

Can Pupils Indicate How Light Exercise Impacts Your Brain?

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✓ Fact Checked

October 19, 2023

STORY AT-A-GLANCE

- › The eyes' pupils dilate in response to very light-intensity exercise, and the dilation provides a window into the activity's influence on your brain health
- › Gentle exercise positively influences executive function, possibly by influencing activity in your brain's prefrontal cortex, an area involved in problem solving, decision making, self-awareness, memory and more
- › Not only did pupils dilate during very light exercise, but the dilation was linked to improvements in executive function associated with the brain's arousal system – the catecholaminergic system from the locus coeruleus
- › The findings could have implications for neurological diseases, including shedding light on how exercise helps ward off brain degeneration
- › High-intensity interval training has been all the rage in recent years, but pushing your body to the limit may not always be necessary to glean positive outcomes, and in some cases gentle exercises may be preferable

That old adage that you've got to "feel the burn" to get any benefits from your workout? It turns out this may not always be the case. Even gentle, low-intensity exercise is good for you, and now researchers with the University of Tsukuba in Japan have the evidence to prove it.

The proof came from an unexpected place – the eyes' pupils which, it turns out, dilate in response to very light-intensity exercise. What's more, the dilation provides a window

into the activity's influence on your brain health.

Dilated Pupils After Light Exercise Signal Brain Benefits

It's widely known that physical activity is good for your brain, but "even stress-free very-light-intensity exercise such as yoga and very slow running can have beneficial effects," the team noted in *NeuroImage*.¹ Gentle exercise positively influences executive function, possibly by influencing activity in your brain's prefrontal cortex,² an area involved in problem solving, decision making, self-awareness, memory and more.

However, there's no available technology capable of reading brain activity during very light exercise. So, researchers used the pupil in the eye as a window. In a study of 34 young adults, participants engaged in 10 minutes of very light-intensity cycling on one day and 10 minutes of rest on a separate day.

An eye-tracking device was used to measure pupil diameter during the exercise and rest states, while functional near-infrared spectroscopy (fNIRS) was used to measure activity in the prefrontal cortex during a test meant to gauge executive function.

Not only did pupils dilate during the very light exercise, but the dilation was linked to improvements in executive function associated with the brain's arousal system – the catecholaminergic system from the locus coeruleus (LC).³ In a news release, study author Hideaki Soya explained:

"When we first saw the raw pupil diameter data, we were amazed by the drastic dynamic change from rest to light exercise ... In the old days, it was said, 'No pain, no gain.' However, it was interesting that we could clearly confirm in the pupil raw data that the brain is activated even by very light-intensity exercise in humans ... even 10 minutes of very light exercise can enhance the function of the prefrontal cortex.

This is good news for those who dislike exercise ... Also, the pupil reflects the brainstem's activity, including the brain's noradrenergic arousal system. In the

present results, pupils were sensitively dilated during exercise, which predicted improved prefrontal cortex function.

The visualization that the brain arousal states for improved prefrontal cognition during very light exercise is new in human participants. Furthermore, looking ahead, pupil observation holds promising potential as a novel biomarker that can be used to predict the effects of exercise on the brain.”

The findings could have implications for neurological diseases, including shedding light on how exercise helps ward off brain degeneration. According to the study:⁴

“Given the involvement of catecholaminergic modulation from the LC to the cortex indicated by pupil dilation, which is a mechanism implicated in Alzheimer's, ADHD, and Parkinson's disease, it is possible that brief mild exercise, such as yoga and very slow running, could be developed into more promising lifestyle interventions as natural and low-risk strategies to ameliorate cognitive impairment.

The evidence presented here demonstrates that mild exercise works as an efficacious method of brain stimulation for enhancing cognitive function and that this effect can be assessed by observing pupil dynamics.”

Is Very Light Exercise Good for You?

High-intensity interval training has been all the rage in recent years, as a method to gain the health benefits of exercise in a fraction of the time. But pushing your body to the limit may not always be necessary to glean positive outcomes, and in some cases gentle exercises may be preferable. In a 2014 study, Soya and colleagues explained:⁵

“A routine of relatively high intensity exercise is often difficult to maintain: the intensity of exercise has been found to negatively correlate with adherence to a long-term exercise program in several studies. It would further be expected that physically inactive people in the modern era may be reluctant to participate in any type of regular exercise with a relatively high intensity and volume.”

Further, even during light-intensity activity such as walking, the neurotransmitter acetylcholine is released, which influences arousal, attention and sleep.⁶ The University of Tsukuba team previously revealed that mild exercise at 30% of VO₂ max is enough to improve the brain's executive function by regulating the arousal system and enhancing neural activations in “task-related prefrontal sub-regions” of the brain.⁷

In another example of the power of even light-intensity activity, a pilot study compared the effects of moderate-intensity cycling for 20 to 50 minutes, three times a week, with light-intensity stretching in older adults with Alzheimer's disease.⁸ Both forms of exercise reduced declines in cognition among the group – and light stretching worked as well as moderate-intensity cycling.

A systematic review using accelerometer data also found light-intensity activity to be beneficial. “Observational evidence that light-intensity PA [physical activity] can confer health benefits is accumulating,” the team, with Goethe University Frankfurt, Germany, explained.⁹

They found light-intensity physical activity was associated with positive outcomes on obesity, markers of lipid and glucose metabolism and mortality. “Currently inactive or insufficiently active people should be encouraged to engage in PA of any intensity,” they concluded.

Meanwhile, when adults with Type 2 diabetes broke up longer periods of sitting with standing and light-intensity walking, it improved glucose levels and insulin sensitivity more than engaging in structured exercise.¹⁰

In another revealing example, a study using data from 5,575 U.S. adults found light-intensity physical activity is inversely associated with the risk of all-cause mortality, such that “promotion of light-intensity physical activity is warranted.”¹¹

When Vigorous Activity Can Backfire

A sedentary lifestyle is associated with an elevated risk of cardiovascular problems and a shorter lifespan, while physical activity is generally associated with improved health

and longer life. However, it's possible to overdo it when it comes to high-intensity activity.

A systematic review published in Missouri Medicine reviewed studies published between 2011 and 2022 that assessed the effects of duration and intensity of exercise, and specific types of training or sports, on long-term cardiovascular health and life expectancy.¹²

The authors concluded that high amounts of strenuous exercise were nowhere as beneficial as moderate exercise, strength training and interactive sports or play. Further, they explained, "Very large volumes of strenuous exercise and/or weightlifting may not be the ideal for optimizing longevity."

It's revealing that while "more is better" when it comes to moderate-intensity exercise, the benefits of high-intensity activity plateau after about 150 minutes a week.^{13,14} After this amount, engaging in more high-intensity exercise may backfire.

Examples of moderate activity include walking, hiking, gardening, housework, dancing, shopping, golf, pickle ball, doubles tennis, volleyball and leisurely bike riding.

Vigorous activity refers to strenuous bicycling, running or swimming, high-intensity interval training (HIIT), singles tennis, basketball or "other activities that cause heart-pounding, sweat-producing, breathlessness," according to the Missouri Medicine study. The team explained that the potential for high-intensity activity to cause harm is real:¹⁵

"This fits well with the hypothesis of extreme exercise cardiotoxicity/cardiac overuse injury, which is particularly relevant for middle-aged and older individuals. A large amount of vigorous exercise, though required for attaining peak physical performance, may not be necessary for maximizing life expectancy and cardiac durability.

Very strenuous exercise acutely increases the risk of CVD [cardiovascular disease] events (myocardial infarction, sudden cardiac arrest) particularly for individuals who are in mid-life and beyond. Admittedly, these catastrophic CVD

events are very rare, but more common issues such as orthopedic injuries and overtraining issues may force individuals to curtail or abandon excessively strenuous exercise regimens.”

Benefits of Tai Chi, Yoga Well-Established

While high-intensity activity has its place, the benefits of gentle activities like tai chi and yoga have been demonstrated for centuries. Light-intensity activities such as these can be performed by people of all fitness levels and ages, including those with health issues and who may have limited mobility.

Tai chi, which is often referred to as “meditation in motion,” involves slow, purposeful movements in which your muscles are relaxed,¹⁶ your breathing is slow and deep, and your mind is focused on the present moment. Similarly, yoga involves engaging in various postures that work different areas of your body while focusing your breath and mind.

Despite their low intensity, these gentle activities offer numerous health benefits. Tai chi, for instance, has been found to benefit:¹⁷

Cognitive capacity in older adults

Dementia

Depression

Parkinson’s disease

Osteoarthritis

Chronic obstructive pulmonary disease

Cardiac and stroke rehabilitation

Fall prevention

Insomnia¹⁸

Yoga offers similar health gains, including improving cardiovascular health, reducing triglycerides and relieving chronic back pain. In addition, yoga benefits:¹⁹

Stress

Insomnia

Obesity

Anxiety

Diabetes

High blood pressure

Oxidative stress

Glucose tolerance

Neurodegenerative
disease

Walking May Be an Ideal Activity for Most

Daily movement is a critical element of health and longevity – and this includes light-intensity activities. The finding that your pupils dilate – and correlate with beneficial brain changes – in response to even gentle exercise reveals its importance to your daily life.

Tai chi, yoga and stretching all apply, but so does the simple activity of walking. Ideally, I recommend walking for at least one hour each day. If you can, walk outdoors so you can get beneficial sun exposure at the same time.

Walking 8,000 steps just once or twice a week is associated with significantly lower all-cause and cardiovascular mortality risk.²⁰ People who participate in outdoor walking groups also enjoy significant reductions in systolic and diastolic blood pressure, resting heart rate, body fat, depression scores and body mass index, along with increases in VO_2 max, a marker of fitness level.²¹

One great aspect of walking is that it's free and accessible for everyone. You can do it virtually anywhere and it's easy to get started even if you haven't exercised in a while. For those seeking specific athletic pursuits or high-level physical performance, high-intensity exercise may be necessary and useful in moderation.

However, most people will benefit from adding not only moderate-intensity activity but also plentiful light-intensity activities to their daily routine.

Sources and References

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