Protecting the brain with exercise
Áine Kelly

The effects of ageing on brain function vary widely in different people, resulting in differing impacts on quality of life. Some older adults develop mild cognitive impairment that may progress to increasingly severe stages of dementia, while many of their peers maintain their youthful cognitive ability throughout life.

Solving the biological puzzle of why some people age more successfully than others has major health and societal consequences for our ageing population and is my key research interest. It appears that the lifestyle choices we make, including the frequency and duration of participation in physical activity, influence how well our brains function in old age.

Worryingly, the latest available data (World Health Organisation, 2013) show that only 31% of Irish adults aged 16 to 65 meet the recommended physical activity guidelines for good health, namely at least 30 minutes/day of moderate intensity activity on five days/week (or 150 minutes/week). This is despite the fact that regular exercise is a ‘polypill’ that can prevent and/or treat many chronic diseases including coronary heart disease, hypertension and type 2 diabetes. Of greatest interest to my laboratory, sedentary behaviour is linked with increased risk of dementia and cognitive impairment in old age.

Cellular changes stimulated by exercise – My work is focussed on assessing the specific impact of exercise on brain health at the cellular level. I investigate how neurogenesis, the birth of new neurons in the adult brain, is stimulated by exercise and may contribute to conferring resilience against age-related cognitive decline. I am also interested in the mechanisms by which exercise can modulate age-related neuroinflammatory changes, measured by assessing the proliferation and activation of glial cells in the brain, that can lead to impaired brain function.

The main experimental strategy in my laboratory, based in the Trinity College Institute of Neuroscience (TCIN), is to assess structural, functional and neurochemical changes in the brain following different periods of exercise. For example, we have recently found that exercising regularly early in life can protect against the cognitive effects of sedentary behaviour later in life. We saw that mice that are sedentary throughout their lives display progressive cognitive decline from middle-age onwards and by old age show evidence of damaging inflammation and decreased neurogenesis in the brain. In contrast, mice that exercised from youth to middle age had better cognitive function, fewer numbers of pro-inflammatory reactive astrocytes and microglia, more new neurons and increased brain size when compared to their life-long sedentary peers. This indicates that exercise undertaken earlier in life has physical effects on brain structure that persist long after exercise ceases and that protect against age-related decline in function. In similar experiments, we have seen that early exercise can slow cognitive symptoms in a mouse model of Alzheimer’s Disease.

Our present work, in collaboration with Prof. Marina Lynch, Professor of Cellular Neuroscience, is probing the anti-inflammatory ability of exercise further, assessing how exercise can modulate metabolic pathways in astrocytes and microglia that are characteristic of the pro- or anti-inflammatory state. Several other strands of research in my laboratory have an exercise focus. Recent projects have assessed the impact of exercise of differing intensities on cognitive function in human subjects, while an ongoing multi-disciplinary international collaborative project aims to identify cognitive and blood-borne markers of brain health and injury that may aid in the management of sports-related concussion.

Áine Kelly is Associate Professor in Physiology in the School of Medicine and Associate Dean of Undergraduate Science Education. A Trinity graduate, she was awarded a B.A. (Mod) in Physiology and College gold medal in 1995, a PhD in 1999 and was elected to fellowship in 2009. She has been a principal investigator in the Trinity College Institute of Neuroscience since 2002. Her research expertise lies at the interface of exercise physiology and neuroscience and she assesses how lifestyle factors including physical activity can enhance and protect brain function throughout the lifespan.

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BELLOW—Early-life exercise protects the brain in old age. Compared with sedentary mice that never exercised, mice that exercised regularly until middle-age, but were then sedentary until old age, had (a) more new neurons (red) (b) fewer reactive astrocytes (green) and (c) a larger brain size (MRI scan; hippocampus highlighted in red).
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