Using Video Games to Tackle Mental Diseases

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Alzheimer's Disease: The Silent Killer

In the United States, the sixth leading cause of death is Alzheimer's Disease, and still no permanent treatment exists because of doctors' uncertainty regarding the disease ("What Is Alzheimer's Disease?," n.d.). In recent medical news, doctors showcase new technologies that bring advanced capabilities to their fields such as being able to perform precise surgeries remotely or stem cell research, but what if different technologies that already exist have medical applications as well (Tarassoli, 2019)? Researchers investigated one such application where video games assist in diagnosing a person's likelihood to suffer from Alzheimer's disease (Coughlan et al., 2019). Even though researchers did not find a definitive test, they found that video games could have beneficial effects on the brain if designed to test certain brain functions including spatial awareness and memory (Coughlan et al., 2019). Currently, there is no cure for Alzheimer's disease and it can only be definitively identified if a person allows for a biopsy after his or her death (Amanzadeh, Moghaddasi, Rabiei, & Harandi, 2018). Patients with Alzheimer's are not the only people who suffer as a result of the disease, but those around the patient also bear a burden of the disease due to the extra care that patients require (Burns, 2000). The theory of technological determinism helps understand the effects of video games on a person's brain because it describes an environment where technology shapes society and the people within that society (Smith, n.d.).

Approach to a Solution

To what extent can video games be used to diagnose and combat Alzheimer's disease? The theory of technological determinism is applied in the context of four different case studies in order to answer the research question. Several case studies have tried to use applications to detect

people's risk of getting Alzheimer's disease (by looking at the brain activity of the participants); through technological determinism, the benefits of these applications are isolated and understood. The case studies examined in this paper include one on a mobile application designed to assess early indicators of Alzheimer's Disease, one on how video games affect blood flow in the brain, one on a virtual test to assess spatial awareness, and one that assesses the ability of video games to determine one's spatial awareness. These case studies establish the important factors that need to be affected by technology and proceed to look at how these factors can be isolated with specific tests or games that are readily available on the market today. Data about brain activity is obtained from the first case study that examined an application that was specifically designed to assess a person's risk of suffering from Alzheimer's disease. With these findings, other video games that trigger similar brain activity are found and analyzed in order to see if they produce similar results to the games and applications used in the other case studies. After compiling the information from different case studies, an answer to the research question is reached based on the effectiveness of the applications in the case studies and the ability of common video games to emulate the same important aspects of those applications that were designed specifically with Alzheimer's disease in mind.

The Burden of Alzheimer's Disease

As of 2017, around 5.5 million Americans of age 65 or older may have Alzheimer's disease ("What Is Alzheimer's Disease?," n.d.). Doctors cannot produce more accurate numbers because a definitive test for Alzheimer's can only be performed after the death of the patient (Amanzadeh, Moghaddasi, Rabiei, & Harandi, 2018). Currently, most approved drugs for treatment of Alzheimer's disease only offer temporary reversal, and the ones that attempt

prevention have varying results along with a limited duration. Alzheimer's disease is labeled with three stages: preclinical Alzheimer's disease, mild cognitive impairment due to Alzheimer's disease, and dementia due to Alzheimer's disease (Alzheimer's Association, 2019). The stage that remains difficult to detect and is still being researched is the first stage; the characteristics of the first stage include identifiable changes in the brain such as spinal fluid and blood flow (Alzheimer's Association, 2019). The latter two stages are typically associated with memory loss and decline in cognitive function, but the first stage does not show these symptoms and those who exhibit the symptoms of the first stage do not definitively go on to the last two stages (Alzheimer's Association, 2019). Thus, doctors have a hard time identifying people who will suffer from Alzheimer's disease in order to attempt to slow the progression.

The stakeholders in this problem include the people who suffer from Alzheimer's disease, their families and people they interact with, and doctors. Doctors have tried, with little success, various forms of treatment to reverse or slow down the effects of Alzheimer's disease. On their unending search for a solution, doctors started looking into different drugs or other forms of treatment. The families and those around patients with Alzheimer's are stakeholders as well because their lives change when somebody they interact with suffers from Alzheimer's disease. While symptoms of Alzheimer's disease may vary from person to person, common ones include decline in aspects of thinking such as impaired reasoning and judgment, vision and spatial issues, and a shortening of temper ("What Is Alzheimer's Disease?," n.d.). Patients with these symptoms require assistance from others, and Burns found that the burden of care falls mostly on unpaid caregivers and continues even after the patient has been admitted to a nursing home or other forms of care (Burns, 2000).

Studies performed on video games help scientists understand which part of the human brain activates and responds to the simulated stimuli. Researchers have found that video games do have an effect on the brain and that different types of video games can have different effects on a person's cognitive functions (Liu et al., 2019). While most video game developers strive to catch gamers attention with enticing stories or intense gameplay in order to achieve high sales, every game will end up affecting players' brains in unique ways. In order to capitalize on this property of video games, researchers must understand the mechanisms in which video games affect the brain and how the parts of the brain affected by Alzheimer's disease can be targeted.

Technological Determinism to the Rescue?

In order to understand exactly how video games affect the brain and could lend knowledge to the issue of Alzheimer's disease, the problem is framed in terms of technological determinism in order to understand games influence on societies and their processes. Two versions of technological determinism exist: soft and hard; the soft view suggests that technological change drives social change but still responds to social pressures, while the hard view suggests that technology does not respond to social constraints (Smith, n.d.). Because the goal is to find how much video games can help society, technological determinism will help by looking at the autonomous and social shaping tendencies of technology (Allan Dafoe, 2015). The soft view of technological determinism will be applied to the problem because developers and the gaming community have control over how video games are produced and can change certain aspects of the game to cater to different needs. Major contributors to the theory of technological determinism include Thorstein Veblen, Robert Heilbroner, and Clarence Ayres.

Critics of technological determinism claim that technology itself cannot shape society and that society also plays a critical role in changing technology. One critic of technological

determinism is Andrew Feenberg who states that one flaw of technological determinism is that in order for the theory to hold true, technology must have autonomous functional logic that does not relate to society (Feenberg, 1992). The functional logic of video games is determined by game developers, so Feenberg accurately identifies a flaw in technological determinism in this context; however, the soft view allows for some dependence on social factors which comes from the gaming community in this scenario. Ralph Schroeder also claims that science and technology never determine social change by themselves, but technology often has unintended consequences which can't be attributed to the game developers (Claude S. Fischer, 2009). Even though these critics create strong arguments against technological determinism, one must consider the context of the situation in order to understand whether technological determinism can be applied effectively. In this situation, video games and applications create unintentional effects in the brain which directly result from technology, thereby lending this study to be analyzed with technological determinism.

Analyzing Scientific Findings with Technological Determinism

In this section a series of case studies are analyzed in order to extract information about how effective video games or applications can help diagnose and treat Alzheimer's Disease. Ultimately the answer to the research question is that video games are a valid method to identify underlying indicators of Alzheimer's Disease and could promote healthy activity in areas of the brain affected by Alzheimer's, but a definitive diagnosis method and treatment cannot be reached currently. The researchers in the cases examined pertinent facts regarding the research question, but there was too much uncertainty around the true causes of the results obtained in their study. With more time and analyzation, perhaps the researchers could eliminate the sources of uncertainty and provide a definitive answer.

Sea Quest Hero

The first study is a case in which researchers tried to use a mobile application in order to uncover differences in performance between subjects with a predisposition to suffering from Alzheimer's Disease and subjects without the predisposition. The application in this case study is called Sea Quest Hero, a game in which users see the path to the objectives at the beginning of the round and then have to remember the optimal route once the round starts. This application relies on the navigational and spatial awareness that Alzheimer's Disease is known to effect. This study found that people likely to suffer from Alzheimer's Disease ($\varepsilon 3 \varepsilon 4$ carriers) performed significantly worse compared to the control group by travelling longer distances to reach the objective (Coughlan et al., 2019). The researchers also found that $\varepsilon 3 \varepsilon 4$ carriers tended to travel near the edge of the course rather than the center which was the primary cause for the longer distances in the results (Coughlan et al., 2019). Through this research, the findings show that technology provides an effective way of uncovering certain traits that help identify people who are more likely to suffer from Alzheimer's disease. While there is currently no known cure for Alzheimer's Disease, early identification could allow people to make the most of their time before serious mental deterioration occur. From the soft viewpoint of technological determinism, Sea Quest Hero guides society towards answers regarding humans based on the gameplay and the actions taken by the player. Game developers still have a chance to shape the technology because they determine the gameplay and story line that the users will end up going through. If other applications of technology are useful in treating Alzheimer's Disease, then total prevention could become a reality too as the proceeding case studies address such a possibility.

Video Games and Blood Levels

A different case study looked at how brains change while playing video games, specifically the level of oxy-hemoglobin and blood flow. Commonalities such as low blood flow and low oxy-hemoglobin levels were found to be symptoms of Alzheimer's Disease in a study done by a group of researchers (Herrmann et al., 2008). Researchers found that video games produced a mix of results for both children and adults; the majority of adults experienced an increase in oxy-hemoglobin levels and blood flow while some children experienced increased, decreased, or no significant change (Nagamitsu et al., 2006). Nagamitsu et al. stated that the mixed results could have been due to the lack of interest in the video game used in the experiment, so if the subjects had been able to choose their favorite game perhaps the results would have been more positive (Nagamitsu et al., 2006). The video game in this trial was Donkey Kong on a Game Boy, which is a simple game (relative to popular games today) as well (Nagamitsu et al., 2006). Complex games that require greater concentration could generate even higher levels of oxy-hemoglobin and blood flow, thus solidifying the results found in this case. Video games trigger a reaction of the human brain and create beneficial effects without being the primary objective of game developers. This reaction exemplifies technological determinism at work because the increased blood flow was not the intention of the game developers, but it still happens in the users as a result of the interaction between the user and the technology. Patients who suffer from Alzheimer's disease can combat their reduced levels of oxy-hemoglobin and blood flow by playing games to reverse or slow these symptoms. Again, the soft viewpoint applies better because humans can make a choice about which game to play; games that they enjoy more will trigger larger reactions and more blood flow, but it still comes down to the technology having an impact on the behavior of society. With more studies to confirm the

findings and to investigate whether games have the same effects on subjects with Alzheimer's Disease, new and effective treatments could be found.

Video Games and Spatial Awareness

As was seen in the first case study, people who are more likely to suffer from Alzheimer's Disease have a hard time performing spatial navigation due to the effects on the brain. In a study led by Suzanne de Castell, researchers tried to assess the role of video game experience on the development of spatial learning and memory portions of the brain (de Castell et al., 2015). Another benefit of this case study is that it used a complex game based on the Morris Water Maze in order to stimulate the brain rather than simple tests or games (de Castell et al., 2015). In this case, researchers found that subjects with more video game performance had an increased ability in spatial awareness, but were unable to identify the factors that contribute to this improvement (de Castell et al., 2015). An issue with this case though is that some of the subjects with experience in video games overestimated their navigational ability which actually led to a decreased performance, so the findings could have understated the true effect of video games on the development of spatial awareness (de Castell et al., 2015). The people with gaming experience developed spatial awareness subconsciously while playing other video games which shows how society is shaped by technology in ways that the creator of such technology did not intend to do so. Identifying these potential benefits of technological determinism in other fields will allow for new methods of treatment and prevention of the symptoms of Alzheimer's disease and capitalize on the multi-faceted nature of technology.

Video Games and Visuospatial Attention

In another study, Green and Bavelier looked at the effect of action video games on the spatial distribution of visuospatial attention, which is the ability to receive and process stimuli of

one's surroundings (Green & Bavelier, 2006). This study also used complex games such as Grand Theft Auto, Half-Life, Counter-Strike, and others in order to analyze various aspects of visual attention and compare video-game players to those who don't play (Green & Bavelier, 2006). Green and Bavelier did find a positive effect of video game experience on the visuospatial attention (Green & Bavelier, 2006). Tying this result back to the findings from the Sea Quest Hero case, it suggests that video game players would travel in the center of the path on Sea Quest Hero (something those who suffer from Alzheimer's Disease do not do). Again, the researchers were unable to pinpoint what exactly caused the video game players to have the increased spatial abilities, but the video game players who had consistently played games behaved differently than those who had not played video games in the previous six months (Green & Bavelier, 2006). Besides the recency and frequency of games played, the test subjects were as similar as possible in order to narrow down the potential causes for the differences in test performance (Green & Bavelier, 2006). Therefore, something about playing video games must be causing the difference in spatial awareness that was found in this case study, and thus technological determinism plays a major role in determining factors that help doctors learn more about Alzheimer's Disease.

All of the previous case studies point to a potential application of video games or software in order to slow and/or diagnose Alzheimer's disease. An important note to address is that these case studies only show potential; researchers still do not fully understand the channels by which software affects the brain and how to make those affects permanent. With these facts in mind, a big limitation on the findings of this paper is that extraneous factors could have contributed to the findings in all of the cited case studies, so a definitive conclusion cannot be reached. Another limitation is that there was a limited time allotted for the completion of this paper; with more time better resources could be obtained and a more complete understanding of

the effects of Alzheimer's Disease and video games on the brain. The aforementioned limitations are reasons why we cannot completely rule out the possibility of applying video games in the medical field.

In order to improve and solidify the knowledge generated in this research paper, some different approaches could have been addressed in order to assess the research question. One valid approach is to examine all of the specific stages of Alzheimer's disease, the parts of the brain affected in each stage, and specific ways to activate those parts of the brain. Research into different genres of video games could also be done in order to see what genres of video games effectively trigger specific areas of the brain. Combining findings pertaining to genre specific video games and a deeper understanding of the effects of Alzheimer's Disease in early stages would have a profound impact on the development of integrating technological methods into the medical field.

Conclusion

Video games primarily function to cure boredom and provide entertainment, looking deeper could provide answers to problems that society currently cannot solve. In this instance, Alzheimer's Disease and other forms of dementia take a big toll on society; the ones directly affected by the disease and their close family members feel a significant burden that could one day be eliminated with proper medical treatment. Rather than feeling hopeless, patients could find hope that methods exist to prevent Alzheimer's Disease and family members need not worry about whether their loved one remembers who they are. It is important to note that the research conducted in this paper did not completely eliminate the possibility that software can be effective in the medical field, with more research and testing even the opposite could still be true.

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