Health Neuroscience: How and Why Exercise Improves Cognitive Health

Professor Kirk I Erickson

Scientia

HEALTH NEUROSCIENCE: HOW AND WHY EXERCISE IMPROVES COGNITIVE HEALTH

We all know exercise is good for us. In addition to the renowned physical benefits, **Professor Kirk Erickson** in the Department of Psychology at the University of Pittsburgh is providing powerful evidence that exercise may improve cognitive faculties throughout the lifespan. Read on to discover the wide range of ways in which exercise can help us to live our lives to the fullest across the years, and how the emerging field of health neuroscience may inform public health policy for our better good.

Sedentary Lifestyles in the Digital Era

Exercise is crucially important for our physical health yet, despite this, many of us do not achieve the recommended levels of physical activity. A major cause of this is the impact of the digital era in encouraging us to lead increasingly sedentary lifestyles. From sitting behind our computers for work to driving or taking public transport from A to B, for many of us, there is little physical exertion in our day to day lives compared to that of our prior generations.

This is of particular concern due to the long-established link between lack of exercise and the development of chronic diseases, including obesity, type 2 diabetes, and cardiovascular disease, all of which are on the rise at a global level at an alarming rate.

In addition to the detrimental impact of lack of exercise on our physical health, increasing evidence obtained over the last 20 years suggests that our brain and cognitive faculties (such as memory and attention) are also negatively affected. However, when we do exercise, the benefits can be significant. Professor Kirk Erickson in the Department of Psychology at the University of Pittsburgh, USA, is a pioneer in elucidating the beneficial impacts of exercise on brain structure, function, and cognition in the emerging field of health neuroscience.

Neuroprotective Effect of Exercise in Old Age

The hippocampus is a small neural structure in the brain, implicated in both learning and memory. As we age, physical deterioration to the hippocampus in the form of shrinkage is both a precursor to and cause of impairments to memory. In older adulthood, increasing difficulties with memory are often considered part of the normal aging process, as well as a hallmark symptom of neurological disease (such as Alzheimer's disease and other forms of dementia) when the impairments are substantially more severe.

Professor Erickson and colleagues noted in a paper published in 2011 that existing research indirectly suggested

that exercise may increase the size of the hippocampus in the brain in older adults but that this suggestion had not yet been confirmed or quantified. To address this, they conducted a randomised controlled trial in which they recruited 120 older adults without dementia, and allocated participants to one of two groups: an aerobic exercise group or a control group who completed only stretching exercises.

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The findings were astonishing – aerobic exercise training increased hippocampal volume by 2%, which the researchers explained effectively reversed age-related loss in hippocampal volume by 1 to 2 years compared to the control group. Furthermore, this was associated with demonstrable benefits to spatial memory, a specific type of memory related to information about our environment and location (how to find our way to the local shops, for example). These findings provided the first direct evidence that aerobic exercise has a neuroprotective effect on critical cognitive functions in aging. In other words, undertaking such exercise can reduce or, to an extent, ameliorate ‘normal’ age-related cognitive decline.

Exercise as an Effective Intervention Post-stroke

Professor Erickson and his team then turned their attention to the effects of exercise in either preserving or potentially even improving cognition following stroke. For survivors of stroke, cognitive impairment presents significant challenges through being associated with further deterioration in health, lowering of quality of life, and decreased independence in daily life skills and self-care.

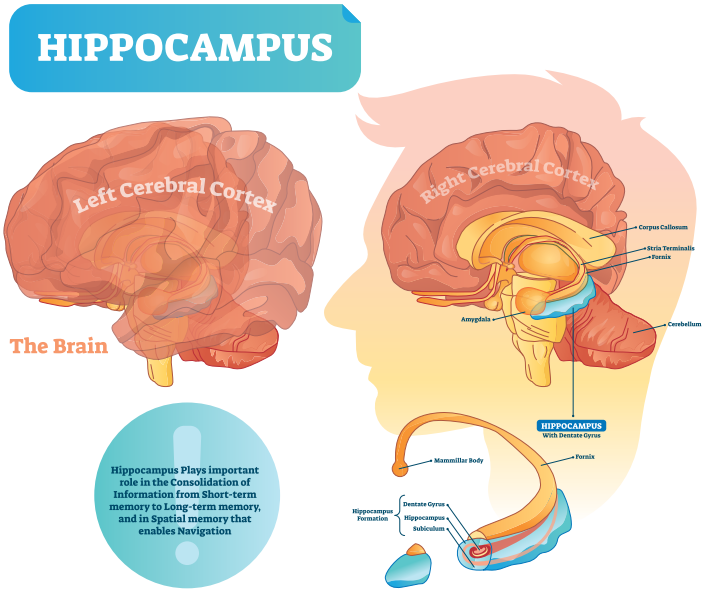
Using a statistical technique known as a meta-analysis, Professor Erickson and colleagues evaluated the combined findings from 14 separate randomised controlled trials (constituting a total of 736 participants) that had tested the effects of exercise on various measures of cognitive function. Conducting a meta-analysis allows a more powerful and reliable estimation of the effects of a given intervention than can be derived from a single study alone.

Professor Erickson found that benefits to cognition were most pronounced for combined aerobic and strength training programs (as compared to either activity being completed in isolation). Benefits were found even in the chronic post-stroke phase (which in this study was on average around 2.5 years), suggesting that exercise as an intervention can be effectively utilised even some time after the stroke itself.

Benefits of Exercise in Children

To date, the majority of research has focused on the benefits of exercise in older adulthood. However, there is converging evidence that childhood is a key stage of development in which physical activity may also provide tangible benefits. In a review paper published in 2017, Professor Erickson and colleagues synthesised the available literature on the effects of exercise in childhood.

Here, the researchers noted that greater integrity of grey matter in the brain, a critical structure associated with a wide range of functions including muscle control, sensory perception, and higher-level functions (such as memory), is associated with greater levels of physical fitness in children and adults alike. The researchers also noted that levels of physical activity can be directly linked to measures of academic success in school children. Such findings are, of course, of keen interest to educationalists, parents, as well as society more broadly, given the profound implications of being able to increase academic attainment in our younger generations.



Taking a reasoned approach, Professor Erickson and colleagues pointed to limitations in the existing research and highlighted avenues for future research. First, they argued for the need for causal rather than merely correlational evidence to elucidate the underlying mechanisms of benefit for exercise in children. Second, they suggested that the circumstances that confer the greatest benefits for exercise on cognition, such as the age of child, duration, frequency, and intensity of exercise, should be identified as a priority.

The Emergence of Health Neuroscience: From Theory to Public Health

The approach adopted by Professor Erickson and colleagues in understanding how the brain affects and is affected by health behaviours such as exercise is known as health neuroscience. This is a new and interdisciplinary field of work, offering both great potential but also, as with any new approach in science, challenges to be overcome in maximising its potential application.

Professor Erickson and colleagues argue that it is not sufficient to merely describe the relationships between our physical health, brain function, and cognition, but rather, that the overarching aim of health neuroscience should be to use empirical findings and the associated theoretical perspectives for the better good, in this case, to improve public health.

As part of work for the USA Physical Activity Guidelines Advisory Committee in 2018, Professor Erickson and colleagues summarised the evidence suggesting that exercise has beneficial effects on both the brain and cognition, and concluded that this is likely to be the case across the lifespan and for different clinical groups. Although they acknowledged that important gaps in the evidence remain, the consistency and magnitude of evidence supporting the beneficial effects were deemed as 'truly remarkable' with the potential to inform the development of public health policies aiming to improve cognitive health across the lifespan.

Striding Forward: *Investigating Gains in Neurocognition in an Intervention Trial of Exercise* (IGNITE)

Professor Erickson is committed to progressing this important field of health neuroscience. To this end, he is currently working on the large-scale *Investigating Gains in Neurocognition in an Intervention Trial of Exercise* (called IGNITE), which is planned to run until the end of 2022. Almost 700 cognitively healthy adults aged between 65–80 years of age are being assigned to one of the following exercise conditions each lasting one year in duration: moderate-intensity aerobic exercise condition (150 minutes per week), moderate-intensity aerobic exercise condition (225 minutes per week), or light-intensity stretching and toning control condition (150 minutes per week).

Participants are undertaking an extensive battery of assessments as outcome measures, including measures of cognition, blood biomarkers, and psychosocial questionnaires at several timepoints. In addition, brain magnetic resonance imaging, physiological biomarkers, cardiorespiratory fitness, physical function, and positron emission tomography are also being utilised as assessments, representing an ambitious yet methodologically robust and comprehensive clinical trial.

On completion, this landmark study will allow the researchers to address key questions about exercise and cognition; most notably, whether the current USA guidelines of 150 minutes of exercise per week are sufficient to elicit benefits to cognition in older adults. Findings will also begin to address the issue of the potential dose-response relationship between exercise and brain and cognitive outcomes. To put it more simply, findings will help determine whether more exercise equates to better cognitive function. As Professor Erickson notes, 'The results from this trial could transform scientific-based policy and health care recommendations for approaches to improve cognitive function in cognitively normal older adults.'

By using exercise as a model within the new field of health neuroscience, Professor Erickson is aptly demonstrating how rigorous experimental and theoretical approaches can help address the monumental need to improve human health and cognition across the lifespan in our current age.

Meet the researcher

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Professor Kirk Erickson completed his PhD at the University of Illinois at Urbana-Champaign in 2005 and then undertook a three-year postdoctoral position at the same institution. In 2008, he moved to the University of Pittsburgh to take up an assistant professorship and rapidly rose through the ranks to be promoted to his current position of professor in 2017. Professor Erickson is widely acclaimed as a scientist, having most recently been appointed as a Distinguished Scientist at Murdoch University (2019–2020) and as a Fellow at the Academy of Behavioral Medicine Research from 2016. From 2016–2018, Professor Erickson was appointed to the Physical Activity Guidelines Advisory Committee by the United States Secretary of Health and Human Services, reflecting his significant contribution to healthcare policy and societal issues. Professor Erickson is an active editor and reviewer for a number of prestigious journals, and has published a total of more than 200 journal articles and book chapters. An impressive track record of funding continues to support Professor Erickson's research into brain changes in late adulthood and the factors that promote successful aging.

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FURTHER READING

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IGNITE