ABSTRACT

Examining the Effects of Casual Video Gameplay as an Intervention to Alleviate Symptoms of Depression on Both Subjective and Objective Measures

By

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Depression can be a debilitating illness that affects more than 300 million people worldwide. Although there are successful treatments for depression with pharmaceuticals and behavioral approaches such as psychotherapy, these approaches are often very costly and may carry a stigma of treatment for some individuals. The purpose of this dissertation study was to compare results of previously collected data that examine whether a prescribed regimen of casual videogame play (CVG) could reduce symptoms associated with depression. This dissertation specifically focused on comparing results of a study group and a comparison group on the self-report instrument, the Patient Health Questionnaire-9 (PHQ-9) as well as objectively measured changes in alpha wave, Electroencephalogram (EEG) data.

Participants in the original study were screened for depression using the PHQ-9. There were a total of 57 participants who met the study inclusion criteria. Each participant that met the inclusion criteria was then randomized into either the comparison group (n=29) or the study group (n=28). Experimental group participants were prescribed to play one of three CVGs three times per week (with 24 hours between each session). This process occurred for 30 minutes each session, over a 1-month period. Comparison group participants reviewed the National Institute of

Mental Health's webpage on depression during a pre-test and a post-test session. The participants in this group did not engage in any intervention over the one-month period of time between the pre-test and post-test sessions.

A repeated-measures analysis of covariance (ANCOVA) was completed to examine three research questions between subjects at Time 1 and Time 3 to compare changes in depression symptoms on both subjective, self-report (PHQ-9) and objective alpha wave EEG measures. The CVGs used as the intervention factor were either *Peggle, Bejeweled or Bookworm Adventure.* Study analysis revealed significant decreases in depression symptoms reported in the study group on the PHQ-9 self-report scale. Results along the objective, EEG alpha wave scale revealed non-statistically significant changes. Potential reasons for the non-significant findings along with recommendations for future research are also discussed. Conclusions from this study found that a prescribed regimen of CVG may have potential as an intervention to help reduce symptoms of depression as measured on the PHQ-9 scale. Further research should consider examining intricacies of CVG play as a potential intervention to address symptoms related to depression. Findings also revealed that while EEG findings were not statistically significant, participants self-report responses were significant and may underscore the importance of individual's subjective feelings in the therapeutic process.

EXAMINING THE EFFECTS OF CASUAL VIDEO GAMEPLAY AS AN INTERVENTION TO ALLEVIATE SYMPTOMS OF DEPRESSION ON BOTH SUBJECTIVE AND OBJECTIVE MEASURES

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DEDICATION

This dissertation is dedicated to my family. To my parents, Ralph and Marina, you both never waiver in your constant and consistent support of my dreams and my passion to pursue a career in helping people. I am empowered to achieve success only through your support. This dissertation is equally dedicated to my sister Jane. You are my best confidant, advocate, friend and support through all the triumphs and tribulations of my work and life. Lastly, I would like to dedicate this dissertation to my uncle Kevin and all individuals with disabilities. May we all continue to pursue and support treatment that supports individuals' optimal growth potential.

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CHAPTER I: INTRODUCTION

Introduction to the Study

Over the course of a person's lifetime, 15% of the US population will experience an episode of depression (National Institute for Health and Clinical Excellence [NICE], 2010). Worldwide, the prevalence of depression ranges from 4.5%-37.4% (Cao et al., 2019). According to the American Psychiatric Association (APA), depression is the leading cause of suicide and the carries highest disease burden on society in terms of health care costs, depression's effects on families and caregivers and its impact on productivity in the workplace (Pilling et al., 2009). Depression is often disabling and distressing and for many, a chronic condition, especially as it becomes difficult to treat (Choi, et al., 2011). Depression in general is associated with high rates of health care utilization and severe limitations in daily functioning (DiMatteo et al., 2010).

The general diagnosis of depression is the leading cause of years of life lost due to disability and is responsible for more than 10% of years of life lost across all diseases (World Health Organization, 2012). The economics of healthcare alone spotlight the overwhelming burden of depression with overall US expenditures topping $200 billion (Greenberg et al., 2015). Demographically, women are almost twice as likely as men to have a diagnosis of depression (Brody et al., 2018). The prevalence of depression has also been found to decrease as family income levels increase (Brody et al., 2018). It is further estimated that 80% of adults with depression reported at least some difficulty with work, home and social activities due to their depression (Brody et al., 2018).

Currently, the standard treatment of care for most subtypes of depression is primarily a prescribed regimen of antidepressants usually either selective serotonin reuptake inhibitors (SSRIs) or serotonin-norepinephrine reuptake inhibitors (SNRIs) (Cao et al., 2019).While

traditional treatment approaches for depression often recommend strict pharmacological interventions, this conflicts with multidisciplinary treatment guidelines which may also include non-pharmacological approaches such as counseling and other neurostimulation approaches (National Institute for Health and Care Excellence [NICE], 2009). For example, the NICE (2009) guidelines state that clients with moderate to severe symptoms of depression should receive a combination of psychological and pharmacological treatments. Wiles et al., (2013) evaluated the effectiveness of using cognitive behavioral therapy (CBT) along with pharmacological treatment in the primary treatment of major depression and found that study participants receiving cognitive behavioral therapy (CBT) exhibited a significantly higher response rate at 6 months when compared to those receiving pharmacological treatment alone at 46% vs. 22% comparatively. Several studies have reviewed the effectiveness of singular psychotherapy interventions for use in mild and moderate depression, however, very few studies have explored whether psychotherapy alone is effective for clients with chronic major depressive disorder (MDD) who have not reached remission of symptoms (Cladder-Micus, et al., 2018).

Within the category of non-pharmacological, supplemental approaches recent applications of video gameplay have grown in popularity for investigating potential effects as a mental-health intervention (Kuhn, et al., 2018). Most of the studies specifically looking at video game usage within the context of depression have used custom made games for training that have explicitly included elements of CBT and psychoeducation (e.g., SPARX; Kuhn, et al., 2018). The first evidence for potential positive effects of commercial video games on alleviating depression specific symptoms came from the original data collection of this study by Russoniello et al., (2013) that asked clients with depression to play one of three different commercial puzzle-based video games. This innovative approach using commercially available video games serves

as the basis for this current replication study which employed similar methodology and additionally examined the effects of gameplay on electroencephalogram (EEG) indicators for changes in depression in addition to self-reported changes.

Although non-pharmacological approaches to treating depression in conjunction with pharmacological interventions have been studied, psychosocial and behavioral approaches have still been insufficiently studied to date (Johnston, et al., 2018). The purpose of the current study was to examine if a prescribed regimen of casual video game (CVG) play could reduce symptoms of depression in a study group as compared to a comparison group of study participants. Additionally, this analysis highlights the potential advancement of using both subjective and objective duel report measures to examine the effectiveness of treatment options by utilizing both the self-report Patient Health Questionnaire (PHQ-9) and the objectively measured electroencephalogram (EEG) data to compare study groups. This study utilized archival data collected from a previous, multi-phase study that examined video gameplay as an augmentation intervention for individuals with both depression and comorbid anxiety.

This chapter will provide an overview of the practical and theoretical connections between the research questions of this study and the necessity for addressing the gap in treatment options for depression (Mrazek et al., 2014). Topics outlined in this chapter will be expanded upon in Chapter two. The purpose of this current chapter is to introduce (a) the background issues of this study's focus (b) theoretical orientation of the study (c) the statement of the problem (d) the purpose of the study (e) research questions of the study (f) definitions of important terms of the study (g) justification for the study (h) significance of the study. This chapter will conclude with a summary of content.

Background to the Problem

Depression symptoms may vary from mild to severe and may include: feeling sad, loss of interest in activities once enjoyed, changes in appetite, difficulty sleeping, fatigue, feelings of worthlessness or guilt, difficulty in thinking and decision making as well as thoughts of death and suicide (APA, 2013). While individuals experiencing depression do not all exhibit the same symptoms or intensity and frequency of symptoms, researchers have found some commonalities in known risk factors for depression (Russoniello, O'Brien & Parks, 2009).

Internal and environmental risk factors potentially play a role in the onset of depression (APA, 2013). Internally, differences in certain brain chemicals may contribute to symptoms of depression (Blanco et al., 2010). Personality characteristics such as low self-esteem, overwhelming feelings of stress and pessimistic attitudes of individuals appear to potentially yield propensities towards depression (APA, 2013). Additionally, genetic factors including specific identified enzymes are increasingly being researched by exploring gene mutations and may provide links to depression that may run in families (Serretti, Chiesa, Calati, et al., 2011). Environmental conditions such as continuous exposure to violence, neglect, abuse and persistent poverty can also potentially make individuals more vulnerable to depression (DiBernardo et al., 2018). More recently, exposure to environmental pollutants from the air, water, chemically-based food additives as well as electrical pollution generated from technological increases in electromagnetic fields are being researched as potentially compounding causes for increased rates of depression (Nemade & Patricelli, 2019).

Depression is currently the leading cause of disability in the United States and worldwide (Anxiety and Depression Association of America [ADAA], 2019). Globally, 322 million people live with depression (ADAA, 2019). Within the United States, between 2013-2016, 8.1% of

Americans age 20 and older had depression in a given 2-week period (National Center for Health Statistics [NCHS], 2016). Demographics of depression vary by age, sex, income and health behaviors (Blanco, et al., 2010). While depression can develop at any age, the median age of onset is 32.5 years old (ADDA, 2019). Depression is almost twice as common among women as men in all countries with global rates at 4.1% and 2.7% respectively for women and men (Brody, Pratt & Hughes, 2018). Rates of depression vary significantly when family income level or socioeconomic status is considered. Overall, 15.8% of adults from families living below the federal poverty level had depression (Brody et al., 2018). Across all categories of the federal poverty level, the prevalence of depression decreased with increasing levels of family income (Brody et al., 2018). This prevalence drops to just 3.5% among adults at or above 400% of the federal poverty level (Brody et al., 2018).

Depression has become a commonly used term in society; however, depression is a serious condition with particular nuances beyond the broadly popular term (Cherney, 2018). There are several criteria indicators for depression. According to the American Psychiatric Association (2013), at least five of the nine characteristics must be present including a loss of interest and pleasure, persisting for most of almost every day for at least two weeks in order to be categorized as major depression. There are several subtypes of depression. The three that were discussed in this study are mild, moderate, major and treatment-resistant depression. The exact classification of subtypes of depression are based on many factors and defined differently, depending on the assessment instrument used during a screening or diagnostic process (Cherney, 2018). Some of the factors used during consideration of subtype include: symptoms experienced, severity of symptoms, frequency and duration of symptoms (Cherney, 2018). When less than five of these symptoms are present, the condition is characterized as minor depression (APA,

2013). These symptoms must be independent of physical illness, normal bereavement, and alcohol or drug use (Pandarakalam, 2018). The subtypes of mild, moderate and major depression have been selected for this study as they correlate with the categories presented on the PHQ-9 scale, which was used in this study.

Subtypes of Depression

Mild depression. Mild depression is generally described as "feeling blue" temporarily (Cherney, 2018). Symptoms of mild depression may occur for days and are noticeable enough to interfere with typical daily activities. Some of the described symptoms of mild depression commonly include: irritability, hopelessness, feelings of guilt, lack of motivation, fatigue and insomnia (Cherney, 2018). Though mild depression is noticeable, it is the most difficult to diagnose as symptoms may also be easily to dismiss (Cherney, 2018). Despite the challenges of diagnosis, mild depression is the easiest subtype to treat (Hu et al., 2016).

Lifestyle interventions remain one of the most impactful interventions for individuals with mild depression (Rejeski & Williamson, 2018). Lifestyle interventions such as exercise, adhering to a sleep schedule and practicing stress reduction techniques may boost serotonin levels in the brain, which help deter symptoms of depression (Rejeski & Williamson, 2018). Other treatments for mild depression include nutritional supplements such as St. John's Wort and melatonin (Cherney, 2018). Antidepressant medications, while often prescribed for mild depression, are not the recommended course of action for this subtype of depression (NICE, 2010). Rather, it is recommended that individuals with mild depression first seek treatment through non-pharmacological methods such as group therapy and physical exercise (Pilling, 2009).

Moderate depression. On a scale of symptomatic severity, moderate depression follows mild depression. While moderate and mild depression often include similar symptoms, moderate depression generally includes a few distinguishing characteristics (Cherry, 2020). These additional characteristics include: persistent negative self-esteem, reduced productivity, excessive worrying and feelings of worthlessness (Cherry, 2020). The most noticeable difference between mild and moderate depression is that moderate symptoms are severe enough to cause issues with home and work life (Cherry, 2020). Individuals with moderate depression may also experience challenges in their social life, different than in previously memorable years (Cherney, 2018). Generally, moderate depression is easier to diagnose than mild depression as symptoms are severe enough to significantly impact one's life (Cherry, 2020). Antidepressant medications are often described for individuals with moderate depression (Cherry, 2020). Additionally, CBT and other forms of psychotherapy are effective and commonly advised for individuals with moderate depression (Bekhuis et al., 2018).

Major depression. Major depressive disorder (MDD) is a serious public health concern with 6.7% of United States adults having at least one major depressive episode in 2015 with significant impairment on individuals' quality of life (Johnston, et al., 2018). Major depressive disorder is further concerning as there is a strong link between MDD and suicide. It has been estimated that up to 60% of individuals who have committed suicide had major depression (Pandarakalam, 2018). In particular, treatment-resistant depression (TRD) represents a key unmet focus within the management of MDD (Johnston et al., 2018).

Treatment-resistant depression. Prior to an individual's MDD becoming defined as Treatment-resistant, treatment of MDD most often consists of pharmacological intervention, either a selective serotonin reuptake inhibitor (SSRI) or serotonin-norepinephrine reuptake

inhibitor (SNRI) medication and may also include a variety of non-pharmacological approaches such as: psychosocial behavioral interventions, neurostimulatory approaches, exercise and a growing array of other complementary and alternative medicines (CAM) (McIntyre, et al., 2014). It should be noted that research indicates that failure to respond to pharmacological interventions in clients with MDD is not a predictor of non-response to psychotherapy (McIntyre et al., 2014). Treatment-resistant depression (TRD) is a specific subtype of major depressive disorder (MDD) that is categorized by chronic and persistent failed attempts to achieve remission of major depressive disorder symptoms following multiple methods of treatment (Peeters et al., 2016). Treatment-resistant depression is often diagnosed after an individual's reported MDD symptoms remain either untreated or treated without remission (Rush et al., 2009). It should also be noted that prior to categorizing an individual's depression as TRD, past and current treatment attempts should be carefully evaluated to ensure standards of adequate dosage, treatment duration and patient adherence have been met (Shelton, Osuntokun, Heinloth, & Corya, 2010). Age may also play a role in the onset of TRD as research has suggested that depression often occurs in older adults as this category of individuals may become less responsive to treatment options over time (Al-Harbi, 2012). Additionally, research in TRD has found that correlations between high levels of stress and noncompliance with medication treatment may contribute to developing TRD (Rush et al., 2009). More detailed information regarding potential causes of TRD will be further discussed in chapter two of this proposal.

Difficulty in Treating Depression

The treatment of depression is quite difficult as the accepted course of treatment heavily relies on subjective assessment on the part of a therapist or treating physician (Pilling et al., 2009). The process of diagnosis and treatment of depression symptoms involves a process in

which the client must honestly and fully report all symptoms. In many situations, clients may hide the true extent of their feelings, or alter social presentation of their emotions as clients may be hesitant due to social stigma or other factors to disclose the severity of symptoms (Solomon et al., 2015). While this is an understandable feeling for a client to have, it may prevent decrease the probability of receiving an accurate diagnosis and course of treatment from the practitioner (Solomon et al., 2015). The National Institute of Health and Clinical Excellence however has recommended that when a person is assessed for having depression, a more comprehensive assessment should occur that does not simply rely on symptom count reported by the client (Pilling et al., 2009). Rather, the clinician should take into account the degree of functional impairment and/or disability associated with the possible depression to determine severity and help to establish a duration of a depressive episode (NICE, 2010).

There is no known specific cause of depression, rather, a range of factors may contribute to the onset of the condition (Shelton et al., 2010). Personal factors such as fewer interpersonal or economic resources, minority status, lower functional abilities, and chronic depression may cause clients to be more likely to experience depression (Thase, 2011). Depression has been associated with several negative health and daily functioning outcomes that may impair an individual's overall satisfaction with their livelihood (Knoth et al., 2010). Among adults with depression, 50.2% report some difficulty with work, home or social activities because of their depression symptoms (Brody et al., 2018). These negative outcomes include: increased emergency department visits and hospitalization and poorer overall health-related quality of life, greater risk of unemployment and reduced work productivity (Knoth et al., 2010). Clients with depression are more likely to incur comorbid physical and mental disorders, marked by greater functional impairments than individuals without depression (Fekadu et al., 2009). Some studies

have shown that up to 80% of individuals with depression experience recurrent rates of symptoms while on a prescribed anti-depressant medication within one year of achieving remission (Fekadu et al., 2009). Moreover, research in the treatment of depression has found that at least 50% of clients will not achieve and sustain remission following multiple pharmacological approaches (McIntyre et al., 2014). In summary, previous depressive illness-related factors, personal characteristics, medication variables, and psychosocial stresses may collectively contribute to the development of depression with additional research needed in the area of treatment (Baud, 2011).

Traditional Treatment Interventions for Depression

The treatment and understanding of depression is quite complex and presents major challenges for both clients and clinicians (Fekadu, Donocik & Cleare, 2018). Clients that experience resistance to traditional pharmacological interventions comprise approximately 10-30% of the overall number of clients receiving treatment for depression (Al-Harbi, 2012). Clients with MDD for example, often undergo a process of receiving several regimens of pharmacological treatment, that combine two or more different medications with potential long-term side effects (Cartwright, et al., 2016). As levels of depression remain suboptimal over time, treatment resistance may develop as attempts by clinicians to match an effective treatment regimen with clients does not yield effective alleviation of symptoms. Compounding the effects of the trial and error process for most clients, risk of relapse of symptoms for clients using traditional antidepressant medications increase if a patient decides to stop using the medication (Hollon, Cohen, Singla, & Andrews, 2019). This process can be tiresome for clients and clinicians as dosage requirements vary with an array of factors including: age, gender, weight, physical health, other medication usage and tolerance to medications and must be prescribed for

clients with all of these factors considered (Al-Harbi, 2012). This process creates a burden for clients and clinicians not only from dealing with the distressing symptoms but also from the trial and error treatment process (Fekadu et al., 2018).

The process of diagnosing and treating depression also represents a dilemma for clinicians (Al-Harbi, 2012). It has been widely accepted that current diagnostic techniques for depression have several disadvantages that are associated with patient denial of symptoms, poor sensitivity to diagnostic questions as well as medications, subjective bias by practitioners and inaccuracy in diagnosis (Li et al., 2016). As depression has become the biggest health burden worldwide, effective detection of the diagnosis is a great challenge and requires latest technological tools including EEG (Li et al., 2016). Currently, there is a growing focus on finding an easy, accurate and practical method of detection depression and exploration of methods such as EEG (Li et al., 2016). The cause of resistance to achieving depression remission through traditional pharmacological approaches is multifactorial, making etiology of the root cause quite complicated to determine for clinicians (Rush et al., 2009). The range of factors that a clinician must consider when diagnosing and treating a client with depression may include: fewer interpersonal and economic resources, minority status, lower function and quality of life, poor social and family support and treatment non-compliance of previously prescribed treatment options (Rush et al., 2009). Ideally, treatment options are addressed through a process of individualized assessment, examination of psychopharmacological approaches and a complete biopsychosocial analysis for each individual case (Popa-Velea, Gheorghe, Trutescu & Purcarea, 2015) with particular focus from care providers on previous medication outcomes and antidepressant history (Al-Harbi, 2012). This diagnostic process may leave room for clinical error as misdiagnosis of identifying the correct subtype of depression such as atypical, psychotic,

bipolar or melancholic may impact treatment selection or choice of pharmacologic intervention (Al-Harbi, 2012). The difficulty in deciphering unique clinical features, response to treatment options and measures of physiological function related to MDD diagnosis compound the challenges for clinicians to adequately provide treatment to clients when remission is not achieved (Casher & Bess, 2010).

There is no specific, standardized approach for treating depression, with current strategies for mental-health experts relying on self-evaluations and subjective opinions of clients for efficacy of treatment options (Al-Harbi, 2012). Clinicians must consider several additional pharmacological and nonpharmacological treatment options for depression as medications even with optimized dosage and durations have not produced a successful outcome, eventually causing a client to become classified as treatment-resistant (Shelton et al., 2010). The process of finding the best individualized approach to treatment can take both a lot of time and effort for both the clinician and the client, creating a need for research to find a more efficient approach to the diagnostic and treatment process (Lynch et al., 2011).

Research for clinical treatment options of depression have predominantly focused on pharmacological interventions thus far (Shelton et al., 2010). Within pharmacological literature, little evidence exists to show that any one classes of prescribed antidepressant medication is more efficacious than another on average (Cipriani et al., 2018). In DiBernardo et al., (2018) health related quality of life outcomes in clients with varying levels of depression were examined. The study concluded that clients with TRD had significantly lower scores on both mental (p <.001) and physical (p = .0126) quality of life scores (DiBernardo et al., 2018). While the emphasis treatment in the literature thus far has focused on pharmacological interventions, the increased prevalence depression in general and TRD necessitates therapeutic options other

than medication including cognitive behavioral therapy and neurostimulation options that may additionally offer intervention relief (Al-Harbi, 2012).

Clients with depression who exhibit mild to moderate symptoms of depression should consider other options of low intensity psychosocial interventions aside from pharmacologically suggested medications (Pilling et al., 2009). These interventions are guided by the client's preference and may include: Individually guided self-help based on principles of cognitive behavioral therapy (CBT), computerized CBT, a structured, group-based physical activity program, or individualized psychotherapy (Pilling et al., 2009). NICE recommendations for mild depression do not include antidepressant medications unless symptoms persist for at least two years, however antidepressant medications are the most widely used intervention for all types of depression ranging from mild to severe (Pilling et al., 2009).

Complementary and Alternative Interventions for Depression

Several intervention alternatives to traditional pharmaceutical treatment for depression have been explored in combination with antidepressants or as monotherapy (Shelton et al., 2010). Psychotherapy has been used as both a primary intervention and as a conjunctive intervention for clients with depression (Al-Harbi, 2012). Psychotherapy has shown to be effective in combination with medication, but is dependent on the number of sessions, expertise of the counselor, the counselor's adherence to a particular form of therapy, as well as the interaction within the client-counselor dyad (Al-Harbi, 2012). These variables make treatment efficiency reliant on the adequacy of specific counselor and client treatment adherence protocols and guidelines (Al-Harbi, 2012). Other studies have also shown efficacy for including psychotherapy as part of a comprehensive treatment plan. Huijbers et al., (2016) compared relapse rates between individuals who selected taking antidepressant medications to those who

preferred mindfulness-based cognitive therapy and found no significant differences in relapse and recurrence rates between the two preference groups. This provides evidence that both psychotherapy and antidepressant interventions may be effective. Both antidepressant medication and psychotherapy have been shown to be efficacious, however, response rates to any given treatment rarely rise above 50% (National Health Service, 2016). While a systematic review of literature found psychotherapy to be useful for clients with depression, there is a lack of quality trials with large enough sample sizes to make any significant clinical claims within some subsets including TRD (Trivedi, Nieuwsma & Williams, 2011).

In addition to cognitive therapy and other forms of psychotherapy, several other types of complementary therapies may offer relief from depression symptoms. Electrical stimulation of the vagus nerve, behavioral activation therapy, neurofeedback, and chronic stimulation of the subgenual cingulate region have shown positive results in clinical trials as well (DeRubeis, Siegle & Hollon, 2008). These additional complimentary methods may be especially effective with individuals with major depression and TRD. For example, electroconvulsive therapy (ECT) is recognized as a consistently effective method of treatment for clients with TRD with a response rate of 50-70% (Shelton et al., 2010). It should be noted as well that ECT has been identified as the treatment of first choice of clients with the most severe cases of TRD (Al-Harbi, 2012). Researching the effectiveness of certain complementary approaches, Park et al., (2013) conducted a meta-analysis of alternative forms of treatment as opposed to antidepressant medication offered in Korea and found that both bibliotherapy and exercise therapy had similar treatment results in decreasing symptoms of depression. Regular exercise has also been found to positively impact depression symptoms, but further research is needed in this area to show true clinical implications (Mota-Pereira et al., 2011).

Casual Video Games

In addition to these complementary treatment options, a growing body of research has investigated the use of video games as a newer alternative intervention (Fish, Russoniello & O'Brien, 2018). Researchers have stated that video games possess intrinsic qualities that may positively effect various mental-health symptoms (Fish et al., 2018). Some of these positive outcomes include promoting real-life social relationships (Kowert & Oldmeadow, 2013), increasing educational outcomes and increasing skill development (Lamb, Annetta, Firestone & Etopio, 2018). Moreover, Kato (2010) found that some types of games categorized as "serious" can be valid methods for delivering education and training to clients with physical injuries, pain resulting from burns, diabetes, and asthma.

Casual video games (CVGs) are categorized differently from serious video games as CVGs are described as fun, easy to play, and spontaneous and were not created with specific educational or training properties in mind (Casual Games Association [CGA], 2008). The Casual Games Association states that CVGs do not require previous gaming skills and cab be played in small time increments due to the nature of these games that are easy to start, pause and restart at any time (CGA, 2008). Some examples of commonly played CVGs include: Bejeweled, Solitaire, Plants vs Zombies, and Peggle. While few studies have shown efficacy for use of video games in reducing stress (Russoniello, O'Brien & Parks, 2009), anxiety (Fish, Russoniello & O'Brien, 2014) and depression (Russoniello, Fish & O'Brien, 2013); current research has not investigated the changes these games may have on alpha brain waves in addition to self-report measures of depression.

Theory of Relationship between Depression and Casual Video Game Interventions

Several theories support the potential use of CVGs as an intervention for alleviating depression symptoms, although the field of video game research thus far has faced challenges in identifying an agreed-upon theory that explains the positive traits of video games. The discourse in game theory may stem from long-held, antiquated negative stigma of video games which paints an inaccurate image of those who may identify as "video gamers" (LaFleur, Hebert & Dupuy, 2018). The general public perception of the video game community thus far has widely been perceived as being primarily male, unhealthy, anti-social and wasteful of their time (LaFleur et al., 2018). Although past research supported these stereotypes by putting forth effort to focus on the potential drawbacks of gaming, recent scholarly research has shifted to focus on a wide range of both of passive and active positive mental-health benefits of playing some video games (Granic, Lobel, & Engels, 2014).

GameFlow Model

The general industry of gaming has grown into such a universally accepted activity that use of games in expanded areas such as mental-health interventions has become the focus of recent research (Kuhn et al., 2018). Recent research concluded that across all age groups, more than 185 million people play and enjoy videogames within the United States (Entertainment Software Association, 2017). The rapid expanse of home-based computer accessibility across demographic sectors and expectation of widespread internet access has recently triggered a growing area of research into the development of novel and cost-effective technologies for general mental-health therapy (Fernandez-A. et al., 2012). Home based, technological interventions such as gaming, may assist with mental-health conditions such as depression by offering clients an alternative option that may help overcome personal barriers to receiving

treatment such as: personal stigma, high costs, waiting lists and potential shortage of qualified providers based on a client's geographic location (Li, Theng & Foo, 2014). One particular gaming theory that may help explain the mechanism behind the positive effects of gaming on individuals is the GameFlow model.

The GameFlow model is a general model used to explain player enjoyment and is applicable to all game genres and platforms (Sweetser et al., 2017). GameFlow is a model based in explaining player enjoyment. It is comprised of criteria derived from gaming user experience literature and includes eight elements (Sweetser et al., 2017). The GameFlow model has been used to evaluate a variety of games and applications including mobile games such as *Bejeweled, Peggle and Bookworm Adventure* (Paavilainen, et al., 2009). The eight core elements of player enjoyment in games are: concentration, challenge, skills, control, clear goals, feedback, immersion and social interaction (Sweetser et al., 2017). Games that adhere to the GameFlow model keep players concentration through a challenging workload but not so challenging that the task is no longer enjoyable. These tasks must have clear goals so the player knows how to conquer the task and the player must receive sufficient feedback on progress towards completing these tasks (Sweetser et al., 2017). If the player and game meet these combined markers, the player will feel a total immersion in the game, causing a loss of awareness of daily concerns and stressors, producing the result of enjoyment (Sweetser, et al., 2017). While this concept of increased gaming enjoyment may not yet be directly linked to lowering reported levels of depression, this sensation describes a reduction in rumination, often reported in individuals with TRD (Kuhn, 2018).

Mental-health and Gaming

Video game research continues to expand in the area of examining the mechanisms behind the positive effects gaming on mental-health outcomes within several domains including cognitive, motivational, and social benefits (Ewoldsen et al., 2012; Russoniello et al., 2009; Uttal et al., 2013; Ventura et al., 2013). Cognitive based neuropsychological research has suggested that positive brain chemical changes may hold therapeutic value as produced by digital interventions for depression therapy (Li, Theng & Foo, 2014). Craig et al., (2013) found that positive game-playing experiences trigger the release of "feel good" chemicals of striatal dopamine and endorphins, that produce feelings of pleasure and well-being (Salamone, 2009). Action game-based research that utilizes fast paced gaming have also found increased cognition and decreased reported levels of rumination, which can be associated with depression (Kuhn, et cal., 2018). These decreased reported levels of rumination are most likely due to improvement in executive function caused by focused attention to the gameplay (Kuhn et al., 2018). While the mechanism behind what may produce these changes as a result of gaming continues to be examined, EEG measurements of brain wave activity support these findings. Alpha-asymmetry (AA) occurs when increases in right alpha are present, as evidenced by EEG measurements relative to left alpha measurements. This effect may be associated with a reduction in depressive symptomatology (Peeters et al., 2014). Objective measures such as EEG have shown that cognitive outcomes such as executive function, attention and memory, normally associated with decreases in clients with major depression may increase as a result of video gameplay (Kuhn et al., 2018).

Casual video game specific research has rarely been conducted but has thus far suggested that that nature of puzzle-like video games may be more rewarding and less frustrating than other

types of gaming and thus best suited to entertain clients with an outcome of increased mood (Russoniello, O'Brian & Fish, 2013). The potential positive effects of CVGs on reducing depression has been described as part of GameFlow Theory and may be due to the immediate and concrete feedback in the form of items such as reward points, obtaining coins, flashing lights and sounds, etc., built in games that serve to reward continual effort and keep players engaged (Sweetser et al., 2017). Philosopher Vygotsky termed this effect the, "zone of proximal development" (Granic et al., 2014). This zone is described as the balance of optimal challenge and frustration with conscious experiences of success and accomplishment (Sweetser & Wyeth, 2005). In the most effective video games on the market, this "sweet spot" works so well because it dynamically adjusts itself, making the level of difficulty continuous by calibrating the game with the players' abilities and then increasing the difficulty of the levels, eliciting more dexterity, focus, quicker reaction times and more complex solutions (Granic et al., 2014). Although several studies have targeted the use of video games to encourage general health improvement, most studies have not focused on the effects of such treatment on depression (Li, Theng & Foo, 2014). In order to begin to investigate the reasons CVGs may effectively reduce symptoms of depression, it is first necessary to understand what depression may look like as an EEG measurement.

Depression and Alpha Wave EEG Measurement

Through several historical and recent research studies, it has been determined that depressive symptoms are associated with brain cortical abnormalities, highly involving the prefrontal cortex area (Cao, 2019). There are several methods to measure prefrontal cortex activity. Among these types of physiological data, EEG measures emotional human brain activity in real time (Cai et al., 2018). This measurement is recorded by reading spontaneous, rhythmic,

electrical activity of brain neurons through the surface of the scalp (Cai et al., 2018). On an electrophysiological level, Davidson et al., (1979) theorized that certain regions of the two cerebral hemispheres (left and right) are differentially lateralized (i.e., asymmetrical) for processing of positive and negative affective stimuli. The difference in alpha activity between both the left and right prefrontal regions is known as alpha-asymmetry (AA) (Peeters et al., 2014). Early studies of EEG asymmetries examined the left and right hemispheres in response to affective stimuli and found that asymmetrical activation to positive versus negative events was observed predominantly in the frontal region of the brain (Davidson, Schaffer & Saron, 1985). This frontal region is the location in which alpha wave activity is measured. Essentially, this early research concluded that greater activation of the left frontal hemisphere occurs, during positive affect events, and is associated with positive feelings as opposed to a greater activation found in the right frontal hemisphere, associated with an avoidance or withdrawal affect and negative emotions (Chia et al., 2016). Thus, individuals with depressive symptoms consistently exhibit higher levels of right frontal activation during rest (Schaffer et al., 1983).

Davidson's theory that originally explained the alpha-asymmetry observed in clients with depression, asserts that depression involves a disorder of emotion. His theory stated that individuals experiencing depressive symptoms should display a pattern of both behavioral and EEG asymmetry, unique for individuals with depression as compared to clients without depression (Davidson, Schaffer & Saron, 1985). Davidson's theory has been supported by numerous experiments, that have concluded observed differences in asymmetry exist when comparing samples with and without depression, during times of rest as well as in response to cognitive and affective tasks (Chia et al., 2016). A substantial number of EEG studies have found a correlation between left-right hemispheric asymmetry in the frontal regions of the cortex and

depressive symptoms (Thibodeau, Jorgensen & Kim, 2006). Choi et al., (2011) sought to replicate previous findings that frontal asymmetric activation can be an underlying mechanism for depression. In their replication study, results showed that following neurofeedback training, participants in the experimental group showed improvements of relative right alpha power as compared to a control group who did not show any difference (Choi et al., 2011). In one example, Fingelkurts et al., (2006) recorded resting EEG data in a sample of clients with depression and a sample of clients without depression to compare changes in brain waves. This study found significantly less left-sided activation in the sample of clients with depression as compared to the normal subjects. Multiple other studies have similarly concluded that reduced left frontal and/or increased right frontal activity exists at rest in clients with depression (Thibodeau, Jorgensen & Kim, 2006). Many of these more recent studies, have been interpreted within the context of Davidson's original theory. In one of Davidson's early experiments, increased intensity of happiness was associated with greater left frontal activation (Davidson, Schaffer & Saron, 1985). The high correlations (.74) between self-report levels of happiness and EEG findings Davidson, Schaffer & Saron's (1985), work support the focus of this particular research that will seek to look for correlations between self-report measures and observed EEG data. By examining objective outcome data such as with EEG measurement, there is hope that clients may endure a more streamlined approach to treatment through the information provided to their clinician's with EEG, direct brain activity information.

Statement of the Problem

The increase in individuals with diagnosed depression poses a significant challenge for health care systems worldwide. As the demand to treat clients with MDD increases, additional resources to improve overall mental-health quality continues to grow (Cipriani et al., 2018).

Traditionally, assessment and treatment of MDD begins with a diagnostic evaluation consisting of a subjective interview and potentially a physical examination to make sure depression symptoms are not due to a medical condition such as a thyroid problem or tumor (Parekh, 2017). During the diagnostic evaluation, a clinician may utilize a variety of self-report assessments such as the PHQ-9, to help determine depression diagnosis as well as proper course of recommended treatment. The clinician then selects a treatment plan, based on several factors including: the pattern, severity and persistence of depressive symptoms as well as any history of previous depression diagnosis and any other co-existing medical diagnoses. While this process remains the clinical standard of treatment, there are several challenges presented by this subjective process, as assessment of behavior in mental-health practice may be constrained by individual subjective observation and lack of real-time, naturalistic measurements (Solomon, et al., 2015).

Symptoms of depression can vary greatly both within and between individuals, compounding the difficulty in assessment, especially as individuals may adapt their behavior to meet the context of their social environment (Solomon et al., 2015). Self-report assessments rely on the client's willingness to seek treatment, report symptoms authentically, and the clinician's ability to interpret this client feedback adequately, to formulate a treatment plan (Von Korff, Katon, Unutzer, Wells & Wagner, 2001). It is quite logical to reason that in this highly subjective process, there may be varying margins of error. This difficulty is only made worse as treatment failure and rates of relapse in some clients with MDD increase consistently along with the number of attempted treatment steps and the client may become categorized as having TRD (Johnson et al., 2018).

The current guidelines for the treatment of depression do not meet the criteria of evidence-based medicine and better-quality research is needed to help inform treatment practices

(Pandarakalam, 2018). Due to the limitations of the current, subjective standard of diagnosis and treatment, an objective approach to address depression in general is essential (Cai, et al., 2018). Clients with moderation and major depression face challenges beyond other clients with MDD as this subset of depression has been associated with decreased health-related quality of life, increased mortality, and higher rates of relapse, relative to clients with minor depression within one year of remission (Fekadu et al., 2009). Several studies have reported clear and consistent trends between increasing level of treatment resistance and total medical costs for both clients and employers providing medical coverage (Johnson et al., 2018). This cost increase may be a result of several factors, the greatest often being the process of trial and error of medications (Khandker et al., 2008). These extra costs are not only financial but also cost clients' time and added stress from medical occurrences including: increased hospitalization, greater returned visits to practitioner offices, additional psychiatry visits, laboratory costs as well as other outpatient costs (Kubitz et al., 2013). While antidepressant medication remains the recommended first line of treatment for moderate, major and treatment-resistant depression, there are several concerns related to this approach. Currently, there is no evidence or consensus for the best approach to diagnosing depression or agreement on a preferred outcome, other than general remission of symptoms and disagreements persist on defining adequate medication dose and duration of treatment (McConnell, Carter & Patterson, 2019). There are no standard benchmarks antidepressants for treating depression (Pandarakalam, 2018). In the arena of antidepressant medication prescription, debate continues regarding both the short-term and long-term efficacy of traditionally prescribed antidepressant medications and the benefits and harms of these drugs are understudied (Ioannidis, 2008). Concerns regarding side effects of medications are of particular concern within the depression subcategory of individuals with TRD, as these clients

often take multiple medications, compounding the possibility of dealing with multiple side effects from several medications (Thase, 2011). It has been noted that traditionally prescribed psychiatric medications to treat TRD may also suppress symptoms at the cost of making the underlying depression worse (Whitaker, 2010). Particular videogames may provide opportunities not only for use as specific interventions to treat depression but may also provide a data source to help identify symptom strength in disorders such as depression and schizophrenia through passive data capture (Carras et al., 2018). Specifically, with regards to the treatment-resistant subtype of depression, the current method for diagnosing and treatment is associated with increased number of treatment steps due to the nature of the currently common trial-and-error approach, resulting in reduced patient health related quality of life and overall health status as reported across several studies (Johnston et al., 2018).

The widely practiced process of assessment, diagnosis and management of depression contrasts with numerous technological innovations in other fields of healthcare (Solomon, et al., 2015). The current process of identifying depression symptoms and selection of appropriate treatment options may be difficult for primary care providers when there is a difference present between the client's subjectively described experience and objective criteria of diagnosis (Caplan et al., 2010). Recent research has suggested attacking the diagnosis of depression from both a biological and non-biological approach (Pandarakalam, 2018). Under this advisement, biological psychiatrists should give due prioritization to the non-biological aspects of depression and psychotherapists should recognize and not overlook biological correlates with depression (Pandarakalam, 2018). Finding convenient and effective methods of detecting depression is an emerging topic of research (Cai et al., 2018). As advancement in sensors and mobile technology increases, exploring physiological measures such as EEG to detect disorders such as depression

opens a new opportunity for an objective and accurate tool to help combat depression (Cai et al., 2018). The continued research and development of using objective methods such as EEG to both assess and treat depression are necessary to improve current diagnostic practice since the clinical standard for depression diagnosis is subjective and inconsistent (Solomon, et al., 2015).

Purpose of the Study

The purpose of this quantitative, *ex post facto* study was to examine if individuals who adhere to a regimen of playing one of three CVGs can reduce symptoms of depression as compared to a group of individuals who did not engage in any intervention. The study used an experimental design using prescribed CVG play as the intervention in the study group as analyzed against a comparison group that did not engage in any intervention to help alleviate their symptoms of depression. Comparisons between and within the two groups were examined on both the self-report, PHQ-9 scale as well as on objectively measured changes of physiological, alpha wave EEG measurement. This research was part of the second phase of a multi-part study investigating CVGs effects on various measures of mood, stress, anxiety and depression. Results from the first phase of study demonstrated that participants were able to significantly increase mood using a variety of CVGs, but did not examine specific mental-health diagnostic symptoms such as depression and did not compare the subjective PHQ-9 results with objective, EEG alpha wave measures.

Most of the current literature on depression interventions focus on the treatment options of psychotherapy and medication management or a combination of the two, which may carry a financial, social and employment cost for many individuals (Amo et al., 2018). While previous studies have researched domains associated with depression such as attention (Dye, et al., 2009) and information processing (Powers et al., 2013), very few studies have specifically examined

the effects of gaming on reducing depression specific symptoms as measured on instruments such as the PHQ-9 and EEG data (Russoniello et al., 2013). Generally, CVGs have been found to offer several unique qualities to potentially help treat depression but have not often been empirically tested. These qualities include the ease of accessibility and low cost of commercially available games. Carras et al., (2018) stated that emerging research suggests that commercially available video games show promise in preventive and therapeutic medicine but require continued research to become accepted in mainstream medical settings.

Research Questions

There were three research questions in this study that examined the effects of two different interventions on reducing symptoms of depression in a comparison group and a study group. In order to address these research questions, a selected activity of browsing the National Institute of Mental-health's consumer website served as the comparison group independent variable and one of three CVGs, either *Peggle, Bejeweled or Bookworm Adventures* served as the study group independent variable. The dependent variables for both comparison group and study group were alpha wave, EEG measurements and PHQ-9 scores. It should also be noted that while it is not the precise focus of this study, advancements in using duel report, both objective and subjective measures, used in this study, may promote increased clinical accuracy and efficiency of depression treatment. The precise research questions are as follows:

> RQ_1: What is the difference between the comparison group (no intervention) and the study group intervention (prescribed CVG play) on objective, alpha wave EEG measurements between Time 1 and Time 3, analyzed separately?

RQ_2: What is the difference between the comparison group intervention (no intervention) and the study group intervention (prescribed CVG play) on subjective PHQ-9 scores, between Time 1 and Time 3, analyzed separately?

RQ_3: Is there a correlation between changes in alpha wave EEG measurements and self-report PHQ-9 scores?

Definitions of Terms

This section contains the definition of terms used in this dissertation that the reader should know. The author defined these terms so the reader can interpret this dissertation using these provided descriptions.

Alpha wave: Alpha waves are EEG activity with a frequency in the alpha range (8-13 Hz).

Casual video game (CVG): Video games are operationally defined as fun, entertaining, quick to access, easy to learn, and requires no previous video game skills or regular time commitment to play (Russoniello, et al., 2019).

Cognition: The mental activities that include thinking, understanding, learning and remembering.

Cognitive Behavioral Therapy (CBT): Type of psychotherapy based on a cognitive model that helps clients connect their thinking to their behavior for improvement of mood and functioning.

Electroencephalography (EEG): The placement of electrodes on an individual's scalp at designated spots in which electrical activity from the brain can be recorded and different waves and amplitudes derived and recorded.

Depression: Measured using the score from the Patient Health Questionnaire (PHQ-9). The nine-item screening instrument asks about the frequency of symptoms of depression occurring within the last two weeks.

Gameplayer: A person who performs the act of playing a digital game under the conditions of his/her personal patterns of media usage (Juul, 2010).

Patient Health Questionnaire (PHQ-9): A commonly used self-administered tool used to screen for depression with a score of ten being the recommended cut-off for detecting depression (Manea, Gilbody & McMilan, 2012).

Treatment-resistant depression (TRDS): A type of depression that occurs when medicine partly relieves symptoms of depression or does not help at all and requires additional forms of treatment (MHA, 2013).

Study Justification

Several studies have investigated the use of non-pharmacological forms of treatment for depression symptoms including cognitive behavioral therapy (CBT), vagal nerve stimulation (VNS), neurofeedback, etc., as an alternative to traditionally prescribed antidepressant medications. However, very few studies have investigated the use of CVGs to treat depression. While CVG research related to depression is scarce, some studies have reported causal relationships between playing preferred video games and improved mood as well as increases in positively experienced emotions (Ryan, Rigby, & Przybylski, 2006; Russoniello, O'Brien & Parks, 2009). Coincidentally, one of the main symptoms of depression is a lack of interest in pleasurable activities and withdrawal (Russoniello et al., 2013). Casual video gameplay may support alleviation of symptoms of depression by helping to promote engagement in the pleasurable activity of video gameplay. This notion has been supported by research that has

found the use of video games to be a contributing factor for positive mental-health outcomes as these games may be real enough for users to experience many of the same positive outcomes of play in a safe environment (Aldao, Nolen-Hoeksema & Schweizer, 2010). Some of these outcomes include: adaptive regulation, problem solving, and reappraisal, which have been linked to more social support and lower levels of generalized depression symptoms (Aldao, Nolen-Hoeksema & Schweizer, 2010). Increasing adaptive regulation strategies for example, may be rewarded in video games because of the game's design that incorporates linking play to goal achievement (Granic, Lobel, & Engels, 2014). By contrast, if gameplayers use less adaptive strategies such as rumination, a trait linked to depression, players are less likely to be rewarded because rumination may impede players from reacting quickly and with flexibility to constantly changing challenges (Aldao, Nolen-Hoeksema & Schweizer, 2010).

Casual video games additionally provide the advantage of convenience for clients by allowing them to engage in CVGs in the comfort of their home, workplace, or other convenient environments. This advantage provides clients with a level of autonomy of care that does not require a visit to a mental-health provider for perceived symptom relief (Fish, Russoniello, & O'Brien, 2018). In addition to providing a safe environment for play, research examining CVG use for alleviating anxiety found that compliance rates for playing CVGs was nearly 90% as compared to prescribed medication adherence rates of 50-60% (Fish, Russoniello & O'Brien, 2018; Consumer Reports Health Best Buy Drugs [CRHBBD], 2011).

The emotional, social and economic burden of TRD for clients, their families and society are also significant. Additionally, relapse rates of depression which may contribute to TRD have been estimated at 50-80% in those who have been depressed previously (Kenny & Williams, 2007). Due to the high cost of burden as well as prevalence, available treatment options are not

always effective for clients, especially with lengthy wait lists for treatment in most healthcare settings (Kenny & Williams, 2007). An intervention such as the proposed video gameplay may provide relief for some clients through an easily accessible, inexpensive tool for treatment.

While some studies have shown promise for a variety of therapeutic applications, many scientists have strong opinions which have skewed gaming research. These sharp opinions have resulted in a lack of unbiased research and an increase in subjective opinions to either support or refute gaming interventions (Bavelier et al., 2015). Additionally, the majority of video game studies, on both the negative and positive effects, depend on survey assessments, which is limiting in the scope of understanding the impact of gaming (Granic, Lobel & Engels, 2014). Bavelier et al., (2015) further suggested that methodology which incorporates psychophysiological and neural assessments may help better identify the emotional, cognitive, and neural changes associated with gaming. While self-report and retrospective assessments are useful, there is a need for a more multimethod approach in which objective observations can be associated with immediate and long-term effects (Granic, Lobel & Engels, 2014). The aim of this current proposal will be to use both objectively measured EEG data and subjectively measured PHQ-9 self-report data to contribute to the growing body of literature which seeks to determine the overall effects of CVG interventions compared with purely pharmacological treatment for reducing symptoms of treatment-resistant depression.

Significance of the Study

The purpose of this study was to examine the effectiveness of CVG play in reducing symptoms of depression in a study group as compared to a control group not playing a CVG. Previous research on the effects of CVG play in rehabilitation settings is new and lacks many empirical studies (Bavelier, et al., 2015). Evidence that is strong and based in sound theoretical

rationale is needed to provide evidence for the largely unexplored mental-health benefits of gaming (Granic, Lobel & Engels, 2014). Thus far, few applications of video game usage in rehabilitation settings have been documented, with only a few studies citing video game interventions including: helping clients overcome experiences related to PTSD, using games to help screen for and rehabilitate clients with dementia, and tracking decreases in some delusional thinking symptoms in clients with schizophrenia after eight weeks of gameplay (Han & Renshaw, 2015). Gaming studies that specifically focus on decreasing symptoms of TRD through CVG play have not been conducted. This particular study will contribute to the growing number of clinical applications for video gameplay as well as provide an additional cost-effective intervention for decreasing symptoms of TRD. Research findings may also provide justification for future designs of CVGs that may result in transferrable learning skills not only within rehabilitation, but education and other forms of training as well (Bavelier et al., 2015).

The current standards and process of TRD treatment include: the diagnosis of depression, treatment adherence reporting and follow-up. This process largely if not entirely, depends on patient self-report tool. One such self-report tool, the PHQ-9, is utilized for determination of successful clinical outcomes. While this process may be effective for many clients, the inclusion of a more objective measurement tool such as EEG data may provide counselors with a more efficient process for determining changes in depression symptoms. Previous research has suggested the treatment of depression would benefit from a broadened field of study as multiple etiological causes likely contribute to depression (Jenkins & Goldner, 2012). Additionally, depression by nature is nebulous in its diagnosis and provides substantial room for improvement of definition, diagnosis, prevention and treatment (Jenkins & Elliot, 2012).

Knowledge from studies that utilize psychophysiological measures (EEG) such as from this study may help provide a better foundation for designing and confirming the effectiveness of targeted interventions and training tools (Bavelier et al., 2015). This study included the use of objective EEG data to examine changes in brain wave functioning. In order to compare results of self-report measures with objective measures, this research sought to correlate changes in the self-reported PHQ-9 measure with changes found in objective EEG measurements. These correlations may provide researchers with additional information that may either support or refute inclusion of self-report and/or objective EEG measures use for increased treatment outcomes.

Current literature in the treatment of TRD reveals that while research supports the usage of cognitive behavioral therapy and other alternative and complementary approaches in addition to medication, CVG interventions may be less costly and more time efficient. The lack of widespread medical insurance across diverse populations, high costs and stigma for receiving mental-health services may prohibit individuals from receiving adequate care (Popa-Velea et al., 2015). The use of games in therapy has long been established with positive markers of their use (Gottman, 1986). More recently, the previous phase of this research demonstrated that individuals experience an increase in mood while engaging in CVG play (Russoniello, O'Brien & Parks, 2009). This study looked to further validate the inclusion of CVG as a treatment option for decreasing symptoms of depression by demonstrating changes in both self-report measures, and objectively measured EEG changes. Thus far, the potential use of CVGs has rarely been applied to the area of mental-health, more specifically depression, but may provide a cost-effective, easily attainable approach to a new mental-health intervention. Findings from this

research study can potentially aide counselors and individuals seeking non-pharmacological interventions that are cost-effective, convenient and safe.

Chapter Summary

This chapter introduced the purpose of this study, which was to compare the effects of prescribed CVG play engaged by the study group with a comparison group who did not participate in any intervention on changes in self-report and objective measures of depression. A brief review of depression prevalence and current treatment options was discussed. The statement of the problem discussed the opportunity for efficacy research to explore the effectiveness of CVG play on reducing symptoms of depression. A review of the theory and design rationale was presented along with study justification, significance of the study, and definition of terms. In the next chapter, a review of literature that examined research related to treatment options for depression, including CVG play and potential changes in EEG output in clients with depression is detailed.

CHAPTER II: LITERATURE REVIEW

Introduction to Literature Review

This literature review will provide an examination of depression as well as the subtypes of depression including: mild, moderate, major and treatment-resistant depression. Each subgroup will be defined by diagnostic characteristics, treatment options discussed and the potential role CVGs play in reducing symptoms of depression. The review will begin with information regarding current definitions and prevalence of depression. Next, the review will examine current traditional and non-traditional treatments for depression. Then, the review will include information regarding this study's methods of measurement including both subjective (PHQ-9) and objective (EEG) and finally, the review will conclude with relevant literature involving CVGs and applications for medical treatment.

General Depression and Subtypes

Although there is a wide range in both symptoms and severity of depression, the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5), generally define depression as a common, yet serious medical condition that negatively affects how one feels, the way one thinks and how one acts (APA, 2013). Depression largely causes feelings of sadness and/or loss of interest in activities once enjoyed (APA, 2013). Depression can also lead to a variety of emotional and physical issues and can decrease a person's ability to function at work and at home (APA, 2013). Symptoms of depression vary widely and may include: feeling sad, loss of interest in activities of pleasure, changes in appetite, trouble sleeping, loss of energy, increase in purposeless activity such as pacing, difficulty thinking and thoughts of death or suicide (APA, 2013). It should also be noted that symptoms must last at least two weeks and must represent a change in previous level of functioning for a diagnosis of depression (APA,

2013). Depression however, often has a much more significant impact on individuals beyond the symptoms listed. Managing depression can be incredibly time consuming and costly to manage for individuals as well as a large financial burden for treating medical institutions (Pandarakalm, 2018). In the United States alone, depression including the treatment of co-morbid diagnoses has been estimated to have cost the U.S. economy more than $210 billion in 2010 (Greenberg et al., 2015). Depression may also affect or be affected by several biological, environmental, social or cognitive factors (Solomon et al., 2015). Depression continues to be a very controversial topic in mental-health as there are long-standing differences in thought regarding the biological versus behaviorally analytical oriented practitioners with associated belifes.

The PHQ-9 is a widely used nine-item, diagnostic instrument used to detect symptom severity in client populations (Spitzer et al., 1994). The PHQ-9 uses checkmarks to ask clients to identify symptoms they have experienced related to depression. The checkmarks on the Likert-scale measure are interpreted as: 0-4 none; 5-9 mild depression; 10-14 moderate depression; 15-19 moderately severe depression; and 20-27 severe depression (Kroenke et al., 2001).

Mild Depression

Mild depression is often overlooked and not widely discusses as there is a pervasive assumption that the word “mild” indicates sub-clinical or mild symptoms (Tartakovsky, 2018). However, a person with mild depression does meet the DSM-V guidelines for depression, however their symptoms are mild in terms of impairment (Tartakovsky, 2018). Mild depression is generally characterized by symptoms such as tearfulness, irritability, fatigue and persistent negative thinking (Serani, 2018). Individuals with mild depression may describe themselves as extra tired, extra moody and achy (Serani, 2018). Some mild depression is short-lived due to an event that may be stressful, but it may also be persistent for months or even years (Serani, 2018).

Antidepressant medications, while often prescribed for mild depression, are not the recommended course of action for this subtype of depression (NICE, 2010). Rather, it is recommended that individuals with mild depression first seek treatment through non-pharmacological methods such as group therapy and physical exercise (Pilling, 2009). College students are one of the largest group of individuals often diagnosed with mild depression. Factors that may contribute to mild depression among this population include: poor academic performance, lower socioeconomic status and stressful tasks such as exams and interpersonal relationships (Hu et al., 2016). In one particular study, Ibrahim et al. (2013) found that depression rates among college students ranged from 10% to 85%.

Moderate Depression

Moderate depression is distinguished generally by two distinct symptoms, persistent low mood and decreased interest in activities (Cherry, 2020). A recent survey found that of the United States population with depression, 50% had moderate depression (Cherry, 2020). Moderate depression differs from mild depression in terms of severity of symptoms and type (Firth et al., 2017). It should also be noted that moderate depression is not a diagnosis listed in the DSM-5 (Cherry, 2020). As previously emphasized in this study, there is no official determination or consensus regarding number of symptoms or severity that can be used to classify depression to distinguish holistically between mild and moderate depression and is usually left to the discretion of the practitioner to make this determination (Cherry, 2020). Moderate and major depression are associated with social, occupational and physical impairments at a more significant rate than mild depression (Pandarakalam, 2018). Some studies have stated that up to 15% of individuals who have committed suicide experienced a minimum of moderate depression subtype (Pandarakalam, 2018). Depression and reported feelings of

hopelessness are among the most commonly known risk factors for suicidal thoughts and behaviors (Ribeiro et al., 2018). Moderate depression is also common among college students with 37% of university students in Egypt reporting moderate symptoms of depression (Ibrahim et al., 2013). Other researchers have found similar rates among college students in Kenya and Ghana at 35.75 and 31.1% respectively (Asante & Andoh-Arthur, 2014). Regarding intervention selection for mild and moderate depression, psychotherapy and antidepressants may be selected depending on an array of factors (Firth et al., 2017). However, individuals who may find themselves in the category of either mild or moderate depression may face many barriers to treatment (Firth et al., 2017). For example, access to mental-health care remains limited as almost half of the world's population lives in countries where there is only one psychiatrist for every 100,000 people (WHO, 2018). Additionally, since many individuals who are thought to have either mild or moderate depression are highly functioning in career and home life, many individuals carry a burden of stigma which may limit the effectiveness of treatment (Pederson & Paves, 2014).

Major Depressive Disorder

Major depressive disorder similar to the other subtypes is heterogeneous in nature, which has a wide range of etiologies, risk factors and symptoms that may be associated with this subtype of depression (Arno et al., 2015). The lifetime prevalence of MDD varies in previous research from 11.2 to 16% worldwide (Dold & Kasper, 2017). Approximately 17.3 million or 7.1% of all adults in the US had at least one major depressive episode in 2017 (NIMH, 2019). Within the United States alone, the economic impact of depression totals approximately $210 billion with 45% of this attributed to direct costs, 5% suicide-related costs and 50% related to

workplace cost (WHO, 2018). Compounding the importance of addressing MDD, up to 10% of clients with MDD have reported at least one suicide attempt (Holma et al., 2014).

Symptoms of depression are one of the most common reasons clients seek medical care worldwide (Dold & Kasper, 2017). The heterogeneity of the root cause of depression may contribute to the variable response to treatment observed that potentially leads to TRD (Craighead & Dunlop, 2014). Approximately 30%-40% of clients with depression requiring medication, usually MDD, will remain clinically symptomatic, even after receiving a variety of treatments and can then be categorized as clients with TRD (Hollon et al., 2014). Risk factors for an individual becoming treatment-resistant include: Suicide risk, melancholy affect, recurrent MDD, more than one hospitalization, symptom severity, comorbid anxiety and failure to respond to initial antidepressant at the age of 18 or younger (Dold & Kasper, 2019). A person with TRD often experiences increases in suicidal thoughts, with an estimated one-third of individuals with TRD attempting suicide within their lifetime (Palmisano, 2018). More than 50% of clients with depression do not reach remission during initial treatment, with 30-50% of those clients, not responding to treatment at all (Mrazek et al., 2014).

Prevalence

Depression is the most common, costly and burdensome psychiatric disorders for adults worldwide (Cipriani et al., 2018). All subgroups of depression may affect all ages and can cause detrimental loss and burdens to economic systems, as well as, the social, educational and justice systems (Solomon, 2015). The prevalence of depression is based on scores from the PHQ-9, which allows for criteria-based diagnoses of depressive disorders (Brody et al., 2018). Depression affects an estimated one in fifteen adults or 6.7% of the United States population in any given year (APA, 2013). It is further estimated that one in six people in the United States or

16.6% of the population will experience depression at some point in their life. Depression may occur at any time, but on average, first appears during the late teens to mid-‘20s (Solomon et al., 2015). Between binary genders, women are more likely than men to experience depression (APA, 2013). Some studies have shown that up to one-third of women will experience a major depressive episode in their lifetime (APA, 2013).

Depression is not selective with regard to age, gender, environmental factors, etc. However, depression rates are lower among non-Hispanic Asian adults, compared with Hispanic, non-Hispanic Black, or non-Hispanic White adults (Brody et al., 2018). Overall, women were almost twice as likely to have depression at 10.4% as men at 5.5% (Brody et al., 2018). This similar pattern of gender-based occurrence was observed across all age groups (Brody et al., 2018). Although all subtypes of depression show similar rates of occurrence across age demographic categories, the average age of onset for initial MDD episodes is late adolescence, with the majority of clients with MDD diagnosed by early adulthood (Craighead & Dunlop, 2014). Contributing to the prevalence of depression in general, the diagnoses is not only chronic and recurrent in nature but frequently occurs comorbidly with other diagnosis (DeRubeis, Siegle & Hollon, 2008). Depression is about two to three times more common in individuals with chronic physical health problems than in people who are in good physical health (Egede, 2007). Chronic physical health problems can both cause depression and make depression symptoms worse, while depression alone may also adversely affect physical health such as contributing to cardiovascular disease and increasing mortality (Pilling, et al., 2009).

Etiology of Depression

There is no one specific root cause of depression, rather, results from a unique interaction of social, psychological and biological factors (WHO, 2018). As individuals encounter adverse

life events such as unemployment, death of a loved one and psychological trauma, the likelihood of developing depression may increase for some people (WHO, 2018). Depression may result from any combination of psychological, biological and social conditions (Pandarakalam, 2018). These contributions from a variety of root causes are generally thought to be subconscious in nature and not of known etiology by the individual (Pandarakalam, 2018). This is important to note as there has been a popular misconception and associated stigma that depression is due to a lack of will power (Bhugra, 2013). While there is currently no agreed upon cause for depression, genetics and biochemical processing are now accepted roots for depression along with environmental factors and personality traits (McConnell, Carter & Patterson, 2019). Risk factors for specifically developing MDD may also include: positive family history for a mood disorder, early life trauma, prior anxiety disorders, and substance use (Craighead et al., 2013). It is unquestionable that depression may come from purely genetic-based, chemical causes, however such a medicalization of depression should also be accepted with caution as this approach often overlooks important psycho-social factos (Pandarakalam, 2018).

Clinical depression is largely a recurrent disorder that frequently becomes chronic (Craighead & Dunlop, 2014). Treatment-resistant depression results from a progression of ineffective treatment of MDD, causing the diagnosis to often require more than one type of the same intervention, or a combination of different interventions (MHA, 2013). Treatment-resistant depression is quite commonly seen as a progression from MDD in clinical practice and constitutes a significant portion of the greater diagnosis of MDD (Peeters et al., 2016). Previous research has reported 20%-40% of clients treated for MDD fail to respond to their first antidepressant treatment and up to 15% do not respond to multiple antidepressants (Fekadu et al., 2009). Due to the progressive nature of MDD resulting from failed first-line treatment

approaches, increases in MDD diagnoses are expected to correlate with resulting increases in TRD diagnoses as well (Craighead & Dunlop, 2014). Treatment resistance to antidepressant medications is one of the most critical clinical challenges in the management of depression (Dold & Kasper, 2017).

Treatment resistance in depression has been historically documented since the introduction of the medication, imipramine, in the 1950's (Kuhn, 1958). Kuhn (1958), observed some clients taking imipramine experienced some degree of improvement, although at the cost of considerable effort to engage in daily activities, while some clients experienced no effect at all. These observations by Kuhn were confirmed with two benchmark studies that followed, both also showing poor treatment response at 50% and 62% respectively (Medical Research Council, 1965). In 1974, the WHO held a conference, specifically to define TRD and attempt to define the concept (Lopez-Ibor, 1974). Although significant advances have been made in understanding the psychopharmacology and biomarkers of MDD, only 60-70% of clients with MDD respond to antidepressant therapy (Al-Harbi, 2012). This disparity leaves up to 30% of people with MDD without satisfactory improvement from their symptoms (Fekadu et al., 2018).

Treatment-Resistant Depression

Treatment-resistant depression is a subcategory of the larger diagnosis of major depressive disorder (MDD) (Ferrari at al., 2013). Currently, there is not one universally accepted definition of TRD (McIntyre, et al., 2014). The term "Treatment-resistant" vaguely describes clients who do not respond to antidepressant therapy after one or more adequate trials of appropriate dosage and duration (Mrazek et al., 2014). Clients that experience treatment resistance to first line interventions are more likely manage comorbid physical and mental disorders with increasingly higher health care costs along with other negative effects resulting

from ineffective treatment (Fekadu et al., 2018). TRD is associated with significantly high levels of personal suffering, considerable functional impairment and monumental medical and mental-health costs (Gibson et al., 2010).

Recent research has concluded that most clients with TRD are dealing with a combination of risk factors leading to their condition (Al-Harbi, 2012). These risk factors include: not adhering to taking prescribed antidepressants long enough (i.e. 6-12 weeks) to benefit from the full effect of medications, skipping medication doses, unpleasant side effects of prescriptions, or drug interactions with other medical treatments (Al-Harbi, 2012). Other risk factors for experiencing TRD may also include: taking the wrong medicine or improperly prescribed dose, genetic predisposition related to speed of metabolizing medications or other comorbid medical conditions such as hypothyroidism and anemia (Al-Harbi, 2012). Underlying conditions such as eating disorders and substance use may also contribute to a TRD diagnosis as each of these conditions may need separate interventions, prohibiting the effectiveness of prescribed medications (Al-Harbi, 2012). Despite the seriousness of TRD, evidence now suggests that even the most treatment-resistant clients can achieve sustained levels of remission when highly specialized, multidisciplinary, intensive and careful intervention programs are followed (Wooderson et al., 2014). Currently, there is little evidence showing that one form of treatment for TRD is superior to another. Several studies have compared treatment options including: combining antidepressant medications, switching medications, and combining medication with psychotherapy as typical first line treatment options (Arnow, et al., 2015). The complexities involved with clinically separating the differences between MDD and TRD pose challenges to clinicians with regards not only to structuring prevalence statistics but also in understanding the point in which a client transitions from having MDD to TRD.

In addition to the challenges of simply defining the term, TRD, there is also much debate regarding the clinical expectations of defining successful remission of TRD as well. In order to meet an expectation of a satisfactory treatment attempt, most clinical definitions of adequate antidepressant therapy require minimum thresholds of dose, duration and client compliance (Gibson et al., 2010). Other researchers have argued that remission should be the absolute goal of treatment and any absence of remission meets the criteria for TRD (Greden, 2010). Additionally, other researchers, posit that TRD should be viewed on a continuum ranging from partial response to complete treatment resistance as opposed to an all or nothing approach (Jenkins & Goldner, 2012). In the largest landmark study examining the effectiveness of treatment options for clients with MDD, clients that had progressed to TRD were defined as those who did not become symptom free after one or more treatments (Trivedi et al., 2006). In the STAR*D trial, 72% of clients did not experience remission after treatment with citalopram, a common SSRI, used to treat MDD (Trivedi et al., 2006). Additionally, as each subsequent treatment that was added the failure to remit rate increased from 79-93% (Trivedi et al., 2006). Further research has found that each additional unsuccessful course of antidepressant therapy added is associated with lower likelihood of remission and higher relapse rates (Gibson et al., 2010).

Depression Interventions

The National Institute of Mental-Health defines treatment for depression as occurring within these categories: Medications, psychotherapies and brain stimulation techniques (NIMH, 2020). For many clients with depression, alleviation of symptoms often elicits several attempts of trying either only pharmacological or a mixture of different types of interventions prior to finding symptom relief. Response to treatment is highly variable across all subtypes of depression (Arnow et al., 2015). In addition to variance in treatment outcomes among

individuals treated with the same course of intervention, there is also little evidence that one treatment is superior to another, whether comparing antidepressant medications, types of psychotherapies, or between several other types of interventions (Arnow et al., 2015). Despite the belief that depressive symptoms are widely thought of as a confluence of biological, psychological and social factors, a scoping review of literature found that the study of treatment for depression has historically focused primarily on biologically based treatments in the form of pharmacological studies (Jenkins & Goldner, 2012). Given the multifaceted factors underlying depression, researchers have hypothesized that the most effective treatment should be equally complex and include interventions that address diverse factors contributing to the debilitating diagnosis (Jenkins & Goldner, 2012).

Treatment for depression depends on several factors including an individual's severity, frequency and duration of symptoms (Firth et al., 2017). For example, most individuals with mild depression may begin treatment interventions through lifestyle changes, while most clients with TRD start with a regimen of antidepressant medication, while some treatment options include psychotherapy or a combination of both. Most commonly, the course of treatment for moderate or severe depression and TRD begins when a first-line antidepressant medication. If this first medication does not alleviate symptoms, a second-line therapy is needed. Selection of the initial treatment options should involve numerous factors including: understanding the client's target symptoms, comorbid medical or psychiatric conditions, concomitant medications, previous response to an antidepressant and review of any potentially adverse effects due to drug interaction potential (McConnell, Carter & Patterson, 2019). If a client is not receiving adequate relief of depression symptoms, guideline recommendations for second-line treatment usually include one of three pharmacological options: increasing the dose of the first medication,

switching to a different antidepressant, or adding a second medication (McConnell, Carter & Patterson, 2019). The cause for a lack of treatment response in these clients may be due several reasons including: errors in the diagnostic process, inadequate treatment, failure to remedy coexisting general medical and psychiatric disorders, or other psychosocial factors (Gautam et al., 2017). Unfortunately, the reported 20-50% of clients who do not experience full remission of symptoms are often left to deal with residual functional impairment as well as increased risk for relapse and recurrence (Kocis et al., 2012).

The section that follows will summarize the various types of depression interventions typically adhered to in efforts to alleviate depressive symptoms. Currently, there is no precise, clinical standard of practice for treating depression (Jenkins & Goldner, 2012). Due to the inconsistent nature of defining and treating depression, and the wide spectrum of potential interventions and variability of effectiveness of treatments, this literature review of depression interventions will briefly examine potential interventions for all subtypes of depression within the same section of this review.

Mild depression as long been treated lifestyle interventions including exercise, sleep scheduling, nutritional interventions and mindfulness (Hu et al., 2016). As research in the area of MDD and TRD continues to grow, interventions other than antidepressant medications, continue to become more widely explored (NIMH, 2019). While causation of TRD research had led to a more multifaceted approach, interdisciplinary approaches to treatment of TRD that may address reasons for TRD diagnosis such as environmental factors, beyond simply biological determinants remain novel and very lightly researched (Jenkins & Goldner, 2012). For example, current literature has established the efficacy of psychotherapy as an evidence-based treatment for general depression diagnosis, limited research has explored this intervention which may address

environmental and social factors of TRD specifically (Jenkins & Goldner, 2012). The main adjunctive, nonpharmacological interventions most often used in treating TRD include psychotherapy, electroconvulsive therapy (ECT) and vagus nerve stimulation (VNS) (Shelton et al., 2010).

Pharmacological Interventions

Currently, no pharmacological treatment is universally effective for treating depression, yet, antidepressant medications continue to remain the recommended course of continued treatment for moderate and severe depression (Gadad et al., 2018). With specific regard to treatment for TRD stems, pharmacological interventions come from a progression of an earlier diagnosis of MDD, resulting in either combined or altered use of medications typically and similarly prescribed for MDD.

Antidepressant medications are often selected for first-line treatment as they are relatively low-cost and easily accessible, however fewer than 50% of clients respond to these medications after 14 weeks (Yasinski et al., 2019). In a study reviewing antidepressant pharmacologic treatments, Dold and Kasper (2017) concluded that resistance to first-line medications is one of the most important clinical challenges in all of disease management. In the STAR*D study examining antidepressants for treating MDD, the cumulative remission rate after four trials of antidepressants, within a fourteen-month period, was 67% (Rush et al., 2006). Even with continued sequenced treatment, 10-20% of participants in the study remained significantly symptomatic for two years or longer (Rush et al., 2006). In general, the current accepted thought is that although antidepressant medications can be effective in treating depression, the current regimens fail to achieve remission in approximately one out of three clients (Voineskos et al., 2020). There are several categories of antidepressant medications commonly used to treat in

medical practice to treat depression including selective serotonin reuptake inhibitors (SSRIs), serotonin-norepinephrine reuptake inhibitors (SNRIs), tricyclic antidepressants (TCAs), monoamine oxidase inhibitors (MAOIs), and others (bupropion and mirtazapine) (Saragoussi et al., 2012). A tremendous increase in the use of antidepressant medications occurred when selective SSRIs were introduced to the pharmacological market in the early 1990s (Hollon et al., 2019). This increase occurred as general practitioners felt safer prescribing SSRIs as they are not lethal in overdose, compared to previously prescribed tricyclic antidepressants and do not require complex dietary restrictions like MAOIs (Olfson, Marcus, Druss & Pincus, 2002). Additionally, some studies have cited antidepressants more frequently prescribed than psychological based interventions due to inadequate resources to provide alternative interventions and a lack of access to care to receive other psychological treatments (Cipriani et al., 2018).

Since up to 40% of individuals taking first line medications to treat their depression, do not achieve symptom relief with the first medication prescribed, it is important to discuss strategies used by mental-health physicians when treatment resistance to first-line medications occur. These strategies are: 1) increasing the dose of the initial antidepressant, 2) combining two antidepressants, 3) switching to another, new antidepressant medication, 4) augmenting the antidepressant with another agent such as second-generation antipsychotics (SGAs) or lithium and finally, 5) combining the antidepressant with non-pharmacological therapies (Bauer et al., 2013). Of these preceding strategies, the most commonly practiced are increasing the dose of the currently administered antidepressant either through dose escalation or high dose treatment and secondly, switching to another, new antidepressant medication (Dold & Siegfried, 2017). Some research indicates this may be a result of the heterogeneous nature of depression, in which a great diversity of pathologies makes any one course of treatment difficult to determine (Shelton

et al., 2010). The complicated nature of clinical evaluation of clients with depression in conjunction with the difficulties in determining the root of the depression calls for continued research to aide clinicians in deciding the proper course of treatment (Shelton et al., 2010).

Most often, response to depression symptoms is defined as a notable improvement of symptoms and remission as a near absence of symptoms. One of the reported negative traits of treating depression with antidepressants alone is the potential threat of symptom relapse. Clients who have recovered from depression by use of antidepressants and then discontinue using the medication have an increased risk of three to five times the risk of a member of the general population experiencing a first episode of depression (DeRubeis, Siegle & Hollon, 2008). Consequently, clinical practice guidelines emphasize the importance of maintaining use of antidepressants indefinitely for clients in remission of depression, especially for clients with a history of chronic depression (DeRubeis, Siegle & Hollon, 2008). There will be two types of pharmacological interventions discussed in the section that follows. These two will be antidepressant medications and atypical antipsychotics. Additionally, pharmacological based strategies designed specifically to address depression symptoms including combining and switching antidepressant medications will also be discussed.

Antidepressants. Antidepressants represent one of the major advancements of modern medicine. In 2006 alone, 5 of the 35 medications with top sales in the United States were antidepressants with each of these having sales of 1.08-2.25 billion dollars in this one year alone (Ioannidis, 2008). Currently, the standard practice for moderate and severe treatment is to keep clients with chronic or recurrent depression on antidepressant interventions indefinitely (APA, 2010). In the past five decades, one of the strongest trends in psychiatry and psychopharmacology has been the exponential increase in the number of available medications

for treatment of mental-health diagnoses, with antidepressant medications being the largest diagnostic category of growth in this area (Popa-Valea, 2015). All of the currently prescribed antidepressant medications aim to alter the function of neurotransmitters in the central nervous system including: serotonin, dopamine or norepinephrine (Popa-Valea, 2015). Critics of many antidepressants state that there is a danger in prescribed medications as safety, tolerability and lethality in overdose are the main drivers of medication choice, rather than efficacy (Archangelo et al., 2017). Many researchers have further stated skepticism of effectiveness studies for antidepressants as the field lacks comparative double-blind treatment vs placebo vs baseline treatment design (Popa-Valea, 2015).

There are two classes of antidepressant medications that will be reviewed in this section; Monoamine oxidase inhibitors (MAOIs) and tricyclics and selective serotonin reuptake inhibitors (SSRIs) (Craighead & Dunlop, 2014). These two classes of medications were selected as they are most commonly selected in treating clients with TRD (Craighead & Dunlop, 2014). The current standard practice for antidepressant prescription recommendations are primarily based on tolerability, safety and personal choice, rather than on efficacy (Craighead & Dunlop, 2014). The goal of antidepressant treatment is to eliminate symptoms with dosages generally increased every 2-4 weeks, until either the goal is reached or the FDA maximum recommended dose is reached (APA, 2010).

While many antidepressants have proven efficacy, the side effects of some frequently used medications can be serious and may range from increased anxiety, to weight gain, sexual dysfunction and suicidal ideations (Cuijpers et al., 2013). Currently, there is not a particular class or individual medication that has consistently proven to be superior for the treatment of MDD and TRD (APA, 2010). Other researchers further suggest that several negative side effects of

antidepressant use may be detrimental to clients. Andershon et al., (2009) found long-term use of moderate antidepressants may be associated with development of diabetes. Other researchers also suggest using antidepressants cautiously. In a recent study examining treatment options, common side effects of antidepressant treatment included: dry mouth, drowsiness, fatigue, sedation, dry mouth, weight gain and increased appetite (McConnell, Carter & Patterson, 2019). The specific types of antidepressants currently used for treating TRD will be outlined below.

Monoamine oxidase inhibitors (MAOIs) and tricyclics. MAOIs and tricyclics are older versions of antidepressants. MAOIs include medications such as: tranylcypromine, phenelzine and moclobemide (Voineskos et al., 2020). MAOIs work by inhibiting MAO-A and B enzymes and can be effective antidepressants (Voineskos et al., 2020). While there is no proven course of recommended antidepressant for treating TRD, SSRI's and SNRIs supersede MAOIs as recommended first-line therapy (Arcangelo et al., 2017). In most cases, older classes of antidepressants, such as MAOIs are reserved for trial-and-error methods of changing medications once SSRI/SNRI options are exhausted (Voineskos et al., 2020).

Selective serotonin reuptake inhibitors (SSRIs). Selective serotonin reuptake inhibitors are newest sub-type of antidepressants prescribed for depression. Selective serotonin reuptake inhibitors (SSRIs) are the second most widely prescribed medications in the world, following statins (Hollon, et al., 2019). SSRI's became so widely accepted, so quickly, that by the mid-1990's they had largely replaced tricyclic antidepressants (TCAs) as the first choice for clients with depression (Thase, 2011). The perceived advantages of SSRI's in both tolerability and safety, compared with other medications may have come at the expense of reduced efficacy, especially for clients with MDD (Thase, 2011). As initial support for use of SSRIs and combined use with other combinations such as TCAs grew, so did the expansion of combining other

antidepressants as well such as: bupropion, mirtazapine and SNRI, venlafaxine (Thase, 2011). These medications grew quickly in popularity due to their relatively benign side effects as opposed to previous antidepressant medications (Popa-Valea, 2015). Research however, has more recently shown that SSRI's may be neither as safe nor efficacious as commonly believed (Hollen et al., 2019). In spite of the advantages of these newer medications, SSRIs may cause nausea in the short-term, however tend to also cause sedation and negative sexual side effects in the long run (Popa-Valea, 2015). However, SSRIs are currently the most extensively used antidepressant medication (Popa-Valea, 2015). SSRIs work by changing levels of serotonin. Serotonin is a neurotransmitter, or brain chemical, that allows cells within the brain to communicate with one another. While it was originally thought that SSRIs and SNRIs were safer and produced fewer side effects than older tricyclic antidepressants, updated research has found conflicting results to this notion. Evidence in recent meta-analysis has found SSRIs to also produce side effects of: dry mouth, gastrointestinal issues, seizure, weight gain, sexual dysfunction, and bleeding (Wang et al., 2018). While SSRIs may still be safer and more widely prescribed than previous antidepressants, evidence regarding side effects, dropout rate and tolerability is inconsistent (Wang et al., 2018).

As TRD has gained traction as a focus of research, new protocols and treatment strategies have been developed to treat this disorder (Perez-Wehbe et al., 2010). While progress has been made in these new strategies, there is still no clear or specific protocol recommended to treat TRD (NICE, 2009). If first-line medications are ineffective, clinicians working to treat TRD often turn to one of two treatment strategies to combat TRD. These strategies are either "switching" or "combining" medications (Shelton et al., 2010). Approximately 25% of clients with TRD tend to respond to combining treatment paradigms, while up to 50% of clients

reportedly respond to switching of medications (Al-Harbi, 2012). Switching involves treatment in which medications are changed within and between classes of compounds whereas combining involves the addition of adjunctive therapies that may build upon achieved improvements (Shelton et al., 2010). Combining medications is generally recommended if partial treatment response has been achieved, whereas, switching is recommended when remission of symptoms is not evident or when occurrence of side effects elicits a change in medication (Shelton et al., 2010). Mitchell (2018) however, proposed an algorithm for practitioners to help with treating TRD that was composed of three treatment options: Optimization of medicine, switching and augmentation. Optimization was proposed as the first step following unsatisfactory results from a single medication as optimization ensures the client is taking the medication exactly as prescribed, for the appropriate length of time and in an ideal quantification of dosage (Mitchell, 2018). After optimization has occurred, Mitchell (2018) recommended pursuing the other options of switching or combining.

Combining antidepressant strategy. When an initial antidepressant is unsuccessful, combining antidepressant medications is a common treatment strategy (McIntyre et al., 2014). Although widely used and most often safe, the efficacy of combining medications to treat TRD has not been established by properly controlled, adequate clinical trials and remains inadequate empirically for such widespread use (Thase, 2011). Using this approach, at least two medications are administered at the same time, usually of the same class, but not always. Further, research in some studies in the area of combining antidepressants supports adjunctive combining atypical antipsychotics such as: lithium, thyroid hormone, triiodothyronine, and buspirone as well as with tricylic antidepressants (TCAs), monoamine oxidase inhibitors (MAOIs) and SSRI/SNRI medications (McIntyre et al., 2014). This strategy is rather common in clinical practice, although

there is little evidence supporting these measures (Dold & Kasper, 2017). Historically, most of these combined medication studies have involved TCAs and MAOIs and collectively support combining antidepressants and lithium as a first-line treatment option and thyroid hormones and buspirone as secondary treatment options (Lam et al., 2009). Thus far, very few RCTs have been conducted to look at the effectiveness of this strategy. Blier et al. (2010) conducted a double-blind RCT examining the responses of 105 clients with MDD to a strategy of combining mirtazapine together with fluoxetine, venlafaxine and bupropion as compared to a group of participants taking fluoxetine medication alone and found the combined treatment more efficacious in terms of remission rates, but not response rates. Additionally, Rush et al. (2011) conducted a single-blind study using two different combinations of medication and found that these combined treatments were not significantly more effective than escitalopram monotherapy. While the approach in combining antidepressant, medications is growing in popularity, it should be noted that no antidepressant is FDA approved and/or established as a reliable adjunctive treatment strategy for TRD (McIntyre et al., 2014).

Switching antidepressant strategy. Switching is a method included in both the Canadian Network for Mood and Anxiety Treatments (CANMAT) as well as National Institute for Health and Care Excellence (NICE) (Voineskos et al., 2020). This strategy is recommended for clients with MDD who do not receive adequate response from first-line medications (Voineskos et al., 2020). Although the efficacy of all officially approved antidepressant medications has been verified by positive clinical trials, most of this data has been derived from non- Treatment-resistant populations with depression. This makes results difficult to be transferred to clients with inadequate response to medications and may merit switching medications altogether. If there is less than 50% improvement following 6-8 weeks of maximum tolerable dosage and medication

adherence is also good, a switch in antidepressant should be considered (Gautam et al., 2017). Switching may be a beneficial strategy as this helps to avoid taking multiple medications that may compound side effects, may produce lower costs than multiple medication dosage and reduces any risk for treatment-emergent adverse side effects and events (Shelton et al., 2010). However, few studies have reported that changing the class of medication after non-response to the initial type, for example an SSRI, may significantly increase response rates (Voineskos et al., 2020). Bschor and Baethge (2010), published a meta-analysis of research-controlled trials and reported only three studies, representing 395 clients could meet their meta-analysis criteria and no significant differences were found between the switching group and a second group that continued taking the same medication. In a follow-up study, Romera et al. (2012) conducted research using a double randomized design with non-responders to first line medications who were randomized into either a switching group who changed to the medication, duloxetine or control group that stayed on the same medication, escitalopram. In this study, no significant between-group differences were found in response rates to medications. Additionally, Souery et al. (2011) compared non-responding groups taking either citalopram or desipramine medications and randomized them into either a group switching to the other respective medication or continuation with the first medication and did find significantly higher remission rates among only the non-switched clients. Based on these findings, a switching strategy in the case of non-responders should not be regarded as an evidence-based strategy for clients with TRD (Dold & Kasper, 2017). In support of previous findings, a most recent meta-analysis found no significant evidence that confirmed that switching antidepressants is effective when compared to simply continuing the initial antidepressant (Bschor, Kern, Henssler & Baethge, 2018). While some clients may benefit from switching medications, it should be used with caution and preferably

with clients who are experiencing absolutely no response or are experiencing adverse effects to current antidepressant medications (Dold & Kasper, 2017). If a switching strategy is selected, it should be noted that a cross-over titration method is recommended to successfully accomplish a medication switch. Using this method of switching, the dose of the first antidepressant medication is gradually decreased while the new medication dosage is gradually increased to its target dose (Dold & Kasper, 2017).

Atypical antipsychotics. After inadequate remission of symptoms with either a single or multiple SSRIs, atypical antipsychotics have more recently been prescribed as adjunctive agents to SSRIs (McIntyre et al., 2014). Atypical antipsychotics are categorized as adjunctive therapy that includes the addition of a second medication, not usually considered an antidepressant as a first-line pharmacological option (Voineskos et al., 2020). Atypical antipsychotics have been increasingly recognized as an important treatment option (Wang et al., 2016). Three antipsychotic agents are Food & Drug Administration (FDA) approved as adjunctive medications to antidepressants, aripiprazole, quetiapine or a combination of olanzapine-fluoxetine (Spielmans et al., 2013). Most of these second-generation antipsychotics have been researched as adjunctive therapies in combination, specifically with first-line SSRI and serotonin-norepinephrine reuptake inhibitors (SNRIs) medications (Voineskos et al., 2020).

Recent interest in these medications by large pharmaceutical companies has resulted in several large-scale, placebo-controlled research control trials of these medications (Voineskos et al., 2020). In these studies, anti-psychotic medications were found to have varying effects on serotonin receptors and may therefore show efficacy in combination with SSRI/SNRI medications to treat TRD (Voineskos et al., 2020). In one study, quetiapine at a dose of 300mg/day demonstrated up to 48% response and 24.5% remission in combination with SSRIs,

leading to its FDA approval for treatment of TRD (El-Khaliki, et al., 2010). Results from two separate meta-analyses concluded that adjunctive atypical antipsychotics are significantly more effective than placebo with approximately double the odds of achieving remission (McIntyre et al., 2014). Additionally, Anderson et al., (2009) conducted an open-trial study to explore the efficacy of atypical antipsychotics (i.e. quetiapine) as an adjunctive strategy for clients with TRD who were taking MAOI medications. While the researchers found the additional atypical antipsychotic may be helpful, limitations of small sample size (n = 24) made these results difficult to generalize (Anderson et al., 2009). Negatively, atypical antipsychotics also have higher odds of discontinuation compared to placed due to akathisia, sedation and weight gain resulting in clients desire to stop taking these medications (McIntyre et al., 2014). With some of these medications, adverse side effects related to taking atypical antipsychotics, notably weight gain, metabolic disruption and sedation are significant barriers for treatment for many clients (Cha & McIntyre, 2012).

Outside of the widespread use of pharmacological treatment options, alternative and complementary approaches to treatment employ indirect mechanisms of change that may still affect brain physiology, similarly to medications (Gadad et al., 2019). Evidence in recent research has suggested non-pharmacological interventions can reduce symptoms of depression with varying efficacy (Russoniello et al., 2019). These treatment options with demonstrated efficacy in clinical populations include: psychotherapy, exercise and other somatic treatments (Gadad et al., 2019).

Psychotherapy

Psychotherapy is a common intervention for treating depression symptoms in all categories of mild, moderate and severe depression and is facilitated by a mental-health

professional who should be qualified to screen for and treat symptoms of depression. Psychotherapy may also be provided in combination with other pharmacological treatments or on their own (Voineskos et al., 2020). Many researchers and clinicians advocate for psychotherapy as part of a holistic package of treatment of depression that should include the physical, psychological and social aspects of care (Pandarakalam, 2018). Additionally, since comorbidity is common amongst individuals with TRD, psychotherapy may help in addressing comorbid, contributing diagnoses as well (Voineskos et al., 2020).

There are several varieties of psychotherapy that may provide relief from depression symptoms. The efficacy of psychotherapy in clients with TRD is good, with 50% of clients reporting benefits from psychotherapy, especially cognitive behavioral therapy (CBT) and mindfulness-based cognitive behavioral therapy (Eisendrath, Chartier & McLane, 2011). Typically, psychotherapy involves either individual or group counseling for four to six months or longer (Blumenthal, Smith & Hoffman, 2012). The APA recognizes three types of psychotherapy for the treatment of MDD that have demonstrated efficacy with control group studies by at least two investigative teams (Blumenthal, Smith & Hoffman, 2012). The most effective psychotherapy treatments include CBT, behavior therapy (BT) and interpersonal psychotherapy (IPT) (Blumenthal, Smith & Hoffman, 2012). CBT focuses on identify and changing maladaptive thought patterns as compared to IPT, which emphasizes the social context in which depression occurs and targets improving communication skills (Blumenthal, Smith & Hoffman, 2012). Behavioral therapy focuses on increasing engagement in positive daily activities, decreasing previous negative life experiences, and improving adaptive social skills (Blumenthal, Smith & Hoffman, 2012). Psychotherapy has been found to be one of the most

effective forms of treatment for depression, especially in conjunction with antidepressant medications with more severe depression, such as TRD.

Several efficacy studies support the use of psychotherapy in populations with major depression and TRD. A recent Cochrane review publication examined six studies of psychological interventions for treating TRD (Ijaz et al., 2018). The psychological interventions included in the review were: dialectical behavioral therapy, cognitive behavioral therapy, interpersonal therapy, and intensive short-term dynamic psychotherapy (Ijaz et al., 2018). The review found that in combination with a typical course of antidepressant medications, the psychotherapy interventions contributed to an overall improvement in depressive symptoms, especially when a form of CBT was used in the intervention sessions (Van Bronswijk et al., 2019). Further, CBT appeared to have good long term, lasting effects following the acute phase of therapy at both 12 and 46-month ranges in lowering overall depression scores (Voineskos et al., 2020). In a study examining the effect of psychotherapy alone versus combined therapy of psychotherapy and antidepressants within a population of individuals with mild to moderate depression, the study suppored findings that psychotherapy combined with antidepressant medications provided the greatest symptom relief (Bekhuis et al., 2018). However, further analysis found the symptoms of blue mood and obsessive thoughts to not be directly connected this treatment intervention (Bekhuis et al., 2018). In a randomized controlled study, CBT was found to be as efficacious as anti-depressant medications, with both interventions producing response rates to treatment at just under 60% (DeRubeis et al., 2005). Additionally, (Patel et al., 2017) pointed to the side effects of CBT being things positive, such as improved functioning in interpersonal relationships as compared to the often negatively reported side effects of medication. With regards to the effects of psychotherapy on traits such as return to work status,

CBT was found to produce greater return to work among a group of unemployed participants in comparison to a group using antidepressants (Fournier et al., 2015). CBT may have an advantage as an intervention over medication alone as it has been found to have a greater enduring effect than typical medications (Cuijpers, et al., 2013). Supporting the enduring effect of CBT, Piet and Hougaard (2011), researched a subtype of CBT, mindfulness-based cognitive therapy (MBCT) and found this form of psychotherapy significantly reduced relapse risk in clients with three or more previous depressive episodes and appeared to be at least as effective as a maintenance regiment of antidepressant medication in the prevention of relapse episodes (Huijbers et al., 2016). This study and other similar studies are important as MBCT and CBT may be a viable intervention for clients who prefer psychological based interventions rather than pharmacological interventions (Huijbers et al., 2016). In a meta-analysis of nine studies, Cuijpers, et al., (2013) compared the effects of acute phase CBT without any subsequent treatment with the effects of anti-depressant medication treatment and found that although short-term outcomes of CBT and pharmacology were comparable, dropout rates in the CBT group were significantly lower. Additionally, clients who received acute phase CBT were significantly less likely to relapse than the clients who received anti-depressant medications in the (Cuijpers, et al., 2013). Similarly, in a TRD specific population, Wiles et al. (2014), completed a randomized control trial named the CoBalT trail among clients who had not responded to antidepressants (Wiles et al., 2014). Results of this study found that augmenting antidepressant therapy by adding CBT was effective in reducing depressive symptoms that were maintained for over twelve months (Wiles et al., 2014). Additionally, a follow-up study was completed that found clients who did not respond to one or two trials of antidepressants had a 30-50% chance of responding to psychotherapy (Kasper & Montgomery, 2013). Group based CBT has also found positive results in treating

TRD. Matsunga et al. (2010), researched effectiveness of group-based CBT that addressed psychosocial functioning and depressive symptomology in clients with TRD. Following a course of 12 weeks of intervention, participants demonstrated significantly reduced symptoms of depression and enhanced psychosocial functioning (Matsunga et al., 2010). Further, these results appeared to be sustainable as participants demonstrated lasting improvements at the 12-month follow-up as well (Matsunga et al., 2010).

A significant body of research has also investigated combining psychotherapy with antidepressant medications. A study that looked at adding CBT to a regimen of prescribed medications found that CBT significantly improves response rates for those with TRD with lower remission rates of 40% or less (Cuijpers et al., 2010). While few studies have examined the effectiveness of combining psychotherapy and medications, the literature indicates that utilizing this combination strategy results in superior treatment results as compared to single mode approaches (Jenkins & Goldner, 2012). In a review of literature, six studies have explored this combination approach and found positive results. Schramm at al. (2008), conducted a study with inpatient psychiatric participants with TRD and randomized individuals into either a treatment group (medication and psychotherapy) or a control group (medication and clinical management, i.e. usual care). Following a five-week intervention, participants who were in the treatment group showed statistically significant improvements over the control group. The rates of remission among the treatment group was 67% as compared to 32% in the control group (Schramm et al., 2008).

Virtual Psychotherapy

Progressive interventions that integrate computerized therapy may offer several advantages including: many opportunities for younger generations who may be more familiar

with computerized services, substantially lower cost than traditional therapy and increased access to treatment (McCrone, et al., 2004). Stasiak (2008) completed a pilot study using computerized interventions to decrease depressive symptoms and found the intervention showed a significant effect when compared with a placebo. Additionally, Fleming et al., (2011) utilized the computerized CBT intervention, SPARX (Smart, Positive, Active, Realistic, X-factor thoughts) and found this computerized intervention to be significantly more effective than a waitlist control group. SPARX was designed as an interactive fantasy game for adolescents seeking help for depression that involves the client creation of an avatar to undertake a series of challenges built within the game to restore the balance in the fantasy world dominated by GNATs (Gloomy Negative Automatic Thoughts) (Merry, et al., 2012). If research and interventions using computerized CBT show to be at least as effective as traditional psychotherapy, the potential for growth in this area is significant as it may be associated with lower cost and the potential for reaching individuals who currently do not access help (Merry et al., 2012).

Neurostimulation Strategies

Within the past decade, reversible invasive stimulation methods have been introduced and studied for the management of TRD (Mohr, Rodriguez, Slavickova & Hanka, 2011). Modern stimulatory techniques such as ECT and DBS have shown renewed interest in stimulatory methods of the 20th century as safer interventions have allowed for the development of precise targeting of key structures in the brain, along with a better understanding of the underlying mechanisms of several mood and psychiatric disorders (Mohr et al., 2011). Several different neurostimulation approaches have shown effectiveness in treating TRD (Rizvi et al., 2011) and may provide a novel approach to precisely target specific brain areas, nuclei and circuits implicated in the cause of MDD (Mohr et al., 2011). Clinical practice guidelines are especially

critical in applications of neurostimulation strategies to identify clients best suited to benefit from these techniques (Mohr et al., 2011). The primary types of neurostimulation techniques studied for use with TRD are electroconvulsive therapy (ECT) and repetitive transcranial magnetic stimulation (rTMS) (Rizvi et al., 2011). It should be noted that while research specifically using rTMS for clients with TRD showed promising results, these techniques are still considered experimental and are not widely available (Shelton et al., 2010).

Electroconvulsive Therapy. Electroconvulsive therapy is recognized as a mode of treatment for a variety of mental disorders, including TRD (Al-Harbi, 2012). ECT is considered a gold standard for relieving depression by many practitioners, many who believe that by not beginning ECT sooner, clients may unnecessarily deal with less effective treatments and risk chronic illness (Pandarakalam, 2018). In one large population study, participants with TRD, ECT was an effective treatment for approximately two thirds of cases (Al-Harbi, 2012). ECT has been found to be particularly effective in the treatment of geriatric TRD for many reasons, including: older adults' low tolerance to medication, somatic comorbidity, higher likelihood of medication interactions, higher reported rates of treatment resistance and high risk of suicide (Kellner et al., 2016). Additionally, the Prolonging Remission in Depression in Elderly (PRIDE) study revealed that ECT combined with an antidepressant was effective in preventing relapse in clients age 60 and older who had severe depression (Kellner et al., 2016). However, contradicting the appropriateness for older adults alone, in a study of 402 clients, Socci et al., (2018), found no significant difference in rates of response to ECT treatment across age categories of three groups: young (18-45 years) at 63.5%, middle (46-64 years) at 55.5% and older (≥65 years) at 69.6% response rate. Supporting ECT's widespread effectiveness across age categories, in one recent study of adolescents with TRD, continuation ECT and maintenance

ECT was found to be a safe and useful treatment strategy for adolescents with severe TRD (Ghaziuddin, Dumas, & Hodges, 2011). This study was particularly important as symptom remission was achieved without cognitive impairment (Ghaziuddin, Dumas, & Hodges, 2011). This study supports evidence that ECT is an effective treatment option, independent of age, while older clients may show a faster response (Socci et al., 2018). One of the main reasons ECT may not be more widely used is the potential for side effects which may temporarily cause memory impairment (Pandarakalam, 2018).

Repetitive Transcranial Magnetic Stimulation (rTMS). Repetitive transcranial magnetic stimulation is a newer alternative for individuals with TRD (Dumas et al., 2012). This is a non-invasive, well-tolerated technique using high-frequency (> 5 Hz) of the left dorsolateral prefrontal cortex or low-frequency (< 1 Hz) of the right dorsolateral prefrontal cortex magnetic pules (Lefaucheur, et al., 2011). These pulses produce up to fifty stimuli per second and can modify the activity of specific brain areas (Pandarakalam, 2018). For example, since research has shown the left prefrontal cortex to be less active in clients diagnosed with depression, rTMS may be used to target that particular area as it is accessible by this technology (Pandarakalam, 2018). The differences in usage of the high versus low frequency rTMS comes from electrophysiological data collected from the motor cortex, showing that high-frequencies may produce a stimulatory effect while low-frequencies have been shown to suppress cortical stimulation (Dumas et al., 2012). Several research studies examining the effectiveness of rTMS have investigated changes in overall depressive symptoms (Berlim et al., 201). Meta-analyses of clinical outcomes using rTMS have shown a threshold of nearly 50% decrease in overall symptom severity, in up to 76% of clients (Slotema et al., 2010). Additionally, rTMS presents a treatment advantage as compared to ECT in that rTMS does not produce any cognitive memory

impairment, does not require general anesthesia and is not invasive (O'Reardon et al., 2007). In 2008, the FDA approved rTMS for use with clients experiencing moderate TRD (O'Rearadon et al., 2007).

Vagus Nerve Stimulation. The mechanism involved with VNS is a stimulation of the left cervical vagus nerve, located near the meeting point of the base of the brain and top portion of the cervical vertebrae (Mohr et al., 2011). All VNS systems until recently, have required surgical implantation. In the newest VNS technique, systems that can sit on the exterior of the body have been develop, which show promise, but are not yet approved for use with TRD clients (Howland. 2014). During this technique, the ascending fibers of the left cervical vagus nerve are stimulated using a programmable neurostimulator, or pacemaker-like device that is implanted in the left chest wall (Mohr et al., 2011). The battery-powered stimulator sends electrical impulses through the subcutaneously located bipolar lead. The associated electrode is wrapped around the left vagus nerve in the neck, near the carotid artery (Mohr et al., 2011). This is usually an outpatient procedure, performed by a neurosurgeon. Stimulator settings are programmed to deliver intermittent stimulation of varying frequencies and wattages in a periodically sequenced protocol (Mohr et al., 2011). This technique was originally used for the treatment of epilepsy since the 1990's and was expanded for use with depression in the United States in 2005 (Mohr et al., 2011). Currently, the use of VNS has been FDA approved for clients with chronic or recurrent depression who failed to adequately respond to at least four antidepressant interventions (Mohr et al., 2011). During the course of VNS treatment, usage of antidepressants, mood stabilizers or other psychotropic drugs is also permitted (Mohr, et al., 2011).

The exact method of the antidepressant action of VNS has not been fully understood, however hypotheses are based on the neurobiology of the vagus nerve and overall effect on brain

functions involved in mood control (Nemeroff, et al., 2006). Alleviation of depression symptoms, may be partially attributed to the projection of afferent fibers to the part of the nucleus that relays incoming sensory information to the brain through an automatic feedback loop to certain portions of the brain (Mohr et al., 2011). During VNS, the locus coeruleus, which is the site of many norepinephrine containing neurons, may be stimulated that connects to important regions of the brain responsible for mood regulation including: the amygdala, hypothalamus, orbitofrontal cortex and other limbic regions (Henry, 2002). Several studies in both humans and animals have indicated that VNS evokes changes in neurotransmitters implicated in the diagnosis of depression including: Serotonin, norepinephrine, gamma aminobutyric acid, and glutamate (Manta, et al., 2009).

While the US FDA has approved VNS as adjunctive therapy, benefits of this therapy have only been documented after prolonged use of up to one year (Shelton et al., 2010). In addition, there have only been a small number of clinical trials that have demonstrated steadily increasing improvement with full benefits after six-twelve months of treatment, sustained up to two years (Mohr et al., 2011). Thus far, VNS is perceived as safe and well tolerated, with no documented negative cognitive effects, but continued research is needed in larger, long term trials (Mohr et al., 2011).

Aerobic Exercise

Physical activity has long been recognized as a key component of a holistic intervention for several mental-health diagnoses including depressive disorders (Rosenbaum et al., 2014). The potential noted benefits range from an overall reduction in reported symptoms to an increase in mental-health service utilization (Rosenbaum et al., 2014). In recent years, formal exercise has received considerable attention as an alternative and as an augmentation strategy for treating

depressive disorders (Rethorst & Trivedi, 2013). Several research studies have indicated that exercise may be a reliable augmentation strategy for individuals with mood disorders who are not responding to conventional medication interventions (Kucyi, et al., 2010).

A recently conducted meta-analysis reported a moderate effect of exercise on quality of life outcomes for individuals with mental illness diagnoses, including major depression (Rosenbaum et al., 2014). Further research conducted by Greer et al., (2016) examined the effect of exercise augmentation within a population of individuals with non-remitted, MDD, meaning participants reported some response to their pre-study antidepressant but were still experiencing symptoms of impairment. The purpose of this study was to examine two doses of exercise as augmentation strategies following SSRI treatment (Greer et al., 2016). The results of this study revealed significant improvements in psychosocial functioning and overall quality of life following exercise augmentation compared to baseline level of reported functioning (Greer et al., 2016). These research findings are particularly important as psychosocial impairments are often continually reported after pharmacological treatment and may highlight the significance of using exercise as an augmentation intervention to improve deficits in psychosocial functioning for clients with non-remitted MDD (Greer at al., 2016). Trivedi et al. (2011) also studied the role of aerobic exercise as an augmentation to antidepressant therapy in a population of individuals insufficiently responsive to adequate duration and dosage of SSRI medication. The two-group randomized trial (4 week or 16 week) plan of prescribed exercise showed significant improvement in depressive symptoms in both groups at study endpoint with adjusted remission rates of 28.3% at week 12 for the longer-term exercise group and 15.5% for the four-week, acute group, both groups showing clinically significant results (Trivedi et al., 2011).

Other studies, not necessarily directly related to TRD have also indicated beneficial results as measured by EEG examination. Woo et al. (2010), examined brain activation in a population of college students and found that when compared to baseline measures, resting left frontal brain activation and self-reported levels of "vigor" were all elevated following exercise at low, moderate and high intensity levels. These results are important to this proposed study as findings reinforce an exercise-effect relationship in which exercise induced positive affective responses in study participants overall. It should also be noted that while numerous studies have found efficacy of exercise interventions, results may be inconsistent, often due to heterogeneity of research participants (Gadad et al., 2019).

Summary of depression treatment interventions

Many such studies have shown promise for treatment options beyond medication. In a meta-analysis comparing CBT with pharmacological interventions, the CBT group was found to have lower rates of depression relapse as well as reporting the CBT group just as likely as the medication group to experience relief of depression symptoms (Cuijpers, et al., 2013). When specifically examining the impacts of media on mental-health outcomes, (Ruggiero, 2000) found that managing one's mood and enhancing their emotional state were some of the top reason's individuals cite for using diverse forms of media. Within the literature of current conventional therapies to depression, an unmet need exists in researching therapies for clients who do not adequately respond to typical courses of treatment (Thase, 2017). The majority of clients who do not respond to first-line therapies, also do not respond to newer combinations of other antidepressants and adjunctive therapies with antipsychotics (Thase, 2016). The interventions reviewed in this section have all been found effective in some capacity and within the scope of particular populations. With the continued growth of the videogaming industry, applications of

gaming have expanded into healthcare settings. Various applications of CVGs specifically were examined in the section following a discussion on measuring TRD.

Measuring Depression using EEG

While the human EEG signal was first discovered by psychiatrist Hans Berger in 1926 (Cai et al., 2018), during the 1960s and 70s it was discovered that brainwave patterns could be measured, reconditioned and retrained (Kamiya, 2011). Psychophysiological measures, particularly EEG, provide reliable, high resolution measurements of brain activity relaying human experience information regarding cognition and emotion (Liu et al., 2018). Electroencephalography is one of the primary methods to measure neural activity in the brain and is one of the main dependent variables of this proposed study. Using EEG methods, non-invasive electrodes are placed along the scalp in various locations to measure spontaneous electrical activity in the brain (Cao et al., 2019). Brainwaves occur at various frequencies and can be identified by their corresponding names (Hammond, 2011). These brainwaves range from very fast to slow and are measured in cycles per second or hertz (Hz). EEG measurements have been used for decades in auxiliary diagnosis of several mental-health conditions including: depression, seizure and schizophrenia (Li et al., 2016). The main advantages of using EEG over other brain activity measures are sensitivity, relatively low-cost, and convenience of recording through portability (Li et al., 2016). Recent advances in neuroscience, sensor technology design, and an increase efficient signal processing has helped facilitate the understanding and transition of EEG from clinical-oriented diagnoses and research to the new potential growth of personal healthcare devices and applications (Lin et al., 2017). EEG measurements continue to expand in applicability and has recently been used to record video gameplayer experience data and game flow during gaming sessions (Berta, et al., 2013). EEG use is growing within the gaming

research community as use of sensors and equipment do not interfere with players while performing most tasks, with data stemming from involuntary processes (Liu et al., 2018).

The names for these EEG bands are: Delta, theta, alpha, beta and gamma. Gamma brainwaves are very fast EEG activity above 30 Hz. Gamma brainwaves are still largely under-researched however, some Gamma activity has been associated with intensely focused attention and in assisting the brain to process and decipher information from different areas of the brain (Hammond, 2011). Beta brainwaves are small, rather fast brainwaves (above 13-30 Hz). These beta brainwaves are associated with a state of mental, intellectual activity and concentration. These brainwaves have been described as a "bright-eyed, bushy tailed" state of alertness (Hammond, 2011). The activity at the lower end of this range, known as sensorimotor rhythm, is associated with a state of relaxed attentiveness. Alpha brainwaves (8-12 Hz) are slower and larger. These brainwaves are associated with a state of relaxation. Low range activity in these brainwaves represent a considerable and measured degree of a person's brain shifting into an "idling mode", potentially disengaged and waiting to respond when needed (Hammond, 2011). It should be noted these alpha waves will be the specific type of brainwave studied within this currently proposed research. Theta brainwaves (4-8 Hz) are generally described as the daydream brainwaves and can produce an absent-minded effect, sometimes associated with mental inefficiency. The very slow levels are correlated the twilight state between waking and sleep. Lastly, Delta brainwaves (.5-3.5 Hz) are very slow, high-amplitude brainwaves and are displayed during deep, restorative sleep. When excessive amounts of slow waves are present in the frontal parts of the brain, mostly identified for executive functioning purposes, individuals may find difficulty controlling attention, behavior, and/or emotions (Hammond, 2011). These symptoms may correlate with cognitions and behaviors such including: difficulty concentrating, memory

issues, impulsive behavior or hyperactivity, and in the long term, diminished intellectual efficiency (Hammond, 2011). While different brainwaves are associated with different levels of awareness, it should be noted that every person always has some degree of each of these various brainwave frequencies, present in various parts of the brain (Hammond, 2011).

The focus of brain activity measurement in this proposed study will be alpha wave activity. Alpha activity is commonly measured using a mid-prefrontal placement of sensors (Fp1/Fp2) location. This placement allows researchers to measure the potential right and left prefrontal asymmetry, often associated with depression (Cao et al., 2019). Since the origins of EEG brain activity measurement, brain asymmetry measured from the frontal regions of the brain has proven to be a reliable biological marker to understand the processing of affect (Chia et al., 2016).

Specific to depression, researchers have postulated that since depression is a mental condition, it is reasonable to believe the brain would be the physical location to look for physiological expression of depression (Rosenfeld et al., 1995). Davidson (1984), proposed decades ago that the measurements in the anterior EEG alpha band (8-12 Hz) reflected the relative differences in affective responsivity between the left and right brain hemispheres. Historically, and more specifically, the left frontal regions may be more active during the experience of positive emotions (approach-related) and right frontal regions may be more active during negative emotions (withdrawal-related) (Gotlib, Ranganath & Rosenfeld, 1998). The conceptual basis for Davidson's findings applied to depression were described by Davidson (1992) in relation to neurological literature originally related to the emotional consequences of cortical lesions, originally examined in patients who had experienced strokes. During his research, Davidson found that lesions in the right frontal area led to positive affective states,

while lesions in the left frontal area lead to negative affective states. The findings of these areas with lesions were thought to correlate if there were negative and positive affective reactions in the right and left frontal areas (Rosenfeld et al., 1995). Previous research had already confirmed that lower frequency (alpha activity) is associated with a resting cortex, thus, reduced activity in the right alpha state, indicating resulting negative affect (Rosenfeld et al., 1995). By contrast, increased activation (reduced alpha) on the left side would coincide with resulting increased positive affect (Rosenfeld et al., 1995). Several studies have compared the resting EEGs of clients with MDD to "normal" controls and have concluded the clients with MDD have elevated resting state EEG alpha power (Jaworska et al., 2012). While sometimes confusing, it is necessary to note that power in the EEG alpha band (8-13 Hz) is inversely related to activation of the corresponding region of the brain (Davidson, 1993). This can be interpreted by understanding that as Hz power increases, activation of that hemisphere being measured decreases (Gotlib, Ranganath & Rosenfeld, 1998). This inverse measurement discovery was first reported in Henriques and Davidson's (1991) research that revealed relatively greater left frontal alpha power in participants with MDD, indicating left frontal hypoactivity (less cortical activity), described as a deficit in the positive affect emotion. This supports the notion that participants with asymmetry are more likely to experience negative affective states, such as depression (Henriques & Davidson, 1991). Most notably for this particular study, early frontal EEG findings paralleled the findings on self-ratings for happiness, showing correlation between self-report and objectively measured mental-health outcomes (Davidson, Schaffer & Saron, 1985). This served as the basis for more recent and in-depth investigations into specific mood disorders such as depression.

Psychopathological states have been studied for decades from the perspective of understanding the conditions in various structures of the brain affected by different diagnoses (Thayer & Brosschot, 2005). Previous studies have particularly noted that under conditions of perceived uncertainty or threat, the prefrontal cortex becomes particularly hypoactive (Thayer & Brosschot, 2005). In conditions such as anxiety, depression, post-traumatic stress disorder and schizophrenia, correlations associated with prefrontal hypoactivity and a lack of inhibitory neural processes have been found (Thayer & Brosschot, 2005). This early research has long suggested that greater left frontal EEG activity is related to positive, approach-related emotion, while greater right frontal EEG activity is related to negative, withdrawal-related emotion (Davidson, 1995). This notion has been confirmed by further research, specifically focused on depression that has long reported individuals with depression exhibit greater right frontal EEG activity (Schaffer, et al., 1983).

Currently, the standard method of diagnosis for all forms of depression is a scale-based assessment and interview conducted by a mental-health provider, most likely a psychologist or psychiatrist (Cai et al., 2018). Self-assessments are most commonly used to diagnose and monitor depression as they are a quick and easily accessible method (Solomon et al., 2015). While these methods may be flawed due to the reliance on accurate and honest reporting of symptoms, they serve do serve as a reasonable and quantifiable standard to use for assessment and measurement of depression (Solomon et al., 2015). The PHQ-9 is one of two most commonly uses assessments and was used in this study (Solomon et al., 2015).Other psychometric questionnaires such as the PHQ-9 that will be used in this proposed study, are additionally used as screening tools by mental-health professionals. These current methods of depression detection are time intensive, expensive and rely on the doctor or provider's

experience and knowledge (Cai et al., 2018). As a result, many clients with depression may be diagnosed incorrectly and do not receive optimal treatment (Cai et al., 2018). Objective forms of assessment of TRD may additionally be helpful when combined with subjective questionnaire or interview assessments such as the PHQ-9 to add increased opportunity for accuracy of assessment (Liu, et al., 2018). As opposed to assessments such as the PHQ-9, EEG indicators are neither affected by the participant's answering style, social preferences, interpretations of questions and scale or wording by observer bias (Kivikangas et al., 2011). This EEG measurement provides an advantage to both clinicians and researchers as a source of information during engagement in a task such as gaming that will not interfere with gaming devices such as joysticks, keyboards, mouse, gesture or voice (Liu, et al., 2018). Additionally, the continuous nature of EEG data collection provides an opportunity for real-time data analysis and tracking of a user within a system (Liu et al., 2018).

Casual Video Games

Video games hold immense potential to teach individuals new patterns of thought and behavior (Granic et al., 2014). A standard definition for a CVG has not been agreed upon thus far, mostly because these games are so diverse in nature, subject matter and objectives (Russoniello et al., 2019). Casual Video Games is part of a class of video games labeled, "commercial off the shelf (COTS)" games that are designed for entertainment, with no consideration of the therapeutic value (Carras et al., 2018). These COTS games contrast custom video games that are based on health interventions and game for health applications (Carras et al., 2018). It has been suggested that using these COTS games, rather than a game specifically created to address a health issue, may be more beneficial as clients are already familiar with games used and are thus, more open to learn how to use play interventions to promote well-being

(Carras et al., 2018). The structural characteristics of games may provide unique offerings that traditional therapies are unable to offer (Carras et al., 2018). The Casual Games Association instead offers an operational definition that proposes all CVGs must be fun, quick to access, easy to learn and require no previous video game skills, experience or regular time commitment (Casual Games Association, 2007). Casual video games have also been described as a break from life, promoting escapism and a way to transition between activities or kill time while waiting (Morris, 2011). Self-reports "gamers" have also cited CVGs as a method to de-stress and relax (Morris, 2011). Russoniello (2011) referenced CVGs process that works on individuals subconscious by relaxing the autonomic nervous system, the part of the brain responsible for what is commonly referred to as the "fight or flight response (as cited in Morris, 2011).

Video games have undoubtedly grown to be an accepted part of everyday life for millions of people globally (Grooten & Kowert, 2014). In 2017, over 130 million Americans (40% of the US population) played commercially available video games (Brown, 2017). The increased growth in ownership of multiple digital technologies including devices such as smart phones and tablets has contributed to the exposure of most of the population to CVGs and other gamified applications (Palaus et al., 2017). The growth of multiple device usage has led to 30% of overall tablet users and 70% of smart phone users to be categorized as "casual gamers" to some varying degree (Casual Games Association, 2013). Antiquated stereotypes of "gamer culture" has continued to prevail regarding the type of individual engaging in CVG, although demographic data actually explains the widespread use of this gaming category (LaFleur, Hebert & Dupuy, 2017). Recent demographic data on video gaming shows that the current mean age of video gameplayers (VGPs) is 31 years old and has continued to rise in recent decades (Entertainment Software Association, 2014). The gender divide between men and women is split nearly evenly

with the majority of CVG players engaging socially in these games with family members, spouses and colleagues (Entertainment Software Association, 2016). Additionally, in a 2010 study sponsored by PopCap, the manufacturer of all three CVGs of use in this study, results found the average CVG user to be 43-year-old women, contradicting typical gaming stereotypes (Farooqui, 2010). For many women in this age category, accessibility is the most commonly listed appeal to CVG use (Farooqui, 2010). Women who often find themselves multi-tasking can find an outlet for competition and social connection through CVGs (Farooqui, 2010).

The CVG segment of gaming is currently one of the fastest growing segments of the gaming industry, with an estimated market share increase of 20% annually (Casual Games Association, 2008). The Entertainment Software Association (ESA) reported that 59% of all Americans play video games with nearly equal distribution across genders (52% of males and 48% females) (ESA, 2014). The CVG industry now reports earnings upwards of $55 billion yearly (Casual Games Association, 2008).

As rates of video gameplay continue to grow, a growing number of video game manufacturing companies such as Electronic Arts (EA) are creating games that are tackling mental-health issues (Parker, 2019). Examples of these mental-health focused games include: “Celeste”, a game that explores depression and anxiety through a main character who must avoid physical and emotional obstacles, “Hellblade: Senua’s Sacrifice”, in which a young Celtic warrior deals with psychosis and “Night in the Woods” that focused on self-identity, anger issues and post-traumatic stress disorder (Parker, 2019). The majority of video games created with a mental-health focus have come from independent creators, stereotypically more willing to take risks in exploring unusual content (Parker, 2019). Electronic Arts introduction of “Sea of Solitude” marks a shift in the gaming industry as one of the largest publishers of video games,

better known for “Madden Football” and battlefield war games (Parker, 2019). Within the context of mental-health counseling, video games may be a useful tool in psychotherapy assessment, building rapport and providing social skills training (Blum-Dimaya, et al., 2010). The CVGs used in this study, *Peggle, Bejeweled and Bookworm Adventures*, are manufactured by PopCap Games, owned by parent company EA and is part of the growing industry of utilizing mainstream video games to examine mental-health outcomes.

Gaming History

In general, games have a rich history for use as general entertainment. A “game” is described as an activity with the key features of challenge, motivation and reward (Li, Theng & Foo, 2014). Recreational activities including board games and cards have shown reduced cortisol levels, improved mood and stress reduction when compared with a matched control in a study group of client participants with alcoholism (Russoniello, 2008). While video games have been played in homes and arcades since the late 1970’s, gaming had been identified mostly as harmless entertainment, increasingly common in the 80’s and early 1990’s (LaFleur, Hebert & Dupuy, 2017). In 1992, the advent of the game, *Mortal Combat,* began to shift this identification of gaming as innocuous to a new identity of something potentially harmful to play (LaFleur, Hebert & Dupuy, 2017). Midway Games released the first version of *Mortal Combat,* a game focused on competing in a martial arts tournament, with the final goal of killing one’s opponent in multiple gruesome ways (LaFleur, Hebert & Dupuy, 2017). As games have expanded and the demographics of those who play them has grown, a gradual shift has taken place to normalize and accept new gaming opportunities such as CVGs (LaFleur, Hebert & Dupuy, 2017).

Casual video gaming has undergone a progressive evolution of normalization of digital play from the early 1990’s through recent years (Chiapello, 2013). Some gaming historians look

to *Windows Solitaire* (Microsoft, 1990) as the game that introduced the casual gaming movement to daily life, leading the way for the current boom in CVGs (Chiapello, 2013). Many CVGs are based on other popular traditional games including: chess, Sudoku and pinball (Pine et al., 2020). These games have been modified for delivery through electronic platforms (Fish & Russoniello, 2013). Typically, CVGs are categorized into several groups including: casual action games (focused on motor skills), casual puzzle games (logic focused), idle games (observation focused), and casual strategy games (strategy focused) (Pine et al., 2020). The diversity of games offered in CVGs allows players to increase their level of choice so they can select a game that best matches their mood and level of interest (Pine et al., 2020). The framework of CVGs specifically values elements of: Acceptability, accessibility, simplicity and flexibility in game design (Kultima & Stenros, 2010). In recent years, gaming experiences have expanded to include fluid experiences between devices allowing a person to play games on multiple devices away from the home (Hisatsune, 2010). This expanded model of multi-device accessibility now allows players to seamlessly transition from a PC console to their mobile phone when leaving their home, increasing overall usage (Hisatsune, 2010). Gaming designers also include the necessity of challenge to have a central role in designing a video game (Kultima, 2009). Other necessary descriptors for CVGs include the necessity of games to be provided in short play sessions that can be interrupted and restarted as necessary (Chiapello, 2013). Surveys of CVG players have indicated feelings of reduced stress and improved mood following CVG play (Russoniello, O'Brien & Parks, 2009). While some recent studies have focused on internet-based psychological interventions for depression disorders, few have specifically focused on using digital interventions with a gaming component (Li, Theng & Foo, 2014).

Puzzle Games – Peggle, Bejeweled, Bookworm Adventures

The specific CVGs used in this research are *Peggle, Bejeweled and Bookworm Adventures*. All three of these games are categorized as puzzle games. Puzzle games meet the criteria of CVGs by being described as: highly popular, easy to learn and play, and liked by a wide range of demographics (Chesham et al., 2019). Puzzle games are also non-threatening, enjoyable and easy to access (Chesham et al, 2019). Puzzle games have also been described as cognitively engaging, which is a benchmark of leisure activities and may play a role in overall cognitive decline (Chesham et al., 2018).

All three of these puzzle games were designed by PopCap Games, Inc., a subsidiary of Electronic Arts. PopCap Games, Inc. was founded in 2000, with the intent to provide widely appealing games for all demographics to enjoy (Morris, 2011). The first game PopCap released was *Bejeweled*, one of the games included in this current proposal. *Bejeweled* quickly grew in popularity to become the company's flagship game (Morris, 2011). *Bejeweled* is a puzzle game, most easily comparable to the Nintendo game, *Tetris* (Morris, 2011). The concept of *Bejeweled* is that the player must match three or more of the descending jewels to make them disappear. The appearance of the jewels are colorful, visually appealing and create opportunities in game to earn coins and buy bonus jewels to enhance gameplay. Bejeweled quickly exploded in popularity with over 500 million downloads and an estimated 10 billion hours of play since 2000 (Edwards, 2014).

Peggle is the second game included in this current proposal. *Peggle* has been described as "equally addictive and playable to *Bejeweled"* (Morris, 2011). The premise of *Peggle* involves zapping pegs or dots on the user's screen that form in an increasingly complex layout (Morris, 2011). As the player increases their level of play, the puzzles become more difficult to conquer.

Part of the psychological reward that may be effective in *Peggle* are the cute animals and characters that appeal Anecdotally, players have described the effect of playing *Peggle* as a form of meditation and relaxation for the brain (Morris, 2011). *Peggle* also rewards successful completions of levels with the playing of the popular song "Ode to Joy", contributing to validating player efforts (Morris, 2011).

Bookworm Adventures is the third game included in this current proposal. *Bookworm Adventures* was developed by PopCap Games Inc., in 2006. It is also categorized as a puzzle game and utilizes word formation as its game mechanism (PopCap Games Inc., 2007). During gameplay, the object of the game is to guide "Lex the Bookworm" through a series of stages, battling creatures along the way, largely based in Greek Mythology (PopCap Games Inc., 2007). Enemies are damaged along "Lex's" journey as the character forms words with the letters given by the game. The words are formed from a grid of available letters. The longer the formed word, the more damage that is done to the opponent characters. Similarly, to PopCap's other games, *Bookworm Adventures* also features gems, generated by spelling words. Each gem earned has a different effect, with properties such as healing "Lex" and inflicting damage on enemy characters. Once all the battles are won by "Lex" a treasure item is rewarded. Treasures provide special abilities to "Lex" for future battles.

The formula for all three of the games is very similar using a variety of different visuals and sounds that correspond with the plot of each game. During each of the games design, developers built each game to increase its difficulty concurrently with the player's developing abilities (Russoniello et al., 2019). Each game was also designed to be appealing to a player's time constraints in a typically busy day by requiring completion of a level to be finished within 5-15 minutes on average. As a player completes a level, they are challenged with increased

difficulty in the next level. One example of this progression may be presentation of different obstacles with new abilities as well as new game assets with abilities not seen before as well. The game presentations are enhanced similarly by including appealing visuals, sounds and animations throughout each game and at the end of each level. As a player reaches their goal, positive feedback is provided in the form of earning badges, praise and unlocking additional game modes. The game achieves the developers' goals by facilitating a sense of control and accomplishment for the player, but does not specifically aim to improve health outcomes (Russoniello, 2019). Further, all three CVGs meet the criteria of a CVG as a game that is described as fun, easy to access, simple to learn and does not require previous video game skills (Casual Games Association, 2007).

Video Game Research

Literature in the area of video game research is often divided sharply by researchers, strongly believing in either the negative or positive effects of gaming. In the past decade, interest in video game research has grown significantly as many of the early adopters of gaming forty years ago, have now become active scientists in this area (Thorens et al., 2016). As a result of the increased focus on gaming research, a shift from gaming as a niche leisure activity to an accepted social, commercial, cultural, medical and psychiatric discipline in research has begun (Thorens et al., 2016). Prior to 1990, little substantive research was published related to video games and mental-health outcomes (LaFleur, Hebert & Dupuy, 2017). By nature, video games vary tremendously across categories, which makes them difficult to compare equally across genres. (Palaus et al., 2017). Mass media also often reports both positive and negative health claims related to video games in general, contributing to consumer confusion (Palaus, et al., 2017). Undoubtedly, video games have become more complex, mostly due to improvements in

computer hardware and software capabilities, catering now to larger audiences of both children and adults as a normal entertainment option (Palaus et al., 2017). Current estimates report that collectively, video gameplayers in the United States spend approximately 3 billion hours per week in front of screens playing (Nichols, 2017). This widespread use has prompted scientists to examine how video games affect the brain and behavior.

The use of video games in research has grown significantly in recent decades as such games have shown to increase participants' motivation better than other traditional tasks used in neuropsychology research (Lohse et al., 2013). Further, video games intrinsically include features that offer a high degree of control over in-game variables make them good for use in experimental procedures in both commercially available as well as video games made for specific purposes (Palaus et al., 2017). The use of video games in research has recently grown in popularity. The number of publications that either study or use video games in research has increased at a rate of 20% per year since 2005 (Palaus, et al., 2017). During the 90's, approximately 15 video game-related articles were published yearly, while over 350 video game articles were published in 2015). Several factors affect the behavioral and neural correlates related to the use of video games depending on variables such as the type of video game, the components of gameplay (hours of play, age of beginning of play, etc.) as well as the individual demographics of each player (Kuhn & Gallinet, 2014; Vo et al., 2011).

Although game-based approaches for mental-health disorders are still in the early stages of development and validation, several recent studies have focused on the neural and behavioral effects of video games, providing an increased amount of data on video game correlates with brain activity (Palaus et al., 2017). Thus far researchers have found data driven results for each side, both negative and positive of the gaming debate. With regards to CVGs specifically,

Holmes et al., (2010) investigated use of the game *Tetris* as a cognitive vaccine in a population of healthy individuals, exposed to violent, traumatic material. Findings showed that the group who played *Tetris* had significantly less flashbacks than the group who did not engage in a task (Holmes et al., 2010). Granic et al. (2014) has found effects that are positive in the areas of cognitive, emotional, motivational and social benefits. Conversely, Ivarsson et al., (2013), Turel et al, (2016) and others have found gaming to result in negative outcomes such as normalization to exposure to graphic violence, contributions to obesity, addiction and cardiometabolic deficiencies. The vast majority of these studies are unlike this currently proposed research however, as most subjects of previous studies have not been screened for mental-health diagnoses such as major depression. In order to complete a well-rounded presentation of gaming research, literature in both the negative and positive effects of gaming will be discussed. Additionally, the Game Flow model will be discussed as the contextual framework for using games in therapeutic settings.

Negative Effects of Gaming

As popularity of violent games such as *Mortal Combat* rapidly grew in the 1990's, especially within teenage populations, the community of mental-health professionals began to question video games as entertainment (LaFleur, Hebert & Dupuy, 2017). Since then, the majority of video game studies have focused on the negative effects of gaming and their potential harm, which is not likely to diminish anytime soon (Ferguson, 2013). As games have become more realistic, a robust amount of research has shown that playing particular violent games can lead to several mental-health issues including: decreased empathy, desensitization to violence and impulsivity (Connolly et al., 2012). This focus on the possible detrimental aspects of gaming is largely due to the popularity of video game genres in which graphic violence is

prevalent in game categories such as: first shooter, survival horror and fantasy (Palaus et al., 2017). Due to this spotlight on detrimental effects of gaming, a large amount of literature is directed towards the study of violent behaviors and violence desensitization as a consequence of violence in gaming (Engelhardt et al., 2011). Other negative effects of gaming-based research has centered around detriments of sedentary screen time, excessive gaming internet addiction (Aarseth, et al., 2016). The focus on negative effects of gaming research was emphasized after Congress allocated $10 million to specifically study the effects of violent media, especially video games, following the tragedy of the Sandy Hook Elementary School shootings (Obama & Biden, 2013). Thus far, the emphasis of gaming research has been centered on first-person shooter or action-adventure games. Combined, these two types of games contribute 49% of the overall gaming market (Nichols, 2017). While research has focused on examining if these shooter and action games in fact stir aggression, cause violence and addiction, decades of video gaming research has failed to find a causal link between playing video games and acts of violence in the real world (Nichols, 2017). However, a growing body of evidence has shown that video gaming may affect the brain and cause changes in some specific regions of the brain (Nichols, 2017).

Although gaming has gone through a historically negative biased past, mental-health is becoming a more central narrative in gaming culture as the industry attempts to normalize mental-health challenges through gaming discussion and design (Parker, 2019). While there is no disputing the necessity to study negative effects of gaming, especially in the aftermath of such horrific devastation such as in school shootings, a more balanced perspective on gaming research, one that considers not only negative effects, but also the potential benefits should be considered (Ferguson & Olson, 2013). While the line of research regarding negative impacts of gaming is necessary, gaming researchers must also consider the evolution of gaming and also

grow to investigate potential positive effects and ways that clinicians may approach gaming (LaFleur, Hebert & Dupuy, 2017).

Positive Effects of Gaming

Several studies are beginning to emerge to examine the potential video games may have as a treatment intervention in both rehabilitation and education (Bavelier, et al., 2015). The field of gaming research is still rather new and has thus far often stated that the benefits of gaming are quite distinguishable in cooperative play, promoting prosocial behavior both in gaming and in real life (Gentile et al., 2009). McGonigal (2011) also noted that youth who spend time playing games that require the player to help each other are significantly more likely to help friends, family, neighbors and strangers.

The growth of interest in non-pharmacological interventions for mental-health conditions has promoted an increase growth in specific research targeting mental-health outcomes. Li, Theng & Foo (2014), completed a meta-analytic review to examine the effects of game-based interventions on depression disorders using four types of games: Psycho-education and training, virtual reality exposure therapy, exercising and entertainment games. From a game design perspective, many CVGs provide users with a method to socially connect with family members and friends as part of their online experience (Gomila & Frederick, 2010). Social connectedness and positive interactions with others have long been associated with lower rates of depression (Seabrook et al., 2016). Thus, casual video games may help use the component of social connectedness to elicit positive emotions in individuals with depression. The analysis of nineteen studies showed a moderate effect size of the game interventions for depression therapy post-treatment (d = -.47 [95%CI-0.69 to -0.24]). Other researchers have inferred that research showing individuals with mental-health issues benefit from pleasurable activities (Layous,

Chancellor & Lyubomirsky, 2014), which may include CVGs for some individuals (Pine et al., 2020). In addition, results of previous phases of this proposed study found that in a randomized controlled study, "normal" participants reported playing CVGs could significantly improve their mood and decrease stress (Russoniello, O'Brien & Parks, 2009). The positive changes that resulted from the CVG play were evidenced by physiological measures that supported the self-reported psychological findings (Russoniello, O'Brien & Parks, 2009). EEG monitoring was similarly used to determine mood changes and followed protocol for collecting alpha wave data (Davidson, 1988). Russoniello, O'Brien & Parks (2009) hypothesized that playing CVG's would result in decreases in left frontal alpha which would indicate improved mood. Results of this study confirmed that playing the CVG, Bejeweled II changed brain waves with a shift towards a more positive mood when compared to controls. Further, these results correlated with self-reported improvements in mood on the Profile of Mood States (POMS) subjective assessment (Russoniello, O'Brien & Parks, 2009).

Additionally, recent video game studies have looked at the effects of exposure from gaming on the nervous system and cognition and support the notion that gaming can influence behavioral aspects, therefore supporting future studies that look for changes in neural activity such as this particular study (Green & Seitz, 2015). Augmented reality games are starting to emerge as the next application of use with commercially available gaming. Recently, the augmented reality game, *Pokemon Go,* was studied as a potential intervention to improve physical activity levels of individuals who are normally reluctant to participate in exercise with encouraging results for increasing engagement (Althoff, White, & Horvitz, 2016). In order for clinicians to consider using video games as a therapeutic tool in research as well as in practice, the clinician must be familiar with the game to be used as well as the broader concepts of the

modality of gaming (LeFleur, Hebert, & Dupuy, 2017). These studies which indicated CVG effectiveness in improving mood and reducing symptoms of depression was the basis for continuing this line of research that supports this proposed study.

In addition to gaming studies, non-profit organizations have recently emerged to support healthy gaming and mental-health outcomes. iThrive Games Foundation for example, aims to improve mental-health in teens by providing clinician guides as educational resources to use video games as treatment (iThrive Games, 2020). These guides are created by mental-health professionals who have used games in therapeutic settings and reviewed by a licensed mental-health provider. “Take This” is also a non-profit founded in 2013 to focus on responding to concerns over gamer mental-health. The organization focuses on providing resources and mental-health support for the unique needs of the game development community. While these two organizations differ in their missions, the hope of such groups is to provide support to those involved with gaming as needed, while promoting the potential applications for positive outcomes in game usage.

Summary of Literature Review

Depression is associated with significant disability and substantive economic and societal burden due to its high prevalence (Jenkins & Goldner, 2012). Recent estimates report 50-70% of individuals being treated for depression are not responding adequately to current treatment approaches (Jenkins & Goldner, 2012). Traditional pharmacological and non-pharmacological interventions for treating depression can be effective, but can often be costly, often produce several side effects and cause multiple rounds of trial-and-error treatment. As the burden of depression on interpersonal factors, medical expenses and societal demands in general increase, development of new treatments, especially in non-pharmacologic ways are especially important

(Thase, 2016). Each individual with depression presents a unique set of traits, risk factors, etc. and should receive a detailed evaluation to identify antidepressant responses (Al-Harbi, 2012). Casual video games, including *Peggle, Bejeweled and Bookworm Adventures* may offer a low cost, low risk possibility for alleviation of TRD symptoms. This specific study will examine if adding a regimen of CVG play has an effect on symptoms of TRD. In addition, this study will seek to determine if changes in measured right and left alpha brain waves correlate with changes in self-reported PHQ-9 scores.

CHAPTER III: METHODS

Introduction to Methods

The purpose of this chapter is to discuss the methodological approach used to examine potential effectiveness of CVGs in reducing symptoms of depression between two groups; a comparison group and a study group. This chapter will include the research questions of the study, a description of the data source, an explanation of the research design, as well as population description, sample and sampling method, study procedures and instrumentation. The chapter will conclude with a description of the statistical analysis that were used to examine the included research questions, as well as a discussion on the limitations of this study findings and finally, ethical considerations of the study.

Archival Data Collection Procedures

This section will outline the procedures that were used to examine the archival data of this study, that served as the data source for this present research. This study utilized data collected from a university in the southeastern United States. The original data collection was completed between July 2010 and November 2010. This doctoral candidate, did not collect this data and conducted only secondary analysis of this existing data. The original data was collected by researchers at the same university. Recruitment for the original study began following approval from the University Institutional Review Board. In order to complete statistical analysis of data, demographic and PHQ-9 data from the original forms as well as EEG data measured using physiological software were entered into SPSS version 26.0.0.1 program (IBM Corporation, 2019).

Research Design

This study that was completed using secondary analysis of existing data, was originally collected as part of a larger study. It should be noted that the terms “original data collection” and “present study” are the terms used to distinguish the differences between the originally collected data set and this current study. The members of the original research team that collected this data examined other variables not included in this present analysis of existing data. This data driven approach is common in health-based research (Cheng & Phillips, 2014).The use of these terms of distinction were selected based on the data usage guidelines of the National Institute of Health (NIH) (Cheng & Phillips, 2014).

This study utilized a non-experimental design to examine archival data collected from a university in the Southeastern United States. The original study utilized a randomized controlled experimental design with individuals who utilized CVGs as a prescribed intervention in comparison to a group that did not receive any treatment. The intent of this research design was to examine if individuals who played the prescribed CVGs had a decrease in symptoms of depression on the PHQ-9 as well as on measured changes in alpha brain wave activity. Grouping of study and comparison groups was completed by the original research team and was unchanged during this present study. The original study design lacks random selection of subjects but includes random assignment to groups. A statistical random number generator was used to randomize participants into either the study or comparison groups. Once participants were randomized into either the study or comparison group, the individual was given a choice of three popular CVGs to play. This element of choice was designed into this study as previous research has shown that freedom of choice is an important element to experiencing the full benefits of interventions (Russoniello et al., 2013). It should be noted all participants met the criteria for

positive depression screening along the PHQ-9 scale but were not precisely diagnosed with depression at the time of the primary research.

When primary data was collected, participants who met inclusion criteria were randomly assigned into one of two group options. These two groups will be discussed in further detail within the "Population" section of this chapter. However, in summation, the first group option is called the "comparison treatment group." This group consisted of a group of participants who did not receive a treatment intervention. The second group is called the "study treatment group." This group consisted of a group of participants who were randomly assigned to the group participating in the prescribed CVG gameplay regimen. The original research team continued to recruit for the study until two separate groups of comparable size were formed to create the two groups included in this current study.

Treatment Groups: Comparison Group and Study Group

Comparison group. Participants who were assigned into the comparison group did not receive an intervention and returned one-month later to complete follow-up assessments. During each of the two sessions meeting with a member of the primary research team (pre and post assessments), each participant engaged in a 30-minute NIMH web browsing session consisting of reading the NIMH consumer website on depression. While this group's task during sessions did not involve gameplay, the NIMH website was selected as valuable information on depression and suggested ways to overcome symptoms was presented to the participant. The NIMH website included comprehensive information about depression including: causes, signs and symptoms, risk factors, diagnostic criteria, treatment options and research references. The purpose of selecting this activity to complete during the two sessions meeting with a researcher was to provide a psychological experience comparable to the study treatment group, with the exception

of the gameplay. The physicality of visiting the computer-based website also provided a similar environment with close proximity to a monitor involved in computer use, similar to gameplay. During each session a member of the research team was present. While the data was collected, the comparison group participants were asked to refrain from playing any CVGs for the one-month period of data collection and to continue with their prescribed regimen of two antidepressants.

Study group. Participants who were randomly assigned into the study group participated in a prescribed regimen of CVG gameplay choosing either *Bejeweled, Peggle or Bookworm Adventure* as the *game for their intervention*. Each participant was given a choice of which of the three games they would like to play. This method was selected by the original research team as research has demonstrated that freedom of choice is an essential component of experiencing the full benefits of recreation participation (Csikszentmihalyi, 1975). Following random assignment into the group, participants were asked to play one of three CVG options*; Bejeweled, Peggle or Bookworm Adventures* to attempt alleviation of symptoms of depression. Following the initial meeting with researchers, the study group participants each followed a prescribed protocol that consisted of 30-45 minutes of CVG play at home, 3 times a week, for a total of 16 sessions (4 weeks). Participants were asked to allow for at least 24 hours of time between sessions. Participants in this group were provided instructions by a member of the original research team who was present during each session. During data collection times, study group participants could play more than the minimum amount of prescribed gameplay and were asked to record the duration of each gaming session in a journal. It should be noted that participants in both groups completed baseline assessments that included 6-minute physiological data during which EEG data was measured.

Population

The participants included in this current study consisted of 57 participants from the southeastern United States. All participants met the cutoff minimum of a 5 on the PHQ-9. The criteria for inclusion of the primary study as well as this secondary analysis consisted of: a) being at least 18 years of age, b) being able to read and speak English, and a score of at least a 5 on the PHQ-9. These stated criteria ensured that participants included in the study met the minimal level of symptom criteria for depression as defined by the *Diagnostic and Statistical Manual of Mental Disorders, 5th Edition* standards, (2013). Comparison non-qualifying participants were given a free CVG of their choice.

Eighty-five (85) potential participants were assessed by the original research team and screened for depression using the PHQ-9. Twenty-six (26) participants were excluded from the study for not meeting entrance criteria, representing a rejection rate of 44%. In total, there were thirty (30) females and twenty-nine (29) males included in original study. Two participants were later eliminated from the data analysis portion of the study as follow-up assessments at session 2 were not completed. These fifty-seven participants met the entrance criteria and completed all sessions and assessments.

Sample and Sampling

Recruitment for the original data collection began following approval from the University and Medical Center Institutional Review Board (UMCIRB) at a university in the southeastern United States. The study's methodology and logistical plan was developed between July 2009 and August 2010. The clinical state of the original study was conducted over four-month period (July 2010-November 2010). The data collection portion of the study was conducted during a one-month period. Recruitment was completed by word of mouth and distributing a recruitment

flier to possible referral resources including: local mental-health agencies, family medicine practitioners, and local newspaper outlets. A recruitment flyer was also posted at various university campus locations including: main university campus, nearby community college campus and student recreation centers.

Sampling Procedure

In order to determine a desired minimum sample size for the original study, several factors were considered. In particular power was examined to determine desired sample size. Power indicates the likelihood that the influence of an independent variable on the dependent variable will be accurately determined when this influence is actually do to the independent variable (Trochim, 2006). This can also be explained by describing power as related to the probability of making a Type I error (McLeod, 2019). A Type I occurs when data leads the researcher to reject the null hypothesis when the null hypothesis is actually true (McLeod, 2019). There are several methods for determining power. Power for this study will be established based on the original data collection procedures, on the entire sample size of 57. This will be based on the contrast between the pre vs. post changes between groups. In order to accurately derive the intended sample size for this study, nQuery 5.0 was selected by primary researchers to decide on a sample size. NQuery is a web-based application employed in clinical research industry for use in determining intended sample sizes for research studies (nQuery, 2019). Based on a two group Satterthwaite t-test of equal means with unequal variances (equal Ns), a sample size of 30 per group was determined to be needed in order to result in 95% power to detect size differences (α=0.05, two sided).

However, the desired, predicted sample size of 30 per group to detect changes of 1 standard deviation between groups with at least 95% power at the α level = 0.05, two sided tests

were not met during the original data collection. The entire sample size of 57 was reduced from the originally screened size of 85 due to several reasons including participants not meeting inclusion criteria and drop-out rate. There are several methods to address a smaller than desired sample size in data analysis. The simplest solution to meet the desired 60 participant expectation would be to sample more of the intended population. However, since this is not a practical option in archival data research, this analysis employed a statistical adjustment technique to address this study limitation. The researcher addressed this smaller than desired sample size by examining the literature of previous, similarly designed studies with regards to effect size. Effect size is described as the strength of an association or difference between the independent and dependent variables (Ary, Jacobs & Sorenson, 2010). Cohen (1988) describes effects sizes as: .2 considered small, .5 considered moderate and .8 considered large. These effect sizes suggest sample size cutoffs based on the number of participants needed in order to achieve a minimally accepted power of .80 (Cohen, 1988). Variations to the required sample size that are needed to meet the accepted power of .80 are related to the nature of the study and type of statistical analysis used in the study. Primary research results as well as related studies were reviewed to help determine acceptable effect sizes for this study. In order to address the smaller than desired sample of 57, potential changes to effect size determinations will be discussed following statistical analysis in the results section as well as discussed in final study limitations.

Study Setting

This study used data previously collected at a university in the southeastern United States. During any study that includes a clinical population, such as this one, confidentiality is the utmost priority for both participants and researchers. In order to ensure confidentiality, the primary researcher met with participants in a secured laboratory room. The researcher and

participant were seated side-by-side at a table during data collection. The researcher had a desktop computer sitting on the table to collect all of the physiological data. This physiological equipment was responsible for monitoring and recording EEG data. The positioning of the researcher and participant as well as physiological equipment is critical as this allowed for data to be clean of artifact. Artifact is defined as recorded activity that is not cerebral in origin (Zhang, et al., 2015).

In physical relation to the primary researcher, study participants sat to the left of the researcher. Participants had a computer similar to the researcher in front of them on the table. All participants used the computer to complete any pre-test assessments available electronically on the computer. Participants in the study group played either *Bejeweled, Peggle or Bookworm Adventures* and those in the comparison group read the NIMH's website on depression. The data collection room remained locked during each session. The researcher stayed in the data collection room with the participant for the duration of each session.

Data Collection Procedures

Diagnosis and treatment for depression can be a lengthy process that usually includes several rounds of trial and error efforts to provide symptom alleviation, most commonly utilizing an antidepressant medication. Along with an evaluation psychiatrists and mental-health providers generally consider several factors that helps identify specific symptoms, side effects, reviews medical and family history, cultural factors and environmental factors to help decide on a proper treatment plan. The diagnostic tool used in this study to quantify self-reported changes in depression symptoms was the PHQ-9. The PHQ-9 is a nine-item scale that is widely used to measure depression symptom severity (Lowe, Spitzer, & Grafe, 2004). The tool uses a Likert-type scale to quantify depression symptoms. The PHQ-9 was selected as it has good

psychometric properties including good construct validity when compared with other self-reports on depression, sick days reported and recorded clinical visits (Spitzer, et al., 1994). The PHQ-9 was further selected as this instrument is commonly used by psychiatrists and recommended for use in this study by mental-health professionals.

Data Collection Times

An overview of the data collection process and times is presented in Table 1 on the page that follows. Data collected at Time 1, initial baseline, was gathered before participants began playing *either Bejeweled, Peggle or Bookworm Adventures* for the study group or reading the NIMH website for depression for the comparison group. Data collected during Time 2 (post-session 1), was completed at the end of the first session. Data collected at Time 3 (pre-session 2), took place one-month post the initial baseline and prior to the beginning of session 2. Time 4 (post-session 2), was collected at the end of session 2. The study and comparison groups had the same data collected at matching times and sessions.

Data Collection

During the first session (Time 1 and Time 2), the researcher screened participants for entrance into the study, explained the purpose of the study including inclusion criteria and data collection procedures. During the entirety of this process, the researcher remained in the room to monitor all physiological signals for integrity, to monitor any potential artifact as well as to assist with and provide answers to any questions regarding data collection procedures. Following completion of the informed consent, participants were asked to fill out pre-intervention demographics and PHQ-9 questionnaires. The PHQ-9 and EEG data were collected at four different times as illustrated in Table 1 below. Data collection during session 1 was obtained prior to playing either *Bejeweled, Peggle or Bookworm Adventures* for the study group and prior

to beginning their reading of the NIMH website in the comparison group. Data collected at time 3 was collected 1 month after baseline and compared with time 1 in order to answer the study's main research question. The standard PHQ-9 guidelines were followed at time 1 and time 3. Data collected during time 2 was used to compare changes pre- and post-CVG play or NIMH website sessions to determine the impact of a single session. Approximately 4 weeks (1 month) later, participants of both the study and comparison group returned to meet with a researcher to complete time 3 and time 4 measurements. All participants were asked to complete the PHQ-9 questionnaire again using standard guidelines as well as to have EEG data measured. Upon completing the study, participants received a free copy of a CVG of their choice and a $100 Visa gift card for their participation.

Table 1

Data Collection Procedures

		Session 1			Session 2	
	Data Collection Time	Time 1 (Baseline)	Time 2 (Post 30 min of activity)- Short term effects	Between Sessions (SG = CVG play) (CG= No intervention)	Time 3 (1-month reassessment)	Time 4 (1-month reassessment) (Post 30 min of activity)
Instrument						
Demographic Questionnaire		SG CG				
PHQ-9		SG- Initial assessment CG- Initial assessment	SG- While playing CVG CG- Reading NIMH website		SG- Re-assessment CG-Re-assessment	SG- While playing CVG CG- Reading NIMH website
EEG		SG- 6 min resting CG- 6 min resting	SG- While playing CVG CG- Reading NIMH website		SG- Re-assessment CG-Re-assessment	SG- While playing CVG CG- Reading NIMH website

Note. SG = Study Group, CG = Comparison Group

The PHQ-9 was used to measure self-reported levels of depression. In addition to PHQ-9, participants also completed a demographic profile that included information regarding age, gender, ethnic background, and previous experience in gameplay. Following completion of questionnaires, participants were connected to a Nexus 10, physiological and data acquisition system, utilizing sensors placed on the skull to measure changes in brain activity in the form of an EEG. Utilizing the software program included within the Nexus 10 system, researchers developed a physiological (EEG) computer screen template that visually displayed the collection of 6 minutes of baseline data and 30 minutes of intervention physiological recordings. This data provided a measure indicative of changes in overall alpha brain wave ratio measures, used for data analysis.

During the four weeks between session 1 and session 2, comparison group participants were asked to refrain from any CVG play. The study group, was asked to record each CVG session played on a log sheet. Using the log, participants in the study group recorded the date they played, duration of each CVG session, and initialed all logs. After the four weeks between sessions 1 and 2 (approximately 12 sessions), participants returned to meet with the research team to complete their participation in the study. During this session 2, participants were connected to physiological monitoring equipment again, using the same software from the first session, while 6-minutes of baseline and 30-minutes of intervention data was collected. Following the completion of the intervention, the PHQ-9, previously administered during pre-intervention was completed again by both the study and the comparison groups. In order to protect the individual identities of participants, all forms used in this study were coded and kept in separate folders.

Treatment Protocol

Study group participants were prescribed to play their choice of *either Bejeweled, Peggle or Bookworm Adventures* and were given instructions regarding frequency and duration. During time 1 in the first session participants played the CVG for 30 minutes, while physiological data was collected. During the next four weeks, participants were required to play the CVG for a minimum of 30-45 minutes per session. Participants were further permitted to play additional sessions and were asked to document any extra gameplay on their log sheet. Each participant was also required to play their CVG for a minimum of three times per week over the one-month period. By the end of the four-week period, participants were required to have completed a minimum of 12 sessions of gameplay.

Instrumentation/Variable Operationalization

This section describes the instruments that were used in collecting the archival data that was analyzed in this current study. This dissertation utilized a portion of data from a larger study that contained several additional instruments not under review in this current study. For the purposes of this particular research, there are two instruments that will be examined, the PHQ-9 and EEG data. Additionally, in order to collect demographic information, a demographic profile sheet was administered during the initial session along with the PHQ-9 and EEG, physiological data. The instruments utilized in this study are listed below in the order they were administered to participants.

Demographic Profile Questionnaire

During the first session, prior to Time 1, participants completed a demographic profile that asked each person to provide relevant demographic information. The questions included asked participants to identify: gender, race, educational status, occupational status, how many

hours per week worked if employed, marital status, and amount of time spent playing video games in the last week. This information was gathered in order to describe the study's population as well as in order to discern participant's previous gaming experience.

Patient Health Questionnaire (PHQ-9)

Instrument development. The brief Patient Health Questionnaire (PHQ-9) was utilized in this study as the main, subjective dependent variable. The PHQ-9 is a subtest used to detect depression and part of the larger, Patient Health Questionnaire (PHQ) that measures the five common types of mental disorders: depression, anxiety, somatoform disorders, alcohol and eating (Spitzer et al., 2014). The PHQ-9 was originally created in the mid 1990's as an improvement to the lengthier Primary Care Evaluation of Mental Disorders (PRIME-MD) which included data from 6,000 clients from primary care facilities in its development (Solomon, Valstar & Crowe, 2015). Since its original development, this assessment has been studied in a wide range of adult populations and conditions including spinal cord injury, stroke, cardiology, primary care, general medicine, oncology and traumatic brain injury (Kroenke et al., 2010). The PHQ-9 has subsequently been adopted as a standard measure for depression screening across a variety of health care systems including the Department of Defense and Department of Veterans Affairs (Spitzer et al., 2014). The PHQ-9 is available in several languages and often used among racially and ethnically diverse populations, although few versions aside from English have been psychometrically validated (Rancans et al., 2018; Spitzer et al., 2014). The PHQ-9 has also been administered in several formats including automated telephone-based administration and touch-screen computer (Beard et al., 2016). The brief questionnaire consists of nine items that focus on the diagnostic criteria for major depressive disorder, based on the *DSM-IV* criteria and have remained unchanged in the *DSM-V* update, making the assessment theoretically consistent with

the revised manual (APA, 2013). This self-administered measure will be used in this study to quantify self-report changes in the severity of depression symptoms throughout the study.

Scoring. The PHQ-9 is a nine-item scale that asks clients to check off the number of days they have experienced each of the listed symptom over the previous two weeks. The PHQ-9 uses a self-report, Likert scale to report symptoms of depression and is interpreted as follows: 0-4: none, 5-9: mild depression, 10-14: moderate depression, 15-19: moderately severe depression; 20-27: severe depression. The standard cut-off scores for screening were established in the original PHQ-9 study consisting of a population of 580 participants and a major depression population n= 41 (Spitzer, Kroenke & Williams, 1999). Major depression is diagnosed if 5 or more of the 9 symptoms have been present for at least "more than half of the days" in the past two weeks as well as one of the symptoms being depressed mood (Spitzer, Kroenke & Williams, 1999). The scoring of the PHQ-9 is straightforward and is widely used due to its simplicity, efficiency of time to take in approximately one minute and is free (Spitzer et al., 2014). The PHQ-9 was developed and has been empirically validated as a screening and diagnostic instrument to detect depression.

Psychometric properties.

Validity. The PHQ-9 was selected as the instrument has been validated in approximately 18 studies conducted in various clinical settings (Manea, Gilboy & McMillan, 2012). During its original validation study, a score of "10" or higher had a sensitivity of 88% and a specificity of 88% for detecting MDD and 78% and 96% specificity for any depression diagnosis (Manea, Gilbody & McMillan, 2012). For this reason, a cut-off score of "10" was originally recommended for diagnosing MDD (Kroenke, Spitzer & Williams, 2001). Criterion validity was established by comparing responses from over 500 mental-health professionals (Lowe, et al.,

2004). Construct validity was established for the PHQ-9 by comparing this assessment with other longer self-report tools, used to screen for depression as well as self-reports of sick days and clinical visits (Russoniello, Fish, O'Brien, 2019). The PHQ-9 was chosen over the QIDS and other depression inventories for measuring changes in depression symptoms due to is sound validation as an outcome indicator when measuring changes in symptoms of clients taking antidepressant medications as well as overall generalizability (Martin, et al., 2006).

Reliability. The PHQ-9 is often administered repeatedly to document improvement or worsening of depression symptoms in related to treatment (Williams et al., 2014). Reliability has been assessed through internal consistency as well as test-retest research techniques. In general, self-report instruments should have Cronbach's alpha of at least .70 to be considered reliable (Streiner & Norman, 1995). Internal reliability has been reported as "excellent" with a Cronbach's alpha coefficient range of .89 to .86 in primary care and obstetrical clinical studies (Spitzer et al., 2014). Test-retest reliability has also been reported as excellent with a kappa of .84 over the time span of 48 hours within primary care settings (Spitzer et al., 2014). Reliability within some European populations has also been reviewed with resulting Cronbach's alpha of .82 for the Latvian version of the PHQ-9 scale and .79 for the Russian version, with both versions determined have very good reliability. Maroufizadeh et al. (2019), further examined psychometric properties of the PHQ-9 in a population of clients managing infertility and determined the PHQ-9 to have good internal consistency with Cronbach's alpha reported of .85. The inter-item correlations of items on the assessment were also found to be statistically significant, ranging from .2 to .6 within this study (Maroufizadeh et al., 2019). To further examine reliability, Daray et al. (2019) compared internal consistency of the PHQ-9 with the following other assessments that are also widely used to screen for depression: The Beck

Depression Inventory-II (BDI-II), the depression subscale of the Hospital Anxiety and Depression Scale (HADS) and the total HADS (anxiety and depression subscales together). The PHQ-9 internal consistency resulted in a Cronbach's alpha of .86 while the other assessments had Cronbach's alpha values of .90, .74 and .84 respectively (Maroufizadeh et al., 2019). These results showed excellent comparative values for the PHQ-9.

During the study, the PHQ was administered at pre-assessment and post-assessment for both sessions. Participants were instructed to answer questions based on their previous two weeks and four-week time periods that correlated with the section of the PHQ being completed. For both post intervention sessions, participants were instructed to answer questions based on how they felt at that moment.

Electroencephalography (EEG)

Brain activity changes were recorded using the NEXUS-10, a 10-channel physiological data acquisition and sensor system that can record EEG measures. In general, EEG examination of asymmetry in the brain has been used for several decades to examine the effects of stimuli and conditions on the brain (Olbrich & Arns, 2013). EEG has been widely used to study antidepressant treatment responses in many previous studies as well as in clinical settings due to its broad availability and cost effectiveness (Olbrich & Arns, 2013). Several researchers dating back to the 1970's have reported EEG findings in clients with depression that show a greater proportion of right versus left sided asymmetry (Abrams & Taylor, 1979). Additionally, it has long been hypothesized that frontal EEG data should parallel behavioral data to reveal greater right front activation in depressed clients (Davidson, Schaffer & Saron, 1985). The particular EEG variable of interest for this research is alpha power. Alpha activity has an inhibitory effect on neural activity in the brain, thus indicating, increased alpha power observed in depressed

patients who respond to antidepressant treatments, is expected following the intervention in this research study. Further, studies have reported antidepressant treatment responses in association with hemispheric asymmetry, as a relative measure of the difference in EEG alpha power between the right and left prefrontal regions of cortical activity (Cao et al., 2019).

In order to record participants' EEG data, a software screen was created to collect 6 minutes of baseline and 30 minutes of intervention physiological data. The purpose of these recordings was to provide EEG alpha brain wave scores. In order to collect these data, experienced EEG researchers were required to inspect the collected data to ensure that the raw EEG data did not have interference from artifact. Despite the fact that wearable EEG devices have a built-in function to remove artifacts through real-time EEG signal enhancement, manual review of raw data scores were also examined. Prior to analysis, the EEG data was bandpass-filtered from 1 to 12 Hz using a zero-phrase finite impulse response filter. The specific protocol utilized in this study for recording participants EEG was as follows:

1. The researcher located and marked F3, F4, and CZ placements using a 10/20 standardized measurement cap.
2. The researcher prepped skin by cleaning connection sites using alcohol pads and Nuprep.
3. The researcher placed EEG sensors labeled with #1s on the left and #2s on the right. Active leads (red) were placed at F3 and F4. Reference leads (black) were placed at CZ. The ground lead was placed on the center-backside of the participant neck.
4. Researcher checked impedance to determine if it was at an acceptable level (between -25,000 and 25,000). If not, sensors were adjusted or replaced until impedance was in an acceptable range.

5. Researcher visually inspected the EEG signal to determine if it was free of signal

Log Sheet

The participants in the study group took a log sheet home during the one-month period between sessions. The items included on this log were: title of their CVG, amount of sessions player, and amount of time played per session. The log sheet data was used to ensure that participants meet minimum requirements for the intervention.

Statistical Analysis Plan

This study examined the influence of CVG play on reducing symptoms of depression in subjective and objective measures of depression. Following data collection, primary researchers coded data, immediately scored PHQ-9 assessments, and electronically entered data into SPSS version 22.0. As a preliminary execution, descriptive statistics were run on all demographic variables for each of the two groups. Each participant in the original research study completed a demographic profile that asked for demographic information relevant to this study. The questions included asked for information regarding: gender, race, educational status, occupational status and amount of time spent playing video games in the previous week. This gathered information was helpful in describing the study population as well as in discerning if participants had any previous gaming experience. Demographics were also analyzed to identify any covariance with the dependent variable of changes in symptoms of depression. Pearson correlations were utilized to examine covariance with the continuous variable of depression scores. After this initial description of the data, the main statistical analyses were examined.

Prior to beginning the main statistical analysis for this current analysis, frequency tables and cross tabulations were run on all included variables. This initial step helped provide information to this current researcher regarding any issues with coding patterns for each variable

as well as information to identify the profiles of any missing data for each variable. This procedure was critical to the analysis plan for this research as the current researcher was not present during the primary data collection and is therefore, unable to account for any variances to variables or potentially missing data that occurred during the data collection process.

The main statistical analysis used to address the five research questions in this current secondary analysis proposal were completed using a repeated measures ANCOVA. An ANCOVA analysis is an extension of ANOVA that additionally provides a way of statistically controlling for the effect of covariates in the study (Vogt, 1999). ANCOVA analysis allows the researcher to remove covariates from the group of potential explanations of variance in the dependent variable. With regards to this current analysis, pre-test scores of EEG and PHQ-9 are the covariates. This is done in ANCOVA analysis by using statistical analysis techniques rather than direct experimental methods to control for covariates (Green & Salkind, 2003).

Since ANCOVA was used to address two of the three research questions, an examination of ANCOVA assumptions and whether the data meets the assumptions for this statistical method was required. There are four main assumptions that should be met for the results of an ANCOVA to be considered valid. These assumptions are: 1) independent observations; 2) normal distribution of the dependent variable across all levels of the independent variables; 3) homogeneity of variance; 4) linearity of data. In order to assess the assumption of independent observations it is ideal to use random sampling to ensure observations are independent. Random sampling was not used in this study and may be a limitation to the study. However, at the time of original data collection, no known relationships existed among participants in the study (Russoniello et al., 2013). Additionally, all participant identifiers were removed from collected data to prevent any potential participant identification. In order to assess homogeneity of

variance, Levene's test of equal variances was completed with non-significant findings at α=0.05 indicating homogeneity of variance. Further, tests of between subjects' effects for each level of independent variable was examined to look for statistically significant findings at α=0.05 along dependent variables while controlling for the pre-test covariate. The assumption of linearity of data was determined by examining scatter plots to look for linear relationships between the dependent variable and the covariate for each level of independent variable. In order to assess homogeneity of regression slopes univariate tests of between subjects' effects were used with non-statistically significant findings at α=0.05. These assumptions have been met, so ANCOVA analysis was used to address the research questions.

ANCOVA, α=0.05 was administered to determine if significant changes occurred during any data collection times (Time 1-Time 3). Specifically, baseline (Time 1) and one-month, post intervention (Time 3) will be used to determine responses to research questions. The use of this ANCOVA method allowed for testing hypotheses regarding changes over time within each group, as well as, to test for changes at each specific time point. The ANCOVA analysis was selected as this type of analysis accounts for changes to the response variable of symptoms of depression by both a factor and a continuous variable. An ANCOVA compares the dependent variable of changes in depression scores by both a factor and a continuous variable. Separately, partial eta squared, which is a measure of effect size was included to determine treatment effect and describe any differences in means relative to common variance (Lakens, 2013). Partial η^2 squared was selected to measure effect size as it is recommended in the literature for use with ANCOVA research design (Lakens, 2013). In regards to this study analysis, partial eta squared was calculated as the difference between the means divided by the pooled standard deviation. Lakens, (2013) classifies effect size changes by the following categories: small (0.02), medium

(0.13), and large (0.26). To answer research question three, a Pearson's-product correlation was conducted to determine if a relationship exists between the instruments used to collect the objective EEG alpha wave data and the participant's subjectively reported PHQ-9 data.

Research Questions

There were three research questions stated in this dissertation research:

RQ_1: What is the difference between the comparison group (no intervention) and the study group intervention (prescribed CVG play) on objective, alpha wave EEG measurement between Time 1 and Time 3?

RQ_2: What is the difference between the comparison group intervention (no intervention) and the study group intervention (prescribed CVG play) on subjective PHQ-9 scores, between Time 1 and Time 3~~?~~

RQ_3: Is there a statistically significant correlation between changes in alpha wave EEG measurements and self-report PHQ-9 scores?

Summary of Methods Chapter

This research design and data collection methods frame the purpose of this study which was to examine the effects of prescribed CVG play on participants with symptoms of depression, as evidenced by their EEG measured physiology and self-report PHQ-9 scores. From a physiological viewpoint, changes in EEG data may show if participant's physiology is indicative of reduced symptoms of depression following the one-month intervention period. Separately, changes on the PHQ-9 self-report scale, were examined to determine if these subjective responses demonstrate reduction in symptoms of depression. Lastly, the goal of this analysis plan was to investigate whether prescribed CVG play significantly decreased participants' symptoms of depression from both an objective, physiological perspective and a subjective perspective.

CHAPTER IV: RESULTS

Introduction to the Chapter

The primary purpose of the current study was to examine the effects of playing one of three CVGs on reducing symptoms of depression when used as a prescribed intervention as compared to a group of individuals who do not engage in prescribed CVG play. Comparisons between the two groups were examined on both the self-report, PHQ-9 scale as well as on objectively measured changes of physiological, alpha wave EEG measurement. Provided in this chapter are the results from this study. These results include demographic data and statistical analyses of research questions. The chapter concludes with a summary of results.

Data Handling Procedures

All data collected in the original study was collected by trained researchers. All demographic and PHQ-9 assessment sheets were scored immediately and turned into the study coordinator for a quality assurance review. Once the study coordinator reviewed the collected data and promptly entered the data into the computer. Data were coded and directly entered into SPSS version 20 software. It should be noted this data analysis was completed using SPSS version 26. This study analysis required further review of de-identified data to examine completeness of all study variables. Two additional participants from the original study did not complete Session 2 (Time 3 and Time 4) assessments so were eliminated from this analysis, bringing to total number of participants to 57.

Demographic Data

There were 57 subjects in the research for this dissertation. All participants in this study, were individuals who met the PHQ-9 screening criteria for depression with a minimum score of 5 or greater. Participants in the study group had a mean PHQ-9 score of 11, while participants in

the comparison group had a mean score of 10.7. As a measure of severity of symptoms, the PHQ-9 scores can range from 0 to 27 since each item can be scored from 0 (not at all) to 3 (nearly every day). PHQ-9 scores of 5, 10, and 15 represent separate screening cut-off categories for depression. A score of a 5 denotes mild depression, while a 10 categorizes major depression, a 15 moderately-severe and a 20, severe depression (Kroenke, Spitzer & Williams, 1999).

Table 2

PHQ-9

		Group				Total	
		0		1			
		N	%	N	%	N	%
Change PHQ 9 Level	-4.00	0	0.0%	1	3.6%	1	1.8%
	-3.00	0	0.0%	1	3.6%	1	1.8%
	-2.00	4	13.8%	8	28.6%	12	21.1%
	-1.00	17	58.6%	14	50.0%	31	54.4%
	.00	6	20.7%	4	14.3%	10	17.5%
	1.00	1	3.4%	0	0.0%	1	1.8%
	2.00	1	3.4%	0	0.0%	1	1.8%
Total		29	100.0%	28	100.0%	57	100.0%

Frequency tables as shown in Table 2 were examined to note total numbers of participants in each category of depression along PHQ-9 measures, as well as movement between categories between Time 1 and Time 3. At Time 1, 25 participants met the cutoff criteria for mild depression, 18 for moderate depression, 9 for moderately severe and 5 for severe depression. Following the intervention phase of the study at Time 3, a remarkable 26 participants dropped below the threshold of 5 for minor depression, with 3 participants reporting no depression symptoms any longer. Additionally, 15 participants met the cutoff for mild depression, 13 for moderate depression, 1 for moderately severe and 1 for severe depression.

These participants were divided as, 29 were in the comparison group while 28 were participants of the experimental group. The following data profiled the sample on various demographic characteristics by group membership. Also, statistical analyses were performed to determine if the comparison group differed significantly from the study group prior to the treatment intervention, a regimen of playing one of the CVGs.

The gender breakdown for the sample was 51% male and 49% female. These statistics were similar for the comparison group as well as for the study group, as Table 3 reports. There was no statistically significant difference between the two groups on gender breakdown.

Table 3

Gender

Group	*Male*	*Female*
	N (%)	N (%)
Comparison	15 (52%)	14 (48%)
Study	14 (50%)	14 (50%)
Total	29 (51%)	28 (49%)

Note. Chi Sq=.02, df=1, p=.90

In terms of employment status, most of the subjects (42%) were full-time employees. Thirty percent were students and twelve percent were part-time workers. The remainder were unemployed (7%), categorized as disabled work status (3.5%), retired (3.5%) or homemakers (2%). There were no significant differences in occupational breakdown between the comparison and study groups, as Table 4 indicates.

Table 4

Employment Status Category

Group	*Part time*	*Full time*	*Not employed*	*Disabled*	*Home-maker*	*Student*	*Retired*
Comparison	4 (14%)	10 (35%)	4 (14%)	1 (3%)	1 (3%)	8 (28%)	1 (3%)
Study	3 (11%)	14 (50%)	---	1 (4%)	---	9 (32%)	1 (4%)
Total	7 (12%)	24 (42%)	4 (7%)	2 (3.5%)	1 (2%)	17 (30%)	2 (3.5%)

Note. Chi Sq=5.85, df=6, p=.44

There was also similarity between the two groups on educational backgrounds. Most of the sample had some college (47%) while a large segment was composed of college graduates (21%). Sixteen percent were either post grads or high school diploma holders. See Table 5.

Table 5

Educational Background

Group	*High School*	*Some College*	*College Graduate*	*Post Grad*
Comparison	2(7%)	16 (55%)	7 (24%)	4 (14%)
Study	7 (25%)	11 (39%)	5 (18%)	5 (18%)
Total	9 (16%)	27 (47%)	12 (21%)	9 (16%)

Note. Chi Sq=4.13, df=3, p=.25

The marital status of the subjects reflected a large segment that was never married (55%), while almost a third reported being married. Fourteen percent was divorced or separated. There were no statistically significant differences in the distribution between the comparison and study groups on this variable, as Table 6 displays.

Table 6

Marital Status

Group	*Married*	*Separated*	*Divorced*	*Never Married*
Comparison	10 (36%)	1 (4%)	1 (4%)	16 (57%)
Study	7 (25%)	4(14%)	2 (7%)	15 (54%)
Total	17 (30%)	5 (9%)	3 (5%)	31 (55%)

Note. Chi Sq=2.70, df=3, p=.44

The racial composition of the sample was predominantly White (68%), while 23% were African American. Latinx (4%), Asian (2%) or another ethnicity (4%) were of minority. There were no statistically significant difference in the distribution between the comparison and study groups on racial breakdown, as Table 7 depicts.

Table 7

Race

Group	*White European Am*	*Latinx*	*Black African Am*	*Asian/ Pacific Is*	*Other*
Control	19 (66%)	2 (7%)	6 (21%)	---	2 (7%)
Experimental	20 (71%)	---	7 (25%)	1 (4%)	---
Total	39 (68%)	2 (4%)	13 (23%)	1 (2%)	2 (4%)

Note. Chi Sq=5.09, df=4, p=.28

There were no statistically significant difference in the distributions on age. The comparison group had a mean age of 31 while the study group's average age was 29. An independent samples t-test determined there were no statistically significant differences on this demographic variable. See Table 8.

Table 8

Age

Group	*N*	*M*	*SD*
Comparison	29	31	15
Study	28	29	11
Total	57	30	13

Note. t-test=.59, df=55, p=.56

In terms of gaming experience, the majority of the subjects were identified as being gamers (70%). This was true for the comparison group (76%) as well as for the study group (64%). There were no statistically significant differences between the two groups, as Table 9 illustrates.

Table 9

Gaming

Group	*Gamer*	*Non-Gamer*
Comparison	22 (76%)	7 (24%)
Study	18 (64%)	10(36%)
Total	40 (70%)	17 (30%)

Note. Chi Sq=.91, df=1, p=.34

Data Collection Times

The PHQ-9 and EEG (alpha wave) data collection methods followed the administrative guidelines outlined in Chapter 3. The PHQ-9 is a well-researched, valid and reliable instrument used often for screening the level of severity of symptoms of depression (Kroenke et al., 2001). It is a self-administered nine-item scale that asks participants to rate their symptoms of severity of depression as “0” (not at all) to “3” (nearly every day). EEG (alpha wave) activity is one of five brain waves and is commonly found in the 8-12 hertz range (Schwartz & Andrasik, 2003). It

is one of the brain waves which changes are often witnessed in individuals with depression (Schwarts & Andrasik, 2003). Alpha brain waves are often described as producing an alert, but relaxed state. The demographic questionnaire included in this study was administered along with consent to participate during session 1, pre-collection Time 1. The PHQ-9 assessment as well as EEG (alpha wave) data collection was completed pre and post session 1 and session 2. The data collected at Time 1 (during session 1) at initial baseline, was collected before randomizing participants into either the comparison or study group. Data collected during Time 2, post-session 1, was completed at the end of session 1. Data collected at Time 3, pre-session 2, took place one-one post initial baseline and prior to the beginning of session 2. Time 4, post session 2, was collected at the end of session 2. Both the comparison and study groups had the same data instruments administered at matching times and sessions. A table containing the sequencing of data collection is located in Chapter 3.

Primary Statistical Analysis

The dissertation empirically tested three research questions:

RQ_1: What is the difference between the comparison group (no intervention) and the study group intervention (prescribed CVG play) on objective, alpha wave EEG measurement between Time 1 and Time 3?

RQ_2: What is the difference between the comparison group intervention (no intervention) and the study group intervention (prescribed CVG play) on subjective PHQ-9 scores, between Time 1 and Time 3?

RQ_3: Is there a statistically significant correlation between changes in alpha wave EEG measurements and self-report PHQ-9 scores?

The first research question used a repeated measures Analysis of Covariance procedure to test the difference between the comparison and study groups on the dependent variable of alpha wave EEG measurement (Testing Time 3).

RQ_1: What is the difference between the comparison group (no intervention) and the study group intervention (prescribed CVG play) on objective, alpha wave EEG measurement between Time 1 and Time 3?

The preliminary statistic of Levene's Test of Equality of Error Variances was required to determine whether the error variance of the dependent variable was equal across both the comparison and study groups. This was the case and the assumption was met. *(F=1.37, df=1,55, p=.25).*

The descriptive statistics on the dependent variable (Time 3) and the covariate (Time 1) were executed and are presented in Table 10. The mean amplitude, measured as microvolts (μV) of EEG alpha waves for the comparison group (N=29) was 5.98 μV (*SD*=4.46) at Time 1 and 5.97 μV (*SD=4.13)* at Time 3. The mean amplitude of EEG alpha waves for the study group (N=28) was 4.37 μV (*SD=2.15)* at Time 1 and 5.19 μV (*SD=2.93)* at Time 3.

Table 10

Alpha Wave EEG

		Time 1		***Time 3***	
Group	*N*	*M*	*SD*	*M*	*SD*
Comparison	29	5.98	4.46	5.97	4.13
Study	28	4.37	2.15	5.19	2.93

The results showed that the comparison and study groups were alike at the beginning of the treatment on Alpha Wave EEG (Time 1) and at the end of the treatment at Alpha Wave EEG (Time 3) as well. Please see Table 11.

Table 11

Mean Differences on Alpha Wave EEG between Control and Experimental Groups

Time	*Mean Difference*	*Standard Error*	*p-value*
Time 1	1.61	.93	.09
Time 3	.78	.95	.42

Given the statistics in Table 9 and 10, the findings on the Repeated Measures ANCOVA showed there were no differences on the Time 3 alpha wave EEG when the Time 1 alpha wave EEG was held as a covariate. *F (1,54) =.50, MSE=13.10, p=.48.* Specifically, the comparison group and the study group were not statistically different on the alpha wave EEG measure at Time 3. This means that the intervention for the study group (subjects who engaged in prescribed CVG play) had no statistically significant impact on alpha wave EEG data.

The second research question used a repeated measures Analysis of Covariance procedure to test the difference between the comparison and study groups on the dependent variable of PHQ measurement (Testing Time 3).

RQ_2: What is the difference between the comparison group intervention (no intervention) and the study group intervention (prescribed CVG play) on subjective PHQ-9 scores, between Time 1 and Time 3?

The preliminary statistic of Levene's Test of Equality of Error Variances was required to determine whether the error variance of the dependent variable was equal across both the comparison and study groups. This was the case and the assumption was met. *(F=1.30, df=1,55, p=.26).*

The descriptive statistics on the dependent variable (Time 3) and the covariate (Time 1) were executed and are presented in Table 10. The mean score, on the PHQ-9 for the comparison

group (N=29) was 10.66 (*SD*=4.81) at Time 1 and 7.48 (*SD=5.64)* at Time 3. The mean score for the study group (N=28) was 10.86 (*SD=5.23)* at Time 1 and 4.54 (*SD=3.74)* at Time 3.

Table 12

PHQ

		Time 1		***Time 3***	
Group	*N*	*M*	*SD*	*M*	*SD*
Comparison	29	10.66	4.81	7.48	5.64
Study	28	10.86	5.23	4.54	3.74

ANCOVA statistics were then executed. The results showed that the comparison and study groups were alike at the beginning of the treatment on PHQ (Time 1) but not alike at the end of the treatment at PHQ (Time 3). In fact, there was an almost three-point decline in PHQ scores for the study group at the Time 3. Please see Table 13.

Table 13

Mean Differences on PHQ

Time	*Mean Difference*	*Standard Error*	*p-value*
Time 1	.20	1.33	.88
Time 3	2.95	1.27	.02*

The findings on the Repeated Measures ANCOVA underscored the treatment intervention as a success. The differences between the comparison and study group at Time 3 were significant and there were statistical differences on the Time 3 PHQ when the Time 1 PHQ was held as a covariate. *F (1,54) =8.21, MSE=16.18, p<.01).* This demonstrates a decrease in the self-reported symptoms of depression for participants following one-month of CVG play. The strength of the relationship between the factor and the dependent variable at Time 3 PHQ was

strong, as assessed by the partial η^2 with the factor accounting for 13% of the variance in PHQ, holding constant the Time 1 PHQ covariate.

Specifically, the comparison group and the study group were statistically different on the PHQ measure at Time 3. Results show that the intervention for the study group (subjects who engaged in prescribed CVG play) had a statistically significant impact on PHQ scores. When examining the data in Table 11, the mean score declines from Time 1 to Time 3 for the study group signified a successful intervention.

To examine the third research question, a Pearson Product Moment Correlation Matrix was computed to determine if there was a correlation between changes in alpha wave EEG measurements and self-report PHQ-9 scores.

RQ_3: Are there statistically significant correlations between changes in alpha wave EEG measurements and self-report PHQ-9 scores?

There were no statistically significant correlations for each of the two dependent variables and the two times of measurement. This would indicate that the EEG (alpha wave) data and self-reported PHQ-9 instrument did not both collect statistically significant correlated data on symptoms of depression. There may be several reasons that explain the lack of correlation and will be further discussed in Chapter 5. Each of the correlation coefficients were low to negligible. Please see Table 14.

Table 14

Correlation Coefficient Matrix on Variables

	Alpha Wave EEGTime1	Alpha Wave EEG Time 3
PHQ (Time 1)	-.04	-.01
PHQ (Time 3)	.05	.01

Chapter Summary

This study sought to determine the effect of CVG play on symptoms of depression along two dependent variables, self-report PHQ-9 assessment and objectively collected EEG (alpha wave) variables. Additionally, a third research question sought to investigate potential correlations between the self-report PHQ-9 instrument and the objectively collected, EEG alpha wave data.

Overall, the repeated measures analyses of this study did show changes in the study group from Time 1 to Time 3 in one out of two dependent variables. Data obtained in this study confirmed significant differences in self-reported symptoms of depression along the PHQ-9 data with significant changes reported from Time 1 to Time 3. Using Time 1 (initial baseline) and Time 3 (1 month later) as comparison points, the experimental group saw significant reductions in depression. However, data obtained in this study for EEG (alpha wave) data showed no significant differences in changes based on EEG (alpha-wave) measures from Time 1 to Time 3. With regards to the third research question, there were no statistically significant correlation was found between the PHQ-9 instrument and collected EEG alpha brain waves. Based on this data, there is strong evidence for the potential use of CVG's as an intervention option to lessen symptoms of depression as results showed on average, a greater than three-point decrease in

PHQ-9 scores in the study group, before and after CVG play. Additional discussion regarding the results of this study will take place in Chapter 5 that follows this summary.

CHAPTER V: DISCUSSION

Introduction

This chapter contains a discussion of results from examining changes in symptoms of depression in a study group who engaged in a regimen of CVG play as compared to a control group who did not participate in an intervention. First, this chapter will provide a review of the study. Next, findings are discussed with respect to descriptive statistics, research questions, and instruments used in the sample. Lastly, this chapter contains an overview of the study's limitations, implications for practice, and recommendations for future research.

Study Review

Depression can be a debilitating condition ranging from mild symptoms to severe and treatment-resistant (World Health Organization [WHO], 2020). The WHO (2020), stated there are currently 264 million people living with depression worldwide. Depending on the duration and severity of symptoms, depression may significantly and negatively impact an individual's quality of life (Russoniello et al., 2013). Although there has been some success in treating depression with antidepressant medication and other therapeutic interventions such as cognitive behavioral therapy, these treatments are often costly and may carry associated stigma and other barriers to treatment (Russoniello et al., 2013). The purpose of this study was to examine whether a prescribed regimen of CVG play could reduce symptoms of depression on both the self-report PHQ-9 assessment instrument as well as on objectively measured EEG (alpha wave) measures. The relationship between depression and prefrontal EEG dynamics, the location of alpha wave activity, has also attracted significant interest recently (Cao, 2019). The novelty of this particular study involved the dynamics of examining changes in prefrontal EEG (alpha

waves) as compared to changes in self-reported PHQ-9 measures to investigate the responses of participants who participated in a prescribed regimen of CVG play.

The results of this randomized control study demonstrated that playing CVGs can facilitate decreases in depression symptoms along one of two measures, the PHQ-9 self-report measure. There were no other interventions used in this study, other than CVG play, lending support to the findings that particular CVGs may hold promise for providing symptom alleviation for individuals with varying degrees of depression. Further, there were no reports of any negative or adverse side effects during CVG play, supporting the notion that CVG play is safe.

Interpretation of Results

This section provides a discussion of the results of the statistical analyses reported in the previous section, Chapter 4. First, a descriptive summary of sample size and all demographic variables included in this study will be discussed. Secondly, the findings of research question one are discussed to explore the results of changes in symptoms of depression along the dependent variable of the alpha wave EEG. Thirdly, the findings of research question two are discussed to explore the results of changes in reported symptoms of depression along the subjective, PHQ-9 dependent variable. Lastly, the findings of the correlation comparing the objective and subjective variables are discussed.

Sample Size

This current research study analyzed data previously collected from a larger, original research study that examined several dimensions of changes in symptoms of anxiety and depression among a study group and a comparison group. All participants were screened for depression using the brief Patient Health Questionnaire-9 (PHQ-9) and met the criteria score for

inclusion of a score equal to or greater than 5. According to the PHQ-9 instrumentation, a "5" is the criteria score for a screening of "mild depression." There were 85 people screened for participation in the original study. Of these 85 screened, 26 did not meet the entrance criteria, representing a rejection rate of roughly 31%. A total of 59 participants were included in the original study. Following data transfer to this study's researcher, a visual review of study variable data revealed two incomplete sets of participants post-assessment data. These two original study member's data was additionally rejected, bringing this study's total number of participants to 57.

Sample Demographics

Demographic data was originally collected using a questionnaire. Demographic data was reported to describe the sample (N=57) of participants who screened for a minimum threshold of mild depression symptoms, rated as a "5" on the PHQ-9 scale. The demographic variables collected on the study's questionnaire were used to describe the study sample. These variables were: age, gender, race, highest level of education achieved, occupational status, marital status, experience playing video games. The purpose of this section is to discuss the findings related to these descriptive statistics.

From a demographic perspective for this study, the study group and comparison groups were very similar on the variables of gender, occupation, and race, while varying slightly on the demographics of education and previous game experience. Each of the similarities or differences within each demographic category will be discussed in-depth under each of the subtitled categories outlined in this section. Implications regarding the role each demographic variable may have on study results will also be discussed. In order to understand the implications of this study's demographic variables regarding depression and CVG play, comparisons were made

between study demographics and national-level data on age, gender, race, education as well as within the context of similarly designed research studies.

Age. According to the Anxiety and Depression Association of America (2020), the overall mean age of depression in the United States is 30.5 years of age. Although ages of this current sample ranged from 18 to 56 years old in the study group and 18 to 74 in the comparison group, the mean age of the total sample (N= 57) was 29.75, rounded up to 30 years of age which is very similar to the mean age of depression in the United States. Therefore, the findings of this study with respect to age among this current sample are largely consistent with what is reported in the literature about the target population of individuals with depression. Further, ANCOVA analysis determined there were no statistically significant differences on this demographic variable between groups, at the $p < .05$ level. Levine's Test for Equality of Variances confirmed equal variances assumed (p=.395). This confirmation of equal variances assured that each group, comparison and study group, were homogeneous or approximately equal and thus able to be compared equally on age. This is important in quantitative research as participants in the study group's age ranged from 18 to 56 years old, with a mean age of 29. The comparison group ages ranged from 18 to 74 years with and had a mean age of 31. The average age of a CVG player is now 33 years old (Williams et al., 2013). Consistently, previous studies have similarly found the average age of gamer to be in the 30s range (Williams et al., 2008; Russoniello et al., 2018). While video game play in the 1980s and 1990s was largely engaged by teenagers, video gameplay has now become mainstream in adulthood as well with approximately 40% of adults now reporting regular gameplay.

Gender. The gender breakdown for the sample was 51% male (n=29) and 49% female (n=28). These statistics were similar for the comparison group as well as for the study group, as

Table 1 in Chapter 4 reports. This gender breakdown of equality among binary identified genders is similar to what is found in the literature, that indicates both male and female genders enjoy CVG play (Liu et al., 2018). For decades a widespread, false stereotype existed that individuals who identified as gamers were largely teenage males. (Lopez-Fernandez, 2019). This stereotype has proliferated by the fact that traditionally games have been designed by males and targeted for males (Kuss & Griffiths, 2012). Similarly, most of the professional and highly visible figures in gaming culture are usually males, which helps to promote the continued stereotype that most gamers are male (Paaben et al., 2017). According to recent demographics, over 45% of international gamers from Western countries are now female (Entertainment Software Association [ESA], 2018). Similarly, national averages within the United States estimate 49.1% of players who self-identify as gamers are male while 50.1% are female (Lopez-Fernandez et al., 2019).

Race. The racial composition of the sample was 68% White (n=39), while 23% (n=13) were African Americans, 4% (n=2) Latinx, 2% (n=1) Asian/Pacific Islander or 4% (n=2) another ethnicity were of minority. There were no statistically significant differences between the comparison and study groups on racial breakdown, as Table 5 in Chapter 4 depicts. In terms of the intervention of CVG play, there are mixed results in the literature regarding racial distribution across the United States of individuals who identify as gamers. For example, the Pew Research Center reports that respondents to a survey regarding gaming habits were divided among racial groups as 19% Hispanic, 11% black and 7% white who self-identified as gamers (Pew Research Center, 2017). However, other studies have shown that white video gameplayers are identified as 81% over overall video game market as compared to 7% identified as Latinx and 2% Black/African-American (International Game Developers Association (IGDA, 2019).

The mixed findings in the literature as compared to this study's racial demographic do not support any assumptions that can be made on the relationship between race and CVG interventions for reducing symptoms of depression.

Highest level of education. The majority of the sample had some college education (n=16; 47%) while a large segment was also composed of college graduates (n=7; 21%). There was a smaller percentage of participants with either post graduate degrees (n=4) or high school diploma holders (n=2) totaling the remaining 16% of participants. According to this research study, the largest sample segment of the study were individuals with some college education (n=16; 47%) which does not correspond with the national data in this category (Morris, 2018).

Employment status. In terms of employment status, most of the subjects (n=24; 42%) were full-time employees. Thirty percent (n=17) of participants were students and twelve percent (n=7) were part-time employees. The remainder of the participants were unemployed (n=4; 7%), disabled in terms of work classification (n=2; 3.5%), retired (n=2; 3.5%) or identified as homemakers (n=1; 2%). There were no significant differences in employment status breakdown between the comparison and study groups, as Table 2 indicates in Chapter 4. The demographic of employment status in this research compared similarly to previous research. For example, Russoniello et al., (2018) conducted research related to a specific video game and symptoms of depression in which 24 participants or 40% were full-time employees and 10 participants or 17% were part-time employees. Similarly, to the factor of education level, researchers have found that employment status is also commonly one of several factors lumped into the complex identifier of socioeconomic status (Eaton et al., 2010).

Marital status. The majority of participants indicated that they were never married (n=31; 55%), while 30% (n=17) reported being married. Fourteen percent were either divorced

(n=3) or separated (n=5). There were no statistically significant differences between the comparison and study groups on this variable of marriage status, as Table 4 in Chapter 4 displays. Within the state of North Carolina, 48% of the adult population is classified single people. Therefore, the results of this study based on the sample somewhat aligns with the population of the geographical area as well as statistics on rates of depression and marriage status.

Experience playing video games. Reporting of gaming experience was a demographic variable that may be examined in future studies. This demographic variable was simply collected to describe the sample population within this particular study. In terms of gaming experience, the majority of the participants identified as being gamers (n=40; 70%), with (n=17; 30%) reporting identification as a non-gamer. This was true for the comparison group (76%) as well as for the study group (64%).

Overall, findings from the demographic data of this study are generalized and profiled as participants who were generally white, evenly distributed between binary male and female genders, full-time employee, with at least some college education, never married and profiled on average between late 20s to early 30s in age. This general portrait of this study's participants similarly aligns with the Casual Games Association, (2012) demographics report on the typical profile of a CVG player on the variables of gender but not age. This report lists the gender breakdown of average CVG player to be 51% female and 49% male (Casual Games Association, 2012). The age division of a CVG player however was listed as 62% over the age of 35 and 38% under the age of 35% (Casual Games Association, 2012). Additionally, 56% of respondents of the Casual Games Association (2012) report identified as being a gamer, while 70% of this study's participants identified as a gamer. Upon analyzing these demographic findings, data

indicated that this study's demographic was generalizable on certain factors discussed in this section but not all factors. This makes it very difficult for the researcher to make any sound inferences on these individual variables in this study in relation to other similar studies utilizing socioeconomic status as a variable. However, previous research completed by members of this study's original research team showed similar demographics related to CVG play, rates of depression and demographic factors (Russoniello et al., 2018). This study provides a point of comparison for this particular study analysis.

Discussion of Findings Related to Research Questions

The primary purpose of the research questions that follow was to examine the effects of CVG play on reducing symptoms of depression on both subjective (PHQ-9) and objective (alpha wave EEG) measures. The participants in this study (N=57) were divided as, 29 were in the comparison group while 28 were participants of the experimental group. In order to answer the repeated measures Analysis of Covariance (ANCOVA) procedure was used to test the difference between the comparison and study groups on the dependent variables each of PHQ-9 and alpha wave EEG measurements based on the data obtained from the original research team. The third research question examines correlation statistics between the two instruments, PHQ-9 and EEG measures. The following section discusses data analyses for each of the three research questions including interpretation of statistical procedures and possible explanations of these findings.

Discussion of Findings Related to Research Question One

The first research question was: What is the difference between the comparison group (no intervention) and the study group intervention (prescribed CVG play) on objective, alpha wave EEG measurement between Time 1 and Time 3? Specifically, this research question examines the objective, physiological alpha wave EEG measures obtained before the

intervention phase at baseline (Time 1) and after the intervention (Time 3) of playing one of three CVG's for the study group or engaging in no intervention for the comparison group. The comparisons between Time 1 and Time 3 conducted for this variable was overall changes in amplitude of alpha wave EEG measurements. To complete this process, a Repeated Measures ANCOVA was completed to test the difference between the comparison group and the study group. Results from this analysis were measured by examining overall changes in amplitude of alpha wave EEG signals. In efforts to contextualize alpha wave amplitude it should be noted that overall, an EEG measure is a continuous recording of waves of differing frequencies and amplitudes. These terms are both commonly used to describe EEG findings. The number of wave cycles or peaks that a occur over a set period of time is the wave frequency measured in Hertz (Hz). The amplitude of the EEG pattern is the strength of the pattern in terms of microvolts (μV) of electrical energy (Schwartz & Andrasik, 2003). The findings from this particular research question indicated no significant difference found between the control or experimental groups along Time 3 when Time 1 alpha wave EEG amplitude was held as a covariate (*p=.48).* This means the comparison group and the study group were not found to be statistically different at Time 3. As a result, statistically, it was found that the intervention of prescribed CVG play for the study group had no statistically significant impact on alpha wave EEG amplitude. However, statistically insignificant results may not equate to clinical changes reported. For example, previous research found that participants who played *Peggle* as an intervention to increase mood reported significant changes in their feelings of mood increases on the Profile of Mood States scale, however statistically, alpha power while playing did not show statistically different results between a control group and experimental group due to the very large variations in individual brain waves (Russoniello et al., 2009). These findings are difficult to compare to previously

completed research studies have not specifically identified changes in alpha wave EEG measurements related to symptoms of depression along the independent variable of prescribed CVG play. Previous studies however have examined changes in alpha wave EEG measurements in relation to overall changes in mood, which may relate to feelings of depression (Russoniello et al., 2009). In this comparison study, increases in alpha power were predicted to improve mood and increase approach/engage behaviors. In this repeated measures study, individuals who participated in CVG play produced changes in alpha EEG brain waves consistent with improved mood (Russoniello, et al., 2009). These results support the results of this current study which indicated significant differences in subjective reporting of decreases in symptoms of depression while not confirming statistically significant EEG data. However, other studies have also found insignificant data along changes in alpha wave EEG results (Li et al., 2016). In this particular study, it was found that the complexities of instrumentation pertaining to ensuring well-trained technicians operate expensive equipment may have contributed to insignificant findings along alpha wave EEG in their study. Future recommendations by Li et al., (2016) included re-evaluating the selection of EEG equipment used as well as collecting data from a larger sample size as factors to consider in future studies. In an additional recent study, Choi et al., (2011) examined changes in alpha band EEG measures in relation to the other four types of EEG bands and found that similarly, results were found to be statistically insignificant, while 50% of study participants indicated clinically meaningful changes that were not found in the comparison placebo control group. These results may similarly relate to this study's results in that statistically significant results were not found, however results on self-report measures were in fact, found to be statistically significant as well.

There are several reasons why insignificant statistical findings of alpha wave EEG amplitude may be dissimilar from clinical self-reports of depression symptoms as was the case in this study. The measurement of EEG waves is a very precise, controlled procedure requiring specific steps and protocols to be followed to ensure accurate collection of data. This is an inherent limitation of conducting secondary analysis of data (Cheng & Phillips, 2014). Further, an examination of raw data prior to analysis would further ensure that proper data cleaning techniques have followed and that confounding issues including what is termed EEG "noise" was properly accounted for through use of filters and proper data collection techniques. Additionally, results for this research question may also be not statistically significant due to the singular variable of individual EEG alpha wave extrapolation. In previous research studies, brain waves are collected and measured in terms of right/left sided ratios or as part of an overall brain map comparing changes along all types of brain waves. For example, Li et al. (2016) measured changes in alpha waves within a population of individuals with depression, however this research was conducted in comparison to Theta waves, which is a different brain wave, often used as a comparison ratio in research related to depression. These results also found insignificant findings along the alpha wave EEG band suggesting perhaps other brain wave bands would be more sufficient in finding significant changes in depression symptoms (Li et al., 2016). An examination of data collection procedures was similarly advised in this study.

In another study that looked at changes in brain waves within a population of individuals with depression, a similarly designed study used an ANCOVA statistical analysis to also account for time as in this current research. However, this Choi et al. (2011) study utilized a more sophisticated type of EEG brain wave collection that allowed for all five brain waves of delta, theta, alpha, low beta and mid beta to be collected. In collecting EEG data in this way, rather

than along a single wave such as alpha alone, comparisons between relative overall brain function were able to be inferred across the totality of brain wave function among a population of individuals with depression. However, even with such sophisticated data collection procedures, changes along alpha waves were statistically insignificant in this study (Choi et al., 2011). This research was similarly first of its kind as researchers stated this was the first attempt to examine the efficacy of asymmetry training in depression by adopting an experimental design. This is aligned with this current research in which previous studies have not involved the same intervention and data collection procedures combined. Lastly, alpha brain waves, similarly to all brain waves are relative compared to the overall picture of a person's brain functionality. In future studies, it is recommended that an overall idea brain functionality should be included to make further inferences regarding functionality. Clinical implication of the findings for this research question one will also be discussed in a section that follows.

Discussion of Findings Related to Research Question Two

The second research question was: What is the difference between the comparison group intervention (no intervention) and the study group intervention (prescribed CVG play) on subjective PHQ-9 scores, between Time 1 and Time 3? Specifically, this research question examined the subjectively reported PHQ-9 data obtained before the intervention phase at baseline (Time 1) and after the intervention (Time 3) of playing one of three CVG's for the study group or engaging in no intervention for the comparison group. Following ANCOVA analysis, the results showed that the comparison and study groups were alike at the beginning of the intervention phase (Time 1) but not alike at the end of the intervention (Time 3). In fact, there was an almost three-point decline in PHQ scores for the study group at Time 3. This three-point decline resulted in 24 participants (42%) even reporting dropping below the minimum threshold

of a “5” for mild depression. As the findings in Table 2 shown, individuals reported downward shifts in several occasions to a lesser category of PHQ-9 depression category. The findings on the Repeated Measures ANCOVA underscored this treatment intervention as a success. The differences between the comparison group and study group at Time 3 were significant with statistical differences on Time 3 measurement of the PHQ-9 when Time 1 was held as the covariate (p<.01). These results demonstrate a decrease in the self-reported symptoms of depression for participants following one-month of CVG play. The strength of the relationship between the factor of CVG play and the dependent variable (PHQ-9) at Time 3 was strong as assessed by the partial n^2 with the factor accounting for 13% of the variance in the PHQ-9 scores, holding constant the PHQ-9 Time 1 covariate. Specifically, the comparison group and the study group were statistically different on the PHQ-9 at Time 3. This is understood as the intervention of CVG play had a statistically significant impact on PHQ-9 scores. When examining individual changes in reported PHQ-9 scores, categorical changes were also noted for the purposes of interpretation of changes. In looking at categorical changes in symptom severity along the PHQ-9 measure, a total of 17 participants in the study group shifted to a categorical score of 0-4 at Time 3, which detects a score of no depression. It should also be noted that among participants in the comparison group, a total of 9 participants shifted to a categorical score of 0-4 at Time 3, which indicates no longer reporting of symptoms great enough to be in a category of depression (Russoniello et al., 2013). While not all participants in the study group moved downward to a category of no reported symptoms of depression, 6 participants experienced a large enough shift in symptoms that they categorically met the criteria for a lesser category of depression. For example, a participant with a score at Time 1 of an 11 indicating moderate depression, had a follow-up score of a 6 at Time 3. This indicates the participant

shifted from a category of moderate depression to mild depression. It should also be noted that 4 participants in the comparison group reported an increase in symptoms of depression at Time 3 as compared to Time 1. No participants in the study group reported increases in symptoms of depression from Time 1 to Time 3. Table 13 included below shows the categorical cutoffs for the PHQ-9.

Table 15

PHQ-9 Categorical Distinction

Total Score	**Depression Severity**
1-4	Minimal depression
5-9	Mild depression
10-14	Moderate depression
15-19	Moderately severe depression
20-27	Severe depression

Note. PHQ-9 Copyright© Pfizer Inc.

Results from analysis of this research question should also account for the fact that some participants that identified in each category of PHQ-9 scores ranging from mild to severe depression experienced categorical shifts to less severe categories of reported depression symptoms.

These study results are similar to previous studies that have examined changes on self-report measures for interventions to help alleviate symptoms of depression. In a study that examined the specific video game called Plants versus Zombies™, Russoniello et al. (2019) examined self-report changes on the same measure used in this study, the PHQ-9. Results from that study support the self-report findings of this study as changes between groups on the PHQ-9 were indeed significant ($p<.001$, $\eta^2=.254$). These supportive results are especially remarkable as there were no reports of negative side effects or adverse reactions to prescribed CVG play

indicating this as a potentially safe method of supporting reduction in symptoms of depression in either study. Findings related to significant changes along self-report measures, utilizing CVG play, may be explained through the application of the GameFlow model proposed in this study as a theoretical basis for positive outcomes involving gameplay. In a study examining engagement, a questionnaire related GameFlow to positive feelings of engagement in the gameplayed (Kiili & Lainema, 2008). These reported feelings include experiences of intensive, interesting, motivating as well as engaging and immersive experiences. These described feelings are relevant to this research measuring alpha wave EEG measures as the descriptors of alpha waves are similar. Alpha waves have been described historically as relating to alertness and task engagement (Schwartz & Andrasik, 2008).

While these findings show promise for the use of CVGs in reducing symptoms of depression, they should be interpreted with caution as there are several potential unknown factors that may confound these changes. Further research would need to investigate questions regarding things like changes in environmental, social, financial factors that may also be responsible for some of the variance in significance. Additionally, participants were not questioned regarding medication or health changes that may also significantly impact these results. Lastly, individual differences in CVG specific game was not included in this analysis. However, it should be noted that 60% of participants in the study group selected *Bejeweled* over either *Peggle or Bookworm Adventures.* The further research section of this chapter will examine indications to investigate differences in nuances between games that may also contribute to changes in PHQ-9 self-reported scores.

Discussion of Findings Related to Research Question Three

The third research question was: Is there a correlation between changes in alpha wave EEG measurements and self-report PHQ-9 scores? The final research question used a Pearson's Correlation Matrix to determine if there was a correlation between changes in alpha wave EEG amplitude and self-report PHQ-9 scores. The findings are reported in Table 16 below. Findings on this research question found no correlation for each of the two dependent variables, the PHQ-9 and alpha wave EEG measurements and the two times of measurement at Time 1 and Time 3. However, the PHQ-9 did show statistically significant correlations between Time 1 and Time 3. Alpha amplitude scores were not statistically significant within at Time 1 and Time 3.

Table 16

PHQ-9 and Alpha Amplitude Pearson's Correlation

		PHQ Time 1	PHQ Time 3	Alpha Time 1	Alpha Time 3
PHQ Time 1	Pearson Correlation	1	.525**	-.041	-.014
	Sig. (2-tailed)		.000	.763	.919
	N	57	57	57	57
PHQ Time 3	Pearson Correlation	.525**	1	.049	.009
	Sig. (2-tailed)	.000		.718	.947
	N	57	57	57	57
Alpha Time 1	Pearson Correlation	-.041	.049	1	.075
	Sig. (2-tailed)	.763	.718		.581
	N	57	57	57	57
Alpha Time 2	Pearson Correlation	-.014	.009	.075	1
	Sig. (2-tailed)	.919	.947	.581	
	N	57	57	57	57

Note. **. Correlation is significant at the 0.01 level (2-tailed).

There may be several reasons that can explain the lack of correlation between instruments.

Previous research has analyzed changes in PHQ-9 scores using similar CVG-based protocols aimed to reduce symptoms of depression and found significant results (Russoniello et al., 2013; Russoniello et al., 2019). This previous research similarly found significant differences in results between Time 1 and Time 3 along the PHQ-9 scores (Russoniello et al., 2013). While recent EEG based affective computing studies, similarly to this study design have recently grown in popularity, there is still little published research in this field comparing self-report and objectively measured data. Recent examinations of this concept by previous researchers have addressed the challenges is comparing self-report and objectively measured data (Hu et al., 2019). The core of affective computing involves using computational devices such as EEG to measure affective states such as depression and physiological responses to stimuli. Along this theory of the benefits of measuring physiological responses such as using EEG, it is the thought of researchers that this physiological data could overcome issues in self-report bias, stigma, coherence, etc. This theory posits the physiological data provides direct measurement of human conscious and subconscious activities that may otherwise be concealed in self-report data (Hu et al., 2019). While the enticement of measuring physiological data to infer affective states has grown tremendously in popularity as evidenced by the increase in recently published articles, there is some reluctance to fully adopt EEG-based affective computing in practical settings as EEG signals may not be sensitive enough to pick up behavioral changes in affective state as the relationship between brain waves and human emotion could be very complicated and should not be oversimplified by researchers (Hu et al., 2019). The non-significant in correlation between the self-report PHQ-9 data and the EEG data may similarly be connected to the difficulty in accurately relating one singular psychological element such as depression to one physiological signal, such as alpha wave amplitude. Hu et al., 2019 calls this a one-to-one relationship and

advises research along these lines may find insignificant results between instruments, such as with this study due to the complexities in sensitivity between EEG data and self-report PHQ-9 assessments. These researchers further support the results of this study by stating the one-to-one relationship may provide an ideal theoretical basis for measuring affective outcomes, but are difficult to validate and rarely reported in existing literature (Hu et al., 2019).

Summary of Research Question Results

Objective and subjective measures of symptoms of depression were measured in this research study. Objective data consisted of analyzing previously collected alpha wave amplitude EEG measures. Subjective data consisted of analyzing previously collected PHQ-9 self-report scores. Differences at Time 1 before any intervention and at Time 3, following intervention were examined to indicate any changes in both the subjective and objective instrumentation. This data was used to examine the primary purpose of this research study which was to examine the effects of CVG play on reducing symptoms of depression along both alpha wave EEG amplitude and self-report PHQ-9 scores.

Research question one was examined along changes in Repeated Measures ANCOVA analysis for alpha wave EEG amplitude changes. This analysis was selected as it accounted for the covariate of Time in this research. Results indicated no significant differences between Time 1 and Time 3 along measured changes in alpha wave EEG data. There were several reasons listed regarding potential explanations for the lack of change detected. Research question 2 was examined similarly along changes in Repeated Measures ANCOVA analysis for PHQ-9 self-report scores. Results indicated significant differences between Time 1 and Time 3 along self-report changes in PHQ-9 scores. This analysis showed that scores between the study group and the comparison group did not differ at Time 1, however differed by an almost three-point decline

at Time 3, making these changes statistically significant. Using Time 1 (baseline) and Time 3 (one month later) as comparison points, the experimental group saw significant reductions in reported PHQ-9 scores, indicating reduction in depression symptoms. The third research question examined correlations between the alpha wave EEG amplitude measures and PHQ-9 scores. Upon completion of research analysis, it was concluded that no significant correlation was found between the PHQ-9 instrument and the collected EEG alpha brain wave amplitude measures. Based on this data, however, there is strong indications for the potential use of CVGs as an intervention option to help reduce symptoms of depression. This conclusion can be made as results showed on average, a greater than three-point decrease in PHQ-9 scores in the study group before and after CVG play. While significant evidence was not found in measured EEG alpha wave data, previous video game research has reported participants associating feelings of engagement, calmness and focus while engaging in video gameplay (Carras et al., 2018). These emotions have been described previous as the emotions measured in alpha waves and may indicate that a relationship does occur between gaming and alpha wave EEG measures, even if not found to be statistically significant. Further theoretical limitations to measuring statistically significant changes along one EEG variable, such as alpha wave amplitude has been discussed. For example, a recent review of literature by Palmiero & Palmer (2017), indicated that the psychological implications for changes in measured EEG signals has reported mixed reviews when such one-to-one measures have been conducted such as with this study. This review of literature indicated that validity of such one-to-one studies should be reviewed with caution (Palmiero & Palmer, 2017). Recently, a study similar to this one have also attempted to compare affective states measured by EEG along with self-report psychological data and similarly found, non-statistically significant results. In this study, participants were asked to watch a video on

gratitude while being connected to EEG measurement equipment (Hu et al., 2017). Given the nature of the emotion of gratitude, it was later determined that participants may also experience feelings of intense hope and love while watching the video which is very difficult to separate and detect the differences between these emotions on an EEG measurement reading (Hu et al., 2017). Similar complications in instrumentation may be a reason correlations between EEG data and PHQ-9 were insignificant as emotional outcomes may be too complicated and interwoven to be precisely measured and compared on these instruments.

Limitations of the Study

As with all research, the current study includes several limitations. These limitations mostly pertain to elements of the research design, sampling, instrumentation, and statistical analyses. Each of these limitations are discussed prior to discussing the clinical implications of study findings and future research recommendations**.** Limitations are an inherent component of any research study. No single study is completely flawless or inclusive of all possible aspects of research for any singular topic, resulting in expected limitations to research.

Particular to this study, the data used is an *ex post facto* investigation using analysis of existing data from a larger archival study. The use of secondary data, particularly in health research is growing, however, use of such data comes with several limitations. These limitations include items related to research design, instrumentation and statistical procedures of this study. These primary limitations are discussed in this section.

Limitations of Study Design

Archival data. The use of archival data poses a limitation to this study's research design. Specifically, the data analyzed in this study was not collected only to address the specific research questions in this study but were part of a larger study that examined several other

variables including anxiety. This technique while common in research, limits the variables of study and does not potentially account for other confounding study variables that affect these study variables (Cheng & Phillips, 2014). A further limitation is that the members of the original research team were not the same individual(s) involved with this study analysis. This is a limitation as the researcher analyzing this data is unaware of the procedures and techniques used to acquire and clean data prior to analysis (Cheng & Phillips). For example, procedures necessary to collect psychophysiological data such as prepping skin, sensor placement, staff training and issues with data collection are unknown to this study's researcher. Additional limitations regarding EEG specific protocols will be discussed in the implications section of this chapter. This human-made error limitation applies to this study. Under this limitation, the researcher conducting this analysis may be unaware of study-specific nuances in the data collection process. These potential glitches may be vital to the interpretation of specific variables in the dataset. In order to mitigate this problem, succinct documentation and communication of important information about the validity of the data by the data collection researchers and careful examination of all relevant documentation was completed by the analysis researcher.

Due to the nature of using archival data, this type of study prohibits the accuracy in suggesting any cause-effect relationships between variables. Due to the nature of secondary analysis, there are many nuances of using archival data that lead to cautious interpretation of results (Cheng & Phillips, 2014). Although data analyzed in this study showed significant evidence for the use of CVG play in reducing symptoms of depression, cause-effect relationships cannot be drawn from this data as there are potential confounding variables and unknown factors that may affect this study's data. This prohibits this study's researcher from claiming that any decreases in depression symptoms resulted directly from CVG play. This is an issue inherent to

the use of secondary analysis of existing data as this available data was not originally collected to address the particular research questions of this study or to test any particular hypothesis (Cheng & Phillips, 2014).

Sample limitations. This study utilized volunteers elicited through several methods of community-based recruitment to participate. This may be a limitation as a convenience sample of volunteers does not accurately represent the population of individuals outside of the study. This creates a threat to external validity. Further, inducement may be a limitation of this study as participants were offered a $100 Visa gift card for completing the study as well as a free CVG of their choosing. The enticement of these incentives to participate may contribute to skewed data in favor of study compliance.

Self-selected intervention. An additional limitation of the study's experimental research design poses threats to internal validity. This is due to the procedure of each participant in the study group, self-selecting the CVG they desired from the choices of either *Peggle, Bejeweled or Bookworm Adventure* to play. There was a disproportionately large selection of the game *Bejeweled* as compared to either *Peggle or Bookworm Adventure.* The CVG each participant chose leads to an element of selection bias which may have influenced the dependent study variables. Additionally, the design elements of CVGs are largely unresearched but may be influential in the participant outcomes, motivation to play and may create a potential for placebo effect if the participant had a particular affinity towards the selected CVG.

Limitations of Instrumentation

There are also limitations in regards to the instrumentation and data set selected for this current study. First, it is unknown if any or all participants were actively taking any antidepressant medication or other interfering medications as this data was not collected in the

original research study. If any medications were taken, factors such as dosing, medication type and brand were not recorded and as a result cannot be reported or analyzed while potentially affecting study variable outcomes. Previous studies of similar constructs appropriately excluded participants with pre-existing comorbid conditions such as: bipolar disorder, depression which includes delusions and hallucinations, paranoid ideation or schizophrenia or delusional disorder (Solomon et al., 2015). These and other co-occurring conditions and disorders may significantly impact accurately accounting for depression symptoms alone. Questions on the demographic questionnaire did not address potential comorbid disorders that may significantly impact reported symptoms of depression as well as covariates of statistical analysis.

The next limitation involves one of the two main study dependent variables, the PHQ-9. These PHQ-9 scores rely on self-report methods of measurement. Self-report methods of assessment may be inaccurate and highly influenced by conscious or subconscious adherence to reporting socially desirable responses (Cheng & Phillips, 2014). While in this study, PHQ-9 results showed positive change based on the study group's CVG play, participants may have either under-reported or over-reported symptoms of depression. While little may be done to ensure accurate self-reporting, the consistency of administration methods through use of manual guidelines as well as policies and procedures for instrument administration ensured best possible scenarios for accurate delivery of the self-report assessment.

One of the assumptions in using a technological based intervention such as CVG play, is that participants in the study are proficient in computer usage skills. In this particular study, one of the limitations involved technological barriers as some participants experienced difficulty connecting to the CVG they selected, connecting to WIFI and general difficulty with computer usage. Further, this was a technology-based intervention. While the ages of participants ranged

from 18 to 74, most participants were in their early 20's and may have more game and technology knowledge than older adults. This presents a limitation as participants may become frustrated in trying to use technology to complete the study, which may exacerbate their symptoms of depression and may also result in inaccurate reporting of study outcomes based on their negative experience with technology.

The next limitation of instrumentation involved the additional use of the objective EEG measurement. There were limitations in the procedure to use EEG both to look for correlations between self-report and objectively collected indications of symptoms of depression and to look at study group changes. While this technique of dual-reporting of assessment (PHQ-9 and EEG) meets the recommended guidelines for ethical obligations of counselors under the American Counseling Association (ACA) Code of Ethics (ACA, 2014), there were issues in this study with accurately collecting the correct depression related alpha amplitude of EEG instrumentation. The use of physiological data in analysis is accompanied by inherent limitations for accuracy in data collection. The precise use of EEG electrodes, placement of electrodes, and procedures to ensure the most accurate data was collected was not supervised by the current researcher. This creates a limitation of a potential unforeseen error in data collection procedures as small changes in procedure and sensor placement may make a significant impact on data collected. Brain wave changes in the alpha band (8-12 Hz), specific to depression have been clinically and empirically researched when alpha waves are examined as a ratio between right and left-brain hemispheres, also known as alpha asymmetry. These brain waves and asymmetry principles have been extensively researched in previous studies. While the researchers of the original study collected EEG alpha wave data that was analyzed in this particular study, no distinction between right and left alpha was able to be made due to a lack of sophistication in equipment instrumentation. This

is a study limitation as overall changes in EEG (alpha waves) was not determined to be significant in this study. However, without distinguishing between right and left alpha ratios, it is impossible to determine if in fact changes did occur which may have been significant enough to impact overall amplitude changes. Rather than an overall total amplitude measure of both right and left-sided alpha combined, right and left side measurements should be taken separately and distinguished in the data as separate figures so that proper right/left alpha ratio could be examined, which is the measure indicated in similar studies.

Additional limitations to the data set and instrumentation include the use of volunteers as participants, inducement to participate and flaws with accurately reporting time spent playing CVGs at home. The participants included in this archival data set were recruited by several methods and included in the study following read of an approved IRB script to the participant. Upon completion of study, all participants received a $100.00 Visa gift card and a free CVG for their time involved in the study. These perceived rewards for participation may have influenced self-selection into the study.

Limitations of Study Analysis

A final set of limitations that threaten the validity of these study results involve the selected statistical approach of analysis. An initial limitation of analyzing data occurs if any archival data includes any coding or typing errors. Data was reviewed before conducting the study analysis to ensure any incorrect data was not entered. In this study, two participants were missing study variables upon data examination and were eliminated from study analysis. In order to mitigate this limitation, data was evaluated along ANCOVA statistical assumptions, to ensure normality of data and homogeneity. There were several limitations involved with this study's data analyses. Firstly, participants in the study group were offered a choice of three CVG

options: *Bejeweled, Peggle, and Bookworm Adventure.* While all three of these CVGs operated under similar principles, rules and game design, it is unclear at this time if there were intricacies between or within each of the games that may have potentially made one game more appealing over another. This information of determining which game produced the greatest reduction in depression symptoms for example, may help future game developers use specific game qualities for targeted intervention use. Further determining what game qualities or game actions produce positive health effects may further provide insights into the underlying mechanisms of change to assist both game programmers and clinicians better maximize the effectiveness of video games and gaming outcomes.

Ethical Considerations

The researchers involved with this study have obtained Institutional Review Board (IRB) approval to perform this research, listed as a research team member under the IRB submission. In respect of participant privacy, ethical considerations were employed throughout analyses and reporting of data. Coded identifiers were used in this study with no identifiable information included. Additionally, all forms completed were coded by the original research team and were not revealed to this researcher. This dataset includes self-report information regarding mental-health, namely self-report depression scores. It should be noted that by using archival data, direct participant contact did not occur for this particular study. This is important to note as some participants may require additional follow-up related to their depression symptoms based on high PHQ-9 self-report scores.

Implications of the Study

The purpose of this study was to examine the potential effects of prescribed CVG play on reducing symptoms of depression along both objective and subjective measures. The results of

this study have revealed potential implications that will be discussed for practice. A section of recommended future recommendations will follow this section to conclude this research.

Implications for Practice

Although this study included several study limitations as discussed in the previous section, findings from this research may have several implications for the fields of counseling and recreational therapy. These implications mostly pertain to practical applications for working with clients who show signs of depression and other mental-health diagnoses. The potential implication for including both subjective and objective assessments for mental-health related conditions such as depression will be the focus of this section.

Over the course of the last decade, practitioners have drawn their attention to introducing more objective methods of measurement to improve clinical standards for diagnostics and management of optimal course of treatment for many diagnoses (Solomon et al., 2015). Recent studies examining brain function as a byproduct of technological advances have allowed practitioners to expand the emphasis on brain-based treatment, including rehabilitation counselors (Dadashi et al., 2015). Clients with depression may greatly benefit from new objective measurement opportunities as so often there is internal as well as social and environment pressure to alter self-reporting for a myriad of potential reasons (Solomon et al., 2015).The current standard of focus on symptom-based definitions of depression can make accurate diagnoses challenging as it has previously been thought that psychological based needs as opposed to physiological needs are difficult to measure objectively (Solomon et al., 2015). A strong argument cannot for the inclusion of objective measurement in clinical practice based on this study's research findings, however the non-statistically significant findings of the alpha wave EEG readings have been explained by limitations of instrumentation in previous sections.

Other research studies on the other hand do support the notion of including objectively measured outcomes in counseling practices and other health care services. Historically, back to the 1980s researchers have found correlations between subjective reporting and objectively measured brain waves. Davidson, Schaffer & Saron (1985) found early frontal EEG findings that paralleled the findings on self-ratings for happiness, showing correlation between self-report and objectively measured mental-health outcomes (Davidson, Schaffer & Saron, 1985). More recently, Potvin et al., (2016) examined assessment of cognition within a population of individuals with depression along self-report and objectively reported data and similarly found correlations. These historical studies along with a critical examination of data collection techniques in this original study indicate further examinations should be conducted to consider implementation of integrating both objective and subjective assessment tools into practice.

Further, reduction of reported symptoms along the PHQ-9 indicate the potential use of non-pharmacological interventions for reducing symptoms of depression. Many pharmacological based interventions do not include the client in the treatment process, rather simply provides medication as an approach to treat a chemical deficit. While this approach may be necessary and effective for some individuals, research has shown that up to 40% of clients with depression do not receive adequate reduction in their symptoms after use of antidepressant medications (Cuijpers et al., 2014). While it is not known at the time of this research the factors involving medication use, comorbid diagnoses and other factors that may affect the effectiveness of some antidepressant treatments, the evidence in the reduction of PHQ-9 scores at Time 3 after intervention are significant enough that CVG play should at a minimum be considered for potential use along with other complementary and alternative treatment options for depression. Additionally, rehabilitation counselors working in areas of focus such as addiction may consider

CVG play as part of their toolkit of treatment interventions as CVG play does not require the use of potentially harmful antidepressant medications and include actions by the participant in the treatment process.

Implications for Research

Proper examination of changes within the alpha wave amplitudes was limited in this study by issues with instrumentation. In order to properly assess brain wave changes related to depression, it is critical to first examine the totality of an individual's brain function and resulting brain waves. This is relevant to this research as only alpha wave activity was examined without understanding the context of each individual's medical history, mental-health conditions and overall brain function. This may potentially be the root cause of the insignificant changes in alpha brain wave findings between Time 1 and Time 3. Additionally, it should be considered that alpha functioning in general is relative to several factors within an individual. For example, certain conditions such as PTSD already produce a high amount of alpha waves as a factor of the condition (Group & Heller, 2016). Therefore, it would not be ethical or correct to train for increases in alpha waves as is typical in EEG depression protocols when as many people with PTSD already overproduce alpha. This is one example of several conditions that should be further investigated prior to engaging in EEG alpha wave measurement or training. On the other hand, individuals dealing addiction may already have very low alpha waves so small gains in recordings may still result in large gains in anecdotal data (Wang & Bulanova, 2018).

Precise examination of changes related to alpha waves further requires measurement of frontal asymmetric activations. In this study, asymmetric activation measures were limited by the strength and complexities of available EEG equipment as well as potential issues with data collection methods. While overall changes in alpha brain waves were measured, precise

differences between right and left-brain hemispheres were not determined for this study. The use of more sophisticated EEG ratio comparisons would be able to detect changes between the right and left alpha which has generally been advised in the literature as the EEG ratio to examine within populations of individuals with depression (Schwartz & Andrasik, 2003). Although the overall changes in alpha are important to measure, clinicians should focus on looking for relative hypoactivation in the left prefrontal area, which differs from that found in individuals without depression who show hyperactivation in the left prefrontal area. As compared to the right frontal area. Equipment that measures EEG changes separated by left and ride sided alpha measures would enable clinicians to examine more precise clinical intake information.

This study and previous studies now indicate the potential effectiveness of video game use as a demonstrated intervention to address clinical conditions such as depression. Based on this data, healthcare professionals such as counselors, recreational therapists may consider prescribed CVG play to clients who are experiencing symptoms of depression. The data from this study indicated that CVG play by the prescribed protocol of three times a week, 30 minutes per session, for four weeks may be effective for reducing symptoms of depression. Due to the low-cost and availability of CVGs, counselors and other allied health professionals may consider use of CVGs as a simple, effective tool for relief of symptoms of depression, similarly to other complementary and alternative approaches such as exercise and general physical activity.

Future Research Recommendations

EEG Right vs. Left Alpha Differentiation

It has long been established that EEG measured frontal brain asymmetry has implications related to depression, however few studies have compared results of subjective self-report with objective EEG measures. In one early study (Schaffer, Davidson & Saron, 1983), high and low

scores on the Beck Depression Inventory were compared with respect to EEG asymmetry at frontal lobe sites using EEG measures while at rest. In this study, participants who were high in self-reported depressed mood exhibited significantly lower self-report scores of depressed mood. However, studies thus far have not examined changes in right frontal alpha asymmetry compared to left frontal alpha when a CVG is used as the intervention. By further examining left versus right sided changes in alpha under similar CVG intervention conditions, future researchers may be able to confirm more precise changes in alpha asymmetry, related to CVG interventions.

Thus far, most studies that have examined changes in alpha EEG functioning have taken place during research study settings. There is a growing body of research that is indicating "pre-exposure EEG" or EEG measurements prior to starting treatment may help capture trait aspects of psychological dysfunction (Cao et al., 2019). Gathering pre-exposure EEG may potentially help predict the effects of particular antidepressants in an individual, helping create a more efficient process for treatment (Cao et al., 2019). By examining EEG patterns before, during and after treatment regimens, practitioners may shortcut the process of matching a correct medication with a client as they examine neurophysiological data, rather than self-report data alone (Cao et al., 2019).

Objectivity in Measuring Mental-Health Outcomes

Neuropsychiatric disorders, which include mental disorders such as depression are having an increasing impact worldwide, with this category being the third ranked cause of disability for persons aged five and older (NIMH, 2020). The call to action to address these disorders has elicited the help of technological innovation to assist with treatment and diagnosis. This is the fundamental focus of the newly defined field of research called, behaviomedics (Valstar, 2014). The general aim of behaviomedics is to apply automatic analysis and synthesis of affective and

social signals to aid in objectively diagnosing, monitoring and treating medical conditions that alter one's affective and socially expressed behavior (Solomon et al., 2015). This new field includes research in several subjects like affective computing which seeks to determine ways that science can create emotionally aware technologies including automatically analyzing affect and expressive behavior (Solomon et al., 2015). Additionally, utilizing computer software to analyze big data sets to generate treatment selection algorithms could largely impact the mental-health field (Fekadu et al., 2018). This process of generating custom algorithms would allow for practitioners to find and advise the best treatment for a given client and will allow for health care delivery to become more efficient (Fekadu et al., 2018).

By definition, mood disorders are directly related to affective state, thus, affective computing promises to be a good approach to depression analysis (Solomon et al., 2015). While EEG may not be perceived as a form of affective computing, it is also a method that seeks to provide a layer of objectivity to the previously, mostly subjective process of mental-health disorder diagnosis and treatment. As efficacy for studies that include such objective measures continue to grow, the hope is that eventually such objective methods will become integral to clinical practice. Other new developments in the journey to find the most effective course of treatment for mental-health conditions includes advances in genetic testing (Pandarakalam, 2018). Tools such as genetic testing for detection of mental-health conditions such as mood disorders have been established in physical medicine but not psychiatric care (Pandarakalam, 2018). Genotype testing may eventually provide information regarding individuals who may be at heightened risk for diagnosis like depression, as well as predicting effective treatment outcomes (Serretti et al., 2011). Additionally, the invisibility of depression as well as subtle and flagrant discrimination and stigma towards individuals with mental-health conditions creates

complexities for treating practitioners to accurately find the best course of treatment. Newer imaging techniques such as functional MRI, EEG and other brain scan technologies may support efforts to find reasons why some people respond to treatment and others do not. These brain-based assessment tools may help provide practitioners with more individualized, objectively measured data that can better target decisions such as antidepressant selection and tailoring intervention choices to each individual separately (Pandarakalam, 2018).

Depression Specific Alternative Intervention and Videogame Research

With such high rates of recurrence through pharmacological approaches, novel treatment strategies for treating depression are needed (Cuijpers, Huibers, & Furukawa, 2017). Treatment-resistant depression is not uniformly defined, which may confuse not only diagnosis but advised treatment options as well (Trevino et al., 2014). One estimate is that TRD affects 20-30% of all individuals with MDD (Fekadu et al., 2009). As with any research, in order to produce reliable outcomes along a variable, the variable must be clearly defined.

The most common method of first-line treatment for depression is pharmacological intervention using antidepressant medication, however, it is estimated that 53% of clients with clinical depression show non-response to the first-line prescribed medication and 67% show non-remission of symptoms (Warden et al., 2007). In order for such individuals to experience alleviation of depression symptoms, the client may require supplemental pharmacological, non-pharmacological and exploratory interventions (Johnston et al., 2018). Some studies have suggested a complementary approach to depression treatment should be added in conjunction with pharmacological measures including: cognitive behavioral therapy (CBT), neurostimulation techniques, and aerobic exercise as a behavioral treatment strategy (Wiles et al., 2013; Trivedi et al., 2011).

To further examine the use of CVGs as an intervention for mental-health treatment, future research should consider investigating the effectiveness of CVGs along with other medications. Traditionally, many antidepressant medications and other therapies have compliance issues as well as side effects that may discourage continued use by clients (NIMH, 2020). One unique quality of this study was that the intervention, CVG, was not specific to healthcare or depression. The findings from this study involving the use of CVGs to help alleviate symptoms of depression point to the potential use of other non-medical specific interventions such as video games to be developed and used for more clinical focused interventions. To the extent of this researcher's knowledge, video game programmers are not generally trained in healthcare specific fields, however games they have developed may help less the burden of depression symptoms for some individuals. In the future, the application of other non-medical specific interventions, specifically around videogames should be investigated. Additionally, it is recommended that future studies further examine different prescribed protocols of CVG play as different frequencies of play, intensities and durations of play may cause either more or less significant effects on symptoms of depression.

As expanse into the use of complimentary forms of treatment for symptoms of depression continues to grow, future researchers should consider different types of CVGs utilizing other prescribed protocols. The protocol used in this study was defined as playing 30 minutes of the video game of choice for three times per week. While there was strong PHQ-9 evidence to follow this protocol, future research should be examined to experiment with other potential prescriptions of play that may produce more impactful results. This would allow researchers to focus on particular elements of prescriptive play that may be helpful including: Number of times played per week, practice skills and length of each session. There are several ways in which

game programmers and players may work together to further develop similar games. For example, players may convey to developers what they would like in a game and developers may take these ideas and combine them with their technical skills to deliver the requested game or something similar (Russoniello et al., 2013). While this process of intervention development is not unfamiliar, the uniqueness of CVGs are their instant feedback, their nature of being fun to play, are inexpensive and readily available.

Chapter Summary

The purpose of this study was to examine if prescribed CVG play could reduce symptoms of depression in a study group as compared to the comparison group that did not participate in any intervention. In order to carry out this study, three research questions were developed and analyzed using a series ANCOVA analyses. In addition to addressing research questions, descriptive statistics were reported for dependent variables as well as participant demographics. Finally, psychometric properties were evaluated for the independent variables used in this study. All findings were discussed, including (a) limitations, (b) clinical implications, and (c) recommendations for future research.

There were multiple limitations identified in the current study. These limitations were relevant to the research design, instrumentation, and statistical analyses. The research design employed in the current study was a quantitative, *ex post facto* examination of archival data. Accordingly, limitations included issues related to secondary data analysis and the inability to make causal inferences. Limitations to instrumentation focused on the issues of self-report measures, and lack of sophisticated instrumentation to accurately measure needed EEG variable data as it prohibited accuracy in EEG alpha wave data collection, measurement and evaluation.

Although there were limitations, findings from the current study have critical implications for counseling practitioners, recreational therapists, and researchers. The use of CVG play offers counseling practitioners the additional homework and intervention modality to provide clients with a low-cost, easily accessible intervention between clinical visits or as an intervention to compliment other counseling care. Recreational therapists by profession use recreational activities, games and leisure interventions to provide rehabilitation and alleviation of disabilities and disorders. Expanding the use of CVG play into recreational therapy practice further offers a low-cost, accessible form of intervention that can also be tracked, monitored and documented remotely. Additionally, the more than three-point average difference from Time 1 to Time 3 within the study population strongly supported the significant image CVG play may have on reducing overall symptoms of depression as documented on the PHQ-9 scores. While EEG recordings did not show similar significant impacts, it is advised in the future recommendations section that further analysis using proper EEG instrumentation be conducted so re-test for correlations and significance on EEG alpha wave data.

Future recommendations for research primarily focused on expanding research into finding additional objective methods to detect and treat depression. Some future suggestions found in the literature include genetic testing for mental-health diagnoses and further examination of EEG and other imaging methods to examine the structure and chemical make-up of the brain. Lastly, this research supports the use of CVG interventions for helping to reduce symptoms of mental-health related diagnoses including depression and anxiety. It was recommended that future research expand in the area of CVG use as well as other progressive forms of technological interventions to help provide individuals with a wider array of treatment options.

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