



# Game Theory

How do video games affect the developing brains of children and teens?

BY AMY PATUREL, M.S., M.P.H.

**A**t age 17, Anthony Rosner of London, England, was a hero in the World of Warcraft online gaming community. He built empires, led raids, and submerged himself in a fantasy world that seemingly fulfilled his every need. Meanwhile, his real life was virtually nonexistent. He neglected his schoolwork, relationships, health, even his hygiene.

"I never saw my real friends. I gained weight, became lazy, and spent nearly all of my time slumped over my computer," says Rosner, who played up to 18 hours a day, every day, for nearly two years.

Rosner nearly threw away a university degree in pursuit of the game. According to a study by the NPD Group, a global market research firm, his gaming obsession isn't unique. Nine out of 10 children play video games. That's 64 million kids—and some of them hit the keyboard or smartphone before they

can even string together a sentence. The problem: many researchers believe that excessive gaming before age 21 or 22 can physically rewire the brain.

Researchers in China, for example, performed magnetic resonance imaging (MRI) studies on the brains of 18 college students who spent an average of 10 hours a day online, primarily playing games like World of Warcraft. Compared with a control group who spent less than two hours a day online, gamers had less gray matter (the thinking part of the brain).

As far back as the early 1990s, scientists warned that because video games only stimulate brain regions that control vision and movement, other parts of the mind responsible for behavior, emotion, and learning could become underdeveloped.

A study published in the scientific journal *Nature* in 1998 showed that playing video games releases the feel-good neurotransmitter dopamine. The amount of dopamine released



#### LETTING GO

Anthony Rosner played World of Warcraft up to 18 hours a day for nearly two years. Eventually, he was able to let his alter ego Sevrin walk off into the sunset.

while playing video games was similar to what is seen after intravenous injection of the stimulant drugs amphetamine or methylphenidate.

Yet despite mounting evidence about the cognitive, behavioral, and neurochemical impact of gaming, the concept of game addiction (online or not) is difficult to define. Some researchers say that it is a distinct psychiatric disorder, while others believe it may be part of another psychiatric disorder. The current version of the Diagnostic and Statistical Manual of Mental Disorders, *DSM-V*, states that more research needs to be done before “Internet Gaming Disorder” can be formally included.

Still, experts agree gaming has addictive qualities. The human brain is wired to crave instant gratification, fast pace, and unpredictability. All three are satisfied in video games.

“Playing video games floods the pleasure center of the brain with dopamine,” says David Greenfield, Ph.D., founder of The Center for Internet and Technology Addiction and assistant clinical professor of psychiatry at the University of Connecticut School of Medicine. That gives gamers a rush—but only temporarily, he explains. With all that extra dopamine lurking around, the brain gets the message to produce less of this critical neurotransmitter. The end result: players can end up with a diminished supply of dopamine.

Take a game like that away from addicted adolescents and they often show behavioral problems, withdrawal symptoms, even

## Got a Gaming Addiction?

The following warning signs may indicate a problem:

1. Spending excessive amounts of time on the computer.
2. Becoming defensive when confronted about gaming.
3. Losing track of time.
4. Preferring to spend more time with the computer than with friends or family.
5. Losing interest in previously important activities or hobbies.
6. Becoming socially isolated, moody, or irritable.
7. Establishing a new life with online friends.
8. Neglecting schoolwork and struggling to achieve acceptable grades.
9. Spending money on unexplained activities.
10. Attempting to hide gaming activities.

## Gaming: A Parent's Guide

**W**ith news about video games turning kids into bullies—or zombies—and a growing number of experts warning about the dangers of too much screen time, it may be tempting to ban computers and smart phones altogether. Don't, say experts.

If you forbid game play, you'll forfeit any opportunity to influence your children's behavior. A better approach: play with them, says Judy Willis, M.D., a neurologist and member of the American Academy of Neurology based in Santa Barbara, CA, who suggests starting with free online educational games.

The key to ensuring your children have a healthy relationship with video games (and, yes, there is such a thing) means ensuring they take advantage of pleasurable experiences outside these games. A few tips:

- ▶ **PAY ATTENTION** According to David Greenfield, Ph.D., founder of The Center for Internet and Technology Addiction and assistant clinical professor of psychiatry at the University of Connecticut School of Medicine, 80 percent of the time a child spends on the computer has nothing to do with academics. Putting computers, smart phones, and other gaming devices in a central location—and not behind closed doors—allows you to monitor their activities. Learn how to check the computer's search history to confirm what your children have been doing on the Internet.
- ▶ **ESTABLISH BOUNDARIES** Set—and enforce—limits on screen time. “Kids are often unable to accurately judge the amount of time they spend gaming. Further, they are unconsciously reinforced to stay in the game,” says Dr. Greenfield, who recommends no more than one or two hours of screen time on weekdays. Taking advantage of firewalls, electronic limits, and blocks on cell phones and Internet sites can help.
- ▶ **START TALKING** Discuss Internet use and gaming early on with your kids. Set clear expectations to help steer them in a healthy direction before a problem begins. Communication doesn't necessarily mean a formal talk. Rather, it's about giving your child an opportunity to share their interests and experiences with you.
- ▶ **KNOW YOUR KID** If your child is doing well in the real world, participating in school, sports, and social activities, then limiting game play may not be as important. The key, say experts, is maintaining a presence in their lives and being aware of their interests and activities. On the other hand, if you have a kid who already has anger issues, you might want to limit violent games, suggests Tom A. Hummer, Ph.D., assistant research professor in the department of psychiatry at Indiana University School of Medicine in Indianapolis.
- ▶ **GET HELP** For some young people, gaming becomes an irresistible obsession. If your child is showing signs of a video game addiction, help is available. Treatment options range from limited outpatient therapy to intensive residential boarding schools and inpatient programs.

aggression, according to Dr. Greenfield.

But not all gaming is bad. Video games can help the brain in a number of ways, such as enhanced visual perception, improved ability to switch between tasks, and better information processing. “In a way, the video game model is brilliant,” says Judy Willis, M.D., neurologist, educator, and American Academy of Neurology (AAN) member based in Santa Barbara, CA. “It can feed information to the brain in a way that maximizes learning,” she says.

### THE DEVELOPING BRAIN ON GAMES

Video games are designed with a reward structure that's completely unpredictable. The tension of knowing you might score (or kill a warlock), but not knowing exactly when, keeps you in the game. “It's exactly the same reward structure as a slot machine,” says Dr. Greenfield. The player develops an unshakable faith, after a while, that “*this* will be the time I hit it big.”

That's a powerful draw for an adolescent's developing brain, which is impressionable. “The prefrontal cortex—the locus of judgment, decision-making, and impulse control—undergoes major reorganization during adolescence,” explains Tom A. Hummer, Ph.D., assistant research professor in the department of psychiatry at Indiana University School of Medicine in Indianapolis. That executive control center is essential for weighing risks and rewards and for putting the brakes on the pursuit of immediate rewards (like gaming) in favor of more adaptive longer-term goals (like next week's chemistry test).

This region of the brain doesn't reach maximum capacity until age 25 or 30, which may explain why young people are more likely to engage in hours of play while ignoring basic needs like food, sleep, and hygiene. Without mature frontal lobes to draw on, adolescents and teens are less able to weigh negative consequences and curb potentially harmful behavior like excessive video gaming, which also impacts frontal lobe development.

Violent video games are of concern to many experts. In a study of 45 adolescents, playing violent video games for only 30 minutes immediately lowered activity in the prefrontal regions of the brain compared to those who participated in a non-violent game. Previous research showed that just 10-20 minutes of violent gaming increased activity in the brain regions associated with arousal, anxiety, and emotional reaction, while simultaneously reducing activity in the frontal lobes associated with emotion regulation and executive control.

The dopamine release that comes from gaming is so powerful, say researchers, it can almost shut the prefrontal regions down. That's one reason why gamers like Rosner can play for 18 hours

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—ANTHONY ROSNER

straight. “Kids plop themselves in front of a computer and they’ll stay there for 8, 10, 25, 36 hours,” says Dr. Greenfield.

And for kids like Rosner, who feel like social outcasts, excelling in the world of gaming can provide a sense of mastery and confidence missing from their actual lives. “When you become one of the top players in a game like World of Warcraft, tens of thousands of players are essentially under you, so you become like a virtual god,” explains Dr. Greenfield.

“I created a Blood Elf Paladin called Sevrin, set up my own guild—the QT Yacht Club—and treated it like a full-time job, maintaining the website, recruiting new players, and organizing and leading raids,” says Rosner, who quickly achieved celebrity status in the gaming community. “People I didn’t know would message me and tell me how amazing I was. It was the complete opposite of what I had in real life.” Soon World of Warcraft took precedence over everything else.

### THE LEARNING BRAIN ON GAMES

Practicing anything repetitively physically changes the brain. With time and effort, you get better at the specific task you’re

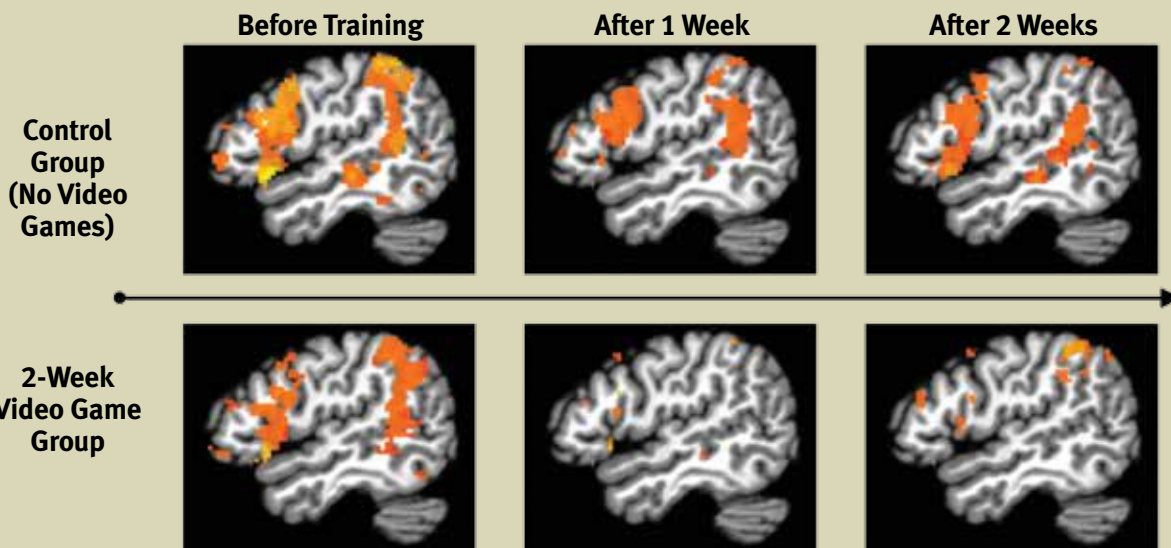
practicing, whether it’s shooting at the enemy in a video game or hitting a baseball. Those repetitive actions and thoughts stimulate connections between brain cells, creating neural pathways between different parts of your brain. The more you practice a certain activity, the stronger that neural pathway becomes. That’s the structural basis of learning.

“Use it or lose it” applies not just to muscles in the body, but also the brain. Neural pathways that are not used eventually get pruned.

In the early 2000s, most research suggested that perceptual and cognitive training was very specific to the task at hand. That’s one of the problems with many brain training tools: it’s easy for people to improve on the individual mini-tasks they’re given—say, arranging a list in alphabetical order or completing a crossword puzzle—but those tasks don’t always translate into better thinking in general. Video games seem to differ from other kinds of brain training.

“Unlike some other brain training tools, video games activate the reward centers, making the brain more receptive to change,” explains C. Shawn Green, Ph.D., assistant professor of

## Your Brain on Games: Experimental Evidence



**LOSING TOUCH** Young adult males who played a violent video game extensively for 2 weeks had lower activity in

important brain areas while attempting to control behavior, compared to those who played no video games.



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psychology at the University of Wisconsin-Madison.

Studies show, for example, playing action video games enhances visual capabilities, such as tracking multiple objects, mentally rotating objects, and storing and manipulating them in the memory centers of the brain. That holds true even for the most maligned action-entertainment games.

Such games also require players to think of an overall strategy, perform several tasks simultaneously, and make decisions that have both an immediate and long-term impact. “That’s very much like the multi-tasking inherent in most jobs today,” says Dr. Willis. “These young people may be better equipped to switch between tasks easily, adapt to new information, and modify their strategy as new input comes in.”

Useful skills, to be sure, but exercised excessively they can also become problems. After all, when kids become so accustomed to multi-tasking and processing large amounts of information simultaneously, they may have trouble focusing on a lecture in a classroom setting.



**IN REAL LIFE** Anthony Rosner confronted his gaming addiction and turned it into subject matter for two documentary films that help others to understand the problem and how to deal with it.

## THE VULNERABLE BRAIN ON VIDEO GAMES

The very nature of action-entertainment games not only attracts young people with focus, attention, and anger issues (particularly in the case of violent games); it also tends to reinforce these negative behaviors.

While a number of companies have tried to create beneficial games for children with attention deficit hyperactivity disorder (ADHD), they’ve had limited success. “It’s difficult to make games that are exciting for kids who have attention issues, but not so exciting that the game reinforces ADHD-like behaviors,” says Dr. Hummer.

Instead, kids with ADHD often play action video games to flood their senses with visual stimulation, motor challenges, and immediate rewards. In this environment, the ADHD brain functions in a way that allows these children to focus, so much so that they don’t exhibit symptoms, such as distractibility, while gaming.

“One of the big issues from a treatment perspective is: how do you tell a kid who has been running the world online and experiencing high degrees of sensory input to function in the real world, which is not very exciting comparatively?” says Dr. Greenfield.

The stakes may be higher for a child with anger and

behavior issues who finds solace in violent video games. While experts disagree about what (if any) impact violent games have on actual violent behavior, some research shows a link between playing violent games and aggressive thoughts and behavior.

For a kid who already has an aggressive personality, that could be a problem, say experts, since video games reward those aggressive tendencies. In fact, two separate studies found that playing a violent video game for just 10-20 minutes increased aggressive thoughts compared to those who played nonviolent games.

However, not all games are equal—and each person’s reaction to those games is different, too. “Asking what are the effects of video games is like asking what are the effects of eating food,” says Dr. Hummer. “Different games do different things. They can have benefits or detriments depending what you’re looking at.”

For Rosner, gaming was detrimental. His grades suffered, he missed assignments, and he almost failed to complete his first year of college. “Here I was in university, finally able to pursue my dream of becoming a film director, and I was throwing it away,” he says. His academic advisor gave him two options: complete all of his essays for the first year within a span of three weeks, or fail and retake the first year. “I didn’t want to let myself or my parents down, so I uninstalled World of Warcraft and focused on my work,” he says.

After turning away from the game, Rosner found other sources of pleasure. He joined a gym, started DJing at his university, and became much more active socially. “I couldn’t believe what I had been missing,” he says.

Ironically, World of Warcraft led Rosner to achieve his dream of making films. His documentary, *IRL – In Real Life*, chronicles his adventures with Sevrin and how he learned to break free from gaming. More than 1 million people worldwide have viewed his film, which can be seen on YouTube at [bit.ly/1fGbYEB](http://bit.ly/1fGbYEB). It has been featured at film festivals, on TV, and in newspapers and magazines.

Today, gaming is just one form of entertainment for Rosner. He even plays World of Warcraft occasionally. But gaming no longer controls his life. “People still ask about my character, Sevrin,” says Rosner, “but I’ve realized it’s far more rewarding to achieve your potential in real life.” NN