

The power of diet in protecting the ageing brain

The relationship between nutrition and brain health is well established and even more poignant in our ageing population, where there is an increased risk of neurodegenerative conditions such as Alzheimer's disease. Professor John Nolan and Dr Rebecca Power at the Nutrition Research Centre Ireland (NRCI) are leading several projects that aim to explore the relationship between nutrition and cognition, as well as how we can fortify the diet with specific nutrients known to have positive impacts on brain health and cognitive performance. Understanding more about nutrition and cognition will allow the development of novel preventative pathways to help reduce the risk of neurodegenerative conditions.

With an ageing population, it is estimated that around 75 million adults worldwide will experience symptoms of dementia by 2030. While there are many different types of dementia, defined as a deterioration in memory, thinking and behaviour, Alzheimer's disease is the most common form.

There is currently no cure for Alzheimer's disease, but it is thought that around a third of Alzheimer's cases could be avoided if lifestyle changes are implemented. Several risk factors have already been identified for dementia, such as low physical and mental activity levels, smoking, excessive alcohol consumption and being overweight.

In particular, there is a growing pool of evidence showing that nutrition is important for optimising cognition and reducing the risk of Alzheimer's disease. This makes a good place to start when thinking about reducing the risk of dementia and optimising cognition. Cognition is defined as the process of thinking, along with all the aspects associated with this, including perception, knowledge, problem-solving, judgement, language, and memory.

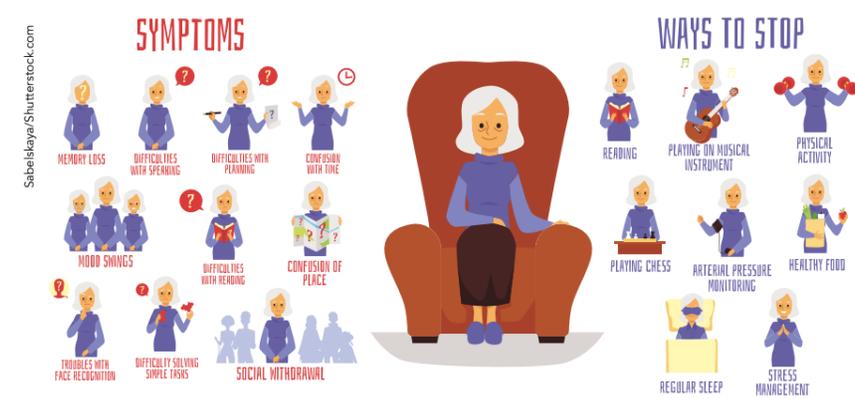
Looking after cognitive health is just as important as looking after physical health,

and scientists at the Nutrition Research Centre Ireland (NRCI) are playing a crucial role in advancing our understanding about the direct influences of nutrition on cognition. Here, Professor John Nolan and Dr Rebecca Power are uncovering the potential that diet and nutrients have in protecting the ageing brain.

MEDITERRANEAN DIET

A Mediterranean diet is best known for its high intake of plant foods, olive oil and fish, alongside lower consumption of dairy products, alcohol, and saturated fats. There is already a lot of evidence showcasing the positive health impacts of a Mediterranean diet. Additionally, there is a large consensus that greater adherence to a Mediterranean-style diet is associated with better cognitive performance, slower rates of cognitive decline, better brain structure and function in later life, and a reduced risk of developing Alzheimer's disease.

Together with their colleagues, Professor Nolan and Dr Power have reviewed the existing evidence that suggests that a Mediterranean diet may be beneficial for brain health with a focus on key nutritional compounds of the diet, namely carotenoids and omega-3 fatty acids. Carotenoids are plant-based pigments that give fruits, vegetables, and some other foods their bright colours. For example, a tomato is red because of the carotenoid lycopene; the yolk of an egg is yellow because of the carotenoid lutein. Oily fish, a key component of a Mediterranean diet, is high in omega-3 fatty acids, known to have multiple health benefits and to be important for heart and brain health.



Alzheimer's disease is the most common form of dementia. Symptoms include memory loss and confusion.

SUPPLEMENTATION WITH CAROTENOIDS AND OMEGA-3 FATTY ACIDS

The brain has a very high oxygen metabolism, consuming a fifth of the body's total oxygen intake to fuel its billions of neurons and trillions of synapses. As a result, a lot of unstable molecules known as free radicals are produced. This leads to a process known as oxidative stress where body cells and tissue can be damaged because of cumulative exposure to these unstable molecules.

Due to their chemical composition, carotenoids primarily act as antioxidants, mopping up molecules that cause damage to the body. Omega-3 fatty acids on the other hand are primarily involved in the control and resolution of inflammation.

Given that oxidative damage and inflammation are important features of the brain pathology of Alzheimer's disease, it is likely that carotenoids and omega-3 fatty acids can play an important role in slowing down the mechanisms implicated in cognitive decline and Alzheimer's disease.

Interestingly, there may also be a synergistic effect which outweighs the benefit of each nutrient in isolation. This area of research has been the focus of the NRCI for the last number of years, where they have used their expertise and unique skillsets to explore whether higher intake of carotenoids and omega-3 fatty acids in combination with one another (in the form of a food supplement) can support brain health in both healthy and cognitively impaired individuals.

Findings from their most recent project (Cognitive impAiRmEnt Study [CARES]) have been promising, reporting improvements in working memory in cognitively healthy older adults following consumption of a carotenoid plus omega-3 fatty acids plus vitamin E formulation for 24 months in comparison to individuals receiving placebo (currently under peer review). Working memory involves the temporary holding of information for later

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access and application, e.g. holding a person's telephone number or address in mind. Therefore, these findings have important implications for carrying out everyday tasks more efficiently.

The other arm of CARES involved individuals at an early stage of cognitive decline (mild cognitive impairment). While only a small number of participants met the eligibility criteria and completed this arm of

CARES, the published results showed that those who took the supplements for 12 months had improved episodic memory (recollection of past events) and global cognition, assessed using a screening tool that covers aspects such as attention, language, and visuospatial abilities.

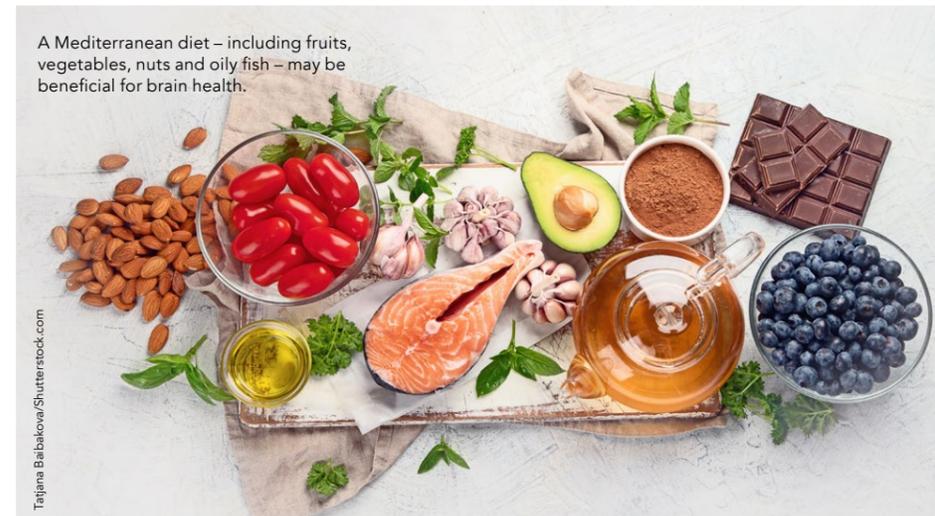
Nutritional interventions may protect against cognitive decline but may also play a role in slowing progression of disease. The Memory Investigation with Nutrition for Dementia (re-MIND) project aims to explore the effects of carotenoids and omega-3 fatty acid supplementation on the natural progression of Alzheimer's disease in patients at a mild to moderate stage of the disease.

Pilot work has already been done for this project and shows that functional benefits in memory, sight, and mood were reported in people with Alzheimer's disease who took a daily supplement that combined carotenoids (lutein, in particular) and fish oil. The findings were unexpected, as the study had originally set out to investigate the impact of supplementation on biological processes.

These preliminary data suggest a synergistic nutritional strategy that may be effective in maintaining function and quality of life in patients with Alzheimer's disease.

UNDERSTANDING "HOW" NUTRITION SUPPORTS BRAIN HEALTH

The team at the NRCI and their collaborators recognise that nutritional interventions can benefit certain elements of cognition in healthy and



mildly cognitively impaired individuals. However, they are also very aware that the underlying biological reasons that support the relationship between nutrition and brain health are less well understood. In order to address this gap, the researchers hope to take advantage of international collaborations that have been established through networks such as the Brain and Ocular Nutrition (BON) network.

a fortified yoghurt product that could be used to improve the nutritional content of the human diet for the general population. Since carotenoids are fat-soluble molecules, using a dairy product to deliver them into the body will improve their effectiveness. Before this product is made available to the general public, this hypothesis will be tested as part of the FortiXan (Fortification with Xanthophylls) nutritional intervention trial.

Carotenoids are already known to have health benefits, but less is known about the levels of carotenoids in products. In response to this, the NRCI are testing commercially available carotenoid supplements in order to verify the levels of carotenoids versus the claims made by the manufacturers. Supplement Certified is an independent scientific certification,

that carotenoids and omega-3 fatty acids have the potential to reduce the risk of Alzheimer's disease. Unfortunately, the modern diet is sub-optimal with respect to type and quality of nutrition, and we do not eat enough carotenoids or omega-3 fatty acids every day.

Moreover, cognitively impaired individuals tend to have poorer dietary patterns than cognitively healthy individuals, and are deficient in both carotenoids and omega-3 fatty acids. Therefore, early intervention, for example through supplementation of these nutrients, may benefit at-risk populations and could be considered as part of the prevention and treatment pathways for cognitive disorders.

By following a certain dietary pattern or taking a food supplement, brain health

In order for these nutrients to exhibit their functional and health properties, they must be present in the blood and tissue in sufficient concentrations.

developed by researchers at the NRCI, for assessing claims made on product labels. So far, Supplement Certified has shown that up to 65% of products do not live up to the claims made on their labels. This suggests that a more rigorous and regulated approach is needed to ensure that commercial companies have the evidence to support claims made on their products.

PROTECTING AN AGEING POPULATION

Dr Power and Professor Nolan emphasise

and function can be improved. This means that we function better in everyday cognitive tasks, for example remembering things better or processing information faster. Nutritional interventions can also help to delay the onset of cognitive decline and/or the development of neurological disease to much later in life. This is something that is particularly important for an ageing population. Therefore, although we are living longer, our quality of life can be improved if we engage in better health behaviours, including healthy eating.

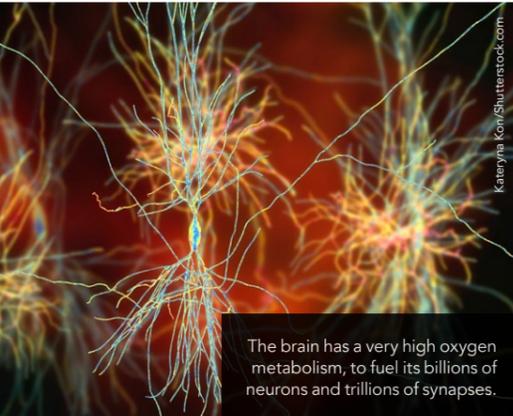
Through this network, Professor Nolan and Dr Power will work with Professor Aron Barbey, University of Illinois at Urbana-Champaign, on the Cognition and Nutrition (CAN) project, which is due to start in February 2022. The CAN project aims to gain a more in-depth understanding of how foods and dietary patterns support the brain in organising and communicating information, a research area known as nutritional cognitive neuroscience. The project is based on methodologies and techniques already used in the US.

Understanding more about the specific regions of the brain that are influenced by the foods we eat will allow findings from nutritional science to be translated into innovative clinical tools and techniques.

FORTIFIED PRODUCTS FOR BRAIN HEALTH

The work done by Professor Nolan, Dr Power and collaborators has shown that supplementation with carotenoids and omega-3 fatty acids can have a positive effect on cognition. Next, the NRCI are interested in more novel ways to deliver these nutrients to people who may benefit from them.

Ireland is the second-highest consumer of dairy products in the world. With this in mind, the NRCI is focusing on developing



The brain has a very high oxygen metabolism, to fuel its billions of neurons and trillions of synapses.

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Behind the Research



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Research Objectives

Professor Nolan and Dr Power study the link between nutrition and cognition in healthy and cognitively impaired individuals.

Detail

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Bio

Professor John Nolan is a Fulbright Scholar, European Research Council fellow and Howard Chair for Human Nutrition Research at the School of Health Science, WIT, Ireland. He is the Founder and Director of the NRCI and has published over 106 peer-reviewed scientific papers.

Dr Rebecca Power is a Postdoctoral Researcher at the NRCI. She is primarily interested in the role of nutrition for cognitive health. Recently she has been awarded a Marie Skłodowska-Curie Action Individual Fellowship, which will enable her to develop a greater understanding of the specific brain

regions and neural networks that are mediated by nutrition.

Funding

- Howard Foundation UK (UK Charity Registration number 285822). Provided funding for CARES, CARDS and re-MIND projects.
- European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement no 101027911. Will fund work related to CAN project.
- Science Foundation Ireland and the Department of Agriculture, Food, and Marine on behalf of the government of Ireland under grant #16/RC/3835—VistaMilk. Funds FortiXan project.
- This research has tested commercially available carotenoid products, which are used for supporting and enhancing vision, including MacuPrime (available in Europe, www.macuprime.ie).

ie); MacuHealth (available in North America, Mexico and Canada, www.macuhealth.com) and a patented formulation combining carotenoids with omega-3 fatty acids for Alzheimer's disease known as Memory Health (available worldwide, www.memoryhealth.com).

Collaborators

- Aron Barbey, Professor of Psychology, Neuroscience and Bioengineering at the University of Illinois at Urbana-Champaign and Director of the Decision Neuroscience Laboratory at the Beckman Institute for Advanced Science & Technology. Will be involved in the CAN project.
- Professor Riona Mulcahy, Consultant Geriatrician, Age-related Care Unit, Health Service Executive, University Hospital Waterford. Has been involved in CARDS, CARES and re-MIND projects.

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Personal Response

What is the one change that we should all make for better brain health?

Of course, we must continue to strive for a balanced diet and healthy lifestyle. This is our foundation for better brain health. However, better brain health will only be possible by enriching the specific nutrients of the brain. Thankfully, the last decade of science has provided us with this exact data. Therefore, targeted nutrients for the brain, with proven antioxidant and anti-inflammatory capacity, such as the xanthophyll carotenoids and high DHA omega-3 fatty acids should be utilised for better brain health.

