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Is Video Enjoyment Deeper for Those with ADHD?

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ABSTRACT

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To find if video enjoyment was deeper for people with ADHD (attention deficit/hyperactive disorder) than for their non-ADHD peers, subjects with ADHD, and without, had their eye movement tracked during video exposure to determine average saccade rates. I interviewed subjects using pre-tested statements to establish periods of flow state (a measure of enjoyment). Results indicate that there is a deeper sense of enjoyment for people with ADHD, as subjects with ADHD passed a greater average time in flow state during video consumption (27% compared to 21%). Furthermore, the effects of flow state on the eye movement of those with ADHD was much greater than the effects of flow state on the eye movement of the non-ADHD control group. Average saccade rates jumped up 0.15 saccades per second when comparing out-of-flow to in-flow states for the ADHD group, while the average saccade rate for the non-ADHD group increased only 0.03 saccades per second when comparing out-of-flow to in-flow states. This helps further understanding of why people with ADHD consume more screen time than their non-ADHD peers; they may be more inclined to choose video consumption as an activity since the enjoyment they receive from video consumption is deeper and more frequent.

Keywords: flow state, eye tracking, saccade, Attention Deficit Hyperactive Disorder, video, enjoyment

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DESCRIPTION OF THESIS STRUCTURE

This Thesis, *Is Video Enjoyment Deeper for Those with ADHD?* is written in accordance with structural standards of Brigham Young University and The Department of Communications. It includes an introduction, literature review, methods, hypotheses, results, and discussion sections; the results section includes one table. Following the discussion section, a complete list of references is given. Thereafter is an appendix including statements used to measure flow state (appendix A), a copy of the visual aid used during interviews (appendix B) and a copy of the consent forms given to the subjects (appendixes C and D).

Introduction

People with attention-deficit/hyperactivity disorder (ADHD) consume significantly higher levels of screen time than their non-ADHD peers (Acevedo-Polakovich, 2005; Swing, Gentile, Anderson, & Walsh, 2010). This leads one to question causational order; do people have ADHD because they consume more screen time? Or do they consume more screen time because they have ADHD? Arguments have been made for both scenarios; for example, the fast-paced arousal habituation hypothesis suggests that as people become accustomed to the fast-paced world of media, the rest of the world seems relatively dull, and attention difficulties can be manifested (Lang, Zhou, Schwartz, Bolls, & Potter, 2000; Nikkelen, Valkenburg, Huizinga, & Bushman, 2014). Others have hypothesized that because those with ADHD tend to have difficulties with peer interactions, they would naturally end up seeking more solitary forms of entertainment such as increased screen time (Nikkelen et al., 2014). A possible driver for greater consumption of screen time explored in this thesis, is that for someone with ADHD, screen time may be a more enjoyable experience, or even create a sense of relief from the pains of the disorder.

Two key theories have been employed in seeking for evidence of screen-time induced enjoyment and relief: flow theory, and uses and gratifications theory. Flow state is a seminal theory for explaining, and measuring, human enjoyment (Csíkszentmihályi, 1975), and uses and gratifications is a media theory exploring why an audience might purposefully choose a specific medium and/or content (Ruggiero, 2000). There are two possible routes explored in this paper for video to be more enjoyable to someone with ADHD: one is that a media-induced flow state (or a state of enjoyment), is easier achieved for people with ADHD. The other, is that said flow state is a more profound experience for someone with ADHD than for their neurotypical (someone with no mental or emotional disorders) peers -- that video consumption not only brings enjoyment, it additionally brings relief from their ADHD-related suffering.

As part of this thesis, I sought to discover if flow state is easier achieved while watching video for those with ADHD. In order to achieve this goal, I employed interview techniques to discover total number of seconds in flow state during in-lab video consumption, and then comparing the results between the ADHD subjects with their neurotypical peers. To discover if flow state is more profound for someone with ADHD, I used eye tracking, which allows observers to see if an ADHD subject's eye movement is becoming similar to how one would expect it to be when the subject is experiencing the relief of medication; which would be similar eye movement to a neurotypical peer (fried et al., 2014). Normally, when off medication, a person with ADHD will have significantly different eye movement — specifically manifested in a greater number of saccades (jumps in eye movement). However, when on ADHD-specific stimulant medication, saccade rates of a person with ADHD, slow down, and regulate to be the same as their neurotypical peers (Fried et al., 2004). The primary assumption of this thesis is that slowed saccade rates as described by Fried et al. (2004), are a valid measure for relief of ADHD symptoms, and that differences in saccade rates would indicate the profoundness of said relief.

Literature Review

The literature examined here first explores flow theory as introduced by Csíkszentmihályi in the 1970's. I then discuss some of the fundamentals of uses and gratification theory to examine the study of why someone might purposefully choose specific a specific mode of media consumption. Afterwards, I provided an overview of what ADHD is, how it is diagnosed, and how it is treated. Following that, I examined some of the research involving ADHD and media;

looking at learning, attention, and media consumption. I then examine the ADHD relationship to flow state. While there is a gap in the research examining ADHD specifically and flow state, there is literature surrounding flow state and attention, and some similar biochemical points of interest. Finally, I discuss eye tracking as a measure, and some of the existing research involving eye tracking ADHD and eye tracking flow state.

Flow State

Csíkszentmihályi introduced flow theory to the world in the 1970s in an effort to describe the optimal human experience. Flow state is characterized by total absorption in a task, in a way that leaves one feeling untaxed by the efforts needed for the task (Csíkszentmihályi, 1975). In flow state, one experiences heightened attention levels, a feeling of control, a balance between one's skills and the demands of the task, a loss of self-awareness, and ultimately a feeling of enjoyment (de Manzano et al., 2013; Sherry, 2004). Pop culture often describes this flow state as "being in the zone." Csíkszentmihályi (1993) describes activities that are most likely to create a flow state as those that "(1) have concrete goals with manageable rules, (2) make it possible to adjust opportunities for action to our capabilities, (3) provide clear information on how we are doing, and (4) screen out distraction and make concentration possible." (p. xiv). Sherry (2004), introduced a secondary realm of flow study — focused on a flow state that is specifically induced by media consumption. Sherry (2004) claimed that media consumption can readily induce that in-the-zone-feeling of flow state. An essential element of flow state is that it is best achieved when skill levels are balanced with task demands (Sherry, 2004). Flow will not occur if the challenges are imbalanced with the skill levels of an individual. Therefore, if consumed media presents challenges that are too easy compared to skill levels, then the individual will feel bored. If the media presents tasks that are too difficult compared to skill levels, the individual will feel frustrated (Sherry, 2004). When the task matches skills perfectly, then those feelings of being underwhelmed, or overwhelmed, are avoided; energy levels are at peak efficiency; and flow can be readily achieved. Sherry (2004) offered further descriptors of media enjoyments that align with one being in flow state: "focused concentration, loss of self-consciousness, a sense that one is in control of the situation, distortion of temporal experience, and the experience of the activity as intrinsically rewarding" (p. 336). The tasks of an experiment testing for flow can be done consecutively, as flow state does not involve any transitory time; one shifts in and out of flow state suddenly from one moment to the next (Weber, Tamborini, Westcott-Baker, & Kantor, 2009).

Sherry (2004) compared some basic cognitive differences in which games are most flow state inducing, with the different cognitive styles commonly associated with the male and female genders. Sherry (2004) noted an inclination for males to enjoy video games with depth movement such as first person shooters, while females tended to enjoy video games involving color and verbal memory such as puzzle games. In recommending future research, Sherry (2004) proposed that other cognitive differences involving media and flow state be explored. While many flow and media studies, like Sherry's, use video games as a flow-inducing medium, any form of media can be flow inducing. Even the most basic information processing required to understand a simple, still photo can challenge skills at the perfect level; and create flow for the observer (Sherry, 2004). However, Omori, Nagano, Kobayashi, & Katayama (2014) suggested that flow state is easier to achieve in circumstances where both audio and visual sensory input is present, when compared to visual-only input. Video consumption serves the needs of supplying audio and visual information, while still moving into areas of research differing from video games.

Uses and Gratifications

As flow state is a measure of enjoyment, it is relevant to discuss the basics of the uses and gratifications theory of media. Uses and gratifications (U&G) is a set of theories used to describe why audiences choose to use specific media, and what they get from it (Katz, Blumer, & Gurevitch, 1974; Katz, Gurevitch, & Haas, 1973; Ruggiero, 2000). The primary assumption of U&G is that people purposefully select media to suit their desires and needs. Some go for information, escape, social purposes, entertainment, or as simply a filler for the silence in their homes (Bays, 2008; Mendelsohn, 1964; Ruggiero, 2000). The more a media choice fills these needs, the more it is enjoyed, and the more it is sought after (Ruggiero, 2000). U&G has its roots in the 1930s and 40s when researchers began seeking to understand motives and patterns of selection for mass media (Ruggiero, 2000). Contrary to the popular propaganda theory at the time asserting a magic bullet or hypodermic needle effect of media that would be both clear and immediate, this research did not assume an idle, all-absorbing audience (Baran & Davis, 201; Neuman & Guggenheim, 2011). Rather, it assumed the audiences had an active role in their interactions with media, and would choose to absorb some content and channels, while filtering out others (Baran & Davis, 2015). A channel, or program, would be actively selected rather than passively received. Schramm, Lyle, and Parker (1961) found that children's television choices are influenced by peers, parents, and their mental abilities. Other correlations of actively chosen media were found in demographics, time capacities, and cultural needs.

Mood management became a secondary path of exploration under the U&G paradigm when Bryant and Zillman (1984) found that people who were feeling stressed tended to choose tranquil programs, and those who were feeling bored tended to choose programs that were more exciting in nature; thus, they theorized that people actively choose media to moderate their emotions and states of arousal. This is a point of interest for those with ADHD since increasing arousal, or acting as a stimulant, is what the most effective ADHD medications do (Advokat, 2010). Also, seeking the balanced state between boredom and stress is the key to creating the enjoyment, and heightened attentiveness, of flow state. Extra time spent by those with ADHD watching television compared to controls may be explained through Agarwal and Karahanna's (2000) cognitive absorption hypothesis, a hypothesis that accounts for time loss among individuals when they engage in an activity that is "highly pleasurable, excites cognitive and sensory curiosity, and arouses imagination" (Beyens, Vandenbosch, & Eggermont, 2014, p. 5).

About ADHD

According to the 5th edition of the *Diagnostic and Statistical Manual of Mental Disorders,* the essential features of attention-deficit/hyperactivity disorder (ADHD) are "a persistent pattern of inattention and/or hyperactivity-impulsivity that interfere with functioning, or development" (Association, 2013 p.59). Inattention manifests itself behaviorally in people with ADHD as wandering off task, lacking persistence, having difficulty sustaining focus, and being disorganized; and it is not due to defiance or lack of comprehension (Association, 2013). The diagnostic manual points out that to receive a diagnosis of ADHD, one must have symptoms present in childhood, and in more than one scenario (i.e., not just at school) (Association, 2013). Despite the prolific studies performed on ADHD, the precise causes and biochemical mechanisms behind the disorder are not yet fully understood (Cortese, 2012). There is, however, enough research to show that structural abnormalities do exist in the brains of those with ADHD. According to Cortese (2012), various brain-scanning techniques displayed differences in cortical thickness, differences in brain wave patterns, and differences in neurotransmitter presence for patients with ADHD when compared to those who do not have ADHD. Studies on families and genetics have shown that ADHD has a substantial genetic component (Faraone & Biederman, 1998); indeed, Cortese (2012) stated that ADHD is “one of the most heritable psychiatric disorders” (p. 427).

Treatment for attention deficit/hyperactive disorder is primarily pharmaceutical via stimulant medications, and secondarily, behavioral training to help the patients integrate into their cognitively different society (Faber Taylor and Kuo, 2011). With medication, an ADHD patient experiences an increase in dopamine levels (Volkow, 2001), increased attentiveness, and a reduction in physical pain sensation (Snyder, 2015). It may seem counterintuitive to treat hyperactivity with a stimulant, however, for those with ADHD, stimulants have a calming effect (Marx, 1999). This makes sense when one understands that ADHD is often ascribed to an under-arousal of executive functions in the brain (Fried et al., 2014), particularly the parts of the brain responsible for filtering out irrelevant sensory information before that information enters into a state of active cognition (Green & Ostrander, 2009). The visible hyperactivity in those with ADHD is often a manifestation of the individuals trying to wake up their sensory filter so that they may be more able to pay attention (Zentall & Zentall, 1983). The other common behavioral manifestation of ADHD is daydreaming, which is a coping mechanism for when a person with ADHD is experiencing information overload (Roberts, Milich, & Fillmore, 2012). Mentally retreating into daydreams is a way to avoid the overwhelming information bombardment. As medications wake up the information filtering functions, hyperactivity and daydreaming are reduced, and the patient’s capacity to focus on one task, for an extended length of time, is increased (Ibrahim & Donyai, 2014).

ADHD and Media

The media-ADHD link in current literature is weakened by being primarily based on ADHD-related behaviors that can manifest themselves in people that don't actually have ADHD (Weinstein, Staffelbach, & Biaggio, 2000). The behaviors most examined in research are inattentiveness, hyperactivity, and impulsivity (Nikkelen et al., 2014). Surveys and attentiveness/memory exams are the tools most frequently used in research, with the findings being mixed depending on medium, and populations, studied. For example, teachers report higher attentiveness problems from their students who consume more television and video games (Swing et al., 2010). However, other literature shows the relationship between ADHD and media as more complex: in Nikkelen's (2014) meta-analysis, it is suggested that there is a difference for media and ADHD-behavior correlations between males and females; that males display of ADHD-related behaviors have a stronger increase with media consumption. A 2006 study showed that children with ADHD did indeed consume more hours of television than their neurotypical peers, however, as their television consumption increased, attentiveness test results did not change. While on the other hand, the neurotypical children did have declining attentiveness scores as their television consumption increased (Acevedo-Polakovich, Lorch, Milich, & Ashby, 2006). In a study examining the effects of hypermedia instruction in the classroom, all children performed better on the follow-up exams than they had on exams following traditional non-screen-based instruction. The neurotypical children improved a little, while the ADHD children improved dramatically; earning scores equal to their neurotypical peers (Fabio & Antonietti, 2012). Stern and Shalev (2013) found that ADHD subjects scored higher on reading comprehension tests when text was well spaced and displayed on a screen, rather than when text was consumed on printed paper. Finally, visual attentiveness has been shown to improve after video game use (Schubert et al., 2015). Indeed, not all screen-time types and not all brain-types are showing the same correlations, and further research examining the details of the ADHD-media usage correlation is needed.

Flow State and ADHD

The balance required between skill and task challenges in flow state has led to research that showed that available attentional resources are predictive of the flow state experience (Weber et al., 2009). In other words, differences in attentional capacity that one starts with creates differences in when, and whether, flow state is experienced. This would suggest that those with a diagnosable level of attention difficulties will have flow state induced by different activities, or experiences, than those of their neurotypical peers. Flow state is also of particular interest for those with ADHD since it is associated with heightened attentiveness (de Manzano et al., 2013), which suggests that the flow itself would be a remedy for the malady of inattentiveness. Yoshida et al. (2012) put this hypothesis to the test when they studied cognitive behavioral therapy for those with injury-induced attention deficits. They created therapeutic gaming tasks, one with qualities likely to induce flow, the other not, and compared attention recovery rates of patients using the different games. The participants given the flow game showed greater improvement in attention than those given the control game. This phenomenon may aid in explaining why hypermedia instruction creates significantly better academic test results for children with ADHD when compared to traditional non-screen instruction (Fabio & Antonietti, 2012). The hypermedia instruction can be experienced at a challenge level that matches the child's skills. The child can move on to more instruction at their own pace, rather than be bored by the instructor going slower than their capacities, or frustrated by the instructor going faster than their capacities. In this flow state, their attentiveness is heightened, and their usual ADHD hindrances for learning are overcome (Fabio & Antonietti, 2012). In this context, if in a mediated environment they get to be equal with their peers, one can understand higher levels of media usage for someone with ADHD. That experience may offer a feeling of relief for those who are otherwise performing at a lower level.

Furthermore, flow state is associated with some interesting medical aspects of ADHD—namely the positive association of flow state and the increase of dopamine levels in the brain (De Manzano et al., 2013, Marr, 2001), which is also the highly effective pharmaceutical approach for treating ADHD in the medical world (Wu, Xiao, Sun, Zou, & Zhu, 2012). That is, the stimulants in ADHD medication have the primary effect of elevating dopamine levels in the brain (Volkow et al., 2012). A person with ADHD experiencing the medication-mimicking effect of flow state may find relief in feeling capable of attention, feeling equally capable of success with their peers, and experiencing physical pain reduction (Treister, Eisenberg, Demeter, & Pud, 2015). People with ADHD may, in fact, be turning to flow-inducing media as a form of self-medication. This would not be the first suggestion that an environment could create an effect similar to that of medication used in ADHD treatment; Taylor and Kuo (2009) showed that effect when exposing children with ADHD to natural environments. The researchers found that attentiveness in those with ADHD can be recovered with tasks that are gently absorbing, and that nature walks provided this recovery from attentional fatigue at levels equal to Ritalin® (a common stimulant medication used for ADHD). Another method of measuring whether or not medication-like attention is recovered in a patient with ADHD is found in eye tracking.

Eye Tracking

Louie Émile Javal is often credited for introducing the research method of eye tracking into academia (Lebensohn, 1939). He was an ophthalmologist who noticed eye movement was not consistent in human beings while they read. In Javal's day, eye tracking was an invasive experience for research subjects. Researchers would apply anesthetics to the subject's eyes, and then place contact lenses (with metal coils attached to them) on their eyes. These coils interacted with magnetic fields, which yielded numeric data of the subject's eye movement (Chennamma & Yuan, 2013). Eye tracking has evolved to become increasingly less invasive, and increasingly detailed in the data offered. Electro-oculography attaches electrodes to the skin around the eyes to measure subtle movement in the surrounding skin and muscles, and is particularly useful in detecting eye movement in closed eyes. Video recordings leave the subject untouched and yield any date the camera can capture. Today, infrared oculography offers extreme details in the precise look zone of the observed media, and millisecond measures of fixations; this can be achieved through glasses with an infrared sensor, or a sensor placed near a computer screen (Mele & Fredrici, 2012).

Some of the most common measures used in eye tracking are saccades, fixations, look zones, attentional blink, and pupil diameter. Saccades indicate a shift in direction of where a person is looking. Fixations are places where a subject continues to look for an extended measure of time (often measured in milliseconds). A look zone is any area that fixations are considered likely, or a pre-established area of interest, for the purposes of any particular research needs. Attentional blink describes the time it takes to shift eyes from one look zone to another, and pupil diameter examines whether the pupil is becoming larger or smaller than normal, which can be attributed to light conditions and/or emotional responses (Holmqvist et al., 2011).

To date, eye tracking has yielded many insights into the nature of cognitive disorders. For example, smooth movements, and catch-up saccades, are impaired in individuals with schizophrenia, and individuals with Autism show significantly fewer fixations on other human eyes (Karatekin, 2007). ADHD has not been left out of this research.

Eye Tracking ADHD

In 1999, Amador-Campos, Aznar-Casanova, Bezerra, Torro-Alves, and Sánchez used eye tracking to find an association between attentional blink and ADHD. Attentional blink describes the time (and inferred difficulty) to attend to a second target when it has appeared close to a primary one. Essentially, the subjects with ADHD had a longer lag time before their eyes fixated on the second target. Carr et al. (2006) noticed that anticipatory saccades were different in those with ADHD. Thereafter, Donnadieu, Berger, Lallier, Marendaz, and Laurent (2014) found that the attentional blink, or lag time, was stronger when the ADHD subjects were younger. Pishyareh, Tehrani-doost, Mahmoodi-gharaie, Khorrami, and Rahmdar (2015) showed that children with ADHD had an attentional bias towards emotionally negative content, shown by a greater number, and longer duration, of eye fixations on content rated as commonly inducing negative valence emotions.

Fried et al. (2014) tested ADHD subjects with and without their ADHD medication and compared their eye movement to a neurotypical group. They discovered that eye movement is significantly different for the ADHD group when off their medication. The differences primarily showed in the saccades and blink rates. However, with medication, the saccades of the ADHD subjects became similar to the saccades of the neurotypical control group. The only eye tracking measure that remained different in the ADHD group while on medications was the pupil diameter, with smaller than control group diameters when the subjects were off their medication and larger than control group measures when the subjects were on their medication. Fried et al.,

(2014) concluded their study with such confidence in their findings that they recommend that medical doctors use eye tracking as a diagnostic tool for ADHD.

Eye Tracking Flow State

Research on finding precise physiological measures for flow state is still in its infancy. There has been sufficient evidence, however, that physiological changes are present during flow state. Omori et al. (2014) recorded that while in flow state, subjects had an increase in heart rate, blood pressure, and a decrease in blood flow. Eye tracking measures have shown that while in a state of immersion (a contributing aspect of flow state in line with the cognitive absorption hypothesis), subjects tended to have fewer fixations per minute, the more they were immersed in a medium (Jennett et al., 2008). Furthermore measurements of the muscles around the eyes have been recorded to indicate physical manifestations of positive valence emotions for subjects while in flow state (Nacke & Lindley, 2008). Further research is needed to discover if flow state has any other predictable eye movement measures.

Hypotheses

If people with ADHD are easier to bring into a video-induced flow state than their peers, it would follow that they would experience a greater number of seconds in the flow state when consuming videos. If flow state mimics ADHD stimulant medication, then saccade rates should go down for those with ADHD, and possibly for those without ADHD. If the video-induced flow state experience is more profound than for those with ADHD than those without, it would follow that differences in saccade rates between in-flow and out-of-flow states would be greater for those with ADHD than those without ADHD. Accordingly, the following hypotheses emerged for testing:

H_1 Subjects with ADHD will have a greater total time in a state of flow, than those in the neurotypical group, when they are exposed to the same video content.

H_2 Average saccade rates will be lower during flow state, than non-flow state, for both the neurotypical and ADHD groups.

H_3 The differences in average saccade rates between flow state and non-flow state will be greater for the ADHD group than for the neurotypical group.

Methods

Although the results of the three hypotheses are quantitative in nature. the methods used for this Thesis were a mix of qualitative and quantitative approaches. This methods section will first describe the sample of subjects; primarily young adults with, and without, ADHD. I will then layout the measures used to determine flow state status, and saccade rates (a questionnaire and an eye tracking computer program). Finally, I will explain the lab procedures utilized to achieve the desired measures, involving consent forms, tracked video consumption, and interviews with the help of a visual aid.

Sample

The sample was a convenience sample. I began recruiting via announcements before classes at my university. At times participants would inform their acquaintances about the study, and volunteers would present themselves from this word-of-mouth reference. In total, 8 adult subjects with ADHD participated in the study, and 20 neurotypical adults participated. The subjects were primarily young college aged (late teens and early twenties), though some were as old as 35. For consistency in calculations, 8 of the neurotypical peers were selected to be in the control group, and their selection was based on percentages offered by © iMotions (2016) indicating amount of eye movement data successfully collected; subjects with the highest percentage of collected data were used.

Group one. Group one was composed of adults with ADHD that were diagnosed by a medical doctor, and who had felt that stimulant medication was significantly helpful. As ADHD is, to date, most commonly diagnosed by behaviors, this can lead to some difficulties in research, as the behaviors can be mimicked by a number of other disorders. Doctors can even misdiagnose non-disordered people who are temporarily bored (Curatolo, D'Agati, & Moavero, 2010). Many of those who are misdiagnosed filter out over time, as they discover the ADHD medication do not work for them, and/or as new insights to their conditions emerge. To filter out those who have been misdiagnosed, ADHD adults must have felt that stimulant medication had been helpful. In order to retrieve data reflective of a natural ADHD state, subjects with ADHD were asked to come to the lab with no stimulant medications in their system (24 hours off of medicine). ADHD Medications do not need to be taken continuously for effectiveness, and many doctors even suggest the occasional "drug holiday" (Ibrahim & Donyai, 2014, p. 1) to ensure sensitivity.

Group two. Group two was composed of neurotypical adults—those who have no medical diagnosis of any mental, emotional, or personality disorder.

Measures

I sought measures that had been through validation testing, however, as this study is the first of its kind, the combination of these measures is done in an innovative manner, and could therefor benefit from further validation testing in future research. For example, while the statements in the interview were pre-established, applying the statement to determine specific time-stamped moments of video consumption is new to this study. While comparing saccade rates between ADHD and neurotypical subjects has been done before (Fried et al., 2014), combining those saccade measures with the flow state questionnaire is new to this study.

Instrument one. Construct validity was established by applying measures tested and validated in past research. Periods of flow state were determined by first, dividing the video into 10 second segments, which is a length of time used in past eye tracking research (Sears, homas, LeHuquet, & Johnson, 2010; Santella, Agrawala, DeCarlo, Salesin, & Cohen, 2006). Then a set of statements that were developed, and tested by Magyaródi, Nagy, Soltész, Mózes, & Oláh (2013), were used to determine whether the subjects were, or were not, in flow state during each segment. The statements excellently capture Sherry's (2004) descriptors of media enjoyments that match flow state: "focused concentration, loss of self-consciousness, a sense that one is in control of the situation, distortion of temporal experience, and the experience of the activity as intrinsically rewarding" (p. 336). The questionnaire developed by Magyaródi et al. (2013) uses two factors: balance of skills with challenges, and absorption. For example, the following are some of the statements Magyaródi et al., (2013) used to determine whether a subject had experienced balance of their skills with the challenges they faced: "I knew exactly what I had to do, and I acted accordingly," "This task was not too difficult," "I felt that what I had to do matched my skills well," and "I could effortlessly perform well." Subjects were instructed, in line with Sherry (2004), that the "task," or "challenge," in the statements referred simply to the task of making sense of the video. Some exemplary statements used to determine absorption of the subjects into the media were, "The activity totally engrossed my attention," "I forgot about the progress of time all along," "I fused with the task," and "I forgot about my close environment." There were also some negative statements such as, "I was bored," and "My attention was not engrossed at all by the activity," that were used to determine if subjects were not in flow state (Magyaródi et al., 2013, p 92–93). (See appendix A for the full list of statements). In order for a 10-second segment to be measured as a period of flow state, the interviewee must have pointed out the segment as being representative of at least one statement indicative of a skills-to-challenge balance, and at least one statement indicative of presence of absorption. The segment must also have not been pointed out as being indicative of any negative statements. Often, subjects would volunteer information that a segment was "negative," or the opposite of the positive statement; those were marked as negative statement segments and eliminated from being a possible segment of flow state. Full analysis of the interviews yielded a timeline for each subject, with each 10-second segment of the video being identified as times of "in flow" and "out of flow" state.

Instrument two. To measure saccades, the eye tracking program © iMotions (2016) was used. The settings for © iMotions (2016) fixation data (maximum time between fixations 75 milliseconds, velocity threshold 30 degrees/second, maximum angle between fixations 0.5 degrees, maximum gap length 75 milliseconds, window length 20 milliseconds, and maximum fixation duration 60 milliseconds) were all configured according to the guidelines established by Komogortsev, Gobert, Jayarathna, Koh, and Gowda, (2010). After tracking a subject's eye movement, © iMotions (2016), produced a report of all instances of saccades with a media timestamp associated with each instance. These saccade instances were totaled in 10-second segments identical to the segments used in the interviews for measuring flow state. Afterwards, the statistics program ©SPSS (2016) was used for the calculation of frequencies.

Instrument three. Video content that the subjects consumed was selected from, and compiled from ©YouTube (2016). The content was chosen for the purpose of covering a broad spectrum of genres and interests in order to increase the chances of all subjects entering into flow state at least once. Content included (a) Animated blobs going down a slide, ringing a bell, and going into a hole; (b) Dennis Northcutt racing an ostrich, and the physics of what makes ostriches so fast is explained; (c) An animation of two people dancing to techno music with bright colors; (d) Two men on a stage sit down at the typewriter-like machine while the audience is in anticipation; (e) "The Most Satisfying Video In The World": swirls growing on machinery, a can-crushing machine, toy trains going in a figure eight, tomatoes being sliced, a machine creating an Eiffel Tower figurine, bricks being cleaned with a hose, marbles rolling down a wooden trail, a machine sorting batteries, camouflage being applied to a helmet, a plastic toy with gears being spun into place, electric tape being wound around a wire, a wavy sea creature swimming, a taffy-pulling machine in action, carrots being harvested, something that looks like frost being burned off a lawn, a foot pressing on ice to crack it, egg yolks on a slide, a close up of a drill going into metal, a metal snowflake sliding into a metal casing, sparks cleaning rusty metal, a truck backing up to pick up a load of yellow tubes, a purple ball nearing a plastic chair that melts, cake being frosted, a tree being shredded, spiraling water, a stack of papers being cut, a cookie being frosted, a hot drill in metal, a watch with spinning cogs, a baseball being smashed, and a mountain biker on hills; and (f) A balloon in a museum approaching a cactus, and then the cactus pops.

Procedures

Subjects were asked to come to an eye tracking lab on the BYU campus to watch the six short video clips, which were presented consecutively, and in randomized order. The subjects were positioned about 60 centimeters from a 24-inch screen. After carefully calibrating the subject's eyes with an infrared camera, © iMotions (2016) eye tracking was used during the video consumption to measure instances of saccades. I made adjustments to focus, or direction, of the infrared eye tracking camera as needed, during the video consumption, to maintain accurate calibration throughout any minor movements made by the subjects. Afterwards, I interviewed subjects to determine if, and when, they were in flow state during the aforementioned video consumption. For the interview, I offered participants a set of numbered still shots (of every 10 seconds of the presented video) as a visual aid (see Appendix B) to discuss the timing of their experience. The interview structure was primarily qualitative to best capture timing of the flow state in the individual subjects. I then read the subjects the statements previously discussed that were constructed by Magyaródi et al. (2013). Subjects then pointed out 1–3 pictures on the visual aid that most closely matched the statements read to them. I asked follow-up questions as needed for clarity.

Saccade rates for each subject yielded from © iMotions (2016) were then split into 10-second intervals to match the 10-second intervals used for the interviews. Averages were then calculated for saccade rates by group and by state (in flow, or out of flow). With that information, I was then able to align the interview data with their individual eye tracking reports to determine saccade rates during in flow and no-flow states.

Results

This results section covers how the first hypothesis regarding those with ADHD passing more time in flow state was confirmed, however the small sample size left that confirmation without statistical significance. Hypothesis 2 regarding saccade rates being lower for both groups while in flow state was refuted, but without statistical significance. Hypothesis 3 regarding those with ADHD having a greater difference in saccade rates when comparing in flow state to out of flow state than the neurotypical controls was confirmed with statistical significance. A table displaying average saccade rate means, and a figure plotting out the average means, have been provided. Finally a paragraph exploring some qualitative descriptions the subjects gave of what likely did, or did not, trigger a flow state for them is provided.

Hypothesis 1 stated that subjects with ADHD would have a greater total time in a state of flow than those in the neurotypical group, when they were exposed to the same video content. In total, ADHD subjects passed 26.9% of their time in flow state, a collective of 970 seconds, or an average of 121.25 seconds in flow state per subject. The neurotypical subjects, on the other hand, passed 21.1% of their time in flow state, a collective of 760 seconds, or an average of 95 seconds in flow state per subject, a lower percentage than that of the ADHD group. However the sample size was too small to confirm statistical significance. A chi-square analysis revealed x^2(1,720) = 3.36, $p < .05$. While there was an approach of significance $p = .07$, the standardized residual was < +-1.96 indicating a larger sample size would be needed to verify significance. Ultimately, Hypothesis 1 was confirmed in that those with ADHD did pass a greater total number of seconds in flow state, but a larger sample size would be needed to confirm statistical significance.

For hypothesis 2, I suggested that saccade rates of all subjects would be lower while the subjects were in flow state. The results of an independent t-test showed the opposite to be true: the mean number of saccades for both groups while in flow state was 0.86 saccades per second ($M = 0.86$, $SD = 4.97$), while the mean number of saccades for both groups, while not in flow state, was 0.77 saccades per second ($M = 0.77$, $SD = 0.75$) —demonstrating an increase in saccades during flow state, but this difference was not statistically significant $t(179.98) = -1.83$, $p > .05$. Again we have an approach to significance with $p = .07$, indicating a larger sample size would be helpful for clarification. All together the data refuted hypothesis 2, but no significantly so.

For hypothesis 3, I focused on the differences of saccade rates between in, and out of, flow states for each subject group, and stated that the difference in saccade rates would be greater for the ADHD subjects than for the neurotypical subjects. The results confirmed hypothesis 3, showing the average saccade rate differing from out-of-flow state, to in-flow state, by + 0.15 saccades per second for the ADHD group: (M = 75.81, SD = 19.04) for out of flow state, and (M = 90.35, SD = 85.68) Meanwhile, the average saccade rate differed from out of flow state, to in flow state, by only + 0.03 saccades per second for the neurotypical group: (M = 77.44, SD = 16.16) for not in flow state, and (M = 80.05, SD 17.57) for in flow state. See Table 1.

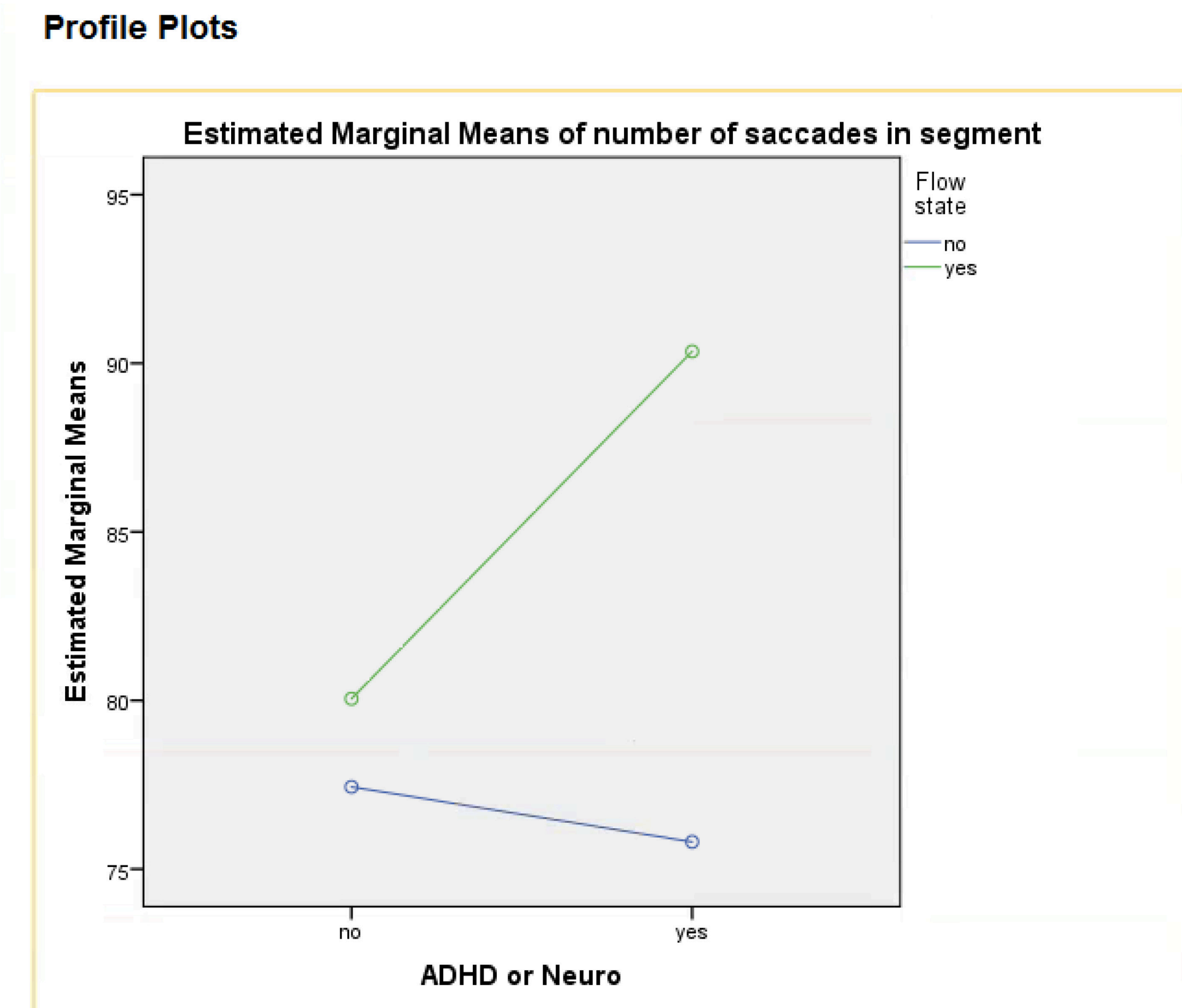
Table 1

Average Saccade Rate

Subject Group	Out of Flow State Saccades per Second	In Flow State Saccades per Second	Difference in Saccades per Second
ADHD	0.758	0.904	0.145
Neurotypical	0.774	0.805	0.031

A profile plot of the estimated marginal means of number of saccades in segment can be seen in Figure 1. The gap between the two points on the left represents the difference in average saccade rates for the neurotypical subjects. The gap on the right represents the difference in average saccade rates for the ADHD subjects. The higher points for both represent flow state.

Figure 1



A two-way ANOVA analysis was conducted on the influence of ADHD and flow state on average saccade rates. ADHD included two levels (ADHD or Neurotypical) and flow state consisted of two levels (in flow, out of flow). The main effect for AHD presence yielded an F ratio of $F(1,716) = 1.95$, $p > .05$, indicating no significant difference between ADHD and

Neurotypicals. The main effect for flow state yielded an F ratio of $F(1,716) = 7.64$ $p < .01$ indicating a significant difference between being in flow state and out of flow state. The interaction effect was significant $F(1, 716) = 3.69$, $p = .05$. Accordingly Hypothesis 3 was confirmed that the differences in saccade rates for between in flow state and out of flow states would be greater for those with ADHD than for neurotypicals; this was confirmed with statistical significance.

Some noteworthy statements came up during the qualitative interviews relating to flow state as well. In confirmation of Magyaródi et al., (2013) statements that measured flow state, subjects cited content of interest, and the balance of their skills with the challenges they faced. One person noted they liked “anything to do with sports,” and another stated they liked “anything to do with food.” In regard to achieving a balance of skills with challenges, subjects would often indicate a segment was not representative of a measuring statement with words like, “I don’t know what was happening here.” Also in line with the desire for a balance of skills with challenges came statements of pacing, with subjects indicating a distaste for video content that was either paced too fast or too slow for them. Some additional points, that were outside of the Magyaródi et al., (2013) measuring statements that came up in the interviews were identification and the vibrations offered by the music. Subjects would manifest aspects of identification by saying, “I could relate to that,” or “I could see myself watching a show with this in it.” One subject pointed out the vibrations of the music as being an important part of their experience, stating that it helped him to relax. While identification and vibrations were not in the statement set by Magyaródi et al. (2013), they are in line with the literature that indicates identification being a part of immersion, which is in turn a part of flow state (Brown, 2015; Magyaródi et al., 2013). These two additional points are also validated by the research by Omori, Nagano, Kobayashi, & Katayama (2014) who proved statements that a combined audio and visual experience amplified the chances of person entering into flow state.

Discussion

This thesis sought to find if video enjoyment was deeper for people with ADHD than for their neurotypical peers. It is known that those with ADHD consume more video than their neurotypical peers (Acevedo-Polakovich, 2005; Swing, Gentile, Anderson, & Walsh, 2010), and in accordance with U&G (Bryant & Zillman,1984; Ruggiero, 2000) I expected that more enjoyment of video would be a driving factor behind that increased consumption of video content. To determine if greater enjoyment was present for those with ADHD during video consumption, time spent in a state of flow, a measure of enjoyment introduced by (Csíkszentmihályi (1975), was observed and compared between neurotypical and ADHD groups -- with the hypothesis that those with ADHD would pass more time in a state of flow. It was also expected that the state of flow derived from video consumption would be more profound for those with ADHD than their neurotypical peers. As flow state was known to also involve heightened attention levels (de Manzano et al., 2013), it was expected that eye movement in flow state would change to a lower saccade rate similar to the change found with the application of typical ADHD medicines used to increase attention (Fried et al., 2004); it further was expected the difference in saccade rate would be larger for those with ADHD to reflect their having been in a deeper state of flow.

Implications

The results indicated that there is a deeper sense of enjoyment for people with ADHD, as subjects with ADHD passed a greater average time in flow state during their video consumption.

Furthermore, the differences in eye movement of those with ADHD was much greater than that of those in the neurotypical control group when comparing in-flow to out-of-flow segments; indicating the flow experience is more profound for those with ADHD. Statistical significance was found for hypothesis 3; offering solidity on the conclusion that those with ADHD have a greater profoundness of video induced flow state. This finding enriches our understanding of why people with ADHD may choose to consume more screen time than their non-ADHD peers, as the enjoyment they receive from video consumption is deeper and, here, more frequent.

I had hypothesized that being in flow state would slow down saccade rates for the ADHD group, much like ADHD medication does (Fried et al., 2004). It turned out, however, the exact opposite was true; that saccade rates actually increased for all subjects while in flow state—with a particularly higher increase for those with ADHD. This finding implies that the increased focus associated with flow state is either (a) not achieved through the same chemical means as stimulant medication, or (b) that additional mental processes involved with flow state overpower the saccade slowing effects that a stimulant medication-like focus would produce. Some explanation may be found in the literature surrounding hypofrontality in the brain. Hypofrontality describes lower levels of activity in the prefrontal and frontal cortex of the brain. These frontal areas are responsible for your conscious, aware, thoughts (Green & Ostrander, 2009). This aligns with flow state as it is described as having a lack of awareness of time and surrounding space (de Manzano et al., 2013; Sherry, 2004). Indeed Dietrich (2004), stated that hypofrontality is a characteristic of flow state; that more of the brain activity happens around the instinctive basal ganglia. It so happens that those with ADHD are also known to have greater hypofrontality than their neurotypical peers (Rubia et al., 1999). It may be that those with ADHD enter flow state with a pre-established strength in employing hypofrontal brain activity, and are consequently able to go deeper into flow state. In spite of reduced frontal cognition levels, flow state is still known for increased attention and productivity (de Manzano et al., 2013; Sherry, 2004). This may make sense when one examines a lesser-known symptom of ADHD: Hyperfocus. Ozel-Kizil et al., (2016) notes that while hyper-focus is not listed in a diagnostic manual for ADHD, there is an observable difficulty in pulling ADHD subjects away from activities that interest them. If people with ADHD can achieved much higher levels of flow state focus than their neurotypical peers, then one could argue that the "deficit" in attention-deficit/hyperactivity disorder may be a misnomer. Perhaps a more accurate title would be "attention-modality/hyperactive disorder."

Limitations

The primary limitation to this study was the small sample size. Although small sample sizes are common for eye-tracking studies (for example, Tsai, Hou, Lai, Liu, & Yang [2012], uses only six subjects), it is always ideal for statistical purposes to have a larger sample. It is also unknown to what degree the aspect of being in the lab itself increased or decreased flow state for the subjects. There was a limitation in the use of self-reporting regarding the medical status of the subjects, and there were some limitations in the video used for the study. For example, subjects did not review full-length films, which could potentially yield different results. Also, for the sake of consistency, the media was not selected directly from the desires of the subjects; which may have limited the aspects of flow state associated with feeling in control of a situation. Finally, the eye tracking tools I used required the use of a desktop computer screen, and therefore, it remains unknown if flow state and eye movement on other screens, such as large theater screen or small mobile devices, would be different. As all of the subjects could be classified as Millennial, there may be a generational and/or age specific aspect to the results; further studies seeking out other age groups would be needed to know for certain.

Implications for Future Research

There are many directions future research could take from this study. For one, more needs to be known about eye movement and flow state: which aspects of eye movement can be expected to been seen when a person is in flow state, and why. Survey, or interview, methods of research could be used to determine enjoyment levels of video consumption for those with and without ADHD as a means of triangulating the data presented here. Since video does not constitute all types of screen time, this study could be replicated using other forms of media consumption (Internet use, game play, music consumption, etc.) to get an all-encompassing picture of screen time use. Indeed, a similar study involving activities outside of screen use (likely using mobile eye tracking devices) would also be important for determining any difference in eye movement for flow state between screen and non-screen consuming activities. A myriad of research avenues remains open that would examine flow state as experienced by those with ADHD—or any other mental disorder, for that matter. What activities are more likely to induce a flow state for people with these different kinds of disorders? Are there any differences in behavioral outcomes of flow state for people with different disorders? Finally, the question remains: if flow state is associated with attentiveness, why did saccades increase while the subjects were in flow state, rather than decrease? A decrease in saccades would have indicated a biochemical mimic of typical ADHD medications. More needs to be learned about hypofrontality as a form of focus, and if it can be harnessed as behavioral or medicinal treatment methods for those with attention issues? Research contributions from those skilled in a variety of disciplines and methods will be needed to answer all of these questions.

REFERENCES

Acevedo–Polakovich, I. D., Lorch, E. P., & Milich, R. (2005). TV or not TV: Questions and answers regarding television and ADHD. *The ADHD Report: Special Issue—Focus on Assessment*, *13*(6), 6–11.

Acevedo-Polakovich, I. D., Lorch, E. P., Milich, R., & Ashby, R. D. (2006). Disentangling the relation between television viewing and cognitive processes in children with attention-deficit/hyperactivity disorder and comparison children. *Archives of Pediatrics & Adolescent Medicine*, *160*, 354–360. http://dx.doi.org/10.1001/archpedi.160.4.354

Advokat, C. (2010). What are the cognitive effects of stimulant medications? Emphasis on adults with attention-deficit/hyperactivity disorder (ADHD). *Neuroscience & Biobehavioral Reviews*, *34*(8), 1256–1266.

Agarwal, R., & Karahanna, E. (2000). Time Flies When You're Having Fun: Cognitive Absorption and Beliefs about Information Technology Usage. *MIS Quarterly, 24*(4), 665–694.

Amador-Campos, J. A., Aznar-Casanova, J. A., Bezerra, I., Torro-Alves, N., & Sánchez, M. M. (2015). Attentional blink in children with attention-deficit/hyperactivity disorder. *Revista Brasileira de Psiquiatria,* 37(2), 133–138.

Association, A. (2013). Neurodevelopmental Disorders. In *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5Ò) (Fifth ed.).* Washington, D.C.: American Psychiatric Publishing.

Baran, S. J., & Davis, D. K. (2015). *Mass Communication Theory Foundations, Ferment, and Future* (7th ed.). Stamford, CT: Cengage Learning.

Bays, H. (2008). On Silence. *Pacific World: Journal of the Institute of Buddhist Studies*, *10,* 3–8.

Beyens, I., Vandenbosch, L., & Eggermont, S. (2014). Early adolescent boys' exposure to Internet pornography: Relationships to pubertal timing, sensation seeking, and academic performance. *Journal of Early Adolescence*, *35*(8), 1–24.

Brown, W. J. (2015). Examining four processes of audience involvement with media personae: Transportation, parasocial interaction, identification, and worship. *Communication Theory*, *25*(3), 259–283.

Bryant, J., & Zillman, D. (1984). Using television to alleviate boredom and stress. *Journal of Broadcasting*, 28, 1–20.

Carr, L. A., Nigg, J. T., & Henderson, J. M. (2006). Attentional versus motor inhibition in adults with attention-deficit/hyperactivity disorder. *Neuropsychology, 20*(4), 430–441.

Chennamma, H., & Yuan, X. (2013). A survey on eye-gaze tracking techniques. *Indian Journal of Computer Science and Engineering, 4*, 388–393.

Cortese, S. (2012). The neurobiology and genetics of Attention-Deficit/Hyperactivity Disorder (ADHD): what every clinician should know. *European Journal of Peadiactric Neurology,* 16(5), 422–33. http://dx.doi.org/10.1016/j.ejpn.2012.01.009

Csíkszentmihályi, M. (1975). *Beyond Boredom and Anxiety*. San Francisco: Jossey-Bass Publishers.

Csíkszentmihályi, M. (1993). *The evolving self: A psychology for the third millennium*, New York: Harper Perennial.

de Manzano, Ö., Cervenka, S., Jucaite, A., Hellenäs, O., Farde, L., & Ullén, F. (2013). Individual differences in the proneness to have flow experiences are linked to dopamine D2-receptor availability in the dorsal striatum. *NeuroImage*, *67*, 1–6. http://dx.doi.org/10.1016/j.neuroimage.2012.10.072

Dietrich, A. (2004). Neurocognitive mechanisms underlying the experience of flow. *Consciousness and Cognition*, *13*(4), 746-761.

Donnadieu, S., Berger, C., Lallier, M., Marendaz, C., & Laurent, A. (2014). Is the impairment in temporal allocation of visual attention in children with ADHD related to a developmental delay or a structural cognitive deficit? *Research in Developmental Disabilities*, *36C*, 384–395. http://dx.doi.org/10.1016/j.ridd.2014.10.014

Faber Taylor, A., & Kuo, F. E. M. (2011). Could exposure to everyday green spaces help treat ADHD? Evidence from children's play settings. *Applied Psychology: Health and Well-Being*, *3*(3), 281–303. http://dx.doi.org/10.1111/j.1758-0854.2011.01052.x

Fabio, R. A., & Antonietti, A. (2012). Effects of hypermedia instruction on declarative, conditional and procedural knowledge in ADHD students. *Research in Developmental Disabilities*, *33*(6), 2028–39. http://dx.doi.org/10.1016/j.ridd.2012.04.018

Faraone, S. V, & Biederman, J. (1998). Neurobiology of attention-deficit hyperactivity disorder. *Biological Psychiatry*, *44*(10), 951–958. http://dx.doi.org 10.1016S0006-3223(98)00240-6

Fried, M., Tsitsiashvili, E., Bonneh, Y. S., Sterkin, A., Wygnanski-Jaffe, T., Epstein, T., & Polat, U. (2014). ADHD subjects fail to suppress eye blinks and microsaccades while anticipating visual stimuli but recover with medication. *Vision Research*, *101*, 62–72. http://dx.doi.org/10.1016/j.visres.2014.05.004

Green, R. L., & Ostrander, R. L. (2009). *Neuroanatomy for students of behavioral disorders*. New York: W.W. Norton & Company.

Holmqvist, K., Nyström, M., Andersson, R., Dewhurst, R., Jarodzka, H., & Van de Weijer, J. (2011). *Eye tracking: A comprehensive guide to methods and measures*. OUP Oxford.

Ibrahim, K., & Donyai, P. (2014). Drug holidays from ADHD medication: International experience over the past four decades. *Journal of Attention Disorders, 19(7)*, 551–568.

iMotions Biometric Research Platform 6.0. (2016). iMotions A/S. Copenhagen, Denmark.

Jennett, C., Cox, A. L., Cairns, P., Dhoparee, S., Epps, A., Tijs, T., & Walton, A. (2008). Measuring and defining the experience of immersion in games. *International journal of human-computer studies*, *66*(9), 641–661.

Karatekin, C. (2007). Eye tracking studies of normative and atypical development. *Developmental Review*, *27*(3), 283–348. http://dx.doi.org/10.1016/j.dr.2007.06.006

Katz, E., Blumer, J. G., & Gurevitch, M. (1974). Utilization of mass communication by the individual. In J. G. Blumler & E. Katz (Eds.), *The uses of mass communications: Current perspectives on gratifications research* (pp. 19-34). London, England: SAGE.

Katz, E., Gurevitch, M., & Haas, H. (1973). On the use of mass media for important things. *American Sociological Review*, 38, 164-181.

Komogortsev, O. V., Gobert, D. V., Jayarathna, S., Koh, D. H., & Gowda, S. M. (2010). Standardization of automated analyses of oculomotor fixation and saccadic behaviors. *Biomedical Engineering, IEEE Transactions on*, *57*(11), 2635–2645.

Lang, A., Zhou, S. H., Schwartz, N., Bolls, P. D., & Potter, R. F. (2000). The effects of edits on arousal, attention, and memory for television messages: When an edit is an edit can an edit be too much? *Journal of Broadcasting & Electronic Media*, 44, 94 –109. doi:10.1207/ s15506878jobem4401_7

Lebensohn, J. E. (1939). Louis Émile Javal 1839-1907: A centenary tribute. *Archives of Ophthalmology*, *21*(4), 650–661.

Magyaródi, T., Nagy, H., Soltész, P., Mózes, T., & Oláh, A. (2013). Psychometric properties of a newly established flow state questionnaire. *Journal of Happiness*, *1*(2), 85–96.

Marr, A. (2001). In the zone: A biobehavioral theory of the flow experience. *Athletic Insight, 131*. Retrieved from http://www.athleticinsight.com/Vol3Iss1/Commentary.htm

Marx, J. (1999). How stimulant drugs may calm hyperactivity. *Science*, *283*(5400), 306–306.

Mele, M., & Federici, S. (2012). Gaze and eye-tracking solutions for psychological research. *Cognitive Processing*, *13*(S1), 261–265. http://dx.doi.org/10.1007/s10339-012-0499-z

Mendelsohn, H. (1964). Listening to the radio. In L. A. Dexter & D.M. White (Eds.), *People, society and mass communication* (pp. 239–248). New York: Free Press.

Nacke, L., & Lindley, C. A. (2008, November). Flow and immersion in first-person shooters: Measuring the player's gameplay experience. In *Proceedings of the 2008 Conference on Future Play: Research, Play, Share* (pp. 81–88). ACM.

Neuman, W. R., & Guggenheim, L. (2011). The evolution of media effects theory: A six stage model of cumulative research. *Communication Theory*, *21*(2), 169-196.

Nikkelen, S. W. C., Valkenburg, P. M., Huizinga, M., & Bushman, B. J. (2014). Media Use and ADHD-Related Behaviors in Children and Adolescents: A Meta-Analysis. *Developmental Psychology, 50*(9). http://dx.doi.org/http://dx.doi.org/10.1037/a0037318

Omori, S., Nagano, Y., Kobayashi, T., & Katayama, J. I. (2014). Psychological and physiological responses during flow state: A study for flow state during a game task. *International Journal of Psychophysiology*, *2*(94), 246–247.

Ozel-Kizil, E. T., Kokurcan, A., Aksoy, U. M., Kanat, B. B., Sakarya, D., Bastug, G., ... & Oncu, B. (2016). Hyperfocusing as a dimension of adult attention deficit hyperactivity disorder. *Research in Developmental Disabilities*, *59*, 351-358.

Pishyareh, E., Tehrani-doost, M., Mahmoodi-gharaie, J., Khorrami, A., & Rahmdar, S. R. (2015). A comparative study of sustained attentional bias on emotional processing in ADHD children to pictures with eye-tracking. *Iran J Child Neurol*, 9(1): 64–70.

Roberts, W., Milich, R., & Fillmore, M. T. (2012). Constraints on information processing capacity in adults with ADHD. *Neuropsychology*, *26*(6), 695–703.

Rubia, K., Overmeyer, S., Taylor, E., Brammer, M., Williams, S. C., Simmons, A., & Bullmore, E. T. (1999). Hypofrontality in attention deficit hyperactivity disorder during higher-order motor control: a study with functional MRI. *American Journal of Psychiatry*, *156*(6), 891-896.

Ruggiero, T. E. (2000). Uses and gratifications theory in the 21st century. *Mass Communication & Society*, *3*(1), 3–37. http://dx.doi.org/10.1207/S15327825MCS0301_02

Santella, A., Agrawala, M., DeCarlo, D., Salesin, D., & Cohen, M. (2006). Gaze-based interaction for semi-automatic photo cropping. In *Proceedings of the SIGCHI conference on Human Factors in computing systems* (pp. 771-780). ACM.

Schramm, W., Lyle, J., & Parker, E. (1961). *Television in the lives of our children*. Stanford, CA: Stanford University Press.

Schubert, T., Finke, K., Redel, P., Kluckow, S., Müller, H., & Strobach, T. (2015). Video game experience and its influence on visual attention parameters: An investigation using the framework of the theory of visual attention (TVA). *Acta Psychologica*, *157*, 200–14. http://dx.doi.org/10.1016/j.actpsy.2015.03.005

Sears, C. R., Thomas, C. L., LeHuquet, J. M., & Johnson, J. C. (2010). Attentional biases in dysphoria: An eye-tracking study of the allocation and disengagement of attention. *Cognition and Emotion*, *24*(8), 1349-1368.

Sherry, J. L. (2004), Flow and media enjoyment. *Communication Theory*, *14*, 328–347. http://dx.doi.org/10.1111/j.1468-2885.2004.tb00318.x

Snyder, J. A. (2015). The link between ADHD and the risk of sexual victimization among college women: Expanding the Lifestyles/Routine Activities Framework. *Violence Against Women*, *21*(11), 1364–1384. http://dx.doi.org/10.1177/1077801215593647

Stern, P., & Shalev, L. (2013). The role of sustained attention and display medium in reading comprehension among adolescents with ADHD and without it. *Research in Developmental Disabilities*, *34*(1), 431–9. http://dx.doi.org/10.1016/j.ridd.2012.08.021

Swing, E. L., Gentile, D. A., Anderson, C. A., & Walsh, D. A. (2010). Television and video game exposure and the development of attention problems. *Pediatrics*, *126*(2), 214–221. http://dx.doi.org/10.1542/peds.2009-1508

Taylor, A. F., & Kuo, F. E. (2009). Children with attention deficits concentrate better after walk in the park. *Journal of Attention Disorders*, *12*(5), 402–409. http://dx.doi.org/10.1177/1087054708323000

Treister, R., Eisenberg, E., Demeter, N., & Pud, D. (2015). Alterations in pain response are partially reversed by methylphenidate (Ritalin) in adults with attention deficit hyperactivity disorder (ADHD). *Pain Practice: The Official Journal of World Institute of Pain*, *15*(1), 4–11. http://dx.doi.org/10.1111/papr.12129

Tsai, M. J., Hou, H. T., Lai, M. L., Liu, W. Y., & Yang, F. Y. (2012). Visual attention for solving multiple-choice science problem: An eye-tracking analysis. *Computers & Education*, *58*(1), 375–385.

Volkow, N. (2001). Therapeutic doses of oral methylphenidate significantly increase extracellular dopamine in the human brain. *The Journal of Neuroscience, 21*, 1–5.

Volkow, N. D., Wang, G. J., Tomasi, D., Kollins, S. H., Wigal, T. L., Newcorn, J. H., ... & Swanson, J. M. (2012). Methylphenidate-elicited dopamine increases in ventral striatum are associated with long-term symptom improvement in adults with attention deficit hyperactivity disorder. *The Journal of Neuroscience*, *32*(3), 841–849.

Weber, R., Tamborini, R., Westcott-Baker, A., & Kantor, B. (2009). Theorizing flow and media enjoyment as cognitive synchronization of attentional and reward networks. *Communication Theory*, 19(4), 397–422.

Weinstein, D., Staffelbach, D., & Biaggio, M. (2000). Attention-deficit hyperactivity disorder and posttraumatic stress disorder: differential diagnosis in childhood sexual abuse. *Clinical psychology review*, *20*(3), 359–378.

Wu, J., Xiao, H., Sun, H., Zou, L., & Zhu, L.-Q. (2012). Role of dopamine receptors in ADHD: A systematic meta-analysis. *Molecular Neurobiology*, *45*(3), 605–620. http://dx.doi.org/10.1007/s12035-012-8278-5

Yoshida, K., Sawamura, D., Ogawa, K., Ikoma, K., Asakawa, K., Yamauchi, T., & Sakai, S. (2014). Flow experience during attentional training improves cognitive functions in patients with traumatic brain injury: An exploratory case study. *Hong Kong Journal of Occupational Therapy*, *24*(2), 81–87. http://dx.doi.org/10.1016/j.hkjot.2015.01.001

YouTube (2016, April 25). Thesis movie. Retrieved from https://www.youtube.com/watch?v=099hASBad0Y&t=2s.

Zentall, S. S., & Zentall, T. R. (1983). Optimal stimulation: A model of disordered activity and performance in normal and deviant children. *Psychological bulletin*, *94*(3), 446.

APPENDIX A: FLOW STATE MEASURE STATEMENTS

Statements by Magyaródi et al. (2013) used in the interview to identify flow state:

- I was able to keep up with the challenges.
- I felt I could meet the requirements of the situation.
- I had a grip on the events.
- I felt I was in control over the situation.
- I knew I was able to solve the task.
- I knew exactly what I had to do and I acted accordingly.
- This task was not too difficult.
- I felt that what I had to do matched my skills well.
- I could effortlessly perform well.
- My skills were in balance with the challenges of the activity.
- My mind worked in total harmony with my body.
- My attention was not engrossed at all by the activity.
- It was boring for me.
- The activity totally engrossed my attention.
- I forgot about the progress of time all along.
- I found the task interesting.
- I forgot about the progress of time.
- Time passed faster than I thought it did.
- I fused with the task.
- I forgot about my close environment.

APPENDIX B: VISUAL AID

This has been shrunk for printing purposes. During the study this was presented on two 11 by 17 inch pieces of paper.

APPENDIX C: CONSENT FORM FOR ADHD SUBJECTS

Consent to be an ADHD Research Subject

Introduction

This research study is being conducted by Daisy Milman, a graduate student in the Communications Department at Brigham Young University, and three faculty members: Dr. Steven Thomsen, Dr. Kevin John, and Dr. Robert Wakefield. The faculty members are in the communications department, and will be offering mentoring and aid throughout this Thesis project. This research seeks to determine differences in eye movement during video consumption. You were invited to participate because you qualified as a part of the subject group described as:

Someone over 18 having been diagnosed with ADD or ADHD, and Regularly using a stimulant medication for it that you feel is helpful**. You have also not taken any of your ADD/ADHD medicine in the last 24 hours.**

Procedures

If you agree to participate in this research study, the following will occur:

- You will refrain from taking any ADHD medication for 24 hours before your appointment
- You will be seated in room 233 Brimhall Building at BYU, and asked to look at numbers on the screen to set up the eye tracking.
- You will watch a short compilation of videos. In this video compilation you can expect to see:

1) Animated blobs going down a slide, ringing a bell, and going into a hole.

2) Dennis Northcutt racing an Ostrich, and the physics of what makes ostriches so fast is explained.

3) An animation of two people dancing to techno with bright colors.

4) Two men on a stage sit down at the typewriter-like machine, while the audience is in anticipation.

5) A video of: Swirls growing on machinery, a can crushing machine, toy trains going in a figure eight, tomatoes being sliced, a machine creating an Eiffel Tower figurine, bricks being cleaned with a hose, marbles rolling down a wooden trail, a machine sorting batteries, camouflage being applied to a helmet, a plastic toy with gears being spun into place, electric tape being wound around a wire, a wavy sea creature swimming, taffy pulling machine, carrots being harvested, something that looks like frost being burned off a lawn, a foot pressing on ice to crack it, egg yolks on a slide, a close up of a drill going into metal, a metal snowflake sliding into a metal casing, sparks cleaning rusty metal, a truck backing up to pick up a load of yellow tubes, a purple ball nearing a plastic chair that melts, cake being frosted, a tree being shredded, spiraling water, a stack of papers being cut, a cookie being frosted, a hot drill in metal, a watch with spinning cogs, a baseball being smashed, and a mountain biker on hills.

6) A balloon in a museum approaches a cactus, then the cactus pops.

- You will then go into the adjoining room for an interview that will last between 10-30 minutes.
- The interview will be audio recorded.
- Total time commitment will be up to 45 minutes

Risks/Discomforts

You understand that while no video content was chosen with the intent to offend, there is no guarantee that offense can be 100% avoided for everybody. If at anytime you feel uncomfortable with video content or questions asked in the interview, you may ask to skip that section.

You understand that refraining from taking ADHD medicine may cause some inattentiveness, frustration, and a decline in productivity, however, skipping a dose will not alter the effectiveness of your medication when you start to take it again.

You may feel emotional discomfort at being thought of as "a person with ADHD." However, I, the researcher have ADHD too, and admire the important, and unique, contributions our brains can bring to the world.

Benefits

There will be no direct benefits to you, however, this research aims to expand knowledge of how people with ADHD see the world, and how they relate to video media. I hope my research will give ideas to people who create therapy for those of us with ADHD, and better understanding to the world in general of what our experience is like. You will know you are contributing to these goals.

Confidentiality

Your data will be stored on a password protected computer and/or locked file. There is no foreseeable discard date of data. Your data will be assigned an ID number rather than your name.

Compensation

I will provide you with $10 cash at the end of your participation. $10 will be given whether or not you successfully complete the study.

Participation

Participation in this research study is voluntary. You have the right to withdraw at any time or refuse to participate entirely without jeopardy to your class status, grade, extra credit, or standing with the university.

Questions about the Research

If you have questions regarding this study, you may contact Daisy Milman at daisykmilman@gmail.com for further information.

Questions about Your Rights as Research Participants

If you have questions regarding your rights as a research participant contact IRB Administrator at (801) 422-1461; A-285 ASB, Brigham Young University, Provo, UT 84602; irb@byu.edu. You may also call Daisy Milman at 801-473-7119

Statement of Consent

I have read, understood, and received a copy of the above consent and desire of my own free will to participate in this study.

Name: Signature Date:

APPENDIX D: CONSENT FORM FOR NON-ADHD SUBJECTS

Consent to be a Non-ADHD Research Subject

Introduction

This research study is being conducted by Daisy Milman, a graduate student in the Communications Department at Brigham Young University, and three faculty members: Dr. Steven Thomsen, Dr. Kevin John, and Dr. Robert Wakefield. The faculty members are in the communications department, and will be offering mentoring and aid throughout this Thesis project. This research seeks to determine differences in eye movement during video consumption. You were invited to participate because you qualified as a part of the subject group described as:

Someone over 18 having never been diagnosed with any emotional or mental disorder.

Procedures

If you agree to participate in this research study, the following will occur:

- You will be seated, in room 233 Brimhall building at BYU and asked to look at numbers on the screen to set up the eye tracking.
- You will watch a short compilation of videos. In this video compilation you can expect to see:

1) Animated blobs going down a slide, ringing a bell, and going into a hole.
2) Dennis Northcutt racing an Ostrich, and the physics of what makes ostriches so fast is explained.
3) An animation of two people dancing to techno with bright colors.

4) Two men on a stage sit down at the typewriter-like machine, while the audience is in anticipation.

5) A video of: Swirls growing on machinery, a can crushing machine, toy trains going in a figure eight, tomatoes being sliced, a machine creating an Eiffel Tower figurine, bricks being cleaned with a hose, marbles rolling down a wooden trail, a machine sorting batteries, camouflage being applied to a helmet, a plastic toy with gears being spun into place, electric tape being wound around a wire, a wavy sea creature swimming, taffy pulling machine, carrots being harvested, something that looks like frost being burned off a lawn, a foot pressing on ice to crack it, egg yolks on a slide, a close up of a drill going into metal, a metal snowflake sliding into a metal casing, sparks cleaning rusty metal, a truck backing up to pick up a load of yellow tubes, a purple ball nearing a plastic chair that melts, cake being frosted, a tree being shredded, spiraling water, a stack of papers being cut, a cookie being frosted, a hot drill in metal, a watch with spinning cogs, a baseball being smashed, and a mountain biker on hills.

6) A balloon in a museum approaches a cactus, then the cactus pops.

- You will then go into the adjoining room for an interview that will last between 10-30 minutes.
- The interview will be audio recorded.
- Total time commitment will be up to 45 minutes

Risks/Discomforts

You understand that while no video content was chosen with the intent to offend, there is no guarantee that offense can be 100% avoided for everybody. If at anytime you feel uncomfortable with video content or questions asked in the interview, you may ask to skip that section.

Benefits

There will be no direct benefits to you, however, this research aims to expand knowledge of how people with ADHD see the world, and how they relate to video media. I hope my research will give ideas to people who create therapy for those of us with ADHD, and better understanding to the world in general of what our experience is like. You will know you are contributing to these goals.

Confidentiality

Your data will be stored on a password protected computer and/or locked file. There is no foreseeable discard date of data. Your data will be assigned an ID number rather than your name.

Compensation

I will provide you with $10 cash at the end of your participation. $10 will be given whether or not you successfully complete the study.

Participation

Participation in this research study is voluntary. You have the right to withdraw at any time or refuse to participate entirely without jeopardy to your class status, grade, extra credit, or standing with the university.

Questions about the Research

If you have questions regarding this study, you may contact Daisy Milman at daisykmilman@gmail.com for further information.

Questions about Your Rights as Research Participants

If you have questions regarding your rights as a research participant contact IRB Administrator at (801) 422-1461; A-285 ASB, Brigham Young University, Provo, UT 84602; irb@byu.edu. You may also call Daisy Milman at 801-473-7119

Statement of Consent

I have read, understood, and received a copy of the above consent and desire of my own free will to participate in this study.

Name:

Signature Date: