

VIDEO GAMES:

A SITE FOR SORE EYES

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This paper will address three distinct areas of research in which video games are being used to improve eye and brain conditions in the medical field.

"I was very surprised by this finding," research Roger Li, PhD, of the School of Optometry and the Helen Wills Neuroscience Institute at University of California, Berkeley said in a news release. "I didn't expect to see this type of improvement." From the earliest days in the history of video games, accusations (whether true or not) have circulated suggesting that they somehow negatively im-



Figure 1. A Play Station 2 controller, used to control the movements of characters in video games.

pact society, specifically the juvenile and adolescent lifestyle. However, recent studies suggest that video games may prove to be useful treatment methods in the field of vision science. It has been assumed that video games are detrimental to vision, in the same way that staring at any electronic screen for long periods of time has been traditionally discouraged. However, the accidental discovery of using video games to cure adult amblyopia, more commonly known as "lazy eye," has provided a basis to help those without perfect vision in a non-clinical way as opposed to contact lenses, glasses, or laser surgery. This study is one of the first to show that playing games can improve blurred vision in adults with amblyopia (Li, 2010).

On September 21, 2010, an issue of PLoS Biology published a study in which people with amblyopia showed improvement in their vision after playing video games. Amblyopia is improvable in children through treatment, but is more difficult to treat in adults. After playing 40 hours of video games, adults with amblyopia showed an

improvement in visual acuity and 3-D depth perception (Li, 2010).

According to the National Eye Institute, amblyopia is a brain disorder in which the vision of one eye does not develop properly (Li, 2010). It is the most frequent type of permanent visual impairment in children, affecting two to three of every 100 children (Li, 2010). Amblyopia is also the most common cause of one-eye visual impairment among young adults or people of middle age (Li, 2010). While the study has shown vision improvement for adults with amblyopia, researchers say this does not necessarily justify spending more time playing video games for the general population, as there have been no observations of similar benefits for people with normal vision (Li, 2010).

"These new findings are very encouraging because there are currently no accepted treatments for adults with amblyopia," says Dennis Levi, of University of California, Berkeley and Dean of Optometry at the Helen Wills Neuroscience Institute. Levi says that conventional wisdom has held that unless the disorder is corrected in childhood, damage was thought to be irreversible. Li and Levi said they have found that intensive training on a perceptual task, such as getting two horizontal lines to align, can lead to an improvement of 30 percent to 40

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percent in visual acuity (Li, 2010).

In one experiment, 10 subjects with patches over the stronger eye played an action video game for two hours at a time for a total of 40 hours in one month. The action video game required subjects to shoot at targets, while the non-action game consisted of users having to construct things on screen. Twenty subjects participated in this study between the ages of 20 and 60. In another experiment, three people played the

non-action game for the same amount of time while also wearing a patch over the stronger eye. Both experiments produced a 30% increase in visual acuity, or an average of 1.5 lines on the standard letter charges used by optometrists (Li, 2010). After measuring performance after every 10 hours of game playing, the researchers found that some subjects began to show improvement even before 40 hours of video game playing. The action video game proved more beneficial than the non-action game. (Li, 2010)

Li says that people who began by playing a non-action video game still improved after playing the action video game for an additional 40 hours. He says it is not clear yet when visual improvement might reach a plateau. He cautions that research is in its early stages and that patients should not try to self-treat their lazy eye condition, but instead, work with eye doctors on their problem (Li, 2010).

It can take 120 hours of occlusion therapy to see the same improvement in children with lazy eye (Li, 2010). In occlusion therapy, a patch is placed over the stronger eye so to force the brain to use the "lazy" one. Though the therapy has been proven to work for children, researchers say few options have been available for adults with the disorder (Li, 2010).

Some studies have shown that video games can even help treat amblyopia in children as well. Sara Shippman of the New York Eye and Ear Infirmary in New York City discovered that "attention-holding target" video games can improve the weaker eye (Silberner, 1984). Usually the stronger eye is just covered with an eye patch, but in the study, while the stronger eye is still blocked with an eye patch, the children play at least an hour of video games each day. Initially, the children start playing the game

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seated close to the screen, but gradually they move one foot back at a time until they are 20 feet away. These "attention-holding target" video games provide more "stimulation of the developing visual system by objects in the environment of an appropriate size to improve

vision," says Shippman. Television images are too large, but the depth illusion in video games, with the objects getting smaller and larger provides the weaker eye with what it needs (Silberner, 1984).

"What seems most encouraging," Shippman says, "is that the group of patients studied is precisely the group that is expected to have a good result, but is resistant to [conventional] treatment" (Silberner, 1984). Children would prefer to play video games as opposed to undergoing other possible treatments. This unconventional treatment of video game playing was assumed to be detrimental to eye health, and now, found to improve impaired vision.

As video games have been helpful in aiding amblyopia in adults and children, they have also been shown to help enhance contrast sensitivity functions of the eye. Contrast sensitivity function, or CSF is the primary limiting factor that determines how well one sees. Contrast



Figure 2. Studies indicate that video gaming improves contrast sensitivity function (CSF) as do eyeglasses.

sensitivity is "the ability to detect small increments in shades of gray on a uniform background." (Li, 2009) Currently, patients improve CSF using glasses, contact lenses and surgery. However, studies have suggested that certain video games can also aid in enhancing CSF. Decrease of contrast sensitivity is due to deterioration of the optical quality of the eye. Neural factors seem to be involved in the deterioration process. Scientists on this study thought it possible to develop interventions that could enhance the CSF through neural plasticity, or the ability of the brain to reorganize neural pathways based on new experiences. The intervention used in this study was video games (Li, 2009).

In order to test CSF enhancement, expert action video game players (VGPs) were compared to non-action game players (NVGPs) in a procedure that tests CSF. Both gender and age were matched, and participants were required to have close

to optimal conditions to one another. The action game player group showed enhanced contrast sensitivity in comparison to the non-action game player group. In order to determine if the action gaming has a causal relationship with the improvement in CSF, there was a study conducted in which a small sample of non-action video game players trained 50 hours over a period of 9 weeks by playing video games. There were two conditions in the training. One group played action video games such as Unreal Tournament 2004 by Atari and Call of Duty 2 by Infinity Ward. The control group played a non-action video game, Sims 2 by Electronic Arts, which is also complex and engaging like an action video game but doesn't require the same skill set. Rather, it has a slower pace and does not demand precise, visually guided aiming actions (Li, 2009).

After the training period, when CSFs were assessed, the action-trained group had improved significantly more than the control-trained group. The control group was still engaged in a stimulating video game-related activity, and still represented a significant margin of improvement in contrast sensitivity (Li, 2009).

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Though these are the first of their kind, other studies have shown the advantages of certain video games on impaired vision. While there are specific treatments for certain cases and should be done under care, this surprising and confounding discovery will hopefully lead to more. One of these new treatments have been shown to treat ADD and help children and adults with a variety of problems, from concentration difficulties to physical stress.

NASA began research on brain waves that has been applied to video games by Alan Pope, Ph.D. and Olafur Pallson, Psy.D (NASA, 200). They have invented a way for Nintendo and Play Station games to provide feedback on the brainwaves of the children playing them. Pope is a psychologist at NASA and an electrical engineer who studies methods to help pilots keep their attention focused during the long, and sometimes monotonous, task of flying a plane. Though there has already been simple video games developed to help reinforce the faster brain 'beta' waves that they want to see, Pope and Pallson



Figure 3. Example of an electroencephalography device while attached to a subject.

have invented a device that works with most off-the-shelf video games. The simple version consists of EEG, or electroencephalography, biofeedback as the child playing the game has to make one colored bar on the screen go higher by producing beta waves and make another go lower by producing fewer theta waves. Producing more beta waves is what allows the child to win as well as treat his ADD at the same time (NASA, 2000).

The version that Pope and Pallson worked on is adaptable for other video games, as the player produces more beta waves, the game pad or joy stick for the video game works more effectively and they can better control the characters. Producing more beta waves brings the player's brainwaves closer to an optimal stress-free pattern and the joystick becomes easier to control. If the player uses slower brain waves, or theta waves, the game pad becomes sluggish. This way, the child can now play his favorite game and learn to pay attention better at the same time (NASA, 2000).

In early research about 20 children between the ages of 9 and 14 received EEG biofeedback, half using the traditional biofeedback, and the other half using the new invention. Though both groups made improvements, Pope and Pallson reported that the participants using the new invention showed improvements sooner (NASA, 2000). They were also more likely to come in for the study since they had a chance to play any of the video games they enjoyed the most.

NASA has had future plans to use this video game concept to train pilots to keep heart rates calm during emergencies, since it can interfere with decision making. Researchers also hope to apply this to experiment in attention management and peak performance training in

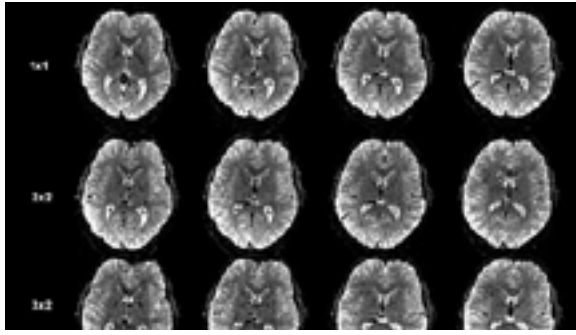


Figure 4. MRI imaging of the human brain.

aviation as well (NASA, 2000).

In another study, the motor control of males with ADHD were assessed and compared with those of non-ADHD males as they played video games. Forty-nine in each group played *Crash Bandicoot I*, a Sony Playstation platform computer game in which the player controls the movements of a small-animated figure through a hazardous jungle environment. The boys with ADHD were case-matched for age (within six months) and Performance IQ with a participant from the control group (Houghton, 2004).

The measures of motor control were assessed under contrasting conditions of low or high working memory and distractor loads. The measures of motor control were designated by the three following criteria: the stage of the game completed (i.e. the number of obstacles successfully passed) before losing the figure's 'life,' the level of complexity that the stage represented, and the time take to get to that point during the video game play. A total of 12 trials were administered, three times each of four different tasks, in which some incorporated distracter conditions (Houghton, 2004).

The first condition was low working memory load with no added distracter which required the participant to maneuver the character as quickly as possible down the jungle path to a specific checkpoint without touching any of the boxes along the way. In condition 2, high working memory load with no added distracter, the participants had to maneuver the character down the jungle path as quickly as possible while remembering a specific game rule: to spin the boxes marked with an arrow. Conditions 3 and 4 were identical to conditions 1 and 2, respectively, but with the added distracter of a popular television show, *The Simpsons*, being played simultaneously on an adjacent television screen (Houghton, 2004).

The study revealed that the ADHD group took less time to complete their trials under the direct condition (i.e. no working memory load) compared to their matched non-ADHD group (Houghton, 2004). However,

the ADHD group took significantly longer when the task required additional working memory. Such video games allow children with ADHD to successfully deploy executive functions, including motor control, which help increase concentration, and reduce unwanted hyperactive-impulse and inattentive behaviors (Houghton, 2004).

There has also been some evidence that video game play promotes the release of striatal dopamine which is through to be deficient in ADHD (Dougherty et al, 1999; Krause et al 1998, 2000). Thus, playing video games may temporarily increase dopaminergic tone, which can temporarily enhance arousal and cognitive control functions in ADHD patients. Here we have seen video games used for amblyopia, CSF, and ADHD. Perhaps the unexpected potential of this activity to improve lives calls into question other "mundane" activities of the everyday that have also been traditionally labeled as distractions. We cannot yet rely on these studies for reliable treatment, but a future consisting of something similar is very close in sight.

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IMAGE SOURCES

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