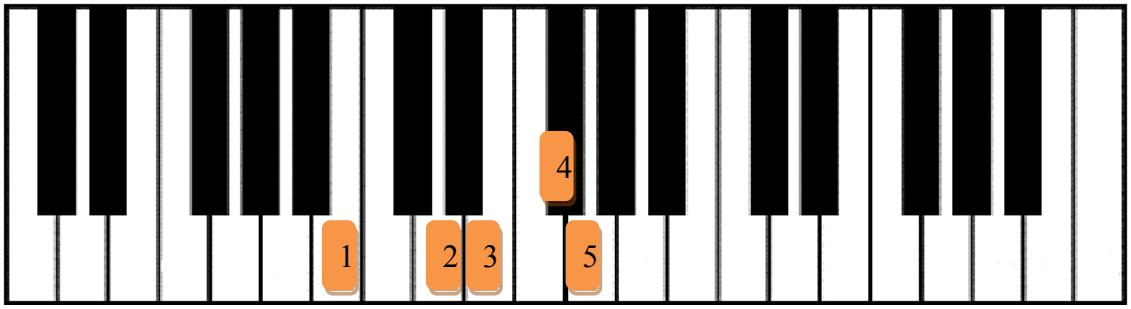
Keyboard Set-Up and Numbered Notation for MBCR Song Playing Exercise

Amazing Grace Keyboard Set-Up



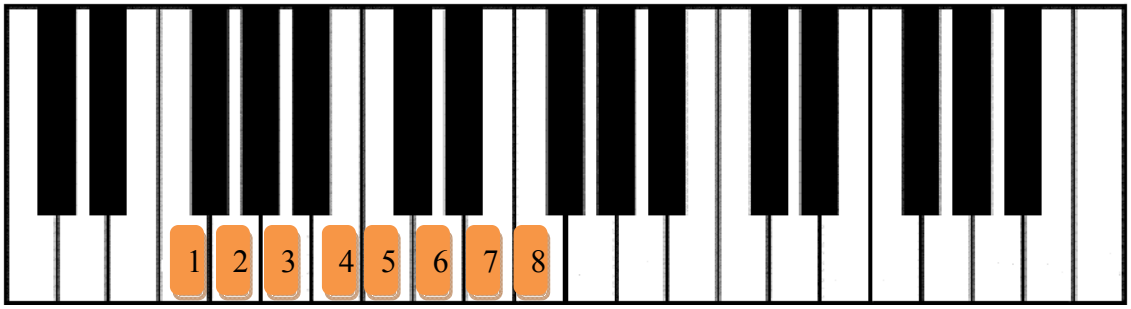
Middle C

Eight Days a Week Keyboard Set-Up



Middle C

Lean On Me Keyboard Set-Up



Middle C

Amazing Grace Numbered Notation

1 3 5 3 5 4 3 2 1

A – maz – in – g Grace, how sweet, the sound;

1 3 5 3 5 4 6

That saved, a – a – wretch like me!

5 6 5 6 5 3 1 2 3 2 1

I on – ce wa – s lost, but now a – m found;

1 3 5 3 5 4 3

Was blind, bu – t now I see!

Eight Days a Week Numbered Notation

4 3 2 3 3 1

Ooh I need your love, babe

1 2 5 5 4

Yes, you know it's true

4 3 2 3 3 1

Hope you need my love, babe

1 2 5 5 4

Just like I need you

4 2 3 1 4 2 3 1

Hold me, love me, hold me, love me

1 4 3 2 2 3 3 1

I ain't got noth – in' but love, babe

5 5 5 4

Eight days a week

Lean On Me Numbered Notation

5 5 6 7 8 8 7 6 5

Some – times in our lives, we all have pain

5 6 7 7 6

We all have sor – row

5 5 6 7 8 8 7 6 5

But, if we are wise, we know that there's

5 6 7 4 5

Al - ways to – mor – row!

7 6 5 7 6 6 5

Lean on me, when you're not strong

1 5 4 3 2 5 6 7 7 7 6

And I'll be your friend, I'll help you car – ry on

5 7 6 6 6 5 1 4 3 2

For, it won't be long 'til I'm gon - na need

7 6 5 5 4 6 5

Some – bo - dy to lea – n on

Appendix F
Informed Consent Form

TITLE: *"The Effect of a Piano-Based Activity on Cognitive Function"*

The following information describes the research study in which you are being asked to participate. Please read the information carefully. At the end, you will be asked to sign if you agree to participate.

PURPOSE OF STUDY:
You are being asked to participate in a research study. The purpose of this study is to investigate the effect of a piano-based activity on cognitive function.

PROCEDURES:
If you agree to participate, the following steps will take place:

Step One: Pretest Measures. This step will be completed prior to the start of any interventions and should take about 30 minutes to complete.

1. You will be asked to complete a short "Participant Information" form. This form asks you for information such as your age, alcohol intake, and health information. Your medical record will not be reviewed to obtain this information.
2. You will be asked to complete a 14-minute computerized activity to assess reaction time.

Step Two: Individual Sessions or No Sessions. This portion of the research will last for 1-2 weeks.

1. You will be assigned to either a treatment condition or a no treatment condition.
2. If you are assigned to the treatment condition, you will participate in individual sessions three times a week for one-two weeks (depending on how long your expected length of stay is). Each session will last for approximately 30 minutes. During each session, you will be participate in piano exercises and receive piano instruction, including:
    a. Playing finger warm-ups
    b. Hearing a rhythm and repeating it back
    c. Repeating a rhythm while a different rhythm is played at the same time
    d. Learning to play the melody to a familiar song
3. If you are assigned to the no treatment condition, you will participate in your regularly scheduled day-to-day activities. You will not receive any individual sessions with the investigator.

Step Three: Posttest measures. These measures will be completed following the completion of treatment or no treatment conditions and will take about 20 minutes to complete.

1. You will be asked to complete a 14-minute computerized activity to assess reaction time. This program is the same one used during the pretest measures.
2. You will be asked to participate in an informal interview with the investigator. During this time, you will be asked to share your thoughts and feelings about your participation in the treatment or no treatment condition.

RISKS AND/OR DISCOMFORTS:
You may feel discomfort answering some personal questions on the "Participation Information" form. You may decline to answer any question or questions which make you feel uncomfortable.

BENEFITS:
No benefit can be promised to you for participating in this study. You may enjoy participating in music-making with the investigator. The information gained in this study may be useful in developing future music therapy interventions.

CONFIDENTIALITY:
Records related to this study will be kept in a locked filing cabinet within an office environment and on a password-protected desktop computer. Only the Primary Investigator and Co-Investigator will have access to this information. Identification Codes will be used in place of your name on all forms or files.

The investigators and their assistants will consider your records confidential to the extent permitted by law. The U.S. Department of Health and Human Services (DHHS) may request to review and obtain copies of your records. Your records may also be reviewed for audit purposes by authorized University or other agents who will be bound by the same provisions of confidentiality.

COSTS:
There are no costs associated with your participation in this study.

COMPENSATION:
You will not receive compensation for your participation in this study.

RIGHT TO DECLINE OR WITHDRAW:
Your participation in this study is voluntary. You are free to refuse to participate in the study or withdraw your consent at any time during the study. Your withdrawal or lack of participation will not affect any treatment you are currently receiving. The investigators reserve the right to remove you from participation without your consent at such time they feel it is in the best interest for you.

CONTACT INFORMATION:

- This is a master's research project. Carolyn Dachinger, MT-BC serves as co-investigator and will gladly answer any questions you may have concerning the purpose, procedures, and outcome of this project. She may be contacted at the University of Miami at (305) 284 – 6189.
- This research project is supervised by Teresa Lesiuk, PhD, MT-BC. She serves as the Principal Investigator and may be contacted at the University of Miami at (305) 284 – 3640

If you have any questions about your rights as a research subject you may contact Human Subjects Research Office at the University of Miami at (305) 243 – 3195.

PARTICIPANT AGREEMENT:

I have read the information in this consent form and agree to participate in this study. I have had the chance to ask any questions I have about this study, and they have been answered for me. I am entitled to a copy of this form after it has been read and signed.

_____ _____

Signature of Participant Date

_____ _____

Signature of Person Obtaining Consent Date

Appendix G

Five-Finger Exercise