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Doctor Mario: How Video Games Are Being Used as Medicine

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The video game industry has become the largest media industry in the world, dwarfing even the movie and music industries. As such, video games are very present in the consciousness of American citizens. This makes them attractive to areas such as the field of medicine, which is always researching new and more effective ways to administer treatments to patients. This thesis examines all the research surrounding the use of video games as medicine, whether it be to treat a mental illness, physical ailment, or just for cognitive training, in an effort to determine if video games are effective as a treatment modality and determine the ideal way to introduce them into the field of medicine. Through an extensive literature review, this thesis determined that video games are, in fact, effective as treatments for various medical issues. Through an examination of the types of video games used in these studies, it was discovered that commercially-available video games are more common, as they are more attractive to doctors and researchers, offering an already existing, nearly endless pool of potential treatments. It was also concluded that the best way to introduce video games to medicine is by using them as a supplement to normal therapies and treatments, rather than as a standalone treatment.

Keywords and phrases: honors thesis, video games, medicine, exergame, commercial game, bespoke game, cognitive-behavioral therapy, physical therapy

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Introduction

While there is some debate about what video game has the distinction of being the first ever, there is no doubt that video games have come a long way since the beginning. The video game industry generated approximately $180 billion in 2021, which is up around fourteen percent from its numbers in 2020. This is in comparison to the movie industry, which grossed only around $21 billion in 2021; it even beats the revenue brought in by the movie industry in 2019, the last year without a pandemic, which was around $41 billion. Aside from the huge revenues that the video game industry pulls in, the actual player base of video games grows more and more every year as well. According to an article by Variety, “There are now a total 226.6 million video game players in the U.S. of all ages, growing nearly 6% from 214.4 million in 2020, according to the ESA.” That is over two-thirds of the population of the United States. This means that video games can reach most American citizens.

Video games are a very versatile medium, able to be used for various purposes. Developers have used games to convey the developers' beliefs, tell stories, or just to generally entertain players. As video games have continued to progress, many developers investigated ways to use them for good. This can be done in many ways. Some of these games for good have serious messages behind them like *Spec Ops: The Line*, which is a seemingly normal first-person shooter that eventually turns on its head to portray the horrors of war and its effects on the human psyche. Other games encourage the player to improve themselves, like *Brain Age*, which consists of math exercises and puzzles to train your critical thinking, or *Wii Fit*, a game containing a multitude of exercise activities that the player can perform with a special controller. Interestingly, developers are also looking into using video games as treatments in medicine. Medicine is an ever-evolving field, one that constantly seeks to improve itself and discover new, effective treatments. One of the main evolutions in this field is the integration of technology as a treatment modality. As technology has evolved over time, it has become clear that it affects people not only physically, but mentally as well. This is especially true in video games, which are explicitly designed to captivate or motivate the player to continue playing. The motivation factor of video games, which is a core element of gamification, the process of applying attributes from video games to other activities, is an attractive one to the field of medicine. This is because many treatments are reliant on the motivation of the patient. To medical professionals, video games can also offer cheaper and more widely available treatment. As a result of this, there is a potential

combination of two titans coming soon: the video game industry, which brought in $180 billion in 2021 as stated above, and the medical industry, which was worth around $715 billion in 2018 in America alone. While the elements of cost and availability are self-evident, the main question in the field of video games for medicine is of their overall effectiveness in relation to established modes of treatment. In this thesis I will describe research that addresses the efficacy and potential for using video games for treating mental health issues. As will become clear, video games can be used to treat various physical and mental ailments as effectively, and in some cases more effectively, than traditional medicine or therapy. This effectiveness is not only seen in specialized video games; commercial video games can also be used as medicine.

Video Games as Treatments for Psychological Phenomena

The beginning of the research into any treatment is establishing that there are noticeable benefits seen from enacting said treatment. Though video games are a unique treatment modality, this research process is the same. Oei and Patterson (2013) lay out the numerous cognitive benefits of video game play. They utilized five different games, all of which had different goals and gameplay. This ensured that the study would not only show that game playing is beneficial, but that different games could have different effects. These five games include finding hidden objects, memorizing and reproducing a pattern, matching three of the same-colored objects, a first-person shooter, and a life simulator. The

participants of the study were administered cognitive tests such as visual attention measurements and spatial memory tests. After this, the participants were split into five groups, each playing one of the games for an extended amount of time. Finally, these groups were tested again to see if there were any cognitive changes that could be caused by gaming. The results of this study indicated that these games not only had beneficial effects on participants, but also that different games affected distinct parts of the participants' cognition. The first-person shooter strengthened participants' visual attention, tracking of multiple objects, and the filtering out of irrelevant information. The hidden object and pattern game improved visual searching and spatial memory. Finally, the match-3 game improved participants' visual searching. This study is an excellent example of the diversity of the benefits that can be caused by video game play. It is interesting to note that almost all of the games are commercially available games, including *Bejeweled 2* and *The Sims*. This was an intentional decision by Oei and Patterson. This, along with the fact that the participants could play their game as long as they want, shows that video games can cause cognitive benefits in regular play, as well as in treatment settings.

Sosa and Lagana (2019) tested the effectiveness of video games on cognition was performed on older adults. They did this by recruiting thirty-five older adults and measuring many factors of their cognition, including visuospatial ability, working memory, reasoning, reaction time, attention, and more. These were all measured to get a wide overview of the state of the subject's cognition as a whole. These measurements were taken before and after the study. The subjects

were split into two groups, experimental and control. The experimental group played *Brain Age*, a video game on the Nintendo DS system that is meant to train a player's cognition. It consists of various minigames that were designed to do this; subjects were to play all available minigames. These subjects played *Brain Age* in one-hour sessions three times a week for five weeks. The control group did not receive any treatment, instead just performing the tests at the same times as the experimental group. At the end of this intervention, Sosa and Lagana noted that while not every measured factor of cognition showed significant changes between the two groups, "over 80% of the obtained effects favored the treatment group," meaning that it appears as if *Brain Age* was effective at training much of the cognition of the subjects. While they concede that the sample size could have been larger and the control group may have been more effective if they had completed some other action rather than doing nothing, Sosa and Lagana posit that their study illustrates the potential of video games as being beneficial to cognition.

Video Game Therapies versus Mental Illness Therapies

As stated above, a large part of why video games are so attractive as a treatment modality to medical professionals is the inherent motivation that games cause in their players. It does not matter what the purpose of a game is, whether it be for treatment or for entertainment, one of the main functions of a video game will always be to get the player to continue playing. Motivation can be a key factor when it comes to medicine. Many treatments rely on the patient actively participating in therapy, exercises, or the taking of medicine. Some illnesses

might even impede this motivation, making it even more difficult to administer treatment. One such ailment is schizophrenia, which causes delusions, hallucinations, and, notably, a lack of participation and motivation. Shimuzu, Umemura, Matsunaga, Hirai, and Langguth (2017) tried to solve this dilemma. They state that “it is difficult for such individuals to voluntarily participate in group exercise programs,” in regard to schizophrenia patients. To attempt to rectify this issue, Shimuzu and colleagues suggested the addition of interactive sports games to normal schizophrenia treatments. The ensuing study involved the use of *Wii Sports Resort*, a commercial exergame that contains twelve diverse types of sports that the player can participate in. A control group participated in normal therapy, while the experimental group played *Wii Sports Resort* for their treatment. Before and after the therapy sessions, Shimuzu and colleagues measured the subjects’ physical abilities, such as balance, flexibility, and endurance, among others. This is because schizophrenia can impair functions like these. Researchers also measured the subjects’ cerebral blood flow before and after treatment, as schizophrenia impacts the brain, specifically the areas that deal with executive functions like decision making and motivation. Increased physical functions, as well as increased blood flow in impacted brain areas, can indicate that the treatment is helping the schizophrenic patient. When the study concluded, Shimuzu and colleagues found that the two distinct types of treatments had remarkably similar results for the patients. However, video game therapy had some advantages, such as reduced bodily pain, increased social function, and increased brain activation. While there were limitations to this

study, namely a smaller number of subjects than anticipated, it seems to indicate that video games can be a good standalone treatment, as well as an excellent companion to traditional treatment, for schizophrenia.

Mental illnesses like schizophrenia that are detrimental to a patient's motivation are difficult to treat, as most treatments, whether they be therapy or medicine, actively rely on the participation of the patient. Shimuzu is not the only researcher that has tried to solve this problem using video games. Brezinka (2013) focused on finding an effective treatment for children who are diagnosed with obsessive-compulsive disorder (OCD). It can be harder to convince a child to participate in treatment, and, in addition to this, OCD can make a patient apprehensive and uneasy. This can lead to an exceedingly arduous task for medical professionals; the patient that needs treatment may not want to commit to it. Brezinka tried to rectify this issue by using video games, as most children have an interest in playing games. By using video games, Brezinka is attempting to make therapy more enticing for children. The game they developed is called *Ricky and the Spider*, which features a story of insects exhibiting symptoms of OCD. The purpose of the game is to explain to a child the cause of the symptoms that they are suffering from more efficiently, while also conveying to them the concepts that they would learn about in traditional therapy. Brezinka conducted their study by attaching a questionnaire to the game that can be answered by the therapists who downloaded the game as well as the children that were being treated using the game. When asked how the game performed therapists said that it very efficiently explained the concepts of therapy to

children, and vastly enhanced the “child motivation for therapy.” Of the eighteen children that took part in the study, seventeen showed “remarkably less severe” OCD symptoms. While this study was slightly limited when it comes to the number of subjects involved, it shows that a video game can be a remarkable supplement to therapy and can even perform some of the actions of therapy itself.

Just like schizophrenia and OCD, ADHD can impair a patient's attention and motivation, other executive functions, and even motor functions. These symptoms are difficult problems to treat with therapy alone, especially when present in children. ADHD usually requires medicine for treatment, but some patients or parents of affected children may be concerned about side effects. To help these patients, researchers have attempted to utilize therapy to treat children with ADHD, and thus, other researchers have attempted to integrate video games into this treatment. This includes Benzing and Schmidt (2019), who sought to use exergames as an intervention for patients’ symptoms. They noticed that patients with ADHD “might … benefit from physical exercise, positively impacting cognitive performance, ADHD symptoms, and motor abilities.” This, coupled with the fact that Benzing and Schmidt were working with children, motivated them to test the effectiveness of exergames in treating the symptoms of ADHD. They utilized a commercial game in the intervention called *Shape UP* which uses Microsoft Kinect to record players’ movements and uses them to control the game. Participants were split up into an experimental group and a waiting list control group. The experimental group trained with the game “for 8

weeks (3 times a week for at least 30 minutes)", while the control group received no intervention. After eight weeks, the patients' executive functions were assessed by using computer-based tests, while ADHD symptoms and motor functions were measured by questionnaire and physical tests. The results of Benzing and Schmidt's study showed that the experimental group showed improvement in several executive functions in comparison with the control group. There was also a small, yet not insignificant, benefit on patients' motor functions. Finally, there was no significant effect on the patients' ADHD specific symptoms. While an effect on ADHD symptoms was not seen by this study, there were still several noticeable benefits that were seemingly caused by the exergame intervention. There were some limitations to Benzing and Schmidt's study, namely that the control group was a waiting list control group, meaning that rather than testing an intervention against something like traditional therapy, the exergame therapy was tested against no intervention. That being said, this study is still important to consider when researching video games as a treatment modality. It shows that while they may not treat ailment specific symptoms, they can help to alleviate other secondary symptoms that may impair patients' lives in some other way. This could also indicate that, while that game did help the subjects of Benzing and Schmidt's study, another game might help patients better. This is similar to traditional therapy, where patients will benefit from different things, leading to changes in treatment being needed. Another game, perhaps one that was designed with ADHD sufferers in mind, might have helped more.

As seen by some of the previously discussed studies, childhood anxiety is an especially prominent issue as it affects so many children and can be hard to treat. Thus, while cognitive behavioral therapy can be effective, new treatment modalities are researched often. Schoneveld, Wols, Lichtwarck-Aschoff, Otten, and Granic (2020) state that “effective, accessible, and engaging prevention programs are needed” to help treat childhood anxiety. Schoneveld and colleagues believed that applied games, such as *Mindlight*, a game specifically designed to help treat anxiety symptoms, could be such an effective and engaging treatment. As stated, *Mindlight* is a video game that is designed with anxiety in mind, and it uses the principles of cognitive behavioral therapy to help ease the symptoms of anxiety. This is different from many of the previous games discussed, as they were primarily commercial games, created for entertainment rather than treatment. Schoneveld and colleagues split the participants into two groups; half of the participants were assigned to regular cognitive behavioral therapy while the other half played *Mindlight* in one-hour sessions once a week for six weeks. Before the treatment, potential subjects were screened for anxiety, and the families of students that exhibited anxiety symptoms were contacted with the opportunity to participate in the study. After the treatments were completed a few key symptoms of anxiety, such as self-efficacy and internalizing or externalizing of problems, were measured by questionnaire. The results of the study showed that while cognitive behavioral therapy was more effective in treating the externalizing of problems, *Mindlight* was just as effective as CBT in treating the internalizing of problems and improving self-efficacy. This is

promising, as video games such as *Mindlight* can be more engaging to a child suffering from anxiety, while also being easier to access and cheaper than traditional CBT. Schoneveld and colleagues also suggest that the results of the study show that “MindLight could be implemented as an indicated prevention program in schools to reduce anxiety symptoms.” While this study does not show that video games are more effective than traditional therapy, it does show that they can be just as effective, while having other benefits, such as better accessibility. The possibility of being used as an anxiety prevention program in school is a promising one as well, as it is easier to implement an hour of video game play into a school day rather than sessions of CBT.

Another disorder that can be difficult to treat is depression, as it can majorly impact a sufferer’s motivation, meaning that it could be harder for patients to adhere to a traditional therapy treatment. Thus, researchers are often looking at new treatment modalities that can motivate patients to continue participating in treatment. Anguera, Gunning, and Areán (2017) sought to use a video game as a treatment rather than traditional therapy. Anguera and colleagues state that depression is such a big problem because of “the modest effects of existing treatments, their limited accessibility, and quality …, and the high rate of early treatment discontinuation for both psychotherapies and medications.” The specific type of depression that Anguera and colleagues focused on was Late-Life Depression (LLD), the effects of which can be more devastating to patients, as they already commonly suffer from cognitive deficits, which can be worsened by depression. These cognitive deficits also impair motivation for treatment and

response to antidepressants even further, making LLD an even more difficult disorder to treat. After recruiting individuals suffering from LLD, Anguera and colleagues split the participants into two groups; half of the participants received eight weeks of normal Problem-Solving Therapy, while the other half received four weeks of treatment using a game called *Project EVO*, playing the game for twenty minutes a day five days a week. *Project EVO* is a game designed to primarily help treat children with ADHD, but because it focuses on strengthening cognition, Anguera and colleagues saw the potential for benefits to other populations. Depressive symptoms were measured before and after treatment with questionnaires, while cognition was measured with different tasks that focused on specific cognitive control domains, such as working memory and attention. Anguera and colleagues noted that both groups "significantly improved their … depressive symptoms from baseline." Notably, the cognitive control of the *Project EVO* group was seen to improve, while the normal PST group did not see any significant improvement. This study illustrates all the benefits of a video game-based treatment, as *Project EVO* was able to treat LLD patients on par with, perhaps better than, traditional PST, while exhibiting better "ease of use, … portability, and … ability to improve cognitive symptoms." The study did show some limitations, namely the relatively small sample size. However, as a proof-of-concept trial, it is a promising one that indicates video games can be a useful treatment for depression and other disorders that affect cognition.

While the previously discussed study performed by Anguera and colleagues focused on late-life depression, depression is not a disorder exclusive to adults.

Merry, Stasiak, Shepard, Frampton, Fleming, and Lucassen (2012) state that “Up to a quarter of young people will have experienced a depressive disorder by the age of 19”. Depression is an already difficult ailment to treat at times, as it attacks the motivation, energy, and cognition of patients. However, it can be even more difficult to treat when the patient is an adolescent, as it can be difficult for children to be motivated to adhere to treatments. Thus, Merry and colleagues sought to utilize a video game intervention for cases like this, as “the cost of computerized therapy is likely to be substantially lower than traditional therapy and can increase access to treatment.” The game they used in their study is called *SPARX*, a game specially designed to help administer cognitive behavioral therapy to players. Players complete challenges in levels, after each of which a guide explains in the context of their depression. Merry and colleagues split the participants, teenagers from the age of twelve to nineteen seeking help for symptoms of depression, into two groups: an experimental group assigned to play *SPARX*, and a control group who received normal cognitive behavioral therapy. Before and after these interventions, subjects’ depressive symptoms were rated by non-biased researchers, and other factors such as mood, quality of life, anxiety, and hopelessness were measured by questionnaire. At the end of the intervention period, it was observed that the mean improvement on the depressive symptom ratings and questionnaires “were significantly higher in the *SPARX* group” than in the cognitive behavioral therapy group. Merry and colleagues note that this is an impressive result, as “SPARX was entirely a self-help resource. The only contact with a clinician was at recruitment and the only

input from health professionals during the course of treatment was a brief phone call after a month." This is a very promising result, as the subjects were able to virtually administer therapy to themselves. This study shows that a video game can be more effective, cheaper, and more accessible than normal CBT, as patients need not even make contact with health professionals to see benefits.

The feasibility of video games as a treatment modality for mental disorders is dependent on cognitive benefits that are caused by video game play. Because of this, some studies focus on the effects of games on the cognition of healthy individuals rather than the treatment of a specific disorder. Ballesteros, Prieto, Mayas, Toril, Pita, Ponce de Leon, Reales, and Waterworth (2014) utilized various non-action video games to measure the effect they have on the cognition of adults. The cognition of the subjects was measured by tests and tasks completed before and after the intervention. These tasks measured subjects' spatial recognition, attention, and other cognitive factors. After the initial testing, subjects were split into a control and experimental group. The control group met with researchers three times for two hours each, discussing "general topics related to aging and their interests" each time. The experimental group met twenty times over ten to twelve weeks, playing video games developed to enhance cognition in one-hour sessions. These video games were part of *Luminosity*, a cognitive training program that includes several different games. These games were made to improve cognitive functions such as rapid recognition, spatial memory, reaction time, attention, and more. After the interventions, it was observed that the video game group saw significant

improvement in all of the games over time, as well as improvement in cognitive functions. These improvements were significantly better than those seen in the control group. While there were no noticeable benefits to executive control and spatial memory in either group, the other benefits seen are promising, as they show several positive effects caused by video game play.

Cognition training of middle-aged adults, both healthy and unhealthy, is a much-studied topic, as demonstrated by the previously discussed study. As stated above, the use of games as a treatment modality for mental disorders and illnesses depends on their effectiveness in brain training and benefits to cognition. McLaughlin, Curtis, Branscombe-Caird, Comrie, and Murtha (2018) tested the cognitive benefits of video game play specifically on middle-aged adults with a commercially available brain-training game, *Big Brain Academy*. McLaughlin and colleagues decided that their main focus should be middle-aged adults, as “studies have primarily focused on individuals older than 60 years, despite cognitive decline beginning decades earlier”. *Big Brain Academy* is a game on the Nintendo DS that contains fifteen different activities designed to train various parts of one’s cognition, such as memory, reasoning, and attention. This makes it an excellent candidate for a cognitive benefit study, as it is commercially available and focuses on many distinct aspects of the player’s cognition. McLaughlin and colleagues chose fourteen middle-aged adults by recruitment and subsequently administered a neuropsychological test to them, which measured things like processing speed and executive functions. This gave them a baseline to compare results to at the end of the study. Half of this group

was then made to answer online trivia questions for three hours a week for six weeks, while the other half played *Big Brain Academy* for three hours a week for six weeks, being allowed to choose which activities they wanted to complete in the game. After these initial six weeks had elapsed, measurements were taken with the same neuropsychological tests as the baseline, along with a depression symptom questionnaire. These groups then swapped and performed another six weeks of the opposite treatment, and measurements were taken again. After these results were compared to the baseline, improvements could be seen in both the game group and the trivia group. Both showed strengthening in executive attention and memory, as well as exhibiting fewer symptoms of anxiety and depression. However, the game group showed greater improvement than the trivia group in all categories. McLaughlin and colleagues stated that “there appears to be a potential relationship between improvements in executive attention and reductions in anxiety associated with the” playing of brain-training games. However, they also noticed that the group who played the game first showed some decline after they performed as part of the trivia group. This could suggest that one needs to continuously play the brain training game to see the long-term benefits, but McLaughlin and colleagues concede that this needs further research, perhaps in the form of a future study. Overall, however, this study illustrates that video game play can have a noticeable benefit on cognition, as well as showing that commercially available brain training games can be effective in this way, making it easier and more convenient for one to get access to and use.

While it makes sense that video games could be a supplement or replacement for various cognitive-behavioral therapies, many researchers are also interested in testing the efficacy of video games against medications. Russoniello, Fish, and O'Brien (2019) sought to use video games to alleviate treatment-resistant symptoms of depression. Russoniello and colleagues noted that "popular recreational activities such as board and card games have been shown to decrease cortisol levels, improve mood, and reduce stress when compared with a matched control group of inpatient alcoholics." As such, it follows that other recreational activities, such as video games, may also be able to improve mood and treat symptoms of depression. Russoniello and colleagues utilized a commercial video game called *Plants vs. Zombies*, which is a strategy game that has players use various kinds of plants to protect a house from attacking zombies as an intervention. All participants were "were actively taking a prescribed antidepressant," but still expressed various symptoms of depression. These subjects were then given a choice between taking a second antidepressant and playing *Plants vs. Zombies* in order to attempt to treat these symptoms. Prior to starting their respective treatments, subjects took a health questionnaire in order to measure the severity of these depressive symptoms. At the beginning of the study, the group of subjects that deigned to take a second antidepressant were "asked to refrain from playing CVGs (casual video games) for 1 month," and the *Plants vs. Zombies* group was given instructions of how to play the game correctly. The video game group was asked to play the game for thirty to forty-five minutes four times a week, though they could play the game

more if they so wished. The antidepressant group was also given a comparison task to ensure that benefits did not result from something like computer use rather than actual gameplay. This comparison task involved “surfing of the NIMH website,” which contains information about alleviating symptoms of depression. After the study commenced, symptoms were measured by questionnaire two more times, followed by a fourth and final time after the conclusion of the study. Russoniello and colleagues observed that the *Plants vs. Zombies* group’s treatment-resistant depressive symptoms “significantly decreased beyond that of the sAD (second antidepressant) group.” Russoniello and colleagues also noted that some of the subjects who played *Plants vs. Zombies* went “well beyond the prescribed time,” that they were meant to play for some reason. This seems to indicate that these subjects adhered very well to their treatment, which is to be expected when dealing with something like a commercial video game, which fosters motivation in an attempt to coerce the player to keep playing. This study seems to suggest that “prescribing PvZ (*Plants vs. Zombies*) as an alternate or complementary intervention” would be effective in the treatment of depressive symptoms. Because it is a commercial video game, it is also relatively inexpensive and very widely available, meaning that it would be easy for *Plants vs Zombies* to be acquired and played by a patient. Russoniello and colleagues concede that “additional research is needed to replicate these findings further and refine the game prescription (frequency, duration, intensity) to produce the maximum sustained benefit.” While the game prescription may need refining, this study still indicates that video game play is able to treat depressive symptoms

just as well, if not better than, antidepressants, at least in a situation where a patient is suffering from treatment-resistant symptoms.

While most researchers are focused on whether video games are in fact effective at treating various ailments, others are focused on determining why they are effective in the first place, specifically when it comes to causing cognitive benefits. Tanaka, Ikeda, Kasahara, Kato, Tsubomi, Sugawara, Mori, Hanakawa, Sadato, Honda, Watanabe, and Herholz (2013) were interested in the effects that action video games have on the brain of their players. Tanaka and colleagues selected a pool of fifty subjects, around seventeen of whom were considered to be action game "experts;" they had an average of fifteen years of experience in video gameplay, and they played video games for an average of twenty hours a week. These subjects also competed in various video game competitions. The rest of the thirty-three subjects "had negligible or no video game experience (i.e., less than two hours of video gameplay per week)." These two groups were subjected to a behavioral task which measured their attention and working memory to measure their cognitive abilities. In this task, subjects were shown various differently colored squares at many positions. After a bit, these squares would disappear, and new ones would show up. Subjects were instructed to press a button if a square of a certain color appeared in the same position it was initially. Subjects completed one-hundred and twenty of these trials before moving on to the brain imaging portion of the study. For the brain scanning portion, Tanaka and colleagues utilized an MRI machine along with Voxel-based Morphometry to scan and analyze the brains of the subjects. At the end of this

procedure, the results of the working memory and attention tasks were compared between the two groups. It was noted that the action video game experts performed significantly better than the non-gamer subjects, suggesting that video game play strengthens a player's working memory, attention, and perhaps other factors of cognition. Tanaka and colleagues then compared the brain scans of the two groups; in this comparison it was observed that "AVG (action video game) experts had significantly higher regional GM (gray matter) volume in the right inferior parietal lobule (IPL) compared with non-experts." They also tested the correlation of a larger gray matter volume in the right inferior parietal lobule with performance in the working memory and attention task, finding a positive correlation. This makes sense because this area of the brain is what controls a person's visuospatial functions, like attention and working memory. This seems to suggest that action video game play trains a players' visuospatial functions as they play. This may partially explain why video game play appears to be effective at treating mental disorders such as schizophrenia and ADHD. Disorders such as these commonly attack these cognitive functions, so an effective treatment for these would be one that can retrain these functions. Tanaka and colleagues concede that another explanation of the greater volume of gray matter in action video game experts could be that players that are good at video games could have an inherently larger gray matter volume from other factors, and this is what allows them to be good at video games. However, this study still represents a promising explanation for the cognitive benefits of video game play.

Kühn, Gleich, Lorenz, Lindenberger, and Gallinat (2014) focused on the cortical thickness of various parts of the brain rather than the gray matter volume. In the study, Kühn and colleagues selected one-hundred and fifty-two fourteen-year-old adolescents, around half of which were male, and half were female. These adolescents were subjected to a questionnaire seeking to measure their video game habits with questions such as “How many hours do you play video games on average on a weekday,” and “How many hours do you play video games on average on a day during the weekend.” This was so Kühn et al. could attempt to correlate the amount of video game play with changes in the players’ brains. They then scanned the subjects’ brains with two different scanners for higher accuracy. Kühn et al. observed that “time playing video games correlated positively with cortical thickness in the left dorsolateral prefrontal cortex in left middle frontal gyrus extending into left superior frontal gyrus.” This is the region of the brain that deals with various executive functions such as decision-making and mood-regulation. Other regions of the brain showed smaller positive correlations or no correlation; no regions of the brain showed “significant negative correlation between cortical thickness and video game playing per week.” They also found no “significant difference … between female and male participants,” as well. As mentioned previously, many mental disorders, especially ones like schizophrenia, can massively impact a patient’s decision-making skills and mood regulation. A higher cortical thickness in the area of the brain that regulates these executive functions could suggest that video game play can train and strengthen a player’s decision-making brain regions, meaning

that they could be effective treatments for various mental illnesses. Kühn et al. note that additional studies are required in order to test the effects of different video game genres and lifetime effects of video game play vs current effects. However, this study is still another promising explanation of why video games could be an effective therapy for mental ailments.

While previous studies have focused on video game play as a whole or on specific genres, others have sought to catalog the effects of a specific video game on the brain. Kühn, Gleich, Lorenz, Lindenberger, and Gallinat (2014), who performed the previous study the same year, wished to observe the effects of *Super Mario 64 DS* on the plasticity, or potential to repair and grow, of the brain. This game was chosen because Kühn and colleagues theorized that a game with "a prominent navigation component, that is, the necessity to orient in a three-dimensional environment" would positively impact the plasticity of regions of the brain dealing with executive functions, such as the prefrontal cortex. Kühn and colleagues recruited forty-eight individuals who were not frequent video game players. These subjects were randomly assigned to two separate groups: a game group, and a control group. The control performed no task, while the game group was to play *Super Mario 64 DS* for at least thirty minutes per day over two months. Every day, the subjects in the game group were to fill out a questionnaire that enumerated the time that they played as well as the tasks that they performed in the game. They were also asked to rate their experience in terms of fun. Before, after, and during the two-month period, the game group and control were subjected "several cognitive performance tests," as well as brain

scans. After the training period, Kühn and colleagues noted that the brain scans seemed to show a clear positive association between gray matter volume and *Super Mario 64 DS* play. They also noted that throughout the study, subjects in the game group expressed a desire to play the game more outside of the study times that were laid out, though they were able to rule this out as being caused by the game's physical effects on the brain. They also observed decreases in gray matter volume in the control group, which are normal detriments observed in aging. The regions of the brain that the game group saw gray matter volume increases in were the ones that control spatial navigation. Kühn and colleagues also noted increased plasticity in the cerebellum, which controls motor functions and learning. They note that because video game play seems to cause positive effects to these regions of the brain, video games could be used to treat mental disorders such as Alzheimer's, which has "consistently been associated with reduced hippocampal volume," and Schizophrenia, which causes "volume reductions in hippocampus and prefrontal cortex." The increase in subjects' desire to play the game outside of study time is also promising, as it illustrates the motivation that video games inherently cause as part of their design. This study shows that video game play can cause various benefits to the brain and cognition, while also ensuring that patients will adhere to treatment. Kühn and colleagues mention that some of the effects on the brain may be caused by the actions undertaken by players while playing a game, such as button-pressing, rather than game play itself, and that future studies should add "an active control group that gets a new technical device to explore" in order to test this. While this

would be useful, this study is still a very promising one that illustrates the numerous benefits that video game play has on brain matter and cognitive functions.

Video Games as Treatments for Physical Phenomena

All of the previous sources serve to illustrate that video game treatments can be as, if not more, effective than traditional therapies, such as cognitive-behavioral therapy. Thus, it can be inferred that gaming could be used as an efficacious treatment for mental illnesses or disorders that require such therapies. However, the potential for video games does not stop here. There are many diverse types of conditions that medical professionals have tried to treat through the use of video games, and this also includes physical injuries instead of mental illnesses. These kinds of injuries are usually treated through the use of physical therapies, like working out and rehabilitation. Video games are potentially useful in these situations, as they can motivate the patients in these therapies, making sure that they are able to push through and get their bodies back into a healthy shape.

While disorders that affect motivation and cognition are the primary focus of research regarding video game treatments, other illnesses could also see improvements from video game play. Other diseases, such as those that affect motor functions, can also be treated through this method. Saposnik, Cohen, Mamdani, Pooyania, Ploughman, Cheung, Shaw, Hall, Nord, Dukelow, Nilanont, De Los Rios, Olmos, Levin, Teasell, Cohen, Thorpe, Laupacis, and Bayley

(2016) tested the feasibility of non-immersive virtual reality as a treatment for stroke victims, specifically patients that are experiencing a loss of motor functions. Subjects were split into two groups, with one performing simple recreation activities, such as playing *Jenga* or playing cards, and the other group playing various Wii games, including exergames like *Wii Sports*. Both groups received normal rehabilitation for two weeks but performed these actions as an add-on therapy. The groups were also allowed to choose what games they played, with the experimental group being given a choice between various video games, and the control group being given several recreational activities. Before and after the intervention, motor functions were measured by the Wolf Motor Function Test. Saposnik and colleagues observed that both groups saw a thirty to forty percent increase in their overall motor function, indicating that both recreational activities and exergames can be beneficial additional therapy for stroke patients. It is of note that normal commercial games were used in the study rather than specially designed games. Saposnik and colleagues admit that perhaps “It is possible that immersive hospital-based systems could provide more beneficial results,” but that requires more testing to know for sure. Also, another limitation could be seen in the lack of a third group that received no add-on therapy at all, just traditional rehabilitation. Nevertheless, this study is a promising one when it comes to the use of video game therapy on disorders that impair motor function.

Phillips, Fitzgerald, Phillis, Underwood, Nunney, and Bath (2018) examined the treatment of patients who suffered from chronic dizziness and vestibular

problems. These problems are typically treated through vestibular rehabilitation, which consists of several types of training, including training that corrects your posture as well as vision, along with different exercises, like stretching, walking, and other general physical exercises. These programs are usually personalized on a case-by-case basis, but they all generally follow this structure. Philips and colleagues sought to find out if video games could be an effective tool in vestibular rehabilitation, as they desired “an effective and inexpensive programme of rehabilitation in the community,” and they saw this potential in the *Wii Fit* balance program. This consisted of nine different games that utilize the *Wii Fit* balance board, a controller that the player will stand on and interact with to play games. This is a commercially available game as well as a controller. Philips and colleagues selected forty patients based on dizziness symptoms. These subjects were split into two groups randomly; one group would undergo standard vestibular rehabilitation therapy two times a day for thirty minutes at a time, while the other group played games with the *Wii Fit* balance board for the same amount of time. All of the subjects were given somewhat personalized treatments, with types of exercises or games to be played varying from person to person in order to ensure improvement of their respective condition. Before and after this treatment, the subjects were given two different questionnaires: one that measured the symptoms of their dizziness and another that sought to measure their quality of life. Philips and colleagues observed that the *Wii Fit* group had seen significant improvement in their dizziness symptoms. Notably, the changes to their symptoms were not significantly different from the normal

vestibular rehabilitation group. This suggests that *Wii Fit* would be a suitable replacement or supplement to vestibular rehabilitation. While the study saw several subjects unable to complete the full treatment process, it illustrates that exergames may be used alongside normal physical therapies to help treat ailments such as dizziness.

As stated above, physical injuries are also a focal point of medicinal video game studies. These can include things like bone breaks, fractures, or even sprains. Arvinen-Barrow, Maresh, and Earl-Boehm (2020) state that lateral ankle sprains are “among the most common injuries encountered during sport and exercise participation.” Arvinen-Barrow and colleagues posit that “use of AVG (Active Video Games) has also been proposed to be beneficial for sport injury rehabilitation because they offer both clients and practitioners new ways of thinking about athletic injury.” This means that, while video game physical therapy is not vastly different from normal physical therapy, at least functionally, it can affect the patient differently psychologically. It can keep them motivated through exercising, as fostering motivation is a primary function of video games. Thus, Arvinen-Barrow and colleagues utilized *Kinect Sports,* a game that is controlled with the Microsoft Kinect along with an Xbox system. The Kinect is fundamentally a camera that tracks and captures the players’ movements, translating them into controls for video games. Arvinen-Barrow and colleagues worked with two subjects, both female NCAA Division I soccer players with lateral ankle sprains. One of these subjects was treated with traditional balance training, while the other was administered the active video game treatment.

Before and after these respective treatments, the subjects' static and dynamic balance was measured through testing, while the subjects were to report on things like their ankle function, pain, mood, and more through the use of various questionnaires. Both subjects were given acute care, which includes the icing of the injury and basic motion training. After this, both subjects participated in strength training as well, using exercises to rebuild ankle strength. Only then were they ready to start their differing rehabilitation procedures. The traditional balance training subject was treated with conventional balance exercises, along with movement exercises. At the same time, the active video game subject was familiarized with the Microsoft Kinect system and played various games that were included in *Kinect Sports* while balancing on their injured foot. They were allowed to choose which games they wanted to play. After these treatments were completed, Arvinen-Barrow and colleagues observed that both of these procedures have comparable results, though it was noted that the active video game seemed to have "a positive effect on the participant's adherence to the rehabilitation," as well as "a positive influence on the participant's mood." This is promising as it seems to confirm the initial beliefs of Arvinen-Barrow and colleagues; while both treatments were physically effective in similar ways, the active video game treatment seemed to be more beneficial for the subject's psychological state and adherence to the treatment itself. Though the study has some limitations, mainly the small number of subjects, it can be seen as promising evidence that active video games can be just as beneficial and effective, if not more so, than traditional physical therapies.

Commercial Games Versus Bespoke Games as Treatments

While all the previous studies have been focused on the overall effectiveness of video games as a treatment for various ailments, both mental and physical, many researchers are interested in the prospect of using commercially available games rather than specially designed games. Many of the games discussed previously have been commercial ones, but are these more effective than games specifically designed as treatment? The reason that this is such a concern is that if commercially available games are as useful as treatment games, they are already widely available and would not require the time and resources to develop. This would increase people's access to games as treatment. Park and Park (2018) sought to compare these two types of games. They noted that "it has been reported that the effects of NCT (non-specific computer training) can be similar to those of CCT (cognition-specific computer training)," meaning that it may not matter if a software has been designed to improve cognition or not. In their study, Park and Park recruited elderly people over the age of sixty with cognitive issues for the study. The seventy-eight subjects chosen were then randomly assigned to two distinct groups: non-specific computer training and cognition-specific computer training. The non-specific computer training used in the study was *Wii Sports Resort*, and the subjects were to play three sports games, table tennis, sword play, and archery, for at least ten minutes each three days a week for ten weeks. The cognition-specific computer training was a program known as CoTras which consists of activities that train various parts of

cognition, including attention, visuospatial ability, and working memory. The subjects in this group also played these three activities for ten minutes each three days a week for ten weeks. Before and after this treatment period, subjects' cognitive functions and executive functions were measured with various tasks, and their quality of life was measured by use of questionnaire. After the treatments, both groups showed a significant increase in cognitive functions and the "mental components of health-related quality of life." The non-specific computer training group showed improvements related to bodily pain, mental health, attention, and vitality. Overall, the non-specific computer training group showed more significant improvements in cognitive function and health than the cognition-specific computer training group. Park and Park theorize that the non-specific computer training was so effective because it consisted of "adapting to new tasks, which has positive effects on attention." They also note that higher motivation can lead to better treatment results, and the *Wii Sports Resort* group exhibited higher motivation than the cognition-specific computer training, which is consistent with other video games. *Wii Sports Resort* also consisted of physical exercise, which can cause physical and mental improvements. This is not to say that cognition-specific computer training is not effective in its own ways. Park and Park note that "elderly adults who received cognitive training that was focused on specific cognitive function … showed significant improvements in the specifically trained tasks but not in other cognitive functions." However, video game play seems to train many distinct aspects of cognition at once. Because of this, Park and Park posit that "CCT may be more appropriate for cognitive training in

patients with a specific cognitive impairment, while NCT is more appropriate for elderly adults with multiple cognitive impairments." This is a very promising study when it comes to the possibility of using commercial games as a treatment for various ailments. While both treatments were effective, it seems that the commercial video game was more effective in every way. While it may be true that cognition-specific computer training may be better at treating specific cognitive issues, this study suggests that commercial games could be a useful treatment for patients with many issues.

Scholten, Malmberg, Lobel, Engels, Granic, and Jimenez-Murcia (2016) focused on the treatment of children with elevated levels of anxiety, as adolescent anxiety is "one of the most common adolescent psychiatric disorders, affecting up to 17% of adolescents in Western countries." Scholten and colleagues believe that video games could be an effective treatment for these anxiety disorders and that the use of video games addresses many of the limitations that traditional cognitive behavioral therapy suffers from, such as engagement with the patient, putting concepts into practice, availability, and cost. Scholten and colleagues utilized a game called *Dojo*, which was specifically designed to treat anxiety symptoms in adolescents. *Dojo* is a game that helps to teach players emotion regulation while also helping them to control their heart rate variability. It does this by measuring a child's heart rate while they are playing, making the game more difficult the more that their heart rate increases. This in turn incentivizes the child to regulate their emotions and heart rate in order to play the game, at the same time teaching them how to do this so that

they could do the same in a real-life situation where they are feeling anxious. Scholten and colleagues deigned to utilize another video game in their control group, as they believe that “active control groups are more scientifically rigorous than wait lists or no-attention control groups,” and would help to determine whether the benefits seen from the intervention are specific to *Dojo* or if other video games may help the children just as much. Thus, in their control group, they selected *Rayman 2: The Great Escape* as the game to play. This game is a commercially available 3D adventure game, designed for fun rather than the treatment of anxiety. The study included one-hundred and thirty-eight adolescents with anxiety symptoms who were randomly split into two groups, with half playing *Dojo* and half playing *Rayman 2: The Great Escape*. These groups were to play their games in two one-hour-long sessions per week for three weeks. In these sessions, every child of both groups was placed in one classroom with their own laptops and headphones to play their respective games, and a research assistant was always present to answer questions and maintain silence. Before and after this intervention, students were to fill out a questionnaire rating their anxiety symptoms, as well as their experiences with the games. After the interventions were concluded, Scholten and colleagues observed that there were no significant differences between the *Dojo* playing group and the *Rayman 2: The Great Escape* group. Subjects in both groups showed improvements in their anxiety symptoms, with the *Dojo* group showing improvement a bit quicker, but not by much. Scholten and colleagues concede that this could mean two things: either the games were not effective at treating

anxiety symptoms, or both were equally effective as each other. They also note a few distinct factors that could have contributed to this lack of a difference between results. Of note, children who played *Dojo* felt that the intervention period was too long as *Dojo* is a relatively short game. This means that they would finish it rather quickly and have to replay it repeatedly during the intervention. Also, Scholten and colleagues note that there are "indications that adolescents with high social anxiety levels respond better to individual interventions," but the study was performed with all the children together in one room. This could have made the treatment less effective than it could have been. Interestingly, this illustrates the fact that there may be a right and wrong way to utilize video games as a treatment. While these problems indicate that the study was not a perfect one, it is still very promising when it comes to the use of video games as a treatment. It is one of the few studies that actually chose to use a commercial video game as a control for a specifically designed one and showed that they were potentially just as effective as each other at treating symptoms of anxiety. Further studies may be needed to alleviate these problems, but this does not discredit the results that were illustrated by this study; commercial video games may be similar in efficacy to video games designed for treatment.

Commercial Games	**Bespoke Games**
Philips et al. (2018)	Fernández-Aranda et al. (2012)
McLaughlin et al. (2018)	Fagundo et al. (2013)
Russoniello et al. (2018)	Hseih et al. (2016)
Sosa and Lagana (2019)	Merry et al. (2012)
Wijnhoven et al. (2015)	Wijnhoven et al. (2015)
Benzing and Schmidt (2019)	Brezinka (2013)
Kühn et al. (2014)	Schoneveld et al. (2020)
Yavuzer et al. (2008)	Anguera et al. (2017)

Kühn et al. (2014)	Park and Park (2018)
Tanaka et al. (2013)	Ballesteros et al. (2014)
Arvinen-Barrow et al. (2020)	Scholten et al. (2016)
Oei and Patterson (2013)	
Saposnik et al. (2016)	
Park and Park (2018)	
Shimizu et al. (2017)	
Scholten et al. (2016)	
Yong Joo et al. (2010)	

Table 1. Examination of Types of Games Used in Studies

One can also see the extent of the research into the efficacy of commercial games as a treatment illustrated in the above table of all the research examined in this thesis. Much of the research involves the use of commercial games rather than bespoke, or specially designed, games. This is a trend that can also be seen in the field as a whole, with researchers seeming to be more interested in the use of commercial games rather than specialized games. There are a couple of reasons for this phenomenon. For one, commercial games have already been developed and released by some third-party companies apart from researchers. This means that the researchers have a large pool of potential games to choose from and use in their studies. If they find that commercial games are potentially effective treatments, that means that the use of video games in medicine is immediately applicable; doctors could start prescribing or recommending video games for their patients to go out and buy. This would also be cheaper and faster overall, as the development of a bespoke video game could take a lot of time and money, compared to a commercial video game which, as stated above, is already developed and released by a third-party company. These benefits are not only for the doctors and researchers; players and patients would also benefit from the use of commercial games over bespoke games. Notably, some bespoke

games such as *Dojo* need specialized equipment and peripherals, like a heart rate variability monitor. Commercial games will not need these, only requiring equipment and technology that the player will usually already own. The games used as treatment may be games that the patient already owns or plays, meaning that it is already available to them. For these reasons, it is evident that going forward, commercial games are going to be utilized more often than bespoke games as medicine begins to integrate the use of video game treatments. This is not to say that bespoke games are not useful or will not be utilized, just that starting out, commercial games will be the main focus in the field of medicine.

How Games Will First be Integrated into Medicine

All of the previous studies have been focused on the efficacy of video games as a treatment modality, with all of them seeming to illustrate that they would be effective at treating various ailments, mental and physical. If they could be used as a treatment though, what is the best way to go about this? The previously mentioned study seemed to show that it may be more complicated than just telling a patient to play a video game. Many researchers have sought to test out the use of games as a supplement to traditional therapy rather than a replacement. Yavuzer, Senel, Atay, Stam, and Yavuzer (2008) sought to treat the damaged motor functions of stroke victims with a PlayStation Eyetoy game. The PlayStation Eyetoy is a precursor to the Microsoft Kinect; it is a camera that records the players' movements and translates them to controls in a game. As such, many of the games involved the players moving around a lot, so Yavuzer

and colleagues theorized that it could be used to train motor functions. They selected twenty participants who had suffered a stroke in the past and still had hemiparesis, or partial paralysis on one side of the body. These subjects were then split into two groups. Notably, unlike the previous studies, both groups received traditional stroke rehabilitation. However, one group was to play PlayStation Eyetoy games as a supplement to this therapy, while the other group only watched the games being played instead of actively playing. The subjects would participate in these game sessions for thirty minutes after their traditional rehab sessions, which occurred five days a week for two to five hours a day over the course of four weeks. Before and after their respective interventions, subjects performed tasks that measured their motor functions and answered a questionnaire that measured their functional independence. After the intervention, Yavuzer and colleagues observed that the rehabilitation along with the PlayStation Eyetoy gaming sessions was more effective at retraining the subjects' motor functions than the rehab alone. This illustrates the potential of exergames as a supplement to traditional physical therapies for motor function issues. Yavuzer and colleagues note that because they are “cheap, easy operating, motivating and enjoyable, EyeToy may even be purchased for use at home to provide regular, intensive therapy after discharge from hospital.” This could be how video games are first integrated into traditional medicine, as additional treatment that doctors prescribe patients to undertake on their own.

Yong Joo, Soon Yin, Xu, Thia, Pei Fen, Kuah, and Kong (2010) also treated stroke victims with video games. They chose to use the Nintendo Wii as a

treatment modality, as it records players' movements with the controller, meaning that it can potentially be used to train motor functions. Yong Joo and colleagues also note that “NW’s (Nintendo Wii’s) fun and interactive approach may motivate patients to increase participation and, ultimately, may lead to better therapy results.” They recruited sixteen stroke victims. The motor functions of these subjects were measured before and after the intervention with various tests. These subjects were to play *Wii Sports*, an exergame imitating movements undertaken while playing actual sports, in thirty-minute sessions six times over two weeks. These subjects also received an hour of traditional occupational therapy and an hour of traditional physical therapy daily. At the end of the intervention, Yong Joo and colleagues observed that the subjects appeared to have “better upper limb motor power and function than before the study,” suggesting that the video game was effective at retraining the subjects’ motor functions. This is promising, though there are a few problems with this study. Notably, there was no control group at all, only the experimental. This means that there are no results to compare the final results of the intervention to. They also had a relatively smaller sample size. However, when considered along with the results of the previous study, the results are still promising.

While the previous studies focused on strokes, Fagundo, Santamaría, Forcano, Giner-Bartolomé, Jiménez-Murcia, Sánchez, Granero, Ben-Moussa, Magnenat-Thalmann, Konstantas, Lam, Lucas, Nielsen, Bults, Tarrega, Menchón, de la Torre, Cardi, Treasure, and Fernández-Aranda (2013) focused on the treatment of the eating disorder bulimia nervosa, which consists of

binging, or eating substantial amounts of food at once, and purging, which usually consists of vomiting. Fagundo and colleagues note that executive functions and emotional regulation are affected in patients that suffer from bulimia nervosa, and these “are difficult to change.” However, they believe that “the high level of brain plasticity in the prefrontal circuits … associated with these functions suggests that they may be improved by training.” To accomplish this training, Fagundo and colleagues chose to utilize *PlayMancer*, a video game “designed to specifically treat impulse control disorders.” They selected nine female subjects, all of whom suffered from bulimia nervosa. These subjects answered various questionnaires measuring things such as anxiety symptoms and eating disorder symptoms. The subjects were to play a game known as *Islands*, which is part of *PlayMancer*, in twenty-minute sessions on the days of their usual cognitive behavioral therapy. This game is an adventure game that trains various parts of the player’s cognition. After the intervention, Fagundo and colleagues observed that the subjects were exhibiting a lower number of binges and purges, as well as improvements to their additional anxiety and eating disorder symptoms. No control group was included in this study, but this does not discount the fact that all of the subjects had their conditions improved through the use of video games along with traditional therapy.

Hsieh, Lee, Lin, and Martinuzzi (2016), who sought to improve the cognition of children with developmental delays, tested the efficacy of traditional therapy along with video games against traditional therapy alone. They tested if using video games as a supplement to therapy would “improve the functioning and

HRQOL (health-related quality of life) of these children." One-hundred and fifty-seven subjects were recruited. These subjects were then randomly split into two separate groups: group A and group B. The intervention would commence over the course of eight weeks. For the first four weeks, group A would receive traditional therapy along with thirty-minute sessions of video game-based treatment, while group B would just receive traditional therapy. For the next four weeks, the groups would switch their respective interventions. The video game used in the study was part of the *HotPlus* system, which uses specially shaped controllers that record the movement of players in order to play games. Hsieh and colleagues picked the specific games that subjects played based on their perceived levels of difficulty. The health-related quality of life and family impact of the subjects were measured by questionnaire before the intervention, after week four before the groups swapped, and at the end of the interventions. After the intervention, Hsieh and colleagues observed that the subjects in group A's health significantly improved between the beginning of the intervention and the end of the first four weeks. These improvements also lasted all the way until the end of the eighth week. Notably, group B's health did not seem to significantly improve until the start of week five through the end of week eight. This seems to suggest that having video games as a supplemental treatment to their traditional therapy actually improved subjects' health significantly. This is a very promising study as it was very thoroughly designed in relation to the previous ones. It seems to illustrate that video games are a highly effective supplement to traditional therapy.

Conclusion

All the research discussed previously has had various purposes. Some looked to illustrate the effectiveness of video games in improving a player's cognition, others compared video game play as a treatment to traditional therapies and medicines, and even more meant to explain why video games could be beneficial to the brain. However, what does this all mean? Video games, whether they be commercially available or specifically designed, can be an effective treatment for various ailments alongside traditional treatments and sometimes by themselves. The fact that commercial games seem to be just as effective, if not more so, than specially designed games is attractive, as that means that there is a vast pool of treatments out there that is cost-effective and widely available right now. Does this mean that doctors should just drop traditional therapies and treatments right away in favor of video games? When one observes the previously discussed studies, they can see some problems. While commercial video games are effective, there is also a right and wrong way to utilize them for treatment. A patient buying a video game and casually playing it at home may or may not be what they need for treatment. Also, the last few studies that were discussed seem to indicate that video games are very effective as a treatment modality when they are used as a supplement to traditional therapy, rather than on their own. For these reasons it seems that the best way that medicine can begin to incorporate video games into their treatments is as a supplemental treatment rather than a standalone. This gives the benefits seen the studies along with a little more control on the part of the doctors and treatment providers, meaning

that it can be ensured that the video game is being played in a way that it would actually help the patient, rather than have not affect or even harm them. This is not to say that there will not be more and more video games such as EndeavorRX, which was approved by the FDA to help treat ADHD, in the future; games that are specifically designed and prescribed to be a standalone treatment for a patient's ailment. However, at the current moment, video games, these powerful tools that foster motivation and affect the makeup of their player's brains, can be used to add on to and improve current therapies and treatments for several different illnesses and disorders.

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