Better Minds Ahead: Understanding Cognitive Enhancement

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Politicians, parents, and students all dream of an easy road to super smarts. What kind of utopia would we live in if everyone were operating at their highest cognitive capacity? How do we get there?

Lorenza S. Colzato says recent economic problems have spurred public interest in cognitive enhancement, from video-game-playing benefits to exercise interventions and music practice.

Lorenza S. Colzato, principal investigator at the Leiden Institute for Brain and Cognition in the Department of Psychology at Leiden University, is one of the scientists at the forefront of cognitive enhancement study.

“In recent years, cognitive enhancement has become a very hot topic” both politically and culturally, she said during her introduction to “Better Minds: Understanding Cognitive Enhancement,” an Integrative Science Symposium at the 2017 International Convention of Psychological Science in Vienna. “Recent economic problems of the welfare system have boosted public interest in enhancement procedures and activities that will make the welfare of society more affordable. [The] ideological turn toward individualism in many societies has boosted public interest in procedures and activities that help to express and to further develop individual needs and interests.”

In the symposium, Colzato and four other leading scientists in the field of cognitive enhancement spoke on such varied topics as video games, music training, exercise, and the neuroethics of “smart drugs.”

Brain Games

Daphné Bavelier has found that playing action video games for as few as 5 hours per week can improve people's vision — and that the phenomenon extends for months after the experiment.

Though many parents worry about the mental and behavioral effects of video games on their children, Daphné Bavelier and other researchers have found a good deal of evidence that some video-game play can enhance cognition in specific ways.

Bavelier, a cognitive psychologist at the University of Geneva, focuses her research on the effects of action games. Some early experiments showed vision improvements such as contrast sensitivity and visual acuity in long-time action gamers as well as experimental short-term gamers. These changes could be induced by having people play action video games for as few as 5 hours per week, and persisted months after the experiment and video-game playing ended.

Along with these promising vision studies, Bavelier began to explore a broader question: "What are the benefits that those games bring and translate to other skills and other behavior?"

Later study results suggested that action-game players were not just better at the skills specific to game play, such as good vision, but also were better at more cognitive skills, a phenomenon driven, at least in part, by improvement in attentional control.

"Attentional control is probably one of the easiest skills to change with action video games," she said. "It can change relatively fast, with 10 to 12 hours of training."

Work from other groups also showed that playing these types of games has real-world benefits.

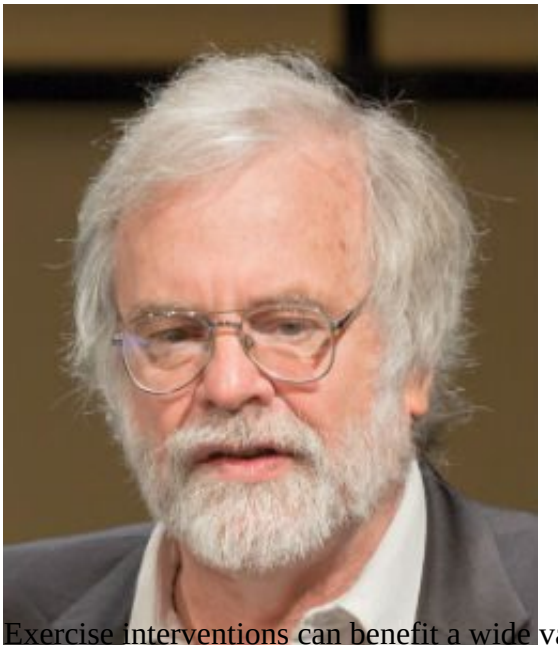
"Young laparoscopic surgeons who play video games — and especially action video games — perform better in the simulators in terms of being faster and not making more errors than the most seasoned laparoscopic surgeons on the team," Bavelier explained.

In these games, players must switch tasks and divide their attention. They monitor errors in skill and

judgment. On a higher cognitive level, they also must plan goals and revise them on the fly. Bavelier and her colleagues have been trying to tease these skills out in isolation in order to identify the ones that are most important for learning. So far, it appears that the combination of demands, and not any challenge in isolation, is what produces the kind of cognitive enhancements seen in relation to commercially available action video games.

“It happens that video games are very efficient training tools,” she said, “at least when it comes to sensing our environment. More research is needed to assess whether this also applies to higher cognitive skills such as reasoning or problem solving.”

Your Brain on Jogging



Exercise interventions can benefit a wide variety of people, from Alzheimer’s patients to women battling breast cancer, says **Arthur F. Kramer**.

As exercise helps the heart and other organs, might it also promote brain health? APS Fellow Arthur F. Kramer, former Director of the Beckman Institute for Advanced Science & Technology at the University of Illinois at Urbana–Champaign and currently senior Vice President for Research and Graduate Education at Northeastern University in Boston, has studied the relationship between exercise and cognitive enhancement for 25 years, with promising results in both animals and humans. Researchers in this field face the challenges of finding good metrics for cognitive enhancement and brain health, identifying the limits of cognitive enhancement from exercise, and bridging the gap between animal and human research.

Brain scans produced some of the first clues about the effects of exercise on the brain, showing that certain regions changed in volume in both long-term exercisers and in intervention groups. Size, white matter, and connectivity measurements all indicated that exercise has lasting effects on the brain. Exercise seems to show benefits in many tests and also in several cognitive tasks. In a 2003 meta-analysis of randomized control trial exercise and cognition studies, Kramer and Stanley Colcombe found that exercise positively impacts cognition with an effect size of nearly half a standard deviation.

“Fitness interventions have been assessed in early Alzheimer’s or mild cognitive impairment patients, multiple sclerosis patients, Parkinson’s patients, and in breast cancer patients,” Kramer said. “In each case, there have been benefits.”

Kramer acknowledged the need to establish the limits of cognitive enhancement, determining which interventions and lifestyle choices work best for different individuals.

“One of the important things we’re trying to do is bring the animal and human literature a bit closer together,” he said.

Minds on Melodies

Improved listening skills, test-training abilities, and language learning are among the gains found in study participants who regularly practiced music, according to **E. Glenn Schellenberg**.

APS Fellow E. Glenn Schellenberg, head of the Music and Cognition Lab in the University of Toronto’s Department of Psychology, investigates the effects of music on our minds. His research spans decades, from his early studies on lullabies and infants to current research on music practice, personality, and intelligence. While studies suggest correlations between music listening and practice and cognition, Schellenberg’s work aims to clarify causal effects through experimentation, teasing out the roles played by personality and disposition in studies of music and the brain.

A great number of studies have found associations between music training and nonmusical abilities. Despite the amount of research, however, it is unclear exactly what the benefits are and which populations would enjoy them.

Studies have shown improved listening skills, test-training abilities, and language abilities in those who practice music often, Schellenberg said, but science has produced few other conclusions.

One of the logistical issues that researchers face is young people’s tendency to drop out of music

lessons. With such attrition rates, empirical results are hard to come by. The experiments that have been performed have found that music practice that focuses on rhythm and timing can have specific reading benefits, even in those with dyslexia. Group music lessons also seem to provide social benefits to children and infants, suggesting that group synchrony could be its own cognitive enhancer.

“There is much evidence of association between music training and nonmusical abilities,” Schellenberg said. “There is little evidence for causal association.”

While taking music lessons is correlated with high grades and IQ scores, researchers also have found preexisting differences between people who take lessons and those who do not.

When studied more closely, the link between school performance and music training appeared to be due to conscientiousness, Schellenberg said.

Research into the benefits of music practice have not held personality variables constant in the past, and Schellenberg believes they should in the future.

Schellenberg cautions against using cognitive arguments as rationales for funding or providing music lessons to young people.

“If you don’t have those effects, you’re saying music is essentially useless,” he says. “Isn’t it reasonable to teach kids about the only thing that makes people everywhere dance, dream, and connect with one another?”

If Only It Were That Easy…

Ilina Singh says that studying the use and misuse of Ritalin, Adderall, and other drugs used for cognitive enhancement can be challenging because their use varies widely by social group and geographic region.

As a researcher of neuroscience, ethics, and society at the University of Oxford, psychological scientist Ilina Singh is focused on the present and potential future use of “smart drugs” for cognitive enhancement. While answering large-scale philosophical questions is part of her study (e.g., is it right to give these types of drugs to low-performing students or populations?), it is also important to determine how widely such smart drugs are actually being used, she says. This has proven complicated, as drug use varies by social group — and by whether or not the drugs are even legal in a given geographic region.

While smart drugs are covered extensively in the media, their effectiveness for students remains in question. “The hype has come before the evidence,” Singh said.

Students report taking the drugs for increased attention, focus, mood modulation, or executive function, but science has yet to produce convincing evidence that the most common smart drugs — Ritalin, Adderall, and Modafinil — provide these benefits in nonclinical populations. Aside from a large placebo effect, “what you hear most is that students say they feel more awake,” Singh said, noting that these drugs are indeed stimulants.

Should we try to make smart drugs more accessible in the name of social justice? Do governments have a responsibility to make them more available to the disadvantaged members of the public, since public-health data show their lifelong outcomes are improved through education?

According to Singh, the answer is no. Existing evidence of benefits is weak and clouded by various factors, including homogenous study samples and unknown effects of group membership, geographic region, and even diagnostic status. On the other hand, researchers haven’t established the risks that widespread, frequent use of these drugs carries.

In Singh’s view, looking at cognitive enhancers and fitting them into the framework of brain health would help to reframe these questions and help define the ethics in a different way.

By looking at brain health in regards to video games, exercise, music, and smart drugs, the questions shift from “Who gets these benefits?” to “How do we promote brain health for everyone?”