The best brain exercise may be physical

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Work out for the brain, not the body.

Exercise tones the legs, builds bigger biceps and strengthens the heart. But of all the body parts that benefit from a good workout, the brain may be the big winner.

Physical fitness directly affects our mind and plays a crucial role in the way the brain develops and functions. Moreover, exercise is linked to brain changes throughout all stages of life, beginning in infancy and lasting through old age.

Babies, for example, need regular movement to carve out critical pathways and form connections in the brain. In children, research suggests exercise improves attention, focus and academic performance. And in the elderly, exercise has been shown to help stave off memory loss associated with some forms of dementia, including Alzheimer's disease.

"Physical activity is crucial to mind and body alike," said neuroscientist Lise Eliot, who writes about the benefits of movement on the brain in her book "Pink Brain, Blue Brain." "The brain benefits as much as the heart and other muscles from physical activity."

Scientists used to believe the mind-body connection was a one-way street: The brain helped build a better physique — or else it sabotaged attempts to get to the gym. But scores of studies suggest that what's good for the body also is nurturing the old noodle. Exercise, it turns out, can help improve cognition in ways that differ from mental brain-training games.

"We've found exercise has broad benefits on cognition, particularly executive functioning, including improvements in attention, working memory and the ability to multitask," said researcher Charles Hillman, a professor of kinesiology and community health at the University of Illinois at Urbana-Champaign. In fact, an active lifestyle during childhood may confer protective effects on brain health across the lifespan, Hillman said.

How does exercise help the brain?

In the mid-1990's, Carl Cotman's team at the University of California-Irvine first showed that exercise triggers the production of a protein called brain-derived neurotrophic factor, or BDNF, which helps support the growth of existing brain cells and the development of new ones.

With age, BDNF levels fall; this decline is one reason brain function deteriorates in the elderly, according to Cotman. Certain types of exercise, namely aerobic, are thought to counteract these age-related drops in BDNF and can restore young levels of BDNF in the age brain.

"In a sense, BDNF is like a brain fertilizer," said Cotman, a professor of neurology and

neurobiology and behavior and founding director of the Institute for Memory Impairments and Neurological Disorders (UCI Mind). "BDNF protects neurons from injury and facilitates learning and synaptic plasticity."

Over the last two decades, researchers have learned that exercise acts on multiple levels in the brain. The brain's wiring depends on the integrity of the brain cells or neurons, as well as the connections between the neurons, or the synapses.

As we age, the synapses are lost or break down. Cotman's work has shown that in older rodents, exercise increases the number of synapses and also stimulates the brain to develop more neurons in the hippocampus, which he called "a critical region in learning and memory formation and a target of massive decline in Alzheimer's disease."

Still, for those newly created brain cells, or neurons, to work — to help us learn and remember new things — they need to be plugged into the existing neural network, said Romain Meeusen, chair of the department of human physiology at the University of Brussels.

Exercise helps integrate the new neurons into the brain's circuitry to help improve learning, Meeusen said.

In general, exercise increases the release of neurotransmitters, or brain chemicals that relay signals between nerve cells, called neurons, Meeusen said. "This could be one of the mechanisms of the anti-depressive effect of exercise," he said. "It also helps to 'train' cognition and attention at all ages."

Research also suggests that exercise improves blood flow to the brain and, as a result, enhances cognitive abilities. "The blood carries oxygen and feeds neural tissues, so you're getting the benefits that come with that," Hillman said.

Brain training for life

The brain loves it when we move and will reward us handsomely if we do, researchers say. Here's a look at how physical activity can be beneficial during three key stages of life.

Infancy

Mobile children hit their cognitive milestones faster, said Eliot, an associate professor of neuroscience at Rosalind Franklin University's Chicago Medical School.

When infants are awake, they're in near-constant motion, which is critical for development, Eliot said. This movement "strengthens their muscles and hones their neural circuits for smooth, purposeful motor skills."

The process continues throughout life but is obviously most intense in infancy and toddlerhood, when children are mastering brand-new skills like sitting, standing, walking, running and jumping, Eliot said.

She worries that babies in the U.S. are spending too much time strapped in devices. Like adults trying to master a new sport, "young children need to practice to speed their neural pathways and select the optimal circuits to hone each milestone," Eliot said.

Pre-adolescence

In a new twist in the debate over physical education in schools, researchers are asking an intriguing question: What if exercise improves academic success?

Some research suggests it can. Hillman's team at the University of Illinois' Neurocognitive Kinesiology Laboratory found that children aged 7 through 9 who participated in a 60-minute after-school exercise program had better focus, processed information more quickly and performed better on cognitive tests than children who didn't exercise.

The researchers also found a dose effect: The more days the children attended the exercise program, the greater the changes in their brain function or cognition, according to the nine-month randomized trial, published in the journal Pediatrics in 2014.

"We didn't take low-fit kids and make them highly fit," Hillman said. "We took low-fit kids and made them a little less low fit. These aren't massive changes."

The effects were seen only on tasks that required executive control, "which is related to attention, behavior and obviously germane to success in school," Hillman said.

"It's our working memory and cognitive flexibility — often called multitasking — the ability to take information, put it on hold and go back and forth."

Late adulthood

Sadly, the hippocampus naturally shrinks in late adulthood, leading to impaired memory and increased risk for dementia.

But research suggests aerobic exercise can increase the size of the hippocampus and increase levels of a protein that aids the growth of new brain cells, potentially holding off changes in the brain and improving memory function.

"Atrophy of the hippocampus in later life is generally considered inevitable," said Kirk Erickson, professor of psychology at the University of Pittsburgh. "But we've shown that even moderate exercise for one year can increase the size of that structure. The brain at that stage remains modifiable."

In another study, researchers from the University of Wisconsin School of Medicine and Public Health found that people who said they exercised for 30 minutes five times a week in late-middle age did better on cognitive tests and showed less accumulation of the beta amyloid plaque, the protein that builds up in the brains of people with Alzheimer's disease.

At all ages, active people did better on immediate memory and visual spatial tests and had less amyloid plaque, better brain glucose metabolism and higher hippocampus volume compared with inactive people, according to the research, published in 2014 the journal Neurology.