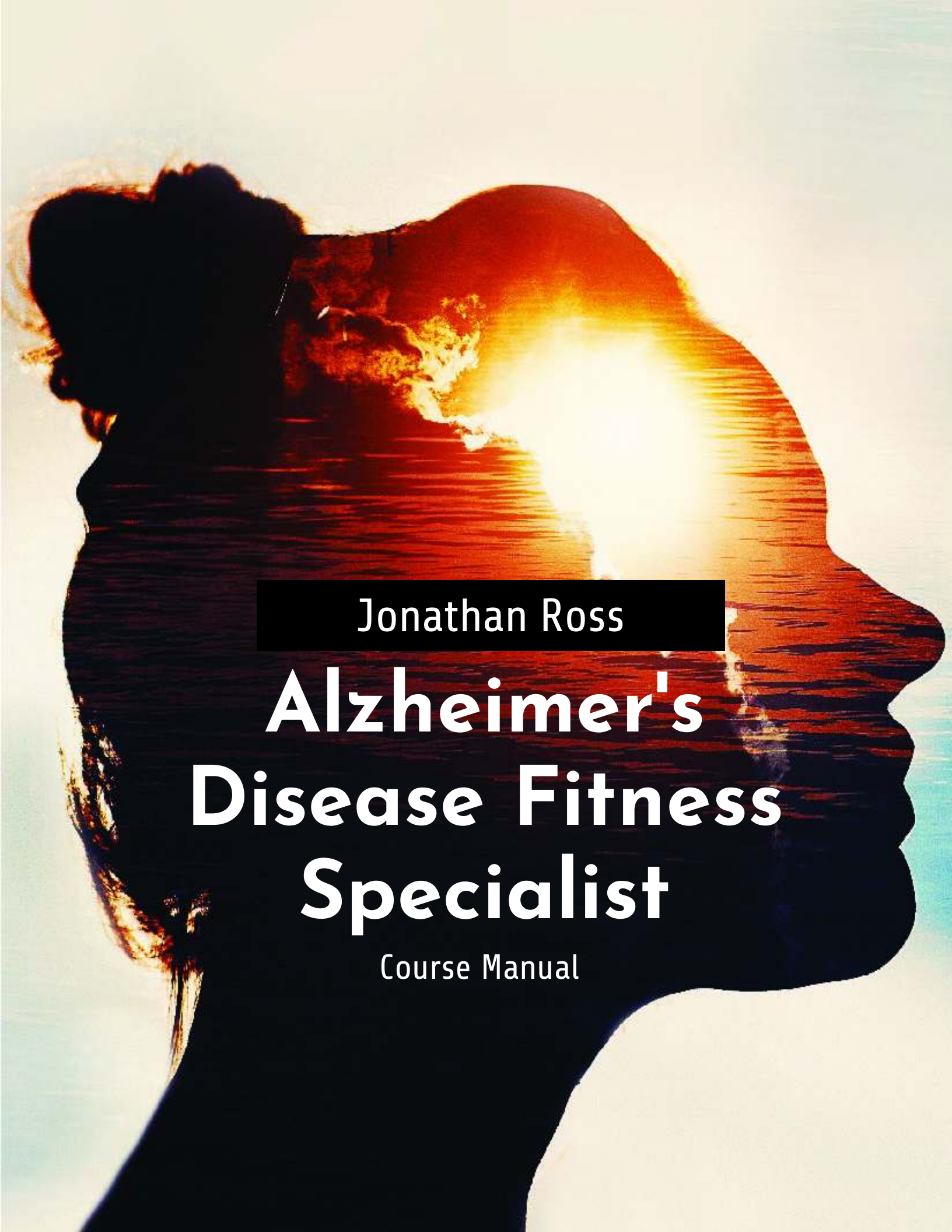

Jonathan Ross

Alzheimer's Disease Fitness Specialist

Course Manual

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Alzheimer's Disease Fitness Specialist Course - Introduction

Welcome to the Alzheimer's Fitness Specialist Course. The course will blend established knowledge with cutting-edge ideas to optimize the impact that fitness can have in the lives of those you serve who are concerned about or diagnosed with Alzheimer's.

What this course will cover:

We briefly examine the current statistics on Alzheimer's and consider the implications for what this means for any allied health professional in caring for a population that is skewing increasingly older.

You will briefly review the major types of dementia – of which Alzheimer's is the most common form – with deeper insights into Alzheimer's provided by unpaid caregivers and patients. These stories will deliver the powerful emotional impact to drive your dedication to this population and keep the human touch in all of the materials to breathe life into learning.

There is someone out there – someone's brother, mother, or significant other – who needs your help right now. Not five or ten years from now until we have "more research" (which will somehow still never be enough for some people to act). There is someone out there you have not met yet who can benefit from the combined cognitive and physical fitness strategies explored in this course. The personal stories will deliver some insights that cannot be gained from statistics.

You will experience an overview of the brain regions involved in Alzheimer's, the current thinking on most likely causes, and perhaps most importantly, you will be equipped to share a message of hope that the vast majority of Alzheimer's is not due to genetics. There are almost twenty modifiable lifestyle factors which play a significant role in Alzheimer's.

All exercise is good for brain health and with that as a foundation, this course presents strategies for making exercise – and all physical activity – even better for brain health by integrating specific techniques into one-on-one training, small group training, and group exercise like never before.

- You will enjoy an unparalleled exercise library of nearly 100 combined cognitive and physical fitness exercises using numerous familiar exercises enhanced with cognitive strategies as well as many novel exercises.
- You will have ample options for using no equipment or traditional – and some unconventional – fitness equipment.
- The exercise library is designed to be extensive enough to give you both ideas you can use right away as well plant the seeds of creativity for you to develop your own exercises using these concepts in the future.
- Further, you will be equipped to introduce non-exercise physical activity strategies to integrate beneficial brain health strategies into many common forms of physical activity apart from exercise.

You will also be introduced to an essential yet often overlooked aspect of fitness training for brain health and Alzheimer's disease. The focus is often excessively placed on future outcomes and the effectiveness of exercise as a potential aid in treatment as this is all that we can study objectively. However, the subjective experience someone has today, in a single physical activity experience designed by you, is of major importance and value.

A single positive experience has the power to lighten the emotional burden of both patients and caregivers while simultaneously creating an enjoyable enough exercise experience that it increases the motivation to continue future exercise participation. This course makes a compelling case that fun is an essential element of physical activity to optimize the role it can play in Alzheimer's disease and quality-of-life in general because it makes *right now* a little bit better and more enjoyable for someone normally under the heavy emotional weight of a progressive, degenerative disease for which there is no cure.

A single workout cannot create lasting physical change, but it can create a lasting change in attitudes and feelings about exercise, and it can make today a little better for someone.

What this course will not cover:

This course will not teach you things you have already learned elsewhere. For example, this course will not cover the basics of exercise program design. Given that this course is considered a secondary continuing education course, program design knowledge is an assumed part of whatever fitness certification has already been completed by course participants and brought you to the point in your career where you are availing yourself of the material in this course.

This course will not include a deep analysis of brain anatomy and physiology and will be limited to areas relevant to Alzheimer's disease to enhance the learning of attendees by keeping the focus to what practical knowledge is most helpful to applying wellness behavior coaching in the context of Alzheimer's disease.

Wherever possible, information and ideas considered to be common knowledge will be omitted from the course. Where they are included, this is done out of necessity of creating the appropriate context for information to follow.

The objective is to include as much streamlined and unique information and ideas as possible to deliver maximum value to participants and whenever possible avoid information that is often repeated in multiple other sources. As a result, this course will hopefully maximize the engagement and the enjoyment you have with the material with the goal of providing you the best possible fitness instruction based on current established science combined with progressive approaches to optimally integrate cognitive challenge into physical challenge.

Module 1 – Alzheimer's Disease By the Numbers

Lesson 1 - Past, Present, and Future

"Who are you if you cannot remember who you are?"

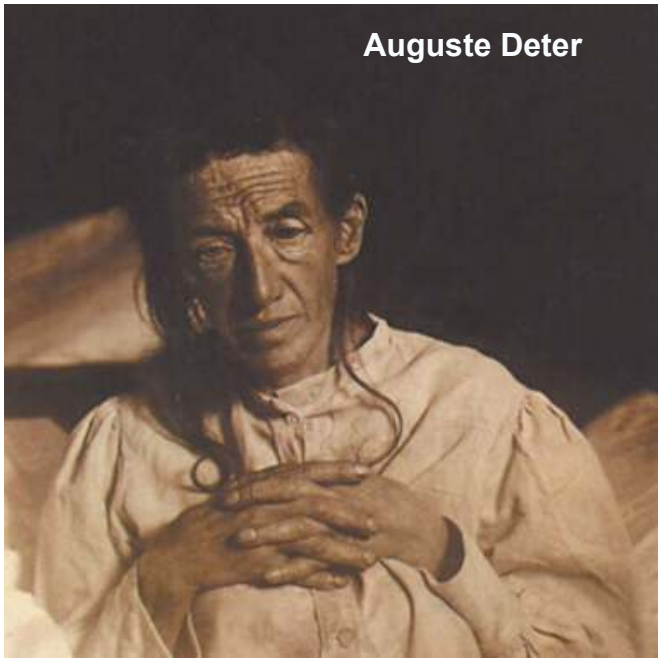
This question is the opening line of the narrator in an episode of the television series *Solos* featuring a patient with Alzheimer's and immediately captures the scope and the terrifying reality of the disease.

Just as the heart can suffer a myocardial infarction or "heart attack" and the brain can suffer a stroke or "brain attack," our mind – the essence of our identity – suffers a "mind attack" in Alzheimer's, although the mind attack takes decades unlike the other two.

When it comes to the brain, the expression "the whole is more than the sum of the parts" finds few more fitting examples. We can describe the individual functions of specific parts of the brain. But put them together and they make us who we are. When enough of the brain degrades in Alzheimer's, *we* start to disappear.

Past – from Rare to Everywhere

In the more than 100 years since **Auguste Deter**, the first known Alzheimer's patient died from the disease, it has gone from being considered a rare condition affecting only younger people to a leading cause of death around the world with advanced age as the leading non-modifiable risk factor.

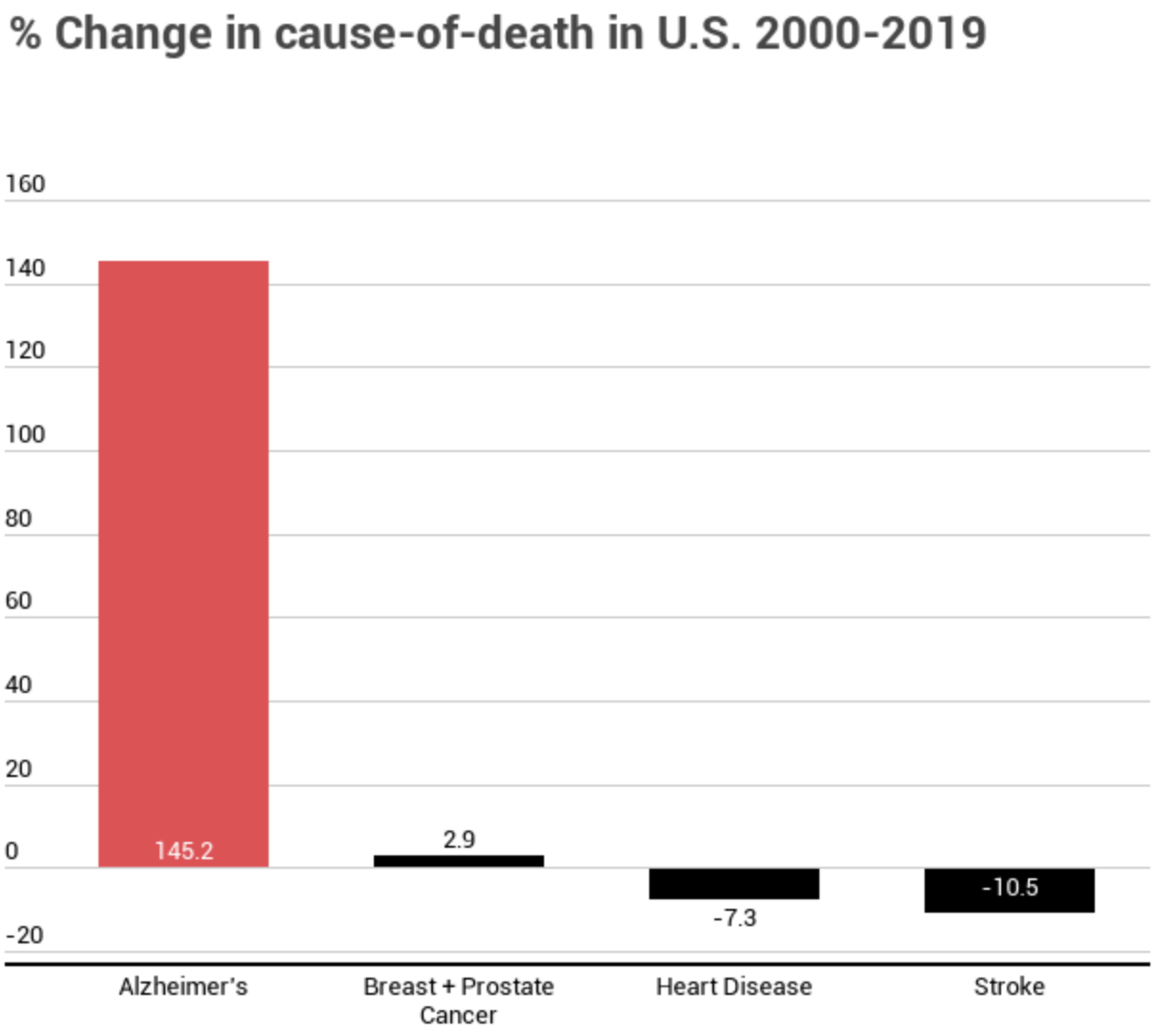


It was not until the latter half of the 20th century that Alzheimer's disease became a major health priority for the entire world. In the mid-1970's we realized that Alzheimer's disease was actually responsible for most dementia.

In 1984, George Glenner identified the beta-amyloid protein from patients with Alzheimer's disease. And in 1990, the apolipoprotein E4 (APOE4) allele was found to be a major risk factor for Alzheimer's disease.

The increasing recognition of the long preclinical period to Alzheimer's disease coincided with a series of failures of treatment trials that included patients with mild to moderately severe dementia. (Ryan, 2015)

Alzheimer's is the 6th leading cause of death in the U.S. (CDC, 2021) During the span of 2000-2019, Alzheimer's diagnoses have gone up 145.2%. This becomes more significant considering that Alzheimer's accounts for 60-70% of dementia diagnoses.



Data source: World Health Organization: Cause-specific Mortality 2000-2019
www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/ghe-leading-causes-of-death

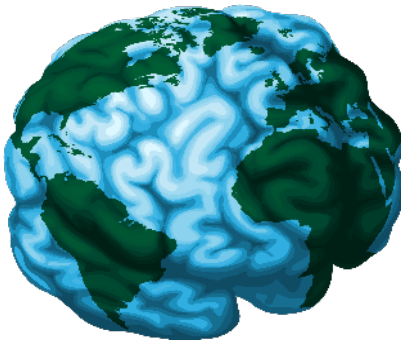
Present and Future

Age is one of the most significant non-modifiable risk factors. The percentage of people with Alzheimer's in the U.S. is as follows:

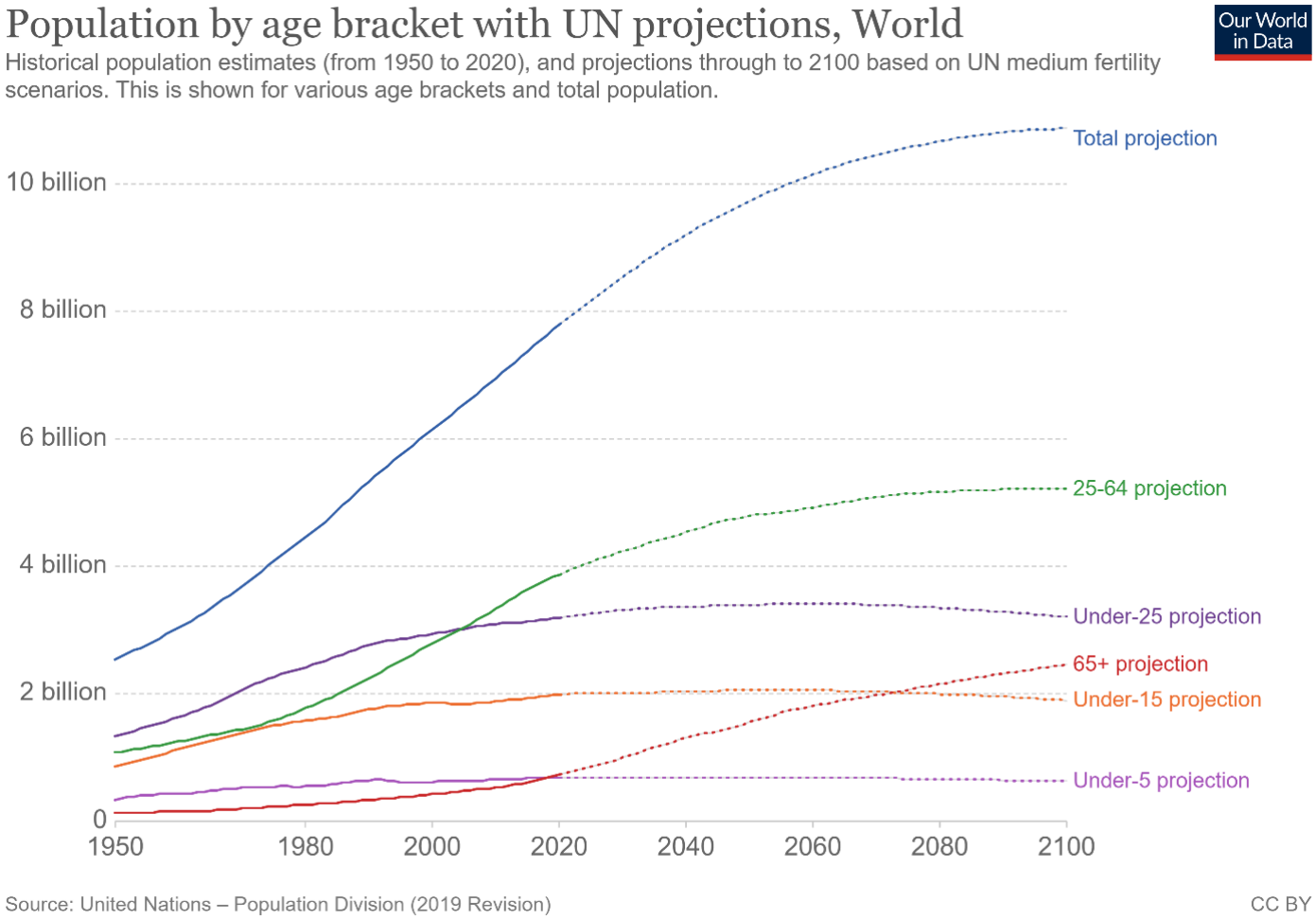
- 5.3% of people aged 65 to 74
- 13.8% of people aged 75 to 84
- 34.6% of people aged 85 and over

One of every 9 people in the U.S. age 65 and older has Alzheimer's (11.3% of those 65 and over). (Alzheimer's Disease Facts and Figures, 2021)

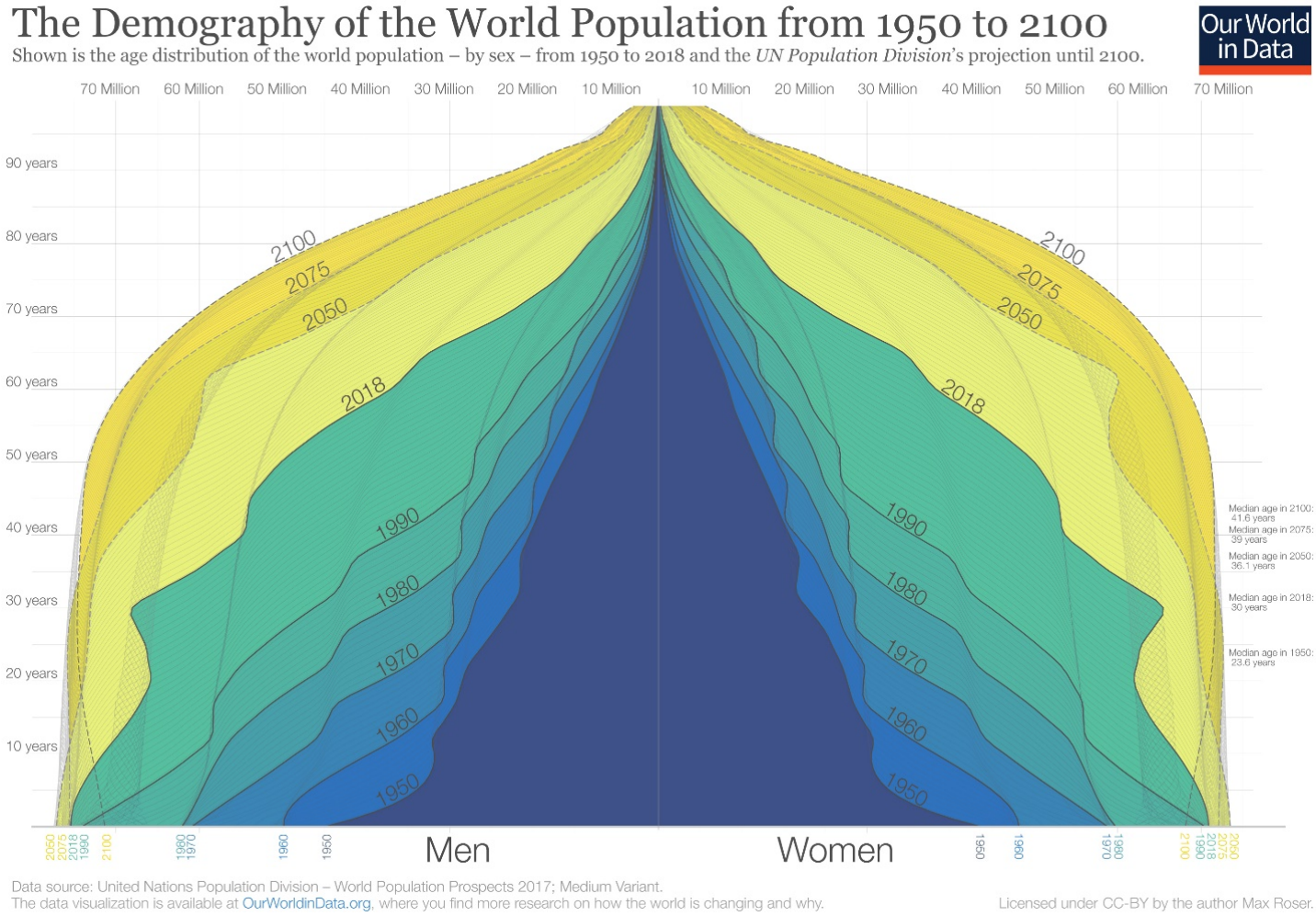
The number of people aged 65 and older in the United States has grown rapidly over most of the 20th century, from 3.1 million in 1900 to 35 million in 2000, or 12.4% of the total U.S. population. More recently, the age 65 and over cohort has increased to 16.0% in 2018, and by 2030 is projected to make up 20% of the U.S. population. Older adults are projected to outnumber children under age 18 for the first time in U.S. history by 2034, according to Census Bureau projections. (U.S. Census Bureau, 2019).



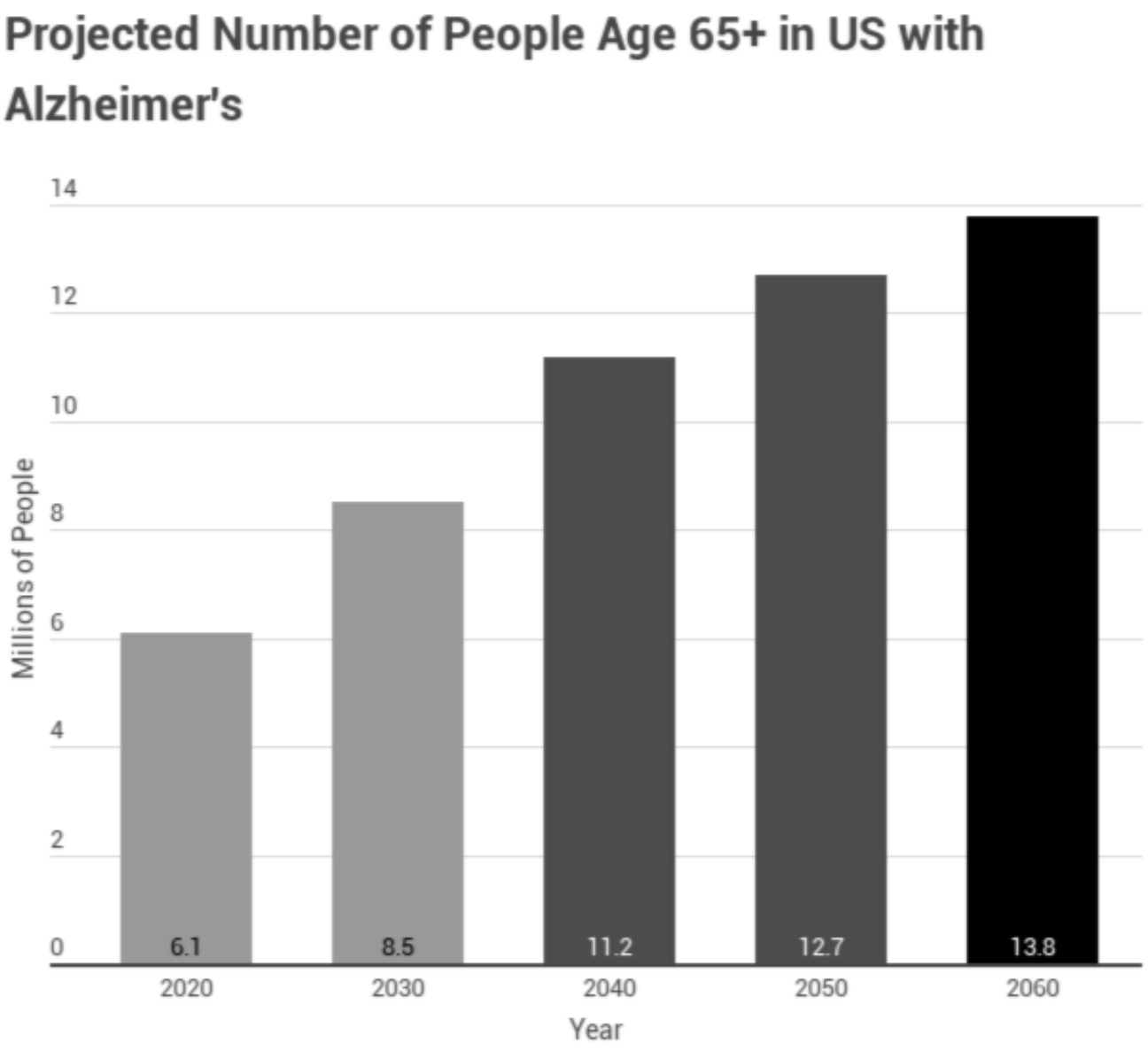
Worldwide, in 2018 the number of people aged 65 and over out-numbered the number of people under age 5 for the first time in recorded history. (Ritchie, 2019)



Age distribution of population most often looks like a pyramid, which makes a kind of intuitive sense as we expect increasingly smaller numbers of people to make it to older and older ages. However, the worldwide population age is changing so that the data is beginning to look more like a tower and in the not-too-distant future, will begin to look like an inverted pyramid. (Ritchie, 2019)



With the increasingly large percentage of the world's population featuring people aged 65 and over, the projections for Alzheimer's disease are substantial. By 2050, in the U.S. there are projected to be 12.7 million Alzheimer's patients, more than doubling the 2020 number of 6.1 million.



created with data from Alzheimer's Association's 2021 Alzheimer's Disease Facts and Figures. p. 26

And this trend is also present around the world. For example, in Australia, dementia (Alzheimer's makes up about 70% of dementia there) is the 2nd leading cause of death and the number of Australians with dementia is projected to be 1.1 million by the year 2056. One in ten Australians over age 65 has dementia and at age 85 and up, that jumps to three in 10. (Queensland Brain Institute, 2018)

All these numbers can make your head spin. When we put statistics aside, *one* becomes the more powerful number. And yet numbers do not tell the story – people do. You can relate more powerfully when you hear specifically how Alzheimer's affects a single human. We cannot relate to large numbers in a meaningful way.

References for this Lesson

Alzheimer's Association. (2021) Alzheimer's Disease Facts and Figures. [Ebook]. Chicago. Retrieved from https://www.alz.org/media/Documents/alzheimers-facts-and-figures.pdf

Centers for Disease Control. (2021) Leading causes of death in the U.S. https://www.cdc.gov/nchs/fastats/leading-causes-of-death.htm (accessed July 2021)

Queensland Brain Institute. (2018) The Brain: Dementia. Issue 3 www.Qbi.uq.edu.au/dementia (accessed June 2021)

Ritchie, H., Roser, M. (2019) - "Age Structure". Published online at OurWorldInData.org. Retrieved from: https://ourworldindata.org/age-structure (retrieved 14 July 2021)

Ryan N., Rossor, M., Fox, N., (2015) Alzheimer's disease in the 100 years since Alzheimer's death. Brain-Journal of Neurology. 138:12. 3816–3821. https://doi.org/10.1093/brain/awv316

United States Census Bureau. (2019, Dec. 10). 2020 Census Will Help Policymakers Prepare for the Incoming Wave of Aging Boomers. Retrieved from https://www.census.gov/library/stories/2019/12/by-2030-all-baby-boomers-will-be-age-65-or-older.html

Lesson 2 - Can Exercise Treat, Prevent, or Slow Progression of Alzheimer's Disease?

This is the "big" question on everyone's mind when it comes to exercise and Alzheimer's Disease (AD). Another way to ask this is "Does exercise make the *future* better?" The quick answer is "yes" with the understanding that there are no guarantees of effectiveness for any one person. The other big question that is rarely asked is "Does exercise make *today* better?" Does it improve quality of life and enhance the coping abilities of patients and caregivers?

We will explore both questions: **The *heart* and the *science* of fitness leadership.**

Can Exercise Treat, Prevent, or Slow Progression of Alzheimer's Disease?

There is solid evidence of the substantial positive effect that exercise can have on Alzheimer's Disease risks and progression. As we discuss later in more detail, the highly multi-factorial nature of AD means no single behavior will guarantee a positive outcome, but rather every positive behavior chosen improves the odds. Alzheimer's does not come out of nowhere – it comes out of everywhere. Numerous lifestyle factors influence the disease – with exercise one of the most influential – and the specific exercise methodologies employed in this course provide a superior benefit over and above generic "exercise."

Here is a brief, initial overview of some research showing a clear benefit to exercise over both the short-term and long-term.

- Swedish women (1,462 of them), ages 38 to 60, followed for 44 years, showed that those who exercised regularly were one tenth as likely to suffer dementia with aging as those who did not exercise. Further, when the more fit women did develop dementia, they developed it an average of 11 years later than women who were less fit – at age 90 instead of age 79. (Hörder, 2018)
- Nearly 6,500 older people aged 61 to 78 wore exercise trackers. After three years, those who exercised regularly had a 36% lower risk of memory loss as well as better memory and executive function. (Wenfei, 2017)
- Using VO_2 Max to measure fitness, the less fit in a group of 81 older adults had an increased rate of dementia and of losing the white matter (nerve fibers and myelin covering) in their brains that helps with decision-making and memory retention. (Ding, 2018)
- A review of hundreds of research articles showed that older people who exercise have far less loss of brain function with aging, less brain blood vessel damage, larger hippocampal brain size (better memory), less loss of brain tissue with aging, better spatial memory, better communication between brain cells and improved ability to learn new facts. Improvements were seen in those without a diagnosis of dementia as well as those with Mild Cognitive Impairment and with dementia. The authors concluded that exercise should not be overlooked as an important therapeutic strategy. (Ahlskog, 2011)

What about more immediate, short-term benefits of physical activity?

Even light workouts can increase the connectivity between parts of the brain responsible for memory formation and storage. A single 10-minute period of mild exertion can yield better connectivity between the hippocampus and cortical areas linked to detailed memory processing. (Suwabe, 2018) In other words, a single bout of even light exercise enhances communication between memory-focused parts of the brain.

Research Clearly Shows That…We Need More Research?

In the past two decades, over 73,000 research articles on AD have been published, averaging 100 per day. The only firm conclusions seemingly drawn from all this work is the unfortunate common refrain, "we need more research." We both *do* and *do not* need more research. We *do* need more research to more efficiently and thoroughly refine our approach in the future. However, **we do not need more research to know how to employ exercise as a strategy to aid in the prevention or slowing the progression of AD right now in people who need your help.**

The tyranny of the double-blind, placebo-controlled study as the gold standard in research will, for some people, lead to endless calls for more research. This ideal type of study can never be done with Alzheimer's since it is an absurd (not to mention unethical) notion to think we would isolate a large group of humans and forcibly prevent them from exercise (or manipulate any other single variable) for decades to see if they get dementia while controlling all other variables like nutrition, living environment, etc.

> The thoughtful professional, however, will eschew inaction while awaiting a near-infinite amount of research to be done and instead will proceed to implement evidence-based – or at a minimum, evidence-led – strategies with confidence and gratitude for the monumental effort of countless researchers to amass the valuable body of knowledge we have at this point. To remain idle awaiting more research is to both dishonor and disrespect the countless hours of hard work by those who have produced the existing body of research we already have and a disservice to the public who can benefit in meaningful ways from the application of what we already do know from that research.

There's the science. *Now for the heart.*

Does Exercise Make the *Experience of Today* Better?

Can exercise improve the subjective quality of life right now, today? For too long, fitness programming has cared only for what the specifics details of the exercise program are. And for many decades now, the public mostly rejects consistent participation in exercise, often participating in it grudgingly for a limited period of time as a chore to be completed.

Exercise leaders must enhance the exercise experience with emotion. We remember the emotional components of an experience far more powerfully than the factual ones. And a single negative experience makes a bigger impression than a single positive one. This bias towards negativity is part of what helped advance the human species as it made us hyper-aware of potential threats to survival. (Remembering which berries are fatally poisonous is far more important than remembering which ones are delicious and nutritious.) Yet is also why allowing the public to continue to view exercise negatively and continuing to present it and sell it in the same ways we always have is so ill-advised.

Many people approach exercise like they are auditioning for the part of a victim in a horror movie. Something scares you into action, and you run panicked and screaming into the woods to get away from the killer. We know what happens next. Running one way at top speed through uncertain terrain while looking back at the awfulness chasing you is a guarantee of a trip and fall. A health scare or other negative motivator might get you started, but failing to adjust perspective toward something positive rather than away from something negative nearly always results in unfavorable outcomes with exercise.

Humans make most decisions based on emotion. We have a rational side for sure, but the majority of what we do and why we do it is connected to something with high emotional value. For many people, their emotional response to exercise is negative for a myriad of reasons. This makes it a continual struggle unless we make it *feel* different for them.

When you change someone's emotional response to exercise for the better, you change them for the better. It is impossible to change anyone's body in a single workout, but you can change their mind. A single exercise experience that creates a powerful, positive emotional response can create adherence to exercise that lasts long enough for the consistency to change the body.

A single workout made or missed matters little. A single workout that puts a smile on someone's face and connects positive emotion with movement while presenting enough mental stimulation to avoid a direct focus on the intensity, has the power to light the fire of desire for health inside someone. This enhanced desire for health is what provides the motivation to engage in regular participation.

In the context of someone at any stage of diagnosed or even suspected dementia or cognitive impairment and their familial caregivers, the weight of concern is mighty. Lifting that emotional weight in a single experience that combines fun, laughs, and social connection with physical activity is immeasurably valuable.

Exercise Works Better If You Believe It Will

Emotionally arousing events tend to be better remembered than neutral events. An emotionally charged event is the best processed kind of external stimulus ever measured. Emotionally charged events persist much longer in our memories and are recalled with greater accuracy than neutral memories. (Medina, 2009)

And a single negative experience leaves a bigger mark on the brain's memory than a single positive one and is harder to erase. The need for reversing the widespread negative emotions and attitude surrounding exercise is perhaps the most important mandate for the future of the fitness industry. We have gone as far as we can bringing fitness to the small minority of people who already enjoy it the way we have been delivering it for decades.

Enhanced desire for health behaviors through elevated emotional experiences while engaging in those behaviors is the future of successful exercise and health behavior change.

One recent study found that people benefit more from exercise when they believe it will have a positive effect. Test subjects derived more psychological as well as neurophysiological benefits from exercise if they already had positive mindsets about sports. Moreover, the team discovered that test subjects could be positively or negatively influenced in this regard before engaging in exercise. (Mothes, 2017)

Expectations and beliefs about exercise can ultimately promote – or possibly inhibit – its benefits. A group of people who were told that the physical activity they performed as part of their daily work as hotel maids was enough to meet government guidelines actually showed better results and more positive physical changes than a group of people with the exact same activity level who were told nothing about whether or not their activity met established guidelines. (Crum, 2007)

Building on this, the same researcher examined questionnaires from over 60,000 people from two large U.S. government databases who estimated their activity levels, many of whom also wore accelerometers to gather data about their actual amount of physical activity. It turns out that people who *believed* they were less active were significantly (71%) more likely to have died than people who *believed* they were more active, *regardless of their actual activity levels*. (Zahrt, 2017) This is not to say that simply believing you are fit will make you so, but there is clearly a correlation between an acceptance that you are active enough to be of benefit and a manifestation of those benefits.

Further, researchers have found that how you feel about your gym class experiences when you were growing up can significantly affect how you feel about exercise and participation rates far into adulthood. "The vividness and emotionality of the reported worst memories underscores the necessity of fostering pleasure and enjoyment from human movement as a fundamental goal of PE," the researchers concluded (Ladwig, 2018)

The Journey You Quit Rapidly Begins with One Step, Too

When it comes to compliance with even short-term prescription medications, human beings average only about 70% adherence. It is likely no surprise to discover that compliance with physical-activity programs is even worse, with as many as two-thirds of those who start quitting rather than exercising consistently.

In people with lower self-motivation scores, the exercise-induced feeling states become the main story when it comes to sticking with exercise. Focus on how a single exercise session—or even just going for a walk—can shift your mood toward the positive. Note how you are thinking and feeling prior to, and then just after, exercising.

These mood changes can become a dynamic motivator, acting ultimately as a bridge between good intentions and actual behavioral change. When you take note of the transformative power of a single physical activity effort on the *mind and mood*, and learn to seek that positive shift, the more long-term transformative power of consistent physical activity on the body becomes possible. As you become more drawn to it, you learn to possibly enjoy some aspects of it and stick with it long term by enjoying the process. It is essential to alter the mindset related to exercise from a "have to" to "want to."

The placebo effect – the belief that an action taken will lead to positive outcomes – is well-documented. It should then come as no surprise that the "nocebo" effect is becoming an increasingly observed phenomenon as well. The expectation that some endeavor will be miserable, unenjoyable, and have little positive effect – the nocebo effect – can create a measurably diminished benefit. In the context of exercise, doing it forcibly and grudgingly out of a sense of obligation is an emotionally aversive experience and creates a stress response that diminishes the benefits of physical activity.

A journey of a thousand miles begins with one step, but so does a journey abandoned after only a few steps. They both begin with one step. It is thus crucial to make the first steps taken positive experiences to engender desire to take the next step. **Fitness is a journey – one that will not be successful as a forced march.**

References for this Lesson

Ahlskog, J., Geda, Y., Graff-Radford, N., Petersen, R. (2011) Physical Exercise as a Preventive or Disease-Modifying Treatment of Dementia and Brain Aging. Mayo Clinic Proceedings. 86:9, 876-884. https://doi.org/10.4065/mcp.2011.0252

Crum, A. J., & Langer, E. J. (2007). Mind-set matters: exercise and the placebo effect. Psychological science, 18(2), 165–171. https://doi.org/10.1111/j.1467-9280.2007.01867.x

Ding, K, et al., Cardiorespiratory Fitness and White Matter Neuronal Fiber Integrity in Mild Cognitive Impairment. *Journal of Alzheimer's Disease*. 61(2):729-739. https://content.iospress.com/articles/journal-of-alzheimers-disease/jad170415

Hörder, H., Johansson, L., et al. (2018) Neurology 90 (15) e1298-e1305 https://doi.org/10.1212/WNL.0000000000005290

Ladwig, M; Vazou, S., Ekkekakis, P. (2018) “My Best Memory Is When I Was Done with It”: PE Memories Are Associated with Adult Sedentary Behavior. Translational Journal of the ACSM 15(3):16. 119-129 https://journals.lww.com/acsm-tj/Fulltext/2018/08150/_My_Best_Memory_Is_When_I_Was_Done_with_It____PE.1.aspx

Medina, J. (2009). Brain rules. Pear Press. p. 80-81

Mothes, H. L. (2017). Expectations affect psychological and neurophysiological benefits even after a single bout of exercise. Journal of Behavioral Medicine, 40, 293-306. doi: https://doi.org/10.1007/s10865-016-9781-3

Suwabe, K., et al., (2018) Rapid stimulation of human dentate gyrus function with acute mild exercise. Proceedings of the National Academy of Sciences. 115:41 10487-10492. https://www.pnas.org/content/115/41/10487

Wenfei, Z., et al. (2017) Objectively Measured Physical Activity and Cognitive Function in Older Adults. Medicine & Science in Sports & Exercise. 49:1, 47-53. https://journals.lww.com/acsm-msse/Fulltext/2017/01000/Objectively_Measured_Physical_Activity_and.6.aspx

Zahrt, O. H., & Crum, A. J. (2017). Perceived physical activity and mortality: Evidence from three nationally representative U.S. samples. Health psychology : official journal of the Division of Health Psychology, American Psychological Association, 36(11), 1017–1025. https://doi.org/10.1037/hea0000531

Module 2 – Alzheimer's and Dementia

Lesson 1 – Differentiating the Dementias & Brief History of Alzheimer's

Dementia is a catch-all term for changes in the brain that cause a loss of function significant enough that they interfere with daily life. Dementia can diminish focus, memory, attention, language skills, problem-solving and visual perception. It also can inhibit emotional regulation and lead to personality changes.

Alzheimer's

Alzheimer's disease is the leading type of dementia, accounting for 60-70% of cases. As our understanding of the disease slowly expands, it is coming to be thought of as a "mind attack" – similar to a heart attack since the contributing factors for cardiovascular disease are also significant contributors to Alzheimer's and dementia. Although the timelines are vastly different with heart attacks measured in minutes and "mind attacks" manifesting in years or decades.

Further, Alzheimer's is also now often thought of as "type-3 diabetes" or similarly, "type-2 diabetes of the brain" since insulin resistance and inflammation-mediated diminished energy supply in the brain are linked to the development of Alzheimer's.

Damage initially appears in the hippocampus, an area of the brain involved in memory formation, and gradually spreads to other areas since every experience we have is filtered through the hippocampus as short-term memory with subsequent communication and comparisons with other brain regions where long-term memories are stored. Once the hippocampus – the hub of memory – begins to deteriorate, it follows that other brain regions heavily dependent on hippocampal interaction will likewise begin to deteriorate.

Vascular Dementia

The second most common type of dementia, it is often associated with left-hemisphere stroke, impacts reasoning, planning, judgment, memory and other thought processes. It's caused by brain damage from impaired blood flow and other conditions that damage blood vessels and reduce circulation. It tends to affect focus, organization, problem-solving and speed of thinking more noticeably than memory.

Lewy Body Dementia

The third most common type of dementia, it occurs when abnormal deposits of alpha-synuclein protein – called Lewy bodies – accumulate and affect brain chemistry, leading problems with behavior, mood, movement, independent function, and thinking.

Frontotemporal Dementia

Featuring degenerative nerve cell damage to the brain's frontal and temporal lobes, it is the most common cause of dementia in people age 65 and younger. It affects personality, behavior, and language. Symptoms might include apathy; difficulty communicating, walking or working; emotional changes; and impulsive or inappropriate behaviors. Diagnosis typically occurs in early 40's-50's. The first signs are often changes in personality and social behavior.

Parkinson's-related Dementia

Develops a year or more after Parkinson's does. 50-80% of Parkinson's patients eventually develop this dementia. Parkinson's is characterized by the accumulation of toxic protein deposits in the brain. Namely, alpha-synuclein – the same protein that clumps to form Lewy bodies. Ultimately, there is a loss of dopamine producing neurons, which are essential for control of normal movement.

Brief History of Alzheimer's

Ancient philosophers used to view mental decline as a normal part of aging. The prevalence and study of dementia increased as the lifespan of humans extended.

Alzheimer's was named officially in 1910 after Alois Alzheimer, a German psychiatrist who, in 1906 published the first case – Auguste Deter, a 50-year-old woman with dementia symptoms. At the same time another German psychiatrist, Oskar Fischer, studied the brains of older people, and he, too, saw plaques and tangles. Both contributions furthered the understanding of the condition, but the naming of Alzheimer's disease by prominent psychiatrist Emil Kraepelin and the occurrence of World War II relegated Fischer's name into obscurity.

1906 – Alois Alzheimer describes first patient

1907 – Oskar Fischer published description of plaques

1910 – Alzheimer's Disease officially named

1960s – Electron microscope allows closer view of plaques and tangles

1970s – Alzheimer's recognized as the most common form of dementia. Computerized tomography (CT) scans show shrinkage of diseased brains

1980s – Tau and Beta-Amyloid identified as components of tangles and plaques

1990s – Genetic mutations related to Alzheimer's identified. Stages of Alzheimer's categorized.

(Queensland Brain Institute, 2018)

References for this Lesson

Mayo Clinic (2021) Dementia: Symptoms & Causes. https://www.mayoclinic.org/diseases-conditions/dementia/symptoms-causes/syc-20352013 (accessed June 2021)

National Institute on Aging, (2021) What Is Dementia? Symptoms, Types, and Diagnosis. https://www.nia.nih.gov/health/what-dementia-symptoms-types-and-diagnosis (accessed June 2021)

Queensland Brain Institute. (2018) The Brain: Dementia. Issue 3:7-8, 14. www.Qbi.uq.edu.au/dementia (accessed June 2021)

Lesson 2 - Stages of Alzheimer's & Brief History of Alzheimer's

Normal Cognitive Decline in Aging

Just like we are not as fast, strong, or agile as we were when we were younger, our cognitive abilities decline gradually with age. With regards to language, vocabulary and verbal skills remain largely unchanged, but the ability to find a particular word can decline. Memories formed many years ago remain quite stable, but forming new memories can be difficult, and working memory is particularly affected. The ability to focus on a single task is largely unchanged but there is increased difficulty with multitasking or switching attention. These changes reveal a pattern: although our general knowledge and crystallized intelligence (the ability to use skills and knowledge) are mostly unaffected, our fluid intelligence (the ability to think on the fly and solve new problems) suffers. (Queensland Brain Institute, 2018)

Subjective Cognitive Impairment

SCI – Subjective Cognitive Impairment (also known as SCD – Subjective Cognitive Decline): self-reported experience of worsening or more frequent confusion or memory loss that cannot be verified by standard tests and is happening more often or gotten worse in the past 12 months. It is one of the earliest noticeable symptoms of Alzheimer's disease and related dementias, although it is essential to note that not all individuals reporting SCI develop Alzheimer's. In the U.S., among adults age 45 and older: (Taylor, 2018)

- The prevalence of SCI is 11.1%, or 1 in 9 adults
- The prevalence of SCI among adults aged 65 years and older is 11.7% compared to 10.8% among adults 45-64 years of age
- Half (50.6%) of adults with SCI experienced SCI-related functional difficulties.

Mild Cognitive Impairment

MCI – Mild Cognitive Impairment is not dementia and not Alzheimer's. It is often described as something between normal age-related memory decline and mild dementia. Individuals with MCI are more likely to get Alzheimer's or other dementias, but MCI is not a guarantee that they will. One or more domains of cognition is measurably impaired in MCI.

Symptoms are similar to dementia but not serious enough to affect functional independence and manifest in the cognitive domains of memory, attention, executive function, language, and spatial orientation. There are two main sub-types, with one – Single-Domain MCI – affecting a single domain, and the other – Multi-Domain MCI – affecting two or more domains. Single-domain MCI affecting memory is called Amnestic MCI. Approximately 14-18% of people over the age of 70 have been diagnosed with MCI. Amnestic MCI is the most common form as it is nearly twice as common as non-amnestic subtypes.

Stages of Alzheimer's Disease

Alzheimer's usually progresses slowly in three general stages: early, middle and late. In a medical setting, these stages are sometimes called "mild," "moderate" and "severe." The symptoms of Alzheimer's worsen over time, but because the disease affects people in different ways, the rate of progression varies. On average, a person with Alzheimer's may live four to eight years after diagnosis, but some people live as long as 20 years. (Alzheimer's Association, 2021)

The following descriptions provide a general idea of changes at each stage. Stages of Alzheimer's may overlap, which can make it difficult to know which stage a person is in.

Early-stage Alzheimer's (mild)

In the early stage of Alzheimer's, patients can frequently maintain function independence and still drive, work and be part of social activities. Despite this, memory lapses can occur, such as forgetting familiar words or the location of everyday objects.

Symptoms may not be widely apparent at this stage, but family and close friends may take notice and a doctor would be able to identify symptoms using certain diagnostic tools.

The disease begins in the hippocampus and spreads to the temporal and parietal lobes of the brain.

Common difficulties include:

- Coming up with the right word or name
- Remembering names when introduced to new people
- Having difficulty performing tasks in social or work settings
- Forgetting material that was just read
- Losing or misplacing a valuable object
- Experiencing increased trouble with planning or organizing

Middle-stage Alzheimer's (moderate)

Middle-stage Alzheimer's is typically the longest stage and can last for many years. As the disease progresses, the person with Alzheimer's will require a greater level of care.

During the middle stage of Alzheimer's, the dementia symptoms are more pronounced. the person may confuse words, get frustrated or angry, and act in unexpected ways, such as refusing to bathe. Damage to nerve cells in the brain can also make it difficult for the person to express thoughts and perform routine tasks without assistance.

In the brain, the disease now spreads to the frontal lobe.

Symptoms, which vary from person to person, may include:

- Being forgetful of events or personal history
- Feeling moody or withdrawn, especially in socially or mentally challenging situations
- Being unable to recall information about themselves like their address or telephone number, and the high school or college they attended
- Experiencing confusion about where they are or what day it is
- Requiring help choosing proper clothing for the season or the occasion

- Having trouble controlling their bladder and bowels
- Experiencing changes in sleep patterns, such as sleeping during the day and becoming restless at night
- Showing an increased tendency to wander and become lost
- Demonstrating personality and behavioral changes, including suspiciousness and delusions or compulsive, repetitive behavior like handwringing or tissue shredding

Late-stage Alzheimer's (severe)

In the final stage of the disease, dementia symptoms are severe. Individuals lose the ability to respond to their environment, to carry on a conversation and, eventually, to control movement. They may still say words or phrases, but communicating pain becomes difficult. As memory and cognitive skills continue to worsen, significant personality changes may take place and individuals need extensive care.

In the brain, the disease now spreads to the occipital lobe.

At this stage, individuals may:

- Require around-the-clock assistance with daily personal care
- Lose awareness of recent experiences as well as of their surroundings
- Experience changes in physical abilities, including walking, sitting and, eventually, swallowing
- Have difficulty communicating
- Experience visual impairment
- Become vulnerable to infections, especially pneumonia

The person living with Alzheimer's may not be able to initiate engagement as much during the late stage, but he or she can still benefit from interaction in ways that are appropriate, like listening to relaxing music or receiving reassurance through gentle touch. During this stage, caregivers may want to use support services, such as hospice care, which focus on providing comfort and dignity at the end of life. Hospice can be of great benefit to people in the final stages of Alzheimer's and other dementias and their families.

Sundowning

"Sundowning" refers to the onset of agitation, irritation, or confusion among dementia patients and occurring often in Alzheimer's patients. It is named for the timing as the onset typically occurs in the afternoon approaching dusk and into the evening hours.

It seems to occur more frequently in the middle stage of Alzheimer's and frequently subsides as the disease progresses. Twenty to 45% of Alzheimer's patients will experience sundowning.

For the medical fitness professional, a major consideration here would be sensitivity toward scheduling sessions with any clients known to be prone to sundowning. The Alzheimer's Association has a web page containing many helpful tips for helping patients managing sundowning and mitigating the symptoms. Find it in the resource document.

References for this Lesson

Alzheimer's Association. (2021) Stages of Dementia. https://www.alz.org/alzheimers-dementia/stages Retrieved July 2021.

Smith, G. (2011). "Sundowning: Late-day confusion". mayoclinic.com. Mayo Clinic. https://www.mayoclinic.org/diseases-conditions/alzheimers-disease/expert-answers/sundowning/faq-20058511 Accessed June 2021

Taylor CA, Bouldin ED, McGuire LC. (2018) Subjective Cognitive Decline Among Adults Aged ≥45 Years — United States, 2015–2016. CDC Morbidity & Mortality Weekly Report. 67:753–757. DOI: http://dx.doi.org/10.15585/mmwr.mm6727a1

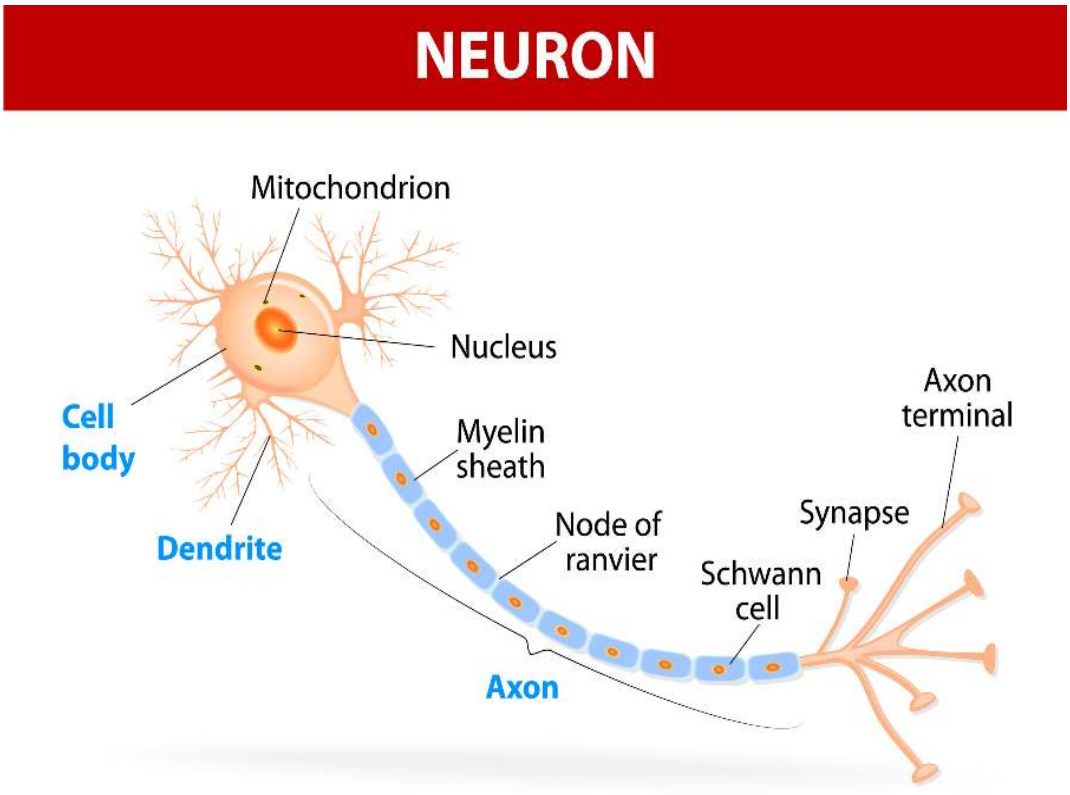
Queensland Brain Institute. (2018) The Brain: Dementia. Issue 3:7-8. www.Qbi.uq.edu.au/dementia (accessed June 2021)

Lesson 3 – Brain Regions Involved with Alzheimer's

Neurons, Gray Matter and White Matter

In the body, afferent (sensory) neurons carry information about the world to your brain. Efferent (motor) neurons in the brain and spinal cord carry information out from the brain to activate the body to respond to the sensory input.

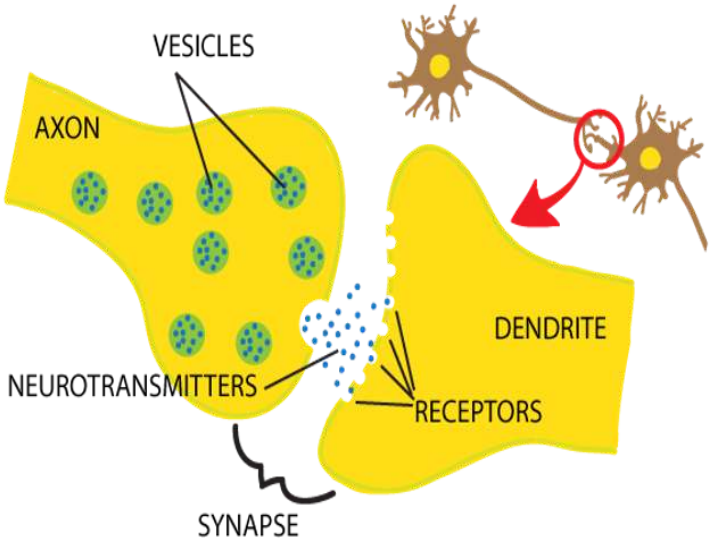
Each neuron has projecting tendrils called dendrites, which receive information from adjacent neurons and transmit it to the cell body. Signals are sent out as an electric current, via a long tendril called an axon, which transmits information to the dendrites of other neurons.



Gray and white matter describe brain tissue. Gray matter refers to brain cells (neurons / nerve cells) and their extensions (dendrites). White matter refers to the nerve fibers (axons) and the nerve fiber's covering (myelin sheath, like insulation for wiring) which facilitate communication between brain cells.

Synapses

A synapse is a small gap between two brain cells (neurons / nerve cells) that allows communication between them via electrical signals from axon to dendrite. (The prefix "syn-" means together with, jointly; alike; at the same time.) The communication is mediated by neurotransmitters, chemical messengers that dictate the firing of electrical signals for synaptic communication.



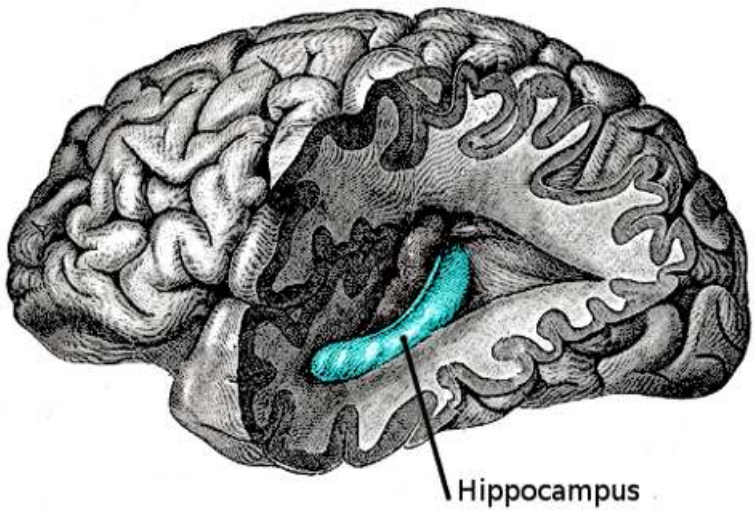
Neuron Forest

It can be helpful to think of your brain like a very dense "neuron forest." One where the branches of the trees do not touch each other but are each very, very close (a synaptic gap's distance) to touching numerous other trees' branches. Whenever one tree needs to talk to another, a chemical messenger (neurotransmitter) allows an electrical signal to pass between the branches of two trees.

This also helps understand what happens with Alzheimer's disease. The trees lose the ability to communicate. Either the trunk of the tree (the neuron) loses the ability to produce the energy to send the signal, or the branches (axons and dendrites) begin to fail and fall apart, diminishing the communicating ability with the other trees. The big difference is that the "trees" in this hypothetical forest depend on the communication with surrounding ones for survival. Once the communication stops between the branches, the trees start to die.

Hippocampus

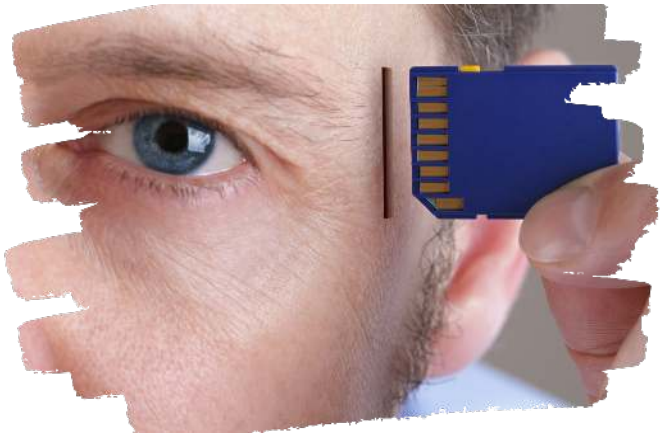
This is where our memories start and thus also where Alzheimer's starts. When your "neuron forest" starts to die in significant enough amounts in the hippocampus, you have Alzheimer's. Problems begin with short-term memory, problem-solving, spatial navigation, conversation – all of which depend on short-term memory. Eventually, the damage spreads to the outer areas of the brain and areas where long-term memories are stored begin to degrade along with numerous other cognitive functions since everything we do depends on our short-term memory of what we just experienced.



Everything we experience through our senses gets sent to the hippocampus as a short-term memory. The hippocampus then communicates with the outer areas of the brain (the cortex) where long-term memories are stored and compares what we are currently experiencing to assess if there are any long-term memories from previous experiences to compare to. We either have or have not experienced this before and then we can choose a course of action in response.

The sequence above happens at lighting speed countless times continuously moment-by-moment as we experience and interact with the world through our sensory system.

Most short-term memories disappear within minutes. Long-term memories are formed through the communication loop described above until the long-term memory is consolidated and stored in the cortex – which can take from hours to years. Our brains mix new experiences with memories and store them together. (Medina, 2009)



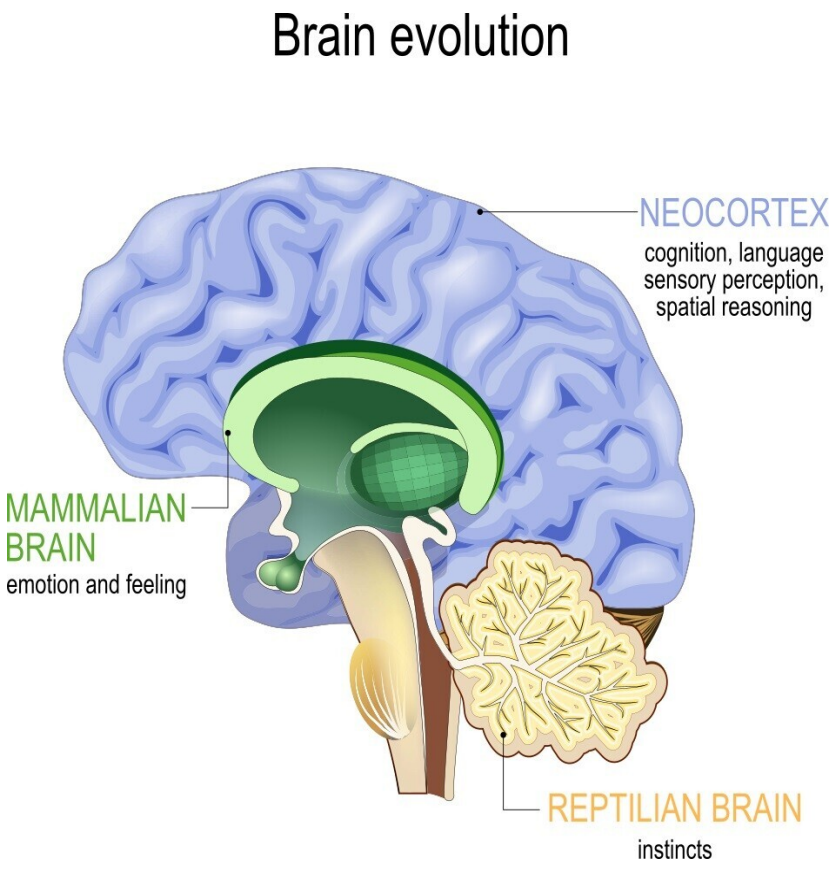
The more deeply encoded a memory is the hardier it is. If you have favorite musical artist you saw when you were young with a close friend, hearing the musical artist can trigger memories of experiences with the friend and vice versa. The more connections to other meaningful memories a long-term memory has, the more robust it will be.

Reading a book, having a conversation, driving, or walking somewhere, and really, most anything you can do, depends on short-term memory so it depends on the hippocampus.

Why Is the Hippocampus So Susceptible to Brain Disease?

It is a tale of our “Old Brain” compared to our “New Brain.” Our old brain or “lizard” brain is in the deepest part of the brain (the limbic system) and is 60-200 million years old. The most important parts are the amygdala (emotions), hippocampus (memories), and substantia nigra (movement). (Colgan, 2008)

Our limbic system is very old and thus very well-established, but also susceptible to injury. Our “new brain” or “human” brain is the outer part (the cortex). The cortex overall is 6 million years old. The pre-frontal cortex – the newest part of our brain and the part that makes our brains unique in the animal kingdom – is about 150,000 years old. Our cortex was added on top of the limbic system and everything is filtered through the limbic system since it was there first. (Colgan, 2008) That’s the “well-established” part – the cortex is incapable of functioning properly unless the limbic system is.



The limbic system has never had to last as long as it does now. Our main biological directive for most of the 60-200 million years of our limbic system has been to seek shelter, nourishment, reproduction, and successful rearing of offspring until they reach reproductive age. For the vast majority of its existence, the limbic system has never needed to last and maintain high function well into old age. Thus, it is not as robust and is more susceptible to degradation.

Interestingly, because the hippocampus is so active and so essential to every moment, it can experience relatively rapid improvement. A 12-week brain fitness program of lifestyle interventions shown to increase the size of the hippocampus showed that larger hippocampus volume decreased the likelihood of progression from MCI to Alzheimer's. Even over a relatively short period of time, we can positively influence the rate of cognitive decline. (Fotuhi, 2016)

Cognitive Functions and Executive Function

The more essential and ingrained into the fabric of perception something is, the harder it becomes to conceptualize in an abstract, descriptive way. Such is the nature of discussing cognitive function. Cognition is your awareness of your surroundings using your perception (seeing, hearing, smelling, propriocepting, tasting), memory, reasoning, judgment, and intuition. Cognitive function then is, in essence, the way your brain goes about achieving desired outcomes based on perception.

For the purposes of Alzheimer's and the fitness strategies employed, we are concerned with the following cognitive functions:

- Attention – focus on relevant stimuli and blocking or ignoring of irrelevant stimuli
- Memory
- Language
- Processing Speed – how rapidly we produce an appropriate response to stimulus through sensory input
- Crystallized Intelligence – ability to use skills and knowledge
- Fluid Intelligence – ability to "think on the fly" and solve problems
- Executive Function – an umbrella term encompassing higher order functions distinct from other mammals which make us uniquely human and includes organization, planning, impulse control, problem-solving, decision-making.

Exercise and cognitive stimulation are both always mentioned as valuable strategies for brain health – yet they are nearly always presented as separate activities. ***Using these cognitive functions simultaneously with physical activity is the fundamental principle of this course – in addition to incorporating social interaction and friendly competition*** – as it pertains to the specific exercise strategies which are recommended.

References for this Lesson

Colgan, M., (2008). Save Your Brain. Science Books

Fotuhi M., Lubinski B., Trullinger M., Hausterman N., Riloff T., Hadadi M., Raji C.A. (2016) A Personalized 12-week "Brain Fitness Program" for Improving Cognitive Function and Increasing the Volume of Hippocampus in Elderly with Mild Cognitive Impairment . The Journal of Prevention of Alzheimer's Disease (JPAD). 3(3):133-137 http://dx.doi.org/10.14283/jpad.2016.92

Medina, J. (2009). Brain rules. Pear Press. p.137-138

Module 3 – Mechanism of Disease, Treatment, and Causes/Contributing Factors

Lesson 1 - Mechanism of Disease and Causes

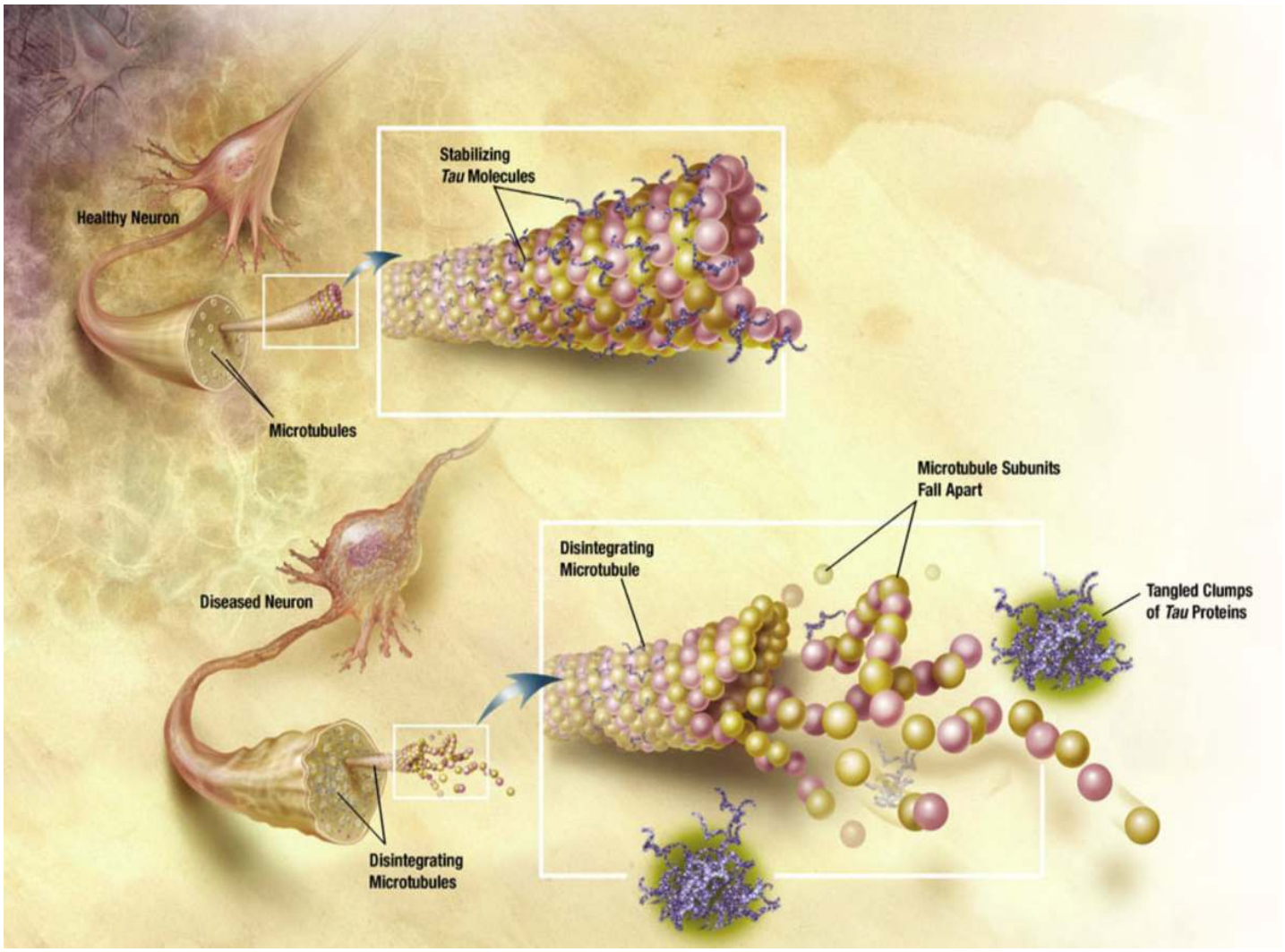
Beta-Amyloid Plaques and Tau Tangles

What are they? And more importantly, are they causative or indicative of Alzheimer's. The first question, we can answer. The second question we do not yet fully know the answer to, as evidenced by the numerous times you see these plaques and tangles described with the vague term "hallmarks" of Alzheimer's. Most likely, they are indicative of the processes which cause Alzheimer's rather than causative.

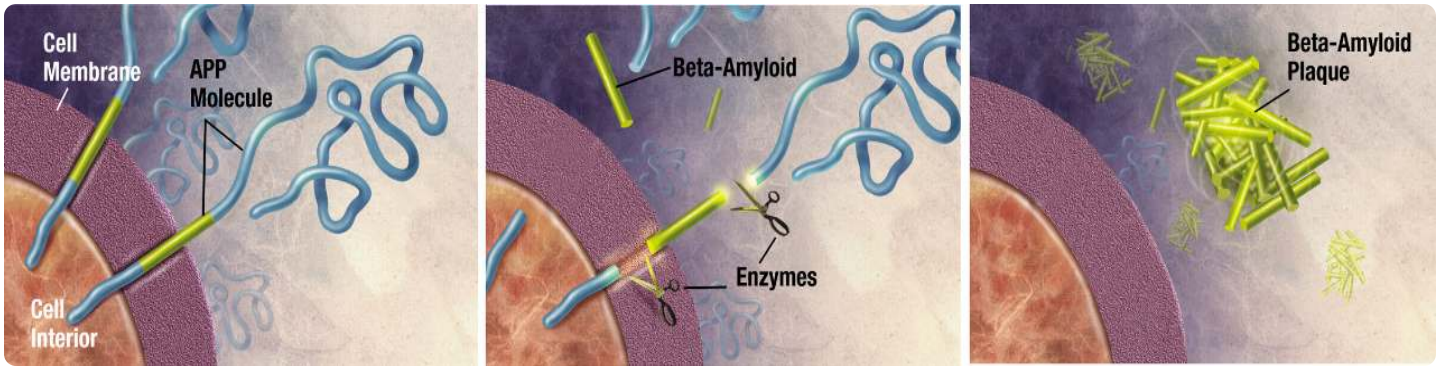
Model illustrating the contrast between a healthy brain (left side) and a brain with advanced Alzheimer's and significant loss of neurons in the cortex (right side).

First, What are Beta-Amyloid and Tau?

Tau: There are tubular rods (called neurofibrils) that form the structural skeleton of the neuron and act as guides for the transport of neurotransmitters and nutrients. These rods occur in parallel lines to guide the flow of chemicals through the axon. A protein called tau acts like railroad ties to hold the tracks apart and parallel. Defective, damaged tau cannot hold the neurofibrils apart and the parallel lines become a clumpy, tangled mess yielding the neurofibrillary tangles commonly referred to as “tau tangles.”



Beta-amyloid: The brain produces APP, amyloid precursor proteins (peptides), essential for the repair of cell membranes. APP has a role in neurogenesis (the creation of neurons), memory, and the normal operation of message transfer between neurons. The problems start when an excessively strong immune response to inflammation causes APP to be clipped off in irregular places. It is normally clipped into two pieces at what is known as the alpha site. When APP is clipped into four pieces instead – one of the locations is called the beta site – this beta-amyloid protein begins to accumulate as insoluble plaque in axons, and in the synapses between cells. (Bredesen, 2020)



Another mechanism by which amyloid plaque accumulates is the decline of glucose metabolism in the brain. The enzyme that breaks down amyloid is the same enzyme that breaks down insulin. If insulin is too high, the enzyme is used up on insulin and breakdown of amyloid is compromised and the result is that you make more amyloid than you break down, causing the excessive accumulation of beta-amyloid. This explains the connection between insulin resistance or diabetes and Alzheimer's. If too much beta-amyloid is made, too little cleared away, or is APP snipped in the wrong places, clumps of it can form.

What is the relationship *between Tau and Beta-Amyloid?*

Beta-amyloid is the precursor of the plaque. Plaques accumulating outside the neuron, cause the tau tangles inside the neuron. (Amyloid is the match, the tangles are like the brushfire that spreads slowly over decades, and Alzheimer's is the raging forest fire that is out of control.) The focus then, needs to be on prevention and figuring out what causes the amyloid to over-accumulate as plaques and cause tau proteins to tangle as well as what causes the neuroinflammation that makes the "raging forest fire."

Second, are Beta-Amyloid and Tau indicative or causative?

Treatment to reduce the amyloid in Alzheimer's patients does not make them better. And there are large numbers of people with accumulated amyloid and no Alzheimer's as well as people with Alzheimer's and little build-up of amyloid. Up to 40% of people in their 70's have amyloid deposits but normal cognition. (Beach, 2012) Something else farther "upstream" then, must be happening to create the conditions which result in Alzheimer's and thus the amyloid clumps and tau tangles are most helpfully thought of as potentially indicative of or an aggravating factor in Alzheimer's. Removing beta-amyloid proteins from degenerated tissue makes about as much sense as removing tombstones and expecting the dead to come back to life. It is quite possible that amyloid deposits are not themselves causal but rather part of the brain's injury response and as we will see, could be an indication of inflammation in the brain and the response to that inflammation.

InsulinResistance: Is Alzheimer's Type-3 Diabetes?

As mentioned previously, the enzyme that breaks down amyloid is the same enzyme that breaks down insulin. If insulin is too high, the enzyme is used up on insulin and breakdown of amyloid is compromised. If insulin is not working you make more amyloid rather than break down amyloid. This is another indication that we do not have an "amyloid problem," we have an "insulin problem." The ineffective amyloid metabolism is a result of insulin resistance in the brain. (Xie, 2002)

The main role of insulin in the hippocampus and cortex is related to the maintenance of energy levels needed to sustain synaptogenesis and neuronal plasticity. For this reason, some researchers have even referred to AD as Type 3 Diabetes. (Folch, 2019) If the insulin receptors at the blood-brain-barrier become damaged, insulin in the brain lowers. The hippocampus needs more insulin than other parts of the brain (due to the high continuous fuel use there) so this sets the stage for the beginning of Alzheimer's.

Mind Your Mitochondria

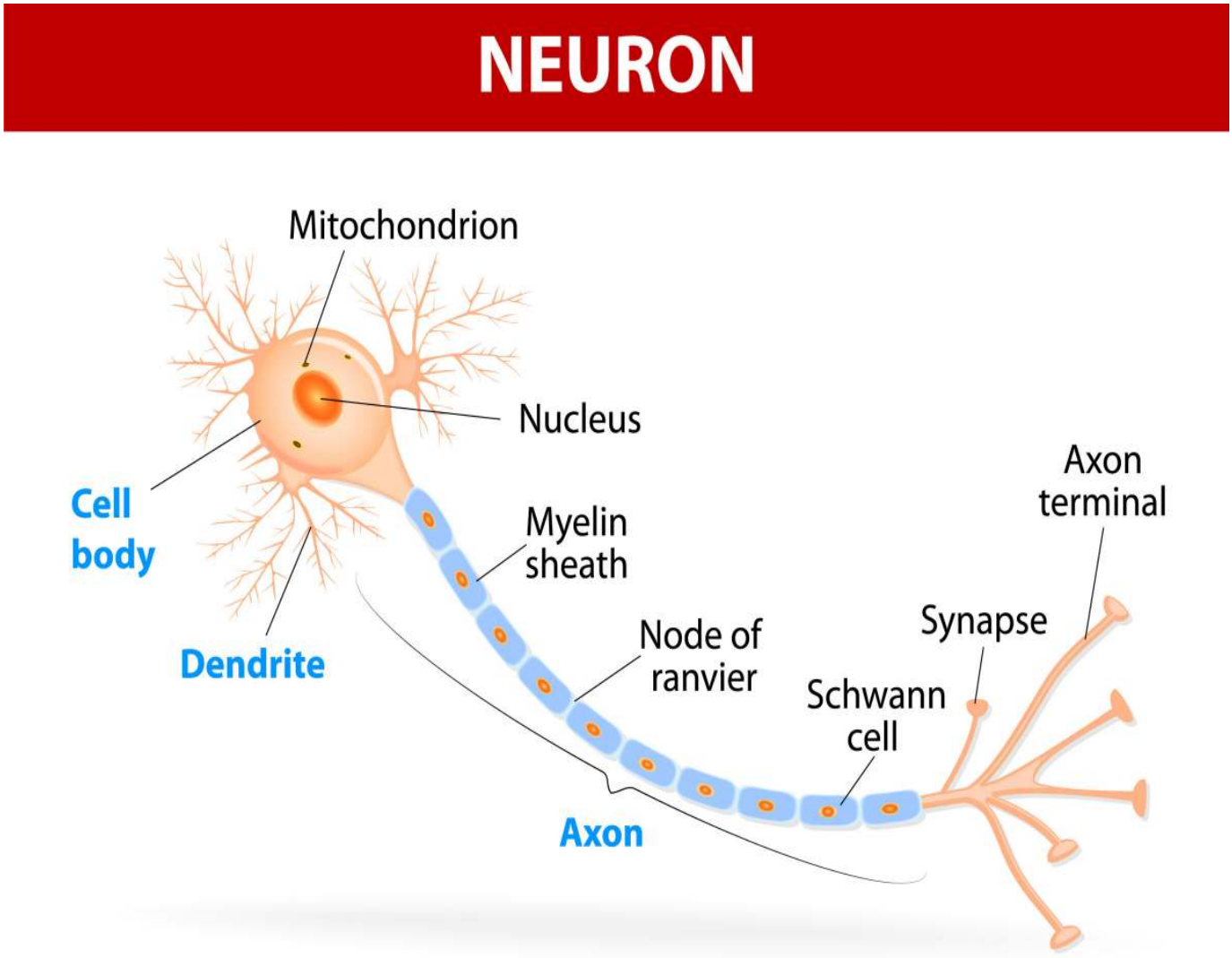
The brain uses a lot of fuel.

Mitochondondria produce that fuel.

Fuel production creates waste products (free radicals, unstable and highly reactive atoms with at least one unpaired electron.)

Inadequate nutrient delivery and/or ineffective or inefficient clearing of waste products damages mitochondrial function and increases inflammation.

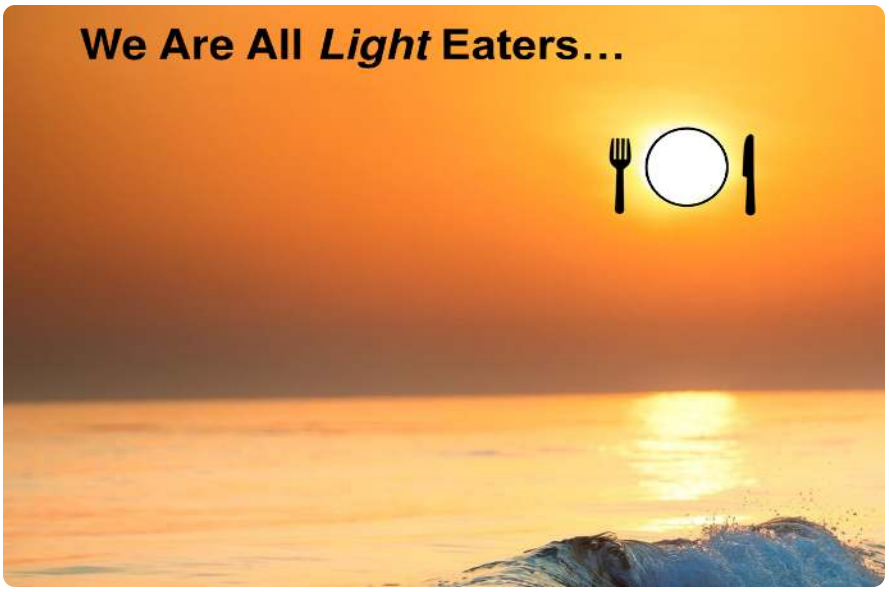
Damaged mitochondria and inflammation create brain disease – the power shortage in brain cells causes them to function improperly and die.



To summarize so far: We have high fuel use in our brains, which inherently produces a high amount of free radicals. If there is inadequate fuel supply OR ineffective free radical clearance OR an excessive immune response, we get damaged mitochondria.

But why?

Human Nuclear Power



Our bodies turn sunlight into fuel through the food we eat. Humanity started by eating plants, then animal products, which are plants one step removed since animals develop by eating plants. At the big picture view, we do not "burn calories" in the traditional sense in a chemistry lab. Our bodies work through nuclear power: we turn sunlight from our food into energy we can use in our bodies. At the cellular level, our mitochondria are miniature nuclear reactors that produce ATP (adenosine tri-phosphate). Humans run on ATP.

Nuclear Waste

As is now commonly known, our brains use approximately 20% of the calories we consume yet comprises 3-4% of our bodyweight.

If we adequately clear out the free radicals produced from fuel use, all is well in our brains and bodies. When our waste removal is compromised or waste production exceeds the rate of removal, the problems start. Mitochondria get damaged and can no longer produce adequate energy. Whatever brain region experiences a high enough threshold of mitochondrial damage to reach a tipping point, we get disease. When this mitochondrial damage accumulates high enough in the hippocampus, we get Alzheimer's. And when high enough in the substantia nigra, we get Parkinson's.

In very general terms, the brain disease we get is determined by the specific brain regions sufficiently affected by waste product build-up, leading to inadequate energy production to sustain the neurons there.

There are four main ways mitochondrial function degrades:

1. Free radical damage to mitochondrial membrane, resulting in less energy production
2. Free radical damage to fats and proteins inside the mitochondria
3. Free radical damage to mitochondrial DNA
4. Chronic inflammation in the brain from free radical overexpression of the inflammatory response (also know as 'neuroinflammation')

Our neurons start to die because they run on the energy provided by the mitochondria. When the mitochondrial nuclear reactors become ineffective, the energy supply runs out, and without electrical activity and blood flow to keep them healthy, our immune system can start to attack the disabled neurons to remove the problem tissues.

Inflammation - the "cause of the causes"

It seems then that runaway inflammation is the "big" cause. (Holmes, 2011) Inflammation happens in response to stress or injury to our tissues and is designed to stimulate the repair process and then switch off when its work is done. If we are living a lifestyle which promotes chronic inflammation – which would consist of the familiar list of usual suspects: poor nutrition, inadequate sleep, inadequate physical activity, runaway stress, lack of recreational or social experiences – then we are promoting disease. The impact of this lifestyle is worsened – but not caused by – a genetic predisposition for Alzheimer's.

The extra challenge for our brains is that unlike a sprained ankle, we do not feel a “sprained brain.” We have no nerve endings in our brain so we cannot feel pain like we would in other areas of the body when inflamed.

Neuroinflammation

If the brain’s immune system – the glymphatic system – responds to the amyloid plaques with an excessive inflammatory response, this overexpressed neuroinflammation is a cause of AD. (Pascoal, 2021) In this scenario, the trouble spots of plaques and tangles become the target of the glymphatic system and the neuroinflammation then kills 10 or 100 times more nerve cells, causing dementia to develop.

As Dr. Rudolph Tanzi of the Harvard Brain Science Initiative, puts it: “With neuroinflammation, glial cells – the brain’s housekeepers – get worked up and say, ‘We have to protect the brain. Nerve cells are dying. There must be an attack or infection.’ This collateral damage kills more nerve cells than the plaques and tangles.” The glial cells that typically clean the brain and plaque, especially at night when we sleep – can become too aggressive and shoot off free radicals that kill nerve cells.

Microglial cells and astrocytes are the brain’s worker bees or housekeepers. While they are normally nurturing, when they think something’s wrong or sense nerve cells dying from plaques and tangles they kick in and say, ‘Wipe out the area.’

Runaway inflammation is the problem in the brain as it can be in the body, but common anti-inflammatory treatments are useless since most of them cannot get into the brain as they are blocked by the blood-brain barrier. Even if we could find effective brain anti-inflammatory medicines, we still need to look for the cause of the overexpressed or chronic neuroinflammation. We would not simply treat a chronically painful joint with anti-inflammatory medicine and be done with it. We cannot treat the neuroinflammation after the fact but rather our efforts must go toward removing what is initiating it – the numerous lifestyle factors that either promote or inhibit it.

References for this Lesson

Beach, T. G., Monsell, S. E., Phillips, L. E., & Kukull, W. (2012). Accuracy of the clinical diagnosis of Alzheimer disease at National Institute on Aging Alzheimer Disease Centers, 2005-2010. Journal of neuropathology and experimental neurology, 71(4), 266–273. https://doi.org/10.1097/NEN.0b013e31824b211b

Bredesen, D. (2020) The End of Alzheimer's Program. Rockbridge Press.

Colgan, M., (2008). Save Your Brain. Science Books

Choi, S., Kim, Y., Hebisch, M. et al. (2014) A three-dimensional human neural cell culture model of Alzheimer’s disease. Nature 515, 274–278. https://doi.org/10.1038/nature13800

Folch J., Olloquequi J., Ettcheto M., Busquets O., Sánchez-López E., Cano A., Espinosa-Jiménez T., García M. L., Beas-Zarate C., Casadesús G., Bulló M., Auladell C., Camins A. The Involvement of Peripheral and Brain Insulin Resistance in Late Onset Alzheimer's Dementia. Frontiers in Aging Neuroscience. 2019 (11) https://www.frontiersin.org/article/10.3389/fnagi.2019.00236

Holmes, C., & Butchart, J. (2011). Systemic inflammation and Alzheimer's disease. Biochemical Society transactions, 39(4), 898–901. https://doi.org/10.1042/BST0390898

Liu J, Ames BN. Reducing mitochondrial decay with mitochondrial nutrients to delay and treat cognitive dysfunction, Alzheimer's disease, and Parkinson's disease. Nutr Neurosci. 8(2):67-89. https://pubmed.ncbi.nlm.nih.gov/16053240/

Pascoal, T.A., Benedet, A.L., Ashton, N.J. et al. (2021) Microglial activation and tau propagate jointly across Braak stages. Nature Medicine. https://doi.org/10.1038/s41591-021-01456-w

Xie, L., et al. (2002). Alzheimer's B-Amyloid Peptides Compete for Insulin Binding to the Insulin Receptor. Journal of Neuroscience. 22:10. RC221. https://doi.org/10.1523/JNEUROSCI.22-10-j0001.2002

Lesson 2: Contributing Factors: Genes and Environment

Alzheimer's and Genetics

To avoid "burying the lead," here it is: Alzheimer's is not primarily determined by genetics.

Except for the relatively rare, early-onset Familial Alzheimer's, genes are not deterministic of Alzheimer's. The most well-known of the genes for Alzheimer's is the ApoE4 allele, related to late-onset Alzheimer's Disease (often referred to as LOAD in research) although there are as many as a dozen other genes which may also contribute to potential risk.

Early Onset Familial Alzheimer's Disease (FAD):

Representing a minority of Alzheimer's cases, comprises 3-5%; typically prior to age 60. FAD has a strong genetic basis. Most cases are inherited and caused by single mutations in 3 genes: amyloid precursor protein (APP), presenilin 1 (PS1), or presenilin 2 (PS2). If these mutations are inherited, an individual will almost certainly develop FAD, yet a small number of people develop FAD without these mutations.

Late-Onset Alzheimer's Disease (LOAD): accounting for as much as 97% of Alzheimer's cases; diagnosis typically occurs after age 65.

ApoE4 Allele

We all get two copies of Apolipoprotein E (ApoE) from our parents and this allele comes in three forms: e2, e3, and e4. The result is six possible ApoE inherited pairs: e2/2, e2/3, e2/4, e3/3, e3/4, e4/4. (Alzheimer's Association, 2021)

- One copy of ApoE4 – 3x risk
- Two copies of ApoE4 – 8x risk
- Eliminating ApoE4 would eliminate only 7% of Alzheimer's (Livingston, 2020)
- One-third of Alzheimer's patients have no copies of ApoE4
- Two-thirds of U.S. citizens have no copies of ApoE4, with the majority featuring ApoE3/3.

Knowledge Is Not Always Power

When it comes to genetic testing, the decision to get tested to see if you are an ApoE4 carrier is not as simple as it may seem. Considering that learning of one's genetic risk may evoke the same physiological changes consistent with the expected risk profile and that perceived risk can potentially have greater effects than actual risk (Turnwald, 2019), thoughtful consideration of how any individual would react to the news of a positive ApoE4 test is warranted prior to testing.

Certainly, for some people the news that they possess increased genetic risk is met with despair, stress, and ineffective coping. While for others this knowledge creates the drive, desire, and motivation for better adherence to health behaviors to counteract the genetic influence.

Environment - micro and macro

Alzheimer's does not come out of nowhere to strike – *it comes out of everywhere*. Our actions – including all the things we do, places we live, what we eat, what we buy, what we wear on our bodies and put on our skin, what we breathe, places we travel, essentially become the dimmer switch that turns up or down the action of a myriad of genes.

For example, a fair-skinned person is not genetically destined to get skin cancer. Living a high-stress lifestyle, eating poorly, and working on a fishing boat in the Caribbean and getting routinely sun-burned are ways of living that increase activation of the genes that promote skin cancer and decrease activation of the genes that fight it.

A striking example of this as it pertains to Alzheimer's is found in the health of the responders who aided in search, rescue, and recovery at the World Trade Center collapse in the terrorist attacks of 11 September 2001. One-fifth of them developed PTSD, an independent risk factor for dementia and most of them spent countless hours and days breathing an overwhelmingly toxic cloud of air at the site. Within 15 years, 12.8% of them had developed cognitive decline. (Clouston, 2016)

With approximately 92% of the world's population living in regions where people are regularly exposed to high levels of anthropogenic (human-generated) air pollution, the chronic exposure to air pollution can change the function of the nervous system leading to neurocognitive impairment and neurodegenerative disease. Even a single severe exposure among World Trade Center responders was enough to induce a neuropathologic response. (Kritikos, 2020) Strong evidence is emerging that greater exposure to airborne pollutants is associated with increased risk of dementia. (Peters, 2019)

As we will see, there is a large cluster of modifiable lifestyle factors which influence AD more than genetics does. Both lifestyle and genetics influence AD, but lifestyle exhibits greater influence and, apart from early-onset AD, it is imprudent to treat AD genes as deterministic.

References for this Lesson

Alzheimer's Association, 2021. 2021 Alzheimer's Disease Facts and Figures. p. 13 https://www.alz.org/media/Documents/alzheimers-facts-and-figures.pdf

Clouston, S.A., Kotov, R., Pietrzak, R.H., Luft, B.J., Gonzalez, A., Richards, M., Ruggero, C.J., Spiro, A., III and Bromet, E.J. (2016), Cognitive impairment among World Trade Center responders: Long-term implications of re-experiencing the 9/11 terrorist attacks. Alzheimer's & Dementia: Diagnosis, Assessment & Disease Monitoring, 4: 67-75. https://doi.org/10.1016/j.dadm.2016.08.001

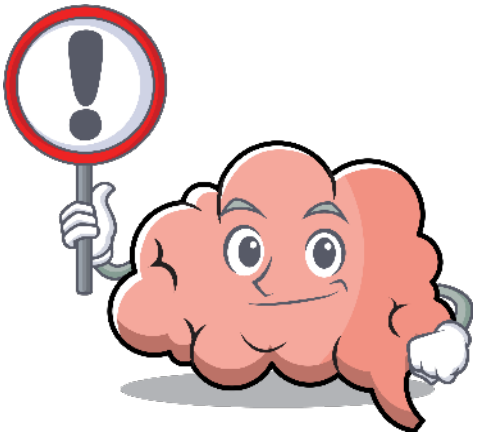
Kritikos, Minos et al. (2020) Acute Versus Chronic Exposures to Inhaled Particulate Matter and Neurocognitive Dysfunction: Pathways to Alzheimer's Disease or a Related Dementia. Journal of Alzheimer's Disease. 78(3): 871 – 886. https://content.iospress.com/articles/journal-of-alzheimers-disease/jad200679

Peters, R., Ee, N., Peters, J., Booth, A., Mudway, I., & Anstey, K. J. (2019). Air Pollution and Dementia: A Systematic Review. Journal of Alzheimer's disease : JAD, 70(s1), S145–S163. https://doi.org/10.3233/JAD-180631

Turnwald, B.P., Goyer, J.P., Boles, D.Z. et al. (2019) Learning one's genetic risk changes physiology independent of actual genetic risk. Nature Human Behaviour. 3:48–56. https://doi.org/10.1038/s41562-018-0483-4

Lesson 3: Treatments-That Mostly Do Not Work

Treatment?



The best-case scenario once there is a diagnosis of Alzheimer's is to slow the rate of progression of the disease. There will never be a treatment which reanimates dead tissue. Once a neuron dies, it will stay that way. Lost cognitive functions in AD patients are due to neurodegenerated or fatally damaged neuronal networks which formerly controlled the lost cognitive abilities. Dead nerve cells cannot be brought back to life.

There are no drugs available to cure or slow down Alzheimer's, though some may briefly help with its symptoms. Fully 99% of clinical trials of Alzheimer's drugs fail, and some major pharmaceutical companies have stopped trying to develop this class of drugs.

Three types of drugs are currently approved by the Food and Drug Administration (FDA) to treat cognitive symptoms of Alzheimer's disease. The first type is cholinesterase inhibitors. These drugs prevent the breakdown of acetylcholine. Acetylcholine is a chemical messenger important for memory and learning. These drugs support communication between nerve cells. The cholinesterase inhibitors most commonly prescribed are: Donepezil (Aricept®), Rivastigmine (Exelon®), and Galantamine (Razadyne®). The second type of drug works by regulating the activity of glutamate. Glutamate is a different chemical messenger that helps the brain process information. This drug is known as: Memantine (Namenda®). The third type of drug is a combination of a cholinesterase inhibitor and a glutamate regulator: Donepezil and memantine (Namzaric®).

These treatments produce different results in different people. They might help symptoms for a while, but they do not slow or stop the brain changes that cause Alzheimer's to become more severe over time. (Alzheimer's Association, 2021) The enhanced quantity of neurotransmitter attempts to make up for diseased and dying neurons. **More neurotransmitter does not stop the neurons from dying.**

The combination of intense desperation for a single pharmacological solution and the extremely unlikely odds that there will ever be one means any positive news surrounding any drug creates a significant overreaction of hope and suspension of normal rigorous standards for drug approval. This manifested itself in the FDA's approval of aducanumab (Aduhelm®) in 2021.

Two large trials with the drug had conflicting results with one showing appreciable slowing of cognitive decline while the other did not. And despite the recommendation of an impartial FDA advisory committee's recommendation against the drug's approval, it was given conditional approval, most likely due to pressure from patients and advocacy groups. Aducanumab was not granted full approval, but conditional approval. Theoretically, this means FDA approval could be withdrawn if the drug does not prove to be effective in the coming years. But withdrawal of conditional approvals rarely happens.

Aducanumab has an annual cost of $56,000 (USD) and side effects including swelling of the brain, headache, confusion, dizziness, vision changes, nausea, disorientation, and tiny bleeds in the brain. That is a lot of money and a lot of potentially deleterious side effects – not to mention much unwarranted enthusiasm – for a drug that may or may not work.

Releasing this drug puts the good of shareholders ahead of the common good; the risks of a new, highly experimental drug with unknown risk over relatively inexpensive, well-established, modifiable lifestyle factors with no risk.

Prevention Needs a Ribbon

It is abundantly clear that the monumental resources devoted to developing single treatments for an inherently incurable disease would be more constructively directed toward efforts at prevention and slowing the progression.

What About Brain Games?

They definitely can't hurt, but how much can they truly help? In a massive review of the data from brain training programs, it was found that brain games:

- Improve performance significantly on the trained tasks
- Minimally improve performance on closely related tasks (meaning, a memory game likely will show very little, if any, improvement to remembering names of people you meet at a party)
- Are ineffective at enhancing performance on distantly related tasks
- Are ineffective at improving everyday cognitive performance

(Simons, D. J. 2016)

The review of the data led one of the authors of the review paper to call them "get smart quick schemes." There does seem to be some minor benefit to using them, but **the problem is that these products often "overpromise and under-deliver."**

Another difficulty with computerized brain training exercises is that in order to have any effect, they have to be hard enough to lead to improvement. It's the same old "stimulus and response" paradigm that drives so much of human biology and a central idea in the world of physical fitness. If it's not challenging enough, it will not lead to change. The problem is that when things people do by choice are hard, many people tend to stop.

One promising study showed some benefit to memory. (Smith, 2009) Some people have reported subjective improvements in everyday cognitive function, but these could easily be the result of the placebo effect – which is not necessarily a bad thing. The biggest improvements seem to occur in brain games centered around processing speed in terms of useful effects of dementia prevention. (Edwards, 2017) However, as we will see later, improved processing speed is a main benefit of high-intensity interval training. When you can get a benefit from either sitting still staring at a screen or through physical activity, it will always be better to get it through physical activity.

In the end, some types of brain games provide a small benefit. However, conceptually, **we simply do not need more products or services that keep us sitting still and looking at screens**. As of 2021, people in the U.S. spend an average of 5.5 hours a day looking at a screen. Unless brain games provide dramatic, rapid, transformative, and permanent improvements (and we know they do not), they are best left as a very occasional experience rather than a pillar of cognitive health. Combining cognitive challenge with physical activity will always be superior to physically inactive brain games.

What Can We Do?

With a cure unlikely, significant efforts at early detection, prevention, and risk reduction are warranted…avoiding any disease is always better than defeating it. The critical question then becomes: What can we do to prevent Alzheimer's?

References for this Lesson

Alzheimer's Association, 2021. 2021 Alzheimer's Disease Facts and Figures. p. 11
https://www.alz.org/media/Documents/alzheimers-facts-and-figures.pdf

Edwards, J.D., Xu, H., Clark, D.O., Guey, L.T., Ross, L.A. and Unverzagt, F.W. (2017). Speed of processing training results in lower risk of dementia. Alzheimer's & Dementia: Translational Research & Clinical Interventions. 3:603-611. https://doi.org/10.1016/j.trci.2017.09.002

McGinley, L. (2021, June 7). FDA approves first drug intended to slow cognitive decline caused by Alzheimer's disease. The Washington Post. (retrieved June 7, 2021) https://www.washingtonpost.com/health/2021/06/07/fda-approves-alzheimers-drug-aducanumab/

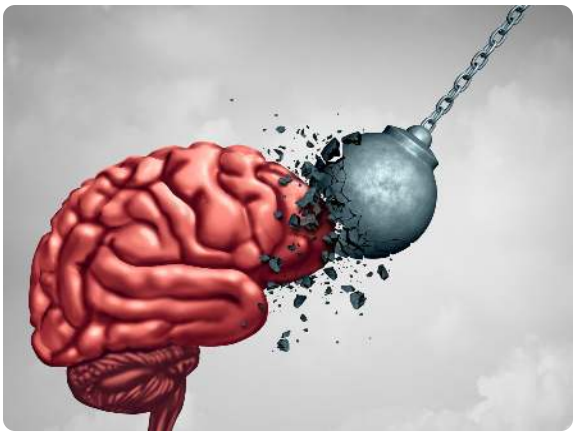
Simons, D. J., Boot, W. R., Charness, N., Gathercole, S. E., Chabris, C. F., Hambrick, D. Z., & Stine-Morrow, E. A. L. (2016). Do "Brain-Training" Programs Work? Psychological Science in the Public Interest, 17(3), 103–186. https://doi.org/10.1177/1529100616661983

Smith, G.E., Housen, P., Yaffe, K., Ruff, R., Kennison, R.F., Mahncke, H.W. and Zelinski, E.M. (2009). A Cognitive Training Program Based on Principles of Brain Plasticity: Results from the Improvement in Memory with Plasticity-based Adaptive Cognitive Training (IMPACT) Study. Journal of the American Geriatrics Society. 57:594-603. https://doi.org/10.1111/j.1532-5415.2008.02167.x

Lesson 4: Treatments: Lifestyle - The Best We Can Do

Prevention

Can we prevent Alzheimer's? Definitively? No. As with getting most diseases, not getting it is an odds game and is heavily multi-factorial. You improve your odds by following more behaviors shown to reduce chances of getting Alzheimer's.



Prevention as a concept is far more nebulous and difficult to conceptualize. Even though never getting a disease is always better than "defeating" it, avoiding illness does not give us an "enemy" to "attack," is not as dramatic and moving, and does not have a colored ribbon. It is why we have "war movies" not "peace movies." It seems odd to "rally the troops" for a "prevention battle." Where there is avoidance of conflict there is no drama, and we are irresistibly drawn to drama.

And when it comes to our health, we suffer for it. We often wait until we get a disease and then fight it with everything we've got. A more sensible path would be to prevent it with everything we've got. For too many people it seems that "an ounce of prevention" is not a heavy enough burden to bother and instead look for many pounds of cure. Health is too often a product to buy when sick rather than a way to live to enhance vitality.

There are numerous actions we can take to prevent – or at least greatly improve our odds of not getting – Alzheimer's.

Non-Pharmacological Treatments for Alzheimer's

Music Therapy

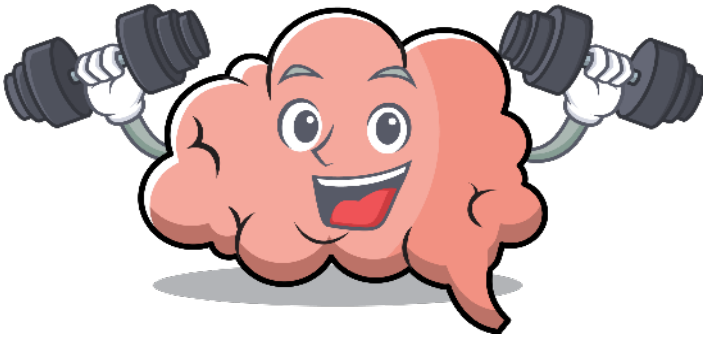
The documentary film *Alive Inside* provides dramatic and moving examples of the power of music to break through the fog of dementia. The parts of the brain involved in remembering and responding to music are little affected by Alzheimer's. (Kish, 2018) Music activates more brain regions than any other stimulus and it enters our brains through movement and emotional pathways.

In the cries of newborns, patterns reflective of the mother's speech have been detected. In a way, we learn to "sing along" with people while in the womb. Children will automatically begin keeping time to the beat of music with their bodies – a behavior not exhibited in other primates.

Music provides a "back door" of sorts to access the person suffering from dementia through memories associated with cherished music. (Janata, 2009)

The significance of brain benefits of music are understood and magnified greatly by playing or creating music. It is one of the most demanding cognitive and neural challenges. Auditory perception and motor actions when playing an instrument uses the auditory cortex and cerebellum. Imagery created by music is analyzed in the frontal lobe. Singing comes from the right temporal lobe. The syntax of lyrics and composition of music come from the left temporal lobe. And of course, in addition to the motor and sensory stimulation, there is the emotional component of music. (Alluri, 2012)

Physical Activity



Since physical activity is woven so essentially into the human experience at any age regardless of disease status, it can be difficult for many people to fully appreciate the positive impact that physical activity can have on brain health.

Specifically, physical activity creates enhanced blood flow *and together* with cognitive demand leads to enhanced (Sherzai, 2019):

- Growth of new brain cells (Neurogenesis)
- Connectivity between neurons (Synaptogenesis – the creation of new synapses)
- Formation of new blood vessels (Angiogenesis), essential for nutrient delivery
- Production of brain growth factors (Neurotrophins): BDNF, NGF, VEGF, FGF-2, IGF-1

Additionally, the hormone irisin, secreted by working muscles during exercise, crosses the blood-brain barrier to improve cognitive function and reduces the neuroinflammation implicated in Alzheimer's. (Islam, 2021)

Exercise has been shown to increase cognitive function at all ages, with a higher degree of benefit shown in people who are older. (Stern, 2019)

BDNF to the Rescue

There are numerous compounds involved in keeping our brains healthy that are enhanced by following a healthy lifestyle, but one deserves special mention: Brain-Derived Neurotrophic Factor (BDNF).

BDNF is the premier member of a powerful group of proteins called neurotrophins – helper molecules that allow a neuron to create, maintain, and protect connections with its neighboring neurons. The brain cells most sensitive to BDNF are in the hippocampus. The more BDNF you have, the more protection you enjoy against brain disease.

All exercise increases BDNF in general. However, we will see how blending specific elements into physical activity can enhance BDNF production over and above amounts produced from traditional exercise.

The Rest of the Neurotrophins

Exercise and physical activity increase:

- Nerve Growth Factor (NGF): enhances spatial working memory and functioning of the hippocampus by enhancing activity of the neurotransmitter Acetylcholine, which is essential for memory formation. (Hall, 2018)
- Vascular Endothelial Growth Factor (VEGF): helps build new capillaries within the brain, enabling greater delivery of oxygen and glucose (fuel) to brain tissue.
- Fibroblast Growth Factor-2 (FGF-2): helps in the formation of new blood vessels. It is also involved in improving some brain functions such as improving synaptic efficiency and affinity between neurons to facilitate learning and retention.
- Insulin-like Growth Factor-1 (IGF-1): an insulin-like anabolic compound manufactured in the liver and active muscle cells. IGF-1 is stimulated by increased levels of human growth hormone (HGH) after certain types of exercise (e.g., hypertrophy training, formats inducing metabolic stress like those with shorter recoveries – HIIT). IGF-1 helps promote increased glucose passage into the brain for fuel through the blood brain barrier (a web of tightly packed capillaries intended to filter compounds and prevent them from entering the brain). It also complements some actions of BDNF.

Make Today Better

Improved quality of life – right now. This is rarely mentioned when discussing the experience of living with Alzheimer's for patients and caregivers with the focus often on future outcomes and projections. For good reason, there is much focus and research on the role exercise and other lifestyle behaviors play in improving future outcomes. For this same reason however, there is far too little focus on making today better.

This is a contradiction of sorts. Humans are now-oriented with short-term concerns, solutions, and rewards driving most decision-making and action. And yet, we prioritize and emphasize long-term outcomes from research studies to try and mobilize people to action – and this continually fails to motivate. Despite the obvious fact that we are more likely to take action related to short-term rewards, the continual focus is on long-term benefits and outcomes of behaviors over years.

There are few more powerful ways to temporarily lighten the heavy emotional and psychological burden of Alzheimer's than providing a subjectively enhanced exercise experience. And even better if you can provide this in a shared experience between patients and caregivers. And with a healthy individual, creating an enjoyable exercise experience will likewise create a positive emotional connection to the activity.

"You can't change a body in a single workout, but you can change a mind." – *Jonathan Ross*

The often-overlooked subjective experience of how people perceive exercise is a common criticism and egregious oversight of the fitness industry in its attempts to reach more of the public. We often ignore people's thoughts, feelings, and attitudes about exercise.

How we present and implement exercise can influence and enhance the attitudes and emotions someone has toward physical activity – in a single experience. One workout can change minds. The practical strategies to follow later in the course will reveal how to do so.

Lifestyle - Promotion or Prevention of Disease

In addition to age and the influence of genetics, there are numerous health and lifestyle factors related to Alzheimer's Disease risk.

In the list below, if a percentage is listed in parentheses, this refers to the Lancet Commission Report estimating the percent reduction in dementia occurrence if this risk factor is eliminated. (Livingston, 2020) Several of the items in this list will be expanded on further along in the material if they are modifiable by health professionals.

(1) **Cardiovascular Disease**: Cardiovascular disease risk factors put people at greater risk for reduced cognitive function and dementia later in life. (Hakala, 2021), (Albai, 2019) Cardiovascular disease could just as easily be called cerebrovascular disease.

(2) **Stress**: Zero stress is not the goal. That is a purposeless life. Hitting the "sweet spot of stress" involves allowing enough stress into your life to give you purpose, meaning, and direction for your energies and efforts while avoiding getting locked into a pattern of chronic stress that will tear down both your brain and your body. Successful stress mitigation during periods of unavoidable or higher stress is the key.

(3) **Sleep**: Poor quality and/or inadequate sleep quantity reduces the time that the brain spends cleaning up after itself. The topic of sleep will get an expanded treatment later in the text.

(4) **Obesity** (1%): With deleterious effects for every organ and every bodily system, obesity unsurprisingly increases the likelihood of dementia. (Solas, 2017)

(5) **Diabetes** (1%): When blood sugar gets too high, the sugar sticks to cells, disrupting proper cellular function and this wreaks havoc throughout the body. With a brain keenly dependent on efficiently using a large amount of fuel, diabetes is potentially disastrous for brain health.

This is also another way to understand how powerful physical activity can be in managing blood sugar and maintaining brain health. Resting muscles remove no sugar from the bloodstream, but contracting muscles remove sugar rapidly from the bloodstream and can do so without requiring insulin.

(6) **Depression** (4%) – depression typically features low-BDNF, less social interaction, poor nutrition, and decreased physical activity so it's relationship to dementia is strong.

(7) **Smoking** (5%) – It is interesting how during the Covid-19 pandemic of 2020, when society decided to do "whatever it takes to save lives," cigarettes remain legal.

(8) **Traumatic Brain Injury** - Falling is the most common cause of TBI. According to the U.S. Centers for Disease Control, 36 million people 65 and over experience a fall annually. TBI need not occur when older to contribute to dementia as TBI at any age is considered a risk factor.

(9) **Hearing Loss** (8%): By itself, hearing loss will greatly decrease both cognitive stimulation opportunities and social interaction. (Note that it is the highest percentage risk factor for dementia of the ones assigned a percentage by the Lancet Commission Report.)

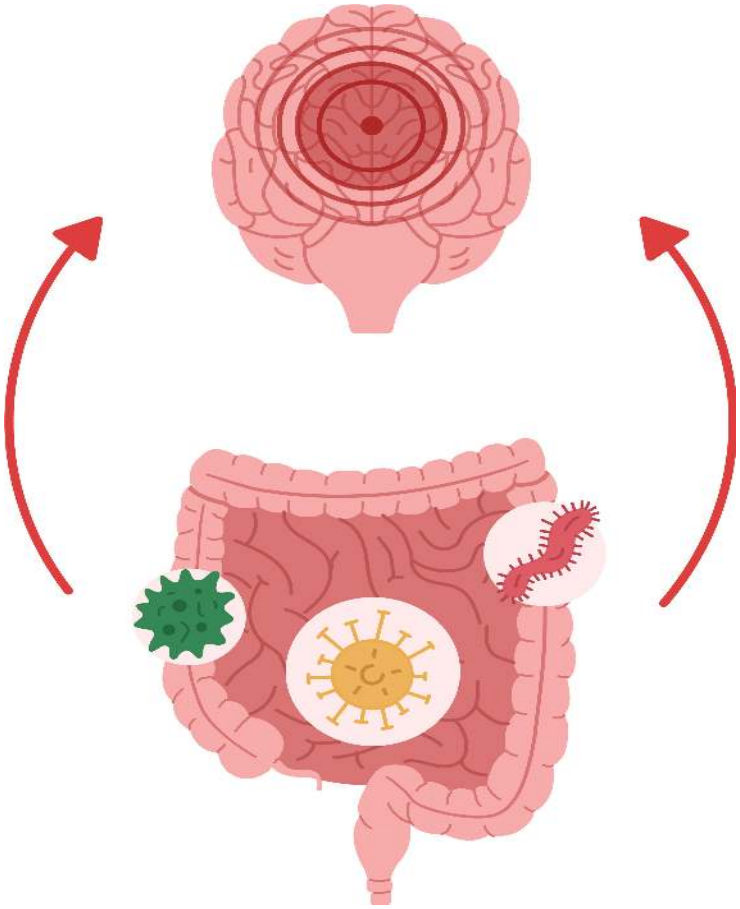
(10) **Peripheral Vision Loss** – Areas of the brain that control peripheral vision deteriorate early in AD. (Javaid, 2016)

(11) **Social Isolation** (2%): Social connection is to our spirit like oxygen is to our lungs. Most of humanity became the subject of an unplanned experiment on the effect of social isolation during the Covid-19 pandemic of 2020. The “results” of this study showed incontrovertibly that social isolation degrades mental health in general and engenders or accelerates cognitive decline specifically. People with extant dementia or MCI experienced rapidly worsening symptoms.

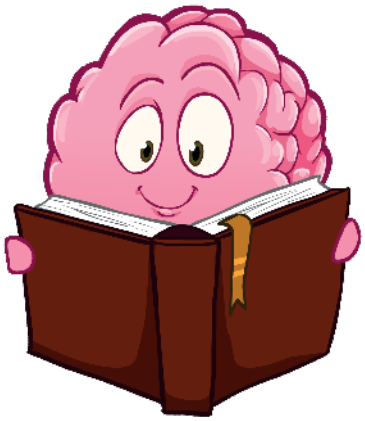
Meta-analyses have identified that social isolation is both a primary and secondary risk factor for increased mortality risk (Holt-Lunstad, 2015) and that the type of social interaction was meaningful with closer, more complex relationships showing a more positive effect than simply living in proximity to other people. (Hold-Lunstad, 2010)

And in another example of how modifiable lifestyle factors are inextricably linked, for most of human history, eating has occurred in a context of social connection. Sharing a meal with friends and loved ones not only contributes to the enjoyment of the subjective experience of eating, doing so activates the parasympathetic nervous system, relaxing you and enhancing optimal digestion and nutrient absorption. (Browning, 2014) This is another in a seemingly endless list of ways that we have changed the way we used to live and do things – yet we rarely seem to change things for the better. More often than not, we eat alone and/or in front of a screen.

(12) **Gut bacteria/microbiome**: Dementia risk is increased by harmful bacteria in your colon. (Saji, 2019) The gut of people with Alzheimer's disease exhibits a distribution of bacteria that looks much like someone with obesity or type-2 diabetes. (Vogt, 2017) The brain and gut are mutually influential of each other and improvement of the gut microbiome for neuroprotection is a rapidly growing area of research. (Lombardi, 2018) Gut bacteria eat what we eat and if we feed the type of bacteria that cause inflammation, we increase our risk for dementia. (Solas, 2017) Further, inflammation in the gut increases gut permeability, allowing more toxins out into our body. Alternatively, if healthy gut bacteria flourish, cognitive function may improve (Kobayashi, 2019). If unhealthy bacteria are dominant, the process to restore gut health may involve (1) antibiotics to kill off bacteria, (2) providing healthy bacteria through nutrition and/or supplementation, and (3) supporting the flourishing of the healthy bacteria through continued participation in a healthy lifestyle (the same place we always end up when discussing how to promote health!)



Gut health naturally leads to conversations about fiber. Soluble fiber is soft, dissolves in water, and bulks up stools. Insoluble fiber (indigestible fiber) ferments in the colon, supplying food for healthy bacteria such as short-chain fatty-acids that are important signaling molecules for the nervous system and brain. Probiotic foods supply beneficial bacteria and prebiotic foods provide the food the beneficial bacteria thrive on.



(13) **Education (Cognitive Reserve)** (7%): this concept states that the more learning you accumulate, the more you build up a cognitive reserve so that if cognitive decline happens, you are subtracting from a higher amount of cognitive ability, delaying the onset of symptoms. People with more education have lower prevalence of dementia, more years of cognitively healthy life, and fewer years with dementia (Crimmins, 2018), and a meta-analysis of studies found robust support for the cognitive reserve hypothesis. (Meng, 2012)

(14) **Hypertension** (2%) – The Whitehall II study of 8,639 people followed for 25 years and ongoing, has evaluated participants at age, 50, 60, and 70. It found that systolic blood pressure > 130 at age 50, but not at age 60 or 70, increased dementia risk by 40%. High blood pressure at mid-life is thus highly correlated with increased dementia risk. (Abell, 2018)

The SPRINT study, a blood pressure intervention which kept systolic blood pressure below 120 was stopped early due to the significantly positive results. (SPRINT Research Group, 2015) Building on this, the SPRINT-MIND study incorporated memory challenges with < 120 blood pressure interventions and found that over three years, the risk of getting MCI decreased by 19%. (Williamson, 2019)

(15) **Nutrition** – we are made of what we eat. Nutrition gets an expanded treatment later in the text.

(16) **Exercise and Physical Activity** (Physical Inactivity 2%): These would most helpfully be considered as two separate categories: “Dedicated exercise,” which would be physical activity done at a high enough intensity to create a stimulus for change; and “Incidental physical activity,” which would be physical activity from housework, walking the dog, etc., which would be done much more frequently than dedicated exercise.

(17) **Excessive Alcohol Consumption** (1%) – defined as greater than 21 units/servings per week by the Lancet Commission Report.

(18) **Air Pollution and Exposure to Secondhand Smoke** (2%) – where we live, work and workout determines what we breathe and take into our bodies.

What Current Research Says: Dementia May Be Preventable

It is by now obvious that Alzheimer’s Disease is heavily multi-factorial and cannot be avoided by a single lifestyle factor nor treated successfully with a single drug. It takes a large cluster of behaviors and interventions to improve chances of a favorable outcome.

Multiple modes of behavior change have a more powerfully positive effect than single mode lifestyle interventions. (Brasure, 2018) We must combine efforts on anything from the above list which is modifiable rather than pick a single behavior to modify and expect to see measurable improvement in existing disease or to aid in prevention.

“Prevention” is likely too strong of a word to responsibly use and should perhaps be better thought of as “risk reduction” since there are no guarantees of absolute prevention. As our understanding of AD expands and our approach becomes more refined, the future holds the opportunity to realistically expect legitimate prevention strategies.

Nevertheless, emerging research is providing valuable insights as to which modifiable behaviors work to reduce or increase risk of dementia.

The FINGER trial is the first randomized controlled trial showing that it is possible to prevent cognitive decline using a multi-domain lifestyle intervention among older at-risk individuals. For two years, over 2,600 people in Finland between age 60-77 participated in this study which used the following lifestyle interventions: diet, exercise (including both strength and aerobic training), cognitive training, and vascular risk monitoring. The results showed that the interventions improve or maintain cognitive functioning in at-risk elderly people. (Ngandu, 2015)

In a massive study of over 300,000 people aged 50-73 years who were monitored for eight years to see who did and did not develop dementia, six healthy lifestyle behaviors were tracked:

- Eating a healthy diet with more fruits and vegetables, and less processed meat and refined grains
- Meeting physical activity guidelines of 150 or more minutes a week of moderate-to- vigorous physical activity
- Sleeping 6 to 9 hours each day
- Drinking alcohol in moderation
- Not smoking
- Not having obesity, meaning they had a BMI (body mass index) of under 30

The results showed that adopting healthy lifestyle behaviors can lower dementia risk even among people who are at higher risk due to a family history of dementia. Following all six healthy lifestyle behaviors cut the risk of dementia by almost half and following three of the healthy behaviors was associated with a 30% reduced risk compared to following two or less healthy behaviors, even when investigators considered familial dementia and accounted for related risk factors for dementia like age, race, sex, education, hypertension, Type-2 diabetes, and depression. (Brellenthin, 2021)

A scientific statement from the American Heart Association titled “A Primary Care Agenda for Brain Health: A Scientific Statement From the American Heart Association,” states that dementia is associated with the following list of modifiable risk factors – most of which are in the numbered list of risk factors above: (Lazar, 2021)

- Depression
- All heart attack risk factors
- High blood pressure
- Diabetes
- Obesity
- High cholesterol
- Physical inactivity
- Inflammatory diet
- Smoking
- Social isolation
- Excessive alcohol use
- Sleep disorders
- Hearing loss

Everywhere you look in the research community, you find clear evidence of the above modifiable risk factors relating to dementia. Our brains are a particularly sensitive part of our bodies. As many of the above risk factors put all organs and bodily systems at risk, protecting our brain is done by doing what protects our bodies, and vice versa. This is welcome – if unflashy – news.

Even with an increased genetic risk for Alzheimer's disease, it is clear that, except for early-onset Alzheimer's, the genes for Alzheimer's are not deterministic. This is clearly, if bluntly, illustrated by the statement "genetics loads the gun, lifestyle pulls the trigger."

Next, we more thoroughly examine the specifics of the lifestyle factors that are modifiable under the guidance of a medical or fitness professional.

References for this Lesson

Abell J., Kivimaki M., Dugravot A., et al. (2018) Association Between Systolic Blood Pressure and Dementia in the Whitehall II Cohort Study: Role of Age, Duration, and Threshold Used to Define Hypertension. European Heart Journal. 39(33):3119–3125 https://doi.org/10.1093/eurheartj/ehy288

Albai O, Frandes M, Timar R, Roman D, Timar B. (2019) Risk factors for developing dementia in type 2 diabetes mellitus patients with mild cognitive impairment. Neuropsychiatr Dis Treat. 15:167-175 https://doi.org/10.2147/NDT.S189905

Alluri, V., et al. (2012) Large-scale brain networks emerge from dynamic processing of musical timbre, key and rhythm. Neuroimage. 59(4):3677-3689. https://doi.org/10.1016/j.neuroimage.2011.11.019

Brasure, M., Desai, P., Davila, H., Nelson, V.A., Calvert, C., Jutkowitz, E., Butler, M., Fink, H., Ratner, E., Hemmy, L., McCarten, J., Barclay, T., & Kane, R. (2018). Physical Activity Interventions in Preventing Cognitive Decline and Alzheimer-Type Dementia. Annals of Internal Medicine, 168, 30-38. https://experts.umn.edu/en/publications/physical-activity-interventions-in-preventing-cognitive-decline-a

Brellenthin, A., Lee D., Lefferts, E., Song, B., Kim Y. (2021) Circulation. 143:A074 https://doi.org/10.1161/circ.143.suppl_1.074

Browning, K.N. and Travagli, R.A. (2014). Central Nervous System Control of Gastrointestinal Motility and Secretion and Modulation of Gastrointestinal Functions. In Comprehensive Physiology, R. Terjung (Ed.). https://doi.org/10.1002/cphy.c130055

Crimmins, E., et al. (2018) Educational Differences in the Prevalence of Dementia and Life Expectancy with Dementia: Changes from 2000 to 2010. The Journals of Gerontology: B73(1):S20–S28. https://doi.org/10.1093/geronb/gbx135

Hakala, J. O., Pahkala, K., Juonala, M., Salo, P., Kähönen, M., Hutri-Kähönen, N., Lehtimäki, T., Laitinen, T. P., Jokinen, E., Taittonen, L., Tossavainen, P., Viikari, J., Raitakari, O. T., & Rovio, S. P. (2021). Cardiovascular Risk Factor Trajectories Since Childhood and Cognitive Performance in Midlife: The Cardiovascular Risk in Young Finns Study. Circulation, 143(20), 1949–1961. https://doi.org/10.1161/CIRCULATIONAHA.120.052358

Hall, J., Gomez-Pinilla, F., Savage, L. (2018) Nerve Growth Factor Is Responsible for Exercise-Induced Recovery of Septohippocampal Cholinergic Structure and Function. Frontiers in Neuroscience. 12:733. https://doi.org/10.3389/fnins.2018.00773

Holt-Lunstad J., Smith TB., Layton JB. (2010) Social Relationships and Mortality Risk: A Meta-analytic Review. PLOS Medicine 7(7): e1000316. https://doi.org/10.1371/journal.pmed.1000316

Holt-Lunstad, J., Smith, TB., Baker, M., Harris, T., & Stephenson, D. (2015). Loneliness and Social Isolation as Risk Factors for Mortality: A Meta-Analytic Review. Perspectives on Psychological Science. 10(2):227–237. https://doi.org/10.1177/1745691614568352

Islam, M.R., Valaris, S., Young, M.F. et al. (2021) Exercise hormone irisin is a critical regulator of cognitive function. Nature Metabolism 3(8):1058–1070 https://doi.org/10.1038/s42255-021-00438-z

Javaid, F., et al. (2016) Visual and Ocular Manifestations of Alzheimer's Disease and Their Use as Biomarkers for Diagnosis and Progression. Frontiers in Neurology. 7:55 https://www.frontiersin.org/articles/10.3389/fneur.2016.00055/full

Kobayashi, Y., Kinoshita, T., Matsumoto, A., Yoshino, K., Saito, I., & Xiao, J. Z. (2019). Bifidobacterium Breve A1 Supplementation Improved Cognitive Decline in Older Adults with Mild Cognitive Impairment: An Open-Label, Single-Arm Study. The journal of prevention of Alzheimer's disease, 6(1), 70–75. https://doi.org/10.14283/jpad.2018.32

Lazar, R. et al. (2021) "A Primary Care Agenda for Brain Health: A Scientific Statement From the American Heart Association" Stroke. 52:e295-e308. https://www.ahajournals.org/doi/10.1161/STR.0000000000000367

Livingston, G., Huntley, J., Sommerlad, A., Ames, D., Ballard, C., Banerjee, S., Brayne, C., Burns, A., Cohen-Mansfield, J., Cooper, C., Costafreda, S. G., Dias, A., Fox, N., Gitlin, L. N., Howard, R., Kales, H. C., Kivimäki, M., Larson, E. B., Ogunniyi, A., Orgeta, V., Mukadam, N. (2020). Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. Lancet (London, England), 396(10248), 413–446. https://doi.org/10.1016/S0140-6736(20)30367-6

Lombardi, V., et al. 2018Nutritional modulation of the intestinal microbiota; future opportunities for the prevention and treatment of neuroimmune and neuroinflammatory disease. The Journal of Nutritional Biochemistry. 61. 1-16. https://doi.org/10.1016/j.jnutbio.2018.04.004

Medina, J. (2009). Brain rules. Pear Press.

Meng X, D'Arcy C (2012) Education and Dementia in the Context of the Cognitive Reserve Hypothesis: A Systematic Review with Meta-Analyses and Qualitative Analyses. PLoS ONE 7(6): e38268. https://doi.org/10.1371/journal.pone.003826

Ngandu, T., Lehtisalo, J., Solomon, A., et al. (2015) A 2-year multidomain intervention of diet, exercise, cognitive training, and vascular risk monitoring versus control to prevent cognitive decline in at-risk elderly people (FINGER): a randomised controlled trial. Lancet (London, England), 385(9984), 2255–2263. https://doi.org/10.1016/S0140-6736(15)60461-5

Ratey, J. (2013). *Spark*. Little, Brown & Company.

Saji, N., Niida, S., Murotani, K. et al. (2019) Analysis of the relationship between the gut microbiome and dementia: a cross-sectional study conducted in Japan. Scientific Reports 9, 1008 https://doi.org/10.1038/s41598-018-38218-7

Solas, M. Milagro, F., Ramírez, M., Martínez, J. (2017) Inflammation and gut-brain axis link obesity to cognitive dysfunction. Current Opinion in Pharmacology. 37:87-92 https://doi.org/10.1016/j.coph.2017.10.005.

Sherzai, D., Sherzai, A. (2019) *The Alzheimer's Solution: A Breakthrough Program to Prevent and Reverse the Symptoms of Cognitive Decline at Every Age*. HarperOne

SPRINT MIND Investigators for the SPRINT Research Group, Williamson, J. D., Pajewski, N. M., Auchus, A. P., Bryan, R. N., Chelune, G., Cheung, A. K., Cleveland, M. L., Coker, L. H., Crowe, M. G., Cushman, W. C., Cutler, J. A., Davatzikos, C., Desiderio, L., Erus, G., Fine, L. J., Gaussoin, S. A., Harris, D., Hsieh, M. K., Johnson, K. C., … Wright, C. B. (2019). Effect of Intensive vs Standard Blood Pressure Control on Probable Dementia: A Randomized Clinical Trial. JAMA, 321(6):553–561. https://doi.org/10.1001/jama.2018.21442

SPRINT Research Group. (2015) A Randomized Trial of Intensive versus Standard Blood-Pressure Control. New England Journal of Medicine. 373:2103-2116

Stern, Y., et al. (2019)Effect of aerobic exercise on cognition in younger adults: A randomized clinical trial. Neurology, 2019 DOI: 10.1212/WNL.0000000000007003

Vogt, N.M., Kerby, R.L., Dill-McFarland, K.A. *et al.* (2017). Gut microbiome alterations in Alzheimer's disease. *Sci Rep* 7:13537 https://doi.org/10.1038/s41598-017-13601-y

Module 4 – Behavioral Risk Factors We Can Modify

Lesson 1 – Sleep

Overview of sleep:

- We know how much sleep we need, and it is not five hours, despite the delusional claims of many who are “fine” on that little sleep
- What matters most is getting the right amount of sleep for the individual, even if it is at odd times or occurs in multiple segments in a day
- The myth that everyone should get up early (and workout early) creates too much anxiety, stress, and disruption for people who are not naturally early risers
- Sufficient, high-quality sleep is essential because this is when brain cells temporarily shrink to allow a “flushing out” of waste products in the brain. Inadequate sleep does not arrest this process – it sends it into overdrive and even healthy tissue can start getting consumed in the process. During sleep, we experience repair and construction of white matter areas (like the highways in the brain).
- Memory consolidation/learning are enhanced during sleep during REM stages of sleep cycles, which are longer during the second half of our sleep. (Yet another reason why short sleeping is particularly deleterious.)
- Watch out for “revenge bedtime procrastination”
- Sleep Tips / Sleep Hygiene: the list of tips for good sleep habits read as if someone designed our modern life around whatever goes against healthy sleep.

How Much Sleep Do We Need?

A better question would perhaps be: ***How many times do we have to ask?*** Popular articles on sleep continually pose this question, even though we already know the answer. We endlessly ask this question because people do not like the answer. The large majority of adults need between 7-9 hours for optimal function. Like many parts of the human experience, sleep needs are on a bell curve. Most of us are under the central, 7-9 hour part of the curve. Certainly, some people are at the long tails at either end of the bell curve – those few who actually thrive on 5-7 hours or on 9-10 hours a night. The legions of people who claim they are "fine" on 5 hours a night, are for the most part, delusional. Fine is not optimal. Fine is getting by. And few of us know anyone who boasts of the 9 hours they need to function optimally, so we know most of the "fine on 5 hours" people are exhibiting wishful thinking.

We need so much sleep because our brains are highly advanced compared to others in the animal kingdom and we need more brain down time for cleaning, maintenance, and memory consolidation.

Where the surprise comes in is that it seems that we do not need to get all our sleep in one, uninterrupted session. Our bodies seem to care most about getting enough sleep, regardless of how it is broken up. In the pre-industrial age, it was quite common for humans to break up the night's sleep into two segments.

How Many Hours of Continuous Wakefulness Should We Have?

A better question you almost never hear asked about sleep is “How many hours of continuous wakefulness should we limit ourselves to?” There are clear, observable negatives to a high number of hours of continuous wakefulness. As little as 17 hours of continuous wakefulness affects your brain in the same way that alcohol does, with cognitive affects equivalent to a blood-alcohol level of 0.05%. And when sustained wakefulness reaches 24 hours, the effects are equivalent to a blood-alcohol level of 0.1%, more than the legal blood-alcohol limit in many states.

Those numbers are rather *sobering…*

Further, at some point very soon, the medical community must alter the well-established yet blatantly irresponsible and likely negligent practice of having new doctors work 24-hour shifts as a rite of passage. In commercial aviation, a flight crew can “time out” after a weather or equipment induced flight delay puts them past a time they are allowed to fly. There must be similar rules in place for any and all industries where the lives of others are entrusted to professionals.

Insufficient sleep promotes dementia

Researchers in the Whitehall Study mentioned earlier collected data on over 8,000 British men and women for 30 years, with their sleep habits measured ages 50, 60 and 70. Those who slept six hours or less per night had a 30% increased risk for dementia, compared with those who slept seven hours or more. (Sabia, 2021) Shorter sleep duration is associated with more beta-amyloid deposits. (Spira, 2013) Once again, no, you are not “fine” on five hours of sleep.

Naps Can Help

Shorter naps, 10-40 minutes subject to individual response to various durations, can aid in preventing sleepiness and loss of focus. However, a nap of this length would not feature the benefits of later sleep stages. (See later section Slow Wave and REM Sleep for details.)

Chronotypes: We must stop trying to make everyone an early bird

Someone who loves to get up early – even before sunrise – is called an "early chronotype," while someone who prefers to sleep late is a "late chronotype." Despite our cultural bias preferring the early chronotype, there is an evolutionary basis for all types and there are more than two types. When we were hunter-gatherers, some people had to stay awake at night to guard the tribe. And those genes get passed on.

In an examination of the Hadza people of Tanzania – one of the few remaining hunter-gatherer societies – there was a strong basis for the existence of numerous chronotypes. There was only 18 minutes per night in which all the tribe members were asleep. Meaning, at least one person was awake and fulfilling sentinel duties for 99.9% of the time (18 minutes is 0.1% of 24 hours.) (Samson, 2017) We clearly have a genetic sleep legacy of variable chronotypes providing vigilance against hostility from animal predators, human foes, and environmental harms. As such, it is time we began to accept rather than vilify those who do not fall into the early-bird chronotype.

Like everything else about humanity, there is variety in the details. We all need sleep, but we all do not need to be early risers. We all function best if we can match our schedule to our biologically determined preferences. We are not all early birds by nature. Some are "night owls" and others are "on-time birds," for lack of a better term.

In fact, psychologist and sleep specialist Dr. Michael Breus has detailed 4 sleep chronotypes:

- Lion (morning/early bird)
- Bear (mid-morning)
- Wolf (late morning/night owl)
- Dolphin (disordered sleeper)

Ignore the scientifically baseless dogma of getting up early (unless it fits your chronotype). If possible, organize your day around waking up a time that fits your chronotype, and plan your workouts and most important mental work of the day accordingly. With more people working from home than ever, there has perhaps never been a better time to reorder your day around the optimal time to sleep, wake-up, and exercise.

Mr. Sandman, Send Me to Clean

While we are asleep, our bodies may be resting, but our brains are busy taking out the trash.

During sleep, brain cells temporarily shrink, allowing a high influx of cerebro-spinal fluid, which flushes out toxins like cellular waste and beta-amyloid proteins in the brain. This flushing dramatically decreases during times when we are awake. (Xie, 2013)

This also provides a bit of a sensible rationale for why we need 7-9 hours, since on the surface it doesn't make sense that we should need that much since we are at risk from predators during long periods of sleep so there must be an important benefit to doing so.

The cleaning happens through the action of glial cells, part of the brain's glymphatic system – the brain's version of the lymphatic system. With sleep deprivation, it might seem that if we sleep less this cleaning system would be less active and less effective. As it turns out, sleep deprivation makes these cells overactive. Lack of sleep – in addition to other lifestyle factors (as well as having the ApoE4 allele) - promotes neuroinflammation.

In this scenario, healthy neurons look like damaged tissue, and it is as if the glial cells are saying "there's trouble here, wipe out this tissue to protect the brain." In essence, glial cells transform from housekeepers to homewreckers. (Bellesi, 2017)

Excessive neuroinflammation, the cause of the causes in Alzheimer's, is an over expression of the brain's immune system. Inflammation in the body is a normal response to injury and disease. Excessive or chronic inflammation – in the brain as well as in the body – represents a tipping point where inflammation transitions from healthy to harmful. Excessive neuroinflammation, especially when combined with the ApoE4 allele and a buildup of amyloid plaques, is our recipe for Alzheimer's disease. (Pascoal, 2021)

Sleep is an elegant practical representation of how harmonious the body's systems can be when optimized as well as how destructive they can be when normally protective measures are overexpressed and run rampant.

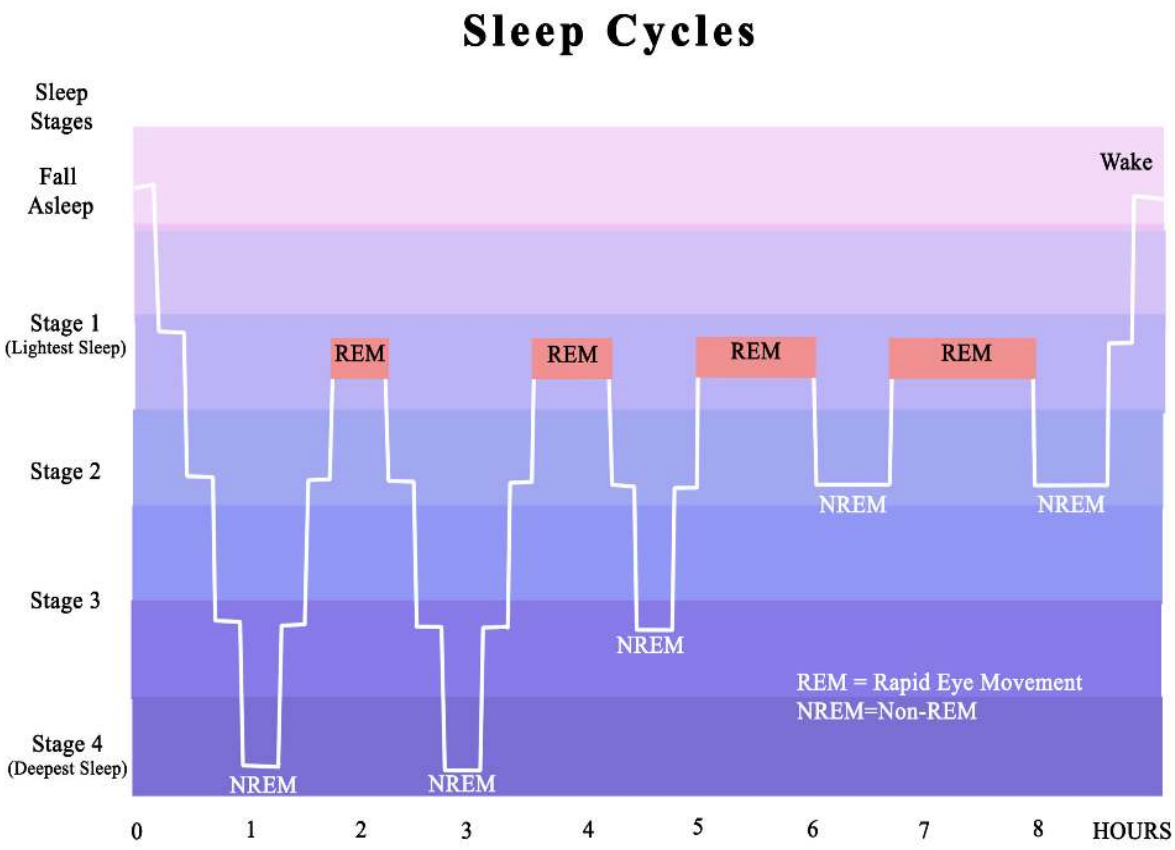
Sleep Position

Sleep position can even potentially enhance glymphatic drainage during sleep. Side sleeping in general, and left side sleeping in particular, optimizes waste removal during sleep. (Lee, 2015)

Slow Wave and REM Sleep

The first half of our sleep is “beauty sleep” and emphasizes more physical repair while the second half is “learning sleep” and emphasizes dreaming. As we sleep, we progress through multiple “sleep cycles,” each consisting of five stages lasting 75-90 minutes. Two parts of the sleep cycles of particular interest are slow-wave sleep (SWS) and rapid-eye-movement (REM) sleep.

The SWS periods in each sleep cycle are longer in the first half of the night. SWS is when blood pressure drops, breathing slows, and body temperature lowers. SWS restores energy, strengthens the immune system, and prompts the body to release human growth hormone. In general, the first half of the night is weighted more toward physical repair time.



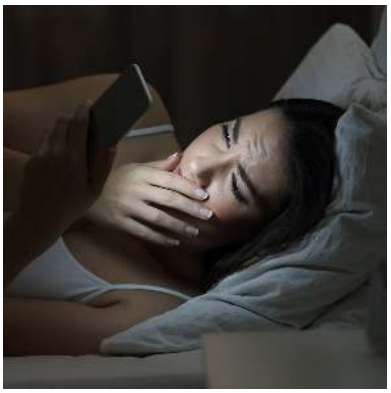
The REM periods in each sleep cycle get longer in the second half of the night. REM sleep features more rapid and shallow breathing, rapid eye movement, and paralysis of extremity muscles (so we do not physical respond to the events of our dreams). REM promotes integration of new knowledge with existing knowledge, enhances creativity and problem-solving, and is important for emotion regulation. The last factor is likely self-evident considering the common grumpiness and irritability of someone who did not get enough sleep.

Naps are recommended to be shorter to keep you in the first two stages of sleep, which are lighter, and thus less likely to generate grogginess upon waking from sleep in the first two stages. However, as mentioned earlier, naps of this length would feature no time spent in REM sleep.

Revenge Bedtime Procrastination

This odd term, revenge bedtime procrastination, has recently become a more significant factor in sleep deprivation. Due to the pandemic of 2020, more people were at home more often than ever before. Parents suddenly were around each other and their kids for a suffocatingly high amount of time. For some people, the only way to get any “me time,” is to be the last one awake at night or the first one to get up in the morning. “Revenge” might be a bit strong of a word, but this phenomenon refers to people who are sacrificing sleep to have some solitude at home. Time to ourselves is important, but sleep is more important.

Sleep Tips / Sleep Hygiene



Instead of trying to “catch some Z’s” it may be easier if we simply stopped chasing them away! If you set out to create a society built around the concept of compromising sleep, you would consider a society like ours to be one to satisfy all the criteria. A read of the list of common sleep recommendations make it seem as if modern life is explicitly designed to work against each of these:

- Keep a regular sleep schedule: bedtime and waketime
- Create a relaxing bedtime routine
- Avoid screens and tech before bed – which have both blue light that shuts off endogenous melatonin release and often has stimulating content that keeps the mind active
- Avoid alcohol and sugary foods before bed (and of course, limit them in general)
- Keep the bedroom cool, dark and quiet – many bedrooms are on the top floor of homes where it is likely to be warmer
- Dim the lights two hours before bedtime
- Use sleep medications as a last resort – these have become a first resort for too many

Sometimes, these recommendations go too far and recommend that we keep consistent meal times and workout times, etc. There is a place where sleep, meal, and exercise times are tightly controlled – it is called prison. Real life is messy and often not conducive to rigid routines. If we get ourselves too accustomed to rigid routines, we risk disrupting the overly fragile equilibrium we have created and now depend on when life presents us with its ongoing, consistent, and typically inconveniently timed disruptions.

References for this Lesson

Lulu Xie, L., et al. (2013) Sleep Drives Metabolite Clearance from the Adult Brain. Science. (342)6156: 373-377 https://science.sciencemag.org/content/342/6156/373

Bellesi, M., et al. (2017) Sleep Loss Promotes Astrocytic Phagocytosis and Microglial Activation in Mouse Cerebral Cortex. Journal of Neuroscience. 37(21):5263-5273. https://www.jneurosci.org/content/37/21/5263

Lee, H., et al. (2015) The Effect of Body Posture on Brain Glymphatic Transport. Journal of Neuroscience. 3(31):11034-11044 https://doi.org/10.1523/JNEUROSCI.1625-15.2015

Pascoal, T.A., Benedet, A.L., Ashton, N.J. et al. (2021) Microglial activation and tau propagate jointly across Braak stages. Nature Medicine. https://doi.org/10.1038/s41591-021-01456-w

Sabia, S., Fayosse, A., Dumurgier, J. et al. (2021) Association of sleep duration in middle and old age with incidence of dementia. Nature Communications. 12:2289 https://doi.org/10.1038/s41467-021-22354-2

Samson, D., Crittenden, A., et al. (2017) Chronotype variation drives night-time sentinel-like behaviour in hunter–gatherers. Proceedings of the Royal Society – Biological Sciences. https://doi.org/10.1098/rspb.2017.0967

Lesson 2 - Stress

Overview of stress:

- Stress is necessary and essential for a healthy, productive, meaningful life
- Stress is acute, episodic acute, or chronic
- Chronic stress inhibits the pre-frontal cortex (PFC), strengthens emotional response pathways – emotional brain neurons get stronger and more efficient
- Chronic stress makes us “experts” at getting stressed
- Stress hormones have a strong affinity for cells in the hippocampus
- Stress is subjective; and so is stress relief (i.e., yoga is not stress relief for everyone)

Stress needs better PR. It is nearly always characterized negatively yet has two main types which may have similar physiological responses yet vastly dissimilar psychological ones: eustress and distress.

The subjective experience of “stress” may differ for many of us but the criteria for defining something as stressful (in the sense of distress) is the same. There must be (1) a physiological arousal (the “fight, flight or freeze” response), (2) an inability or significantly diminished ability to control the circumstances, and (3) it must be perceived as aversive. (Medina, 2009) The latter criterion is the distinguishing difference between distress and eustress.

Stress used to be in the form of immediate threats to our survival. (“Is that tiger going to eat me?”) But now, the stresses are vague, long-term, and cannot be handled by a physical response. (“My retirement fund is doing terribly.” “How will I pay for college for my kids?”)

For most of human history, problem-solving a stressful situation involved short-term, physical responses with a relatively rapid resolution. Stress is now more often experienced around situations involving long-term, psychological responses with uncertain outcomes. We have traded in our formerly immediate physical stressors for delayed psychological ones.

Our frequency of exposure to physical versus psychological stress is also different. Instead of the occasional physical threat, many people spend their waking hours filled with anxiety, paranoia, and worry over multiple psychological stressors at once. This difference is lost on our brains and we experience the same physiological response to psychological stress, and our health suffers.

Instead of an actual need to fight for the future, we fret for the future.

Meet the New Stress…Nothing Like the Old Stress

Stress then… immediate & physical	Stress now… delayed & psychological
Is that tiger going to eat me?	Will I have enough money in retirement?
Should I run away or stay & fight?	Should I eat, drink, or binge watch?
Short-term	Long-term
Physical response	Mental response
Specific	Vague
Occasional	Frequent & Simultaneous
Fight for the Future	**Fret for the Future**

It can happen to all of us, at any time, with little notice. This happened to me during the writing of the above material. One morning when working on this section on stress, I experienced an acute episode of this psychological stress. I was reading the news in the morning – late July 2021 – and I read about how (1) the Amazon rainforest is now a net emitter of carbon due to clearing of enough forest there to tip the scales there from its historic role of a carbon absorber to carbon emitter; (2) the increasing divergence of the real estate haves and have-nots putting the have-nots in deeper financial peril; and (3) in the Western U.S. there was a health crisis among the hawk population due to the extreme heat experienced there. The three of these combined created an acute bout of anxiety and worry for my fellow creatures and planet.

Fight, Flight...or Fitness!

The acute physiological stress response results in a large amount of glucose mobilized into the bloodstream to provide the fuel for fight or flight. With modern stressors requiring little physical output, this is yet another mechanism by which blood sugar can become chronically elevated, promoting insulin resistance.

Thus, it is also yet another way in which exercise benefits us with stress management as it provides both a form of psychological relief as well as a means of using the glucose mobilized to physically handle a stress response. Exercise drives glucose into muscle cells without the use of insulin so it is particularly effective for lowering blood sugar in the presence of insulin resistance.

For most people, participation in challenge exercise is the only way to mimic the physical response we used to have to a stressful experience.

Stress is acute, episodic acute, or chronic

There are three types of stress we experience:

1. **Acute** – nearly get in a car accident, drop your phone, almost fall
2. **Episodic Acute** – a recurring acute stressor such a daily commute with bad traffic
3. **Chronic** – major life event where the stress carries forward over days, weeks, or months

There is no specific point measurable in the body at which stress transitions from acute to chronic. But the effects on the brain are significant and we know chronic stress when we see it.

The hippocampus is very responsive to the stress hormones adrenaline, noradrenaline, and cortisol. Sympathetic nerves involved in fight or flight use acetylcholine as a neurotransmitter, as does your hippocampus. This makes evolutionary sense since most stressors were a direct and immediate threat to survival and thus remembering as many details about the experiences as possible helps prevent or more successfully handle similar experiences in the future.

However, chronic stress prevents neurogenesis in the hippocampus. A brain that perceives it is living in a ceaselessly threatening environment weakens pre-frontal cortex connections with the hippocampus – the effect of which inhibits the ability to incorporate new information and develop new coping strategies. Instead, more habitual behaviors get strengthened and the amygdala takes over, leading to rapid, emotional responses to the stress. In essence, chronic stress renders the brain unable to easily absorb new information as it devotes energy resources to handling the immediate threat of the stress in a way it has now learned to automatically. With chronic stress, the brain is in constant “crisis-mode” and unable to strategize and organize thoughtful, nuanced solutions to problems.

Emotion-driven (amygdala) behavior is lightning fast yet prone to error. Thought-driven (pre-frontal cortex) behavior is slow and prone to more accurate, appropriate responses. In a chronically stressful environment, there is no time to think as pausing to think increases the likelihood of serious injury or death (from the brain’s perspective). The result is that we strengthen knee-jerk responses to stress. If stress hormones get high enough for long enough, they can take over your memories, encoding even non-stressful events as stressful. Given enough time and repetition, the end point of this is the extreme situation of post-traumatic stress disorder (PTSD). However, chronic stress harms the brain long before it gets as bad as PTSD. (Sapolsky, 2017)

Chronic stress generates vast amounts of inflammatory free radicals in the hippocampus. This in turn can result in the overexpression of the immune response to inflammation that is implicated in Alzheimer's and other brain disease. And this is once again where BDNF plays a critical role and having more of it is of tremendous benefit. Even in high stress situations, in sufficient quantities BDNF protects the brain from the damaging effects of stress.

I Can't Stress This Enough

Beyond the major obvious negative events like the death of a parent, the diagnosis of a major degenerative disease, or the loss of a job, distressing events are subjective. Some people are thrilled and have fun in a haunted house or on a roller coaster while others are legitimately terrified of either. Likewise, stress relief is subjective. Recommendations for how to relieve stress contain the predictable list of stuff like yoga, meditation, walking, sit quietly and breathe, etc. These things are helpful if they help to relieve YOUR stress. Stress relief is in the eye of the beholder.

Yes, meditation improves cognition, executive functioning, working memory, attention, and processing speed (Gallant, 2015) and white matter connectivity and gray matter concentrations in multiple brain regions. (Tang, 2010) (Luders, 2015) But none of this is true if meditation does not work for you, and you find it frustrating and difficult to do. Of course, meditation is a skill. Like many skills, we rarely master them with limited practice. Certainly, making a concerted effort to improve meditative abilities is warranted. However, if you have tried it enough to know that it is not for you, then it is not for you.

The best coping mechanisms – the healthy ones – are the ones that you know work for you. Maybe you dislike yoga and get agitated when you try to meditate. Perhaps you get stress relief from playing with your dog, tossing a ball around with a kid, a tough workout, or cooking, gardening, or some other hobby.

Numerous potentially surprising techniques have been shown to provide acute, in-the-moment stress relief. They include plunging your face into ice water while holding your breath, sucking on a lemon (which activates the parasympathetic nervous system), talking to yourself in the third person and/or using your proper name, intentionally adjusting your posture to a non-stressed one, and even yawning. Of course, the efficacy of these is subjective as well.

Employ the stress management techniques that work for each person, not the ones that are on some list of stress-management techniques. People do not hire professionals to get a regurgitate list of stock-standard approaches available anywhere. This involves encouraging people to reflect on their own personal effective coping mechanisms for stress relief. A useful coaching tip: It can be helpful to ask someone, “What are some positive stress management or coping methods you know that work for you?” This is the essence of true leadership. Rather than directing people toward a list of pre-determined stress management techniques, it encourages people to seek the most appropriate solution for themselves from self-knowledge.

Reverse Engineering Stress Relief

Even though the perception of stress is subjective, there are certain physical characteristics we share in our stress response. Breathing gets faster and shallow when stressed. We get “tunnel vision” with the central target of our line of sight coming into hyper-focus and a loss of peripheral vision. Our psychology changes our physiology. But this also can work the other way around as well. The way into physical distress shows the way out. When we notice an acute physical reaction to stress, if we slow and deepen our breathing, our brain knows that we do not breathe like that when we are stressed, and begins to come down from the stress response. Similarly, if we focus on our peripheral vision – put your arms out to the side at the limit of peripheral focus and move the hands or wiggle the fingers while trying to keep them in sight just at the edge of peripheral perceptive ability – this is another way to use our physiology to change our psychology.

These quick, in-the-moment strategies are ways to quickly turn around our physiological stress response. This will not remove the stressor nor solve the problem; it just improves our physical response.

Effective stress management does not involve eliminating stress.

It involves two components:

1. Reducing the stress to eustress levels and acute distress events (like your car breaking down)
2. Re-taking control of your body's response to stress in the short-term (using the Reverse Engineering strategies identified above) and in the long-term (by reflecting on and identifying effective, healthy coping mechanisms to ameliorate harmful effects of chronic stress.)

Eliminating all stress is disastrous for health as it removes meaning and engagement from life with nothing to strive for. Hitting the "sweet spot of stress" involves allowing enough stress into your life to give you purpose, meaning, and direction for your energies and efforts while avoiding getting locked into a pattern of chronic stress that will tear down both your brain and your body.

References for this Lesson

Gallant, S. (2015) Mindfulness meditation practice and executive functioning: Breaking down the benefit. Consciousness and Cognition. 40:116-130. https://doi.org/10.1016/j.concog.2016.01.005

Luders E., Cherbuin N., and Kurth F. (2015) Forever Young(er): potential age-defying effects of long-term meditation on gray matter atrophy. Frontiers in Psychology. 5:1551. https://doi.org/10.3389/fpsyg.2014.01551

Medina, J. (2009) *Brain Rules*. Pear Press.

Sapolsky, R. (2017) *Behave: The Biology of Humans at Our Best and Worst*. Penguin Press.

Tang, Y., et al. (2010) Short-term meditation induces white matter changes in the anterior cingulate. Proceedings of the National Academy of Sciences. 107(35):15649-15652. https://doi.org/10.1073/pnas.1011043107

Lesson 3 - Social Isolation

In the practical sense, the problem of social isolation is already in a sense being addressed by the fact that an individual is using the one-on-one coaching services of a medical fitness professional and/or is attending small group workouts led by one.

However, this only holds true if the professional employs a coaching approach rather than an authoritative, directive approach that is unfortunately commonly used by many fitness professionals. The cliché of the tough, drill-instructor type of fitness instructor will, for most people, be a turn off as it has already proven to be with the population at large.

We already know that social older adults have more robust gray matter in regions of the brain relevant to dementia (Felix, 2021) and that low social engagement makes people more susceptible to beta-amyloid-related cognitive decline. (Biddle, 2019)

Social interaction, and more specifically, the cooperation that it engendered in the early days of humans, became a survival skill as the collective skills of a collaborative, cooperative group became reproductively selected against less social humans. We got this far by being more social while the least social of our ancestors were less likely to have successful offspring. The success of our species is the result of successful social interaction. (Wilson, 2012)

Toward More Purposeful, Meaningful Social Interaction

We must deliver an elevated social interaction as part of medical fitness leadership and go beyond cordial chit-chat over current events in client's lives and provide a more direct, enjoyable social interaction which the nature of the exercise and physical activity we present is dependent on.

Social interaction needs to become an active, overt part of the physical activity experience rather than a passive, incidental, background part of the experience.

What does this look like?

Partner interactivity and friendly competition.

Partner interactivity in this context means the one partner's movements are somehow dependent on sensory input from the other partner. For example, one partner might say something like a number to determine direction of movement based on even or odd numbers. It can be direct physical contact, like taps to introduce a stability challenge to a plank.

Friendly competition is a fun means of enhancing both the effort and the experience of physical activity through collaboration and cooperation to achieve a goal.

Furthermore, incorporating the essential components of fun and play discussed earlier with social interaction is a way to amplify the positive effects of the exercise experience among participants.

For example, in any partner or small group workout:

- When choosing who goes first among partners for an exercise, facilitate connection and interaction by using personal details about the participants. For example, set a fun rule to determine who goes first according to who has:
    1. the most kids or pets
    2. the lighter or darker colored shirt, pants/shorts, or shoes
    3. the longest hair
    4. eaten a specific food more recently
    5. more/less height
    6. the larger number when adding up digits of phone number

The options here are nearly limitless. Choose something light and fun that will get participants to know each other better while steering clear of anything that might create awkwardness (e.g., who has the highest amount of formal education) or anything that would put participants in a position like they are revealing too much personal information (e.g., who lives the farthest away).

- In a circuit workout with a group, designate an exercise as the one that determines when it is time to rotate to the next exercise. When the person at that station completes the predetermined number of reps, they call out “Switch!” to advance everyone else in the circuit to the next exercise.

Plentiful examples of purposeful, enhanced social interaction integrated with exercise will be presented in a later module.

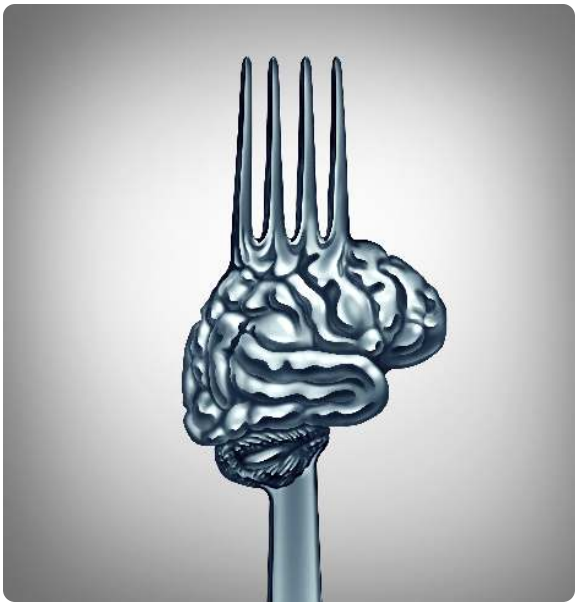
References for this Lesson

Felix, C. et al. (2021) Greater Social Engagement and Greater Gray Matter Microstructural Integrity in Brain Regions Relevant to Dementia. The Journals of Gerontology: Series B 76(6):1027-1035 https://doi.org/10.1093/geronb/gbaa173

Kelsey B, et al. (2019) Social Engagement and Amyloid-β-Related Cognitive Decline in Cognitively Normal Older Adults, The American Journal of Geriatric Psychiatry https://doi.org/10.1016/j.jagp.2019.05.005

Wilson E. (2012) *The Social Conquest of Earth*. New York. Liveright Pub. Corporation.

Lesson 4 - Nutrition



This overview of nutrition is provided to highlight some key elements of nutrition as it pertains to Alzheimer's Disease and will help medical fitness professionals provide substantive coaching. A full treatment of the subject is beyond the scope of this course and the depth of the topic warrants several books worth of information. Several excellent books have been written which include valuable information on nutrition as it pertains to Alzheimer's Disease. Those seeking a more detailed exploration of nutrition related to AD are referred to the following:

- The End of Alzheimer's Program by Dale Bredesen
- The Alzheimer's Prevention Food Guide by Sue Stillman Linja
- Brain Food: The Surprising Science of Eating for Cognitive Power by Lisa Mosconi

Overview of nutrition:

- Yes, fitness professionals can (and in fact, should) discuss nutrition…it is debatable if people should talk to their doctors about nutrition
- Organic vs. Conventional Farming – put the burden of proof where it belongs
- Extremism is for lazy thinkers – human physiology is complex and nuanced
- Low fat diet is not for brain health
- Minimal processing – stay close to real foods in a form you can imagine and connect more easily to in nature.

- Extra-virgin olive oil helps prevent dementia and is an example of how food processing is not always harmful to health
- High blood sugar = cellular death
- High flavonoid foods, turmeric and many aromatic spices increase BDNF

Nutrition is confusing. At least that's what people always say. On a basic level it is not confusing at all. It can be when you get into the details. However, it is not confusing to consider which is healthier: doughnuts or… almost any other kind of nut? The common complaint about how confusing nutrition is often is someone's way of saying "I am not ready to change," so they maintain the status quo of how they eat now because it is "too confusing" to know how to eat healthier. It excuses inaction.

In that spirit, to avoid getting lost in the "confusing" details, it is important to address a few big-picture topics and then zero in on a few more detailed specifics relevant to brain health and Alzheimer's.

Can Fitness Professionals Discuss Nutrition with Clients?

First, the unnecessary debate about whether fitness professionals can discuss nutrition if they do not have a nutrition credential. Yes, they can, but with a '*but*.'

Very early in my fitness career, I tried to evade nutrition questions from clients more often than not as I was concerned with staying within my scope of practice. Then, on more than one occasion, came the question that you will inevitably hear if you attempt to avoid any nutrition coaching: “What do *you* eat?” We all eat. This means that if we are a healthy individual, we eat reasonably healthy for ourselves so we must – at a bare minimum – have enough knowledge in this area to provide valuable insights to a public so monumentally confused about nutrition.

It is perfectly within the scope of practice of any credentialed fitness professional to discuss the basics of nutrition. Without a nutrition credential, a fitness professional should not detail specific meal plans with calorie counts, etc. With the well-documented insufficient nutrition education in traditional medical training (Abbasi, 2019), it is arguable that general practitioners without a secondary nutrition credential should likewise avoid anything beyond the same basic nutrition guidance within the scope of practice of fitness professionals.

Even worse, in a survey of nearly 200 doctors, 65% demonstrated inadequate clinical nutrition knowledge as they got 70% of the questions wrong. Less than half knew the correct number of calories in carbohydrates, protein, and fat. And of those scoring low, 30% of them had high self-perception of their nutrition knowledge. Overall, 56.5% of participants accurately estimated their knowledge. (Grammatikopoulou, 2019)

It is certainly odd that with the common knowledge of nutrition among physicians so inadequate, any mention of diet or nutrition is routinely linked to admonitions to “talk to your doctor.” Even worse, doctors often make recommendations based on bias, personal preference, or personal gain such as diet book sales or promotion of in-office, so-called “medically supervised diet programs” selling packaged food, shakes or supplements – creating the significant identical ethical concerns most often attributed to fitness professionals who promote specific diets or sell supplements. (Katz, 2018)

Asking about client preferences and offering suggested potential recipes or replacement foods for unhealthy options and allowing the client to choose the specific actions taken is one acceptable way to address this. And of course, this provides an opportunity to develop a mutual referral relationship with a competent nutrition professional.

I would even go a little farther and suggest that doing any kind of wellness or fitness coaching must explicitly include some discussion of nutrition patterns and how to improve them while staying ethical, within scope of practice and nutrition education level, and referring to competent nutrition professionals when appropriate.

Organic vs. Conventional Farming

"Can you prove that organic farming is better than conventional farming?"

No one needs to.

The question itself contains a fatal logical fallacy.

"Organic farming" is how farming was done for millennia – the entire history of agriculture itself – until almost 100 years ago. Organic farming should really just be called “farming.” It is the original standard and is thus conferred with the reasonable assumption that it is the better choice.

"Conventional" farming using pesticides and fertilizers is the new way of doing things, having only been in existence for a little less than 100 years.

It is a contest of nearly 12,000 years for organic farming (agriculture arose around the end of the last ice age) up against less than 100 years for conventional farming. No contest.

The burden of proof then is on conventional farming to prove itself to be as healthy as organic farming, **not the other way around**.

This is no minor consideration given the significant role environmental toxins play in generating the systemic inflammation implicated in Alzheimer’s.

The logical fallacy generating this question is the same one that leads to two other mischaracterizations around nutrition:

- *Healthy food is too expensive*. Reality: (1) junk food is unrealistically cheap due to mass production and low-quality (low-cost) ingredients, which sets an unrealistic price expectation on food in general. (2) While some healthier foods do carry a premium, most do not. Try and find a high-priced package of lentils and you will be disappointed.
- *Healthy food tastes boring*. Reality: junk foods are engineered to taste unrealistically and unnaturally strong, rendering normal-tasting food comparatively bland. Much like how our vision is affected when coming indoors after being outside in bright sunlight, our taste sensitivity adjusts – albeit much more slowly – once we primarily expose ourselves to natural flavors.

The Environmental Working Group produces a list of foods to help figure out which foods are worth the extra investment in organic. The “Dirty Dozen” and “Clean Fifteen” – are the foods that are most contaminated and least contaminated with pesticides, respectively, in conventional farming. An even simpler guideline for people to follow is that food where you eat the skin, do not peel, and has a highly corrugated surface (lettuce or kale, for example) is best consumed as organic.

Extremism - intellectual laziness

A thoughtful undertaking of an examination of what healthy eating means and how much individual variance there is within humanity naturally leads to the conclusion that absolute statements about how all humans should or should not eat will be, by default, incorrect for many people although correct for many others. There is too much long-term genetic variability from ancestral geography to narrowly determine a specific diet for all humans. All humans should not be vegan, nor should all be omnivores. Beginning with such oversimplified conclusions will inevitably lead you away from the truth. There are countless examples of people whose health and performance thrive with nearly any reasonably healthy eating style.

It is admittedly more difficult for each person to figure out what types of foods or styles of eating do and do not serve the goal of health well. It typically involves elimination or addition of a single food item and allowing time to note the response over a period of hours, days, weeks, or even months. Extremism is easy to follow conceptually with “always…” or “never…” blanket statements. Reality is nuanced, individualized, and more accurate.

The irresistible appeal of a simple one-size-fits-all approach makes it no less inaccurate.

Food Processing - minimal is usually better

It is at once not particularly surprising yet still alarming to note that highly processed foods made up 58% of calorie intake for just over 9,000 people in a typical day. (Steele, 2016) In general, processed foods have become popular due to their convenience, availability, and unnaturally amplified flavor. A helpful way to frame this up is to think about the contrast in apples, applesauce, and apple juice. The farther you get from the actual apple, the unhealthier you make the food. Most unhealthy food is heavily processed, but not all processed food is unhealthy. This is another area where a lack of nuance and an extremism creates judgment errors. Extra-virgin olive oil, all nut butters, and any form of cooking – which renders numerous foods more healthful – is a form of "food processing."

Extra-Virgin Olive Oil

An illustrative exception to the general recommendation to avoid highly processed foods is found in olive oil. I have personally witnessed the processing of olives at an olive farm to produce extra virgin olive oil (EVOO) and it involves a lot of machinery. The output of this processing was a delight to see, smell, and taste. 'Extra virgin' is an olive oil that is produced from healthy, fresh olives, solely by mechanical means, without the use of heat or solvents.

The extra virgin olive oil sampled by the author as it came out of the processing equipment.

Polyphenols are naturally occurring plant chemicals. We have studied only a small percentage of them in our foods. The limited value in a reductionist approach notwithstanding, one polyphenol in olive oil for example, oleocanthal has neuro-protective effects and attenuates markers of inflammation implicated in Alzheimer's disease. (Parkinson, 2014) Extra virgin olive oil reduced early neurological signs of Alzheimer's disease in mice by enhancing authophagy (a brain cell's ability to eliminate waste), improving metabolic markers, reducing neuroinflammation, improving synaptic integrity, and increasing BDNF. (Lauretti, E. 2017)

As with most areas of nutrition there are a staggering number of confounding variables to consider when assessing the number of beneficial polyphenols in an olive oil: (Hoffman, 2015)

- geographical location, growing conditions and cultivar of the olive trees, ripeness of the olive at harvest, extraction method for the oil, and storage of the oil
- when olive oil is used for cooking, the stability of olive oil polyphenols is strongly influenced by cooking temperature and time, the type of food cooked in the oil and the composition of the oil – including antioxidants and polyunsaturated fatty acid content

Clearly, this can get complicated and rather than getting too lost in the details the takeaway message is to consume less of unhealthy, highly processed foods and recognize the value of some processed foods in supporting health.

High Blood Sugar = Cellular Death

Remember eating cotton candy as a kid? Your tear it off with your fingers, put it in your mouth, and everything you come into contact gets sticky as a result. A high rise in blood sugar does the same thing to the cells of your body.

For example, with high blood sugar glucose (the term for sugar when it is the blood) sticks to the outside of cholesterol. The body is unwilling and unable to let the abnormally sticky and clumpy cholesterol out of the capillaries. This is the mechanism by which high blood sugar increases serum cholesterol as this sugar-coated cholesterol gets marooned in the bloodstream, continually circulating. The higher your blood sugar, the more sugar sticks permanently to the outer membrane of cells (Misciagna, 2005), eventually converted to sorbitol which kills the cell. This increases blood vessel damage, risk of strokes and Alzheimer's. (Srikanth, 2011)

Higher consumption of food and drink with added sugar was associated with loss of ability to remember facts and recognize objects and a greater risk of dementia. And a high rise in blood sugar that is part of Type II diabetes can cause loss of brain function and dementia. (Frison, 2021)

The MIND diet (combination of DASH and Mediterranean diets), which restricts added sugars, reduced Alzheimer's risk 53% for those who followed the diet closely, and by 35% for those who followed it most of the time. (Morris, 2015).

More added sugars equals higher risk for dementia. And less added sugars equals less risk. A key message to communicate is that foods do not need to taste sweet to have a negative impact on blood sugar. For example, pretzels do not taste sweet but lead to a high rise in blood sugar due to the high amount of heavily processed carbohydrates.

Low Fat is Not High Cognition

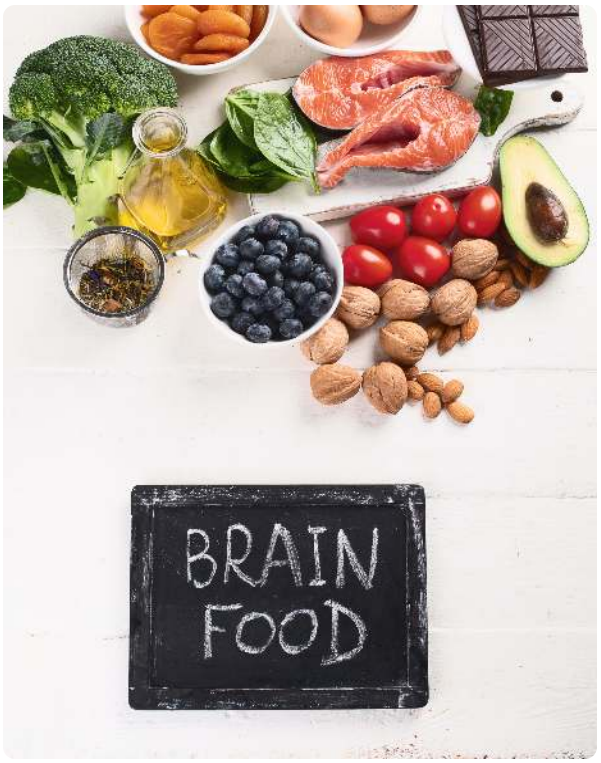
Fats are the component in a Mediterranean diet responsible for its improvement of cognition. A study that compared a high-fat (olive oil and nuts) version of the Mediterranean diet – already shown to be the leading candidate for brain health amongst the popular diets – against a low-fat version found better cognition with the higher fat one. (Valls-Pedret, 2015)

Participants in the Framingham Heart Study consuming 3 fish meals per week – consisting of 1,200 mg EPA (eicosapentaenoic acid) and 200 mg of DHA (docosahexaenoic acid) – demonstrated slowed yearly rate of cognitive decline by 10%. Fish oils are associated with a 47% decline in risk of developing dementia. (Schaefer, 2006) DHA is abundant in the brain with the main source fatty fish. In fact, there is strong evolutionary evidence that the reason our brains evolved relatively rapidly and have advanced in function and size as much as they have is through our long-ago ancestors consuming the omega-3 fats found only in fish and shellfish. (Cunnane, 2005)

Vegan omega-3 fat is alpha-linolenic acid (ALA) fat and is found in many healthful foods: walnuts, chia and hemp seeds, Brussels sprouts, hemp seed, flaxseed, seaweed. ALA, however, must be converted to the longer chain, more bioactive EPA and DHA to provide the benefits necessary for optimal brain health. The body's ability to convert ALA is limited to 5% for EPA and less than 0.5% for DHA. (Bredesen, 2020) Many of the foods listed here provide other valuable nutrients such as fiber and minerals and thus have value beyond the omega-3 fat content.

The brain is about 60-70% fat. The fat serves to support neurons, mitochondrial membranes, myelin sheaths (insulation for nerve conduction), and other structures. The quality of the fat we consume contributes to the functionality of these structures. (De Fabiani, 2014)

Foods for Brain Health



Many foods have a beneficial effect on neurotrophins in general and BDNF in particular. The list is unsurprising as it is populated with foods that we already know to be salubrious. BDNF boosting foods include high flavonoid foods (Neshatdoust, 2016), blueberries (Williams, 2008), along with the spice turmeric (Fanaei, 2016), (Saffar, 2019), to name a few examples. A review of the data from the massive Nurses Health Study showed high-flavonoid foods were associated with lower subjective cognitive decline after adjusting for other variables. (Yeh, 2021)

Cruciferous vegetables, richly colored vegetables and fruits, alliums (onion, garlic, etc.), nuts and seeds all provide numerous nutrients important for brain health as do fatty fish that are wild caught, not farmed.

Many of the same foods that make up a healthy diet for “body fitness” that we have been hearing about for years also promote brain health.

A significant if seemingly obvious step towards brain health is taken simply by adopting nutrition habits which have already been recommended for decades.

Coffee

Coffee consumption has already been shown to be of benefit in preventing Parkinson's Disease. Coffee's neuroprotective benefits reduce risk of cognitive decline, increase alertness, enhance cognitive performance, and slow memory decline in the aging brain and in Alzheimer's Disease. The Cardiovascular Risk Factors, Aging and Dementia (CAIDE) study found that drinking 3-5 cups per day at midlife was associated with a 65% decreased risk of dementia/AD at late life. (Eskelinen, 2010)

When you consider that the beverage we know as 'coffee' is the seed of a berry – the coffee berry – which is dried, roasted, ground and then has water passed through it. Filtering water through a ground seed would be expected to have some health properties.

To address the popular yet baseless dehydration concern with coffee and tea: Coffee and tea are ground up seeds and plants that are created with – and consist mostly of – *water*. Caffeine has a diuretic effect, but it is unclear how the fallacious idea that drinking something that is mostly water will dehydrate you has become so deeply entrenched in the public's consciousness. A diuretic beverage will likely result in less water being retained than drinking water alone. For coffee or tea to ***de***hydrate, they would have to result in more elimination of water than was ingested. Meaning, if you drink an eight-ounce coffee, it would have to cause elimination of more than eight ounces to dehydrate you. And this just does not happen with coffee or tea.

Coffee and tea are thus perhaps not the best rehydration beverages, but they do not dehydrate.

If Animal Products are on the Menu…

They should be organic, grass-fed, pasture-fed, and free-range. Marine life should be wild caught not farmed. It is better for the animals and better for us. This is how animals always lived and fed themselves before we started modern farming. The organic versus conventional farming debate that is not a true debate applies here as well. Nevertheless, there is in fact evidence that organic animal products are healthier:

- Organic, grass-fed cow's milk has the following:
  - significantly more very long-chain omega-3s (EPA, DHA)
  - higher levels of vitamin E
  - higher levels of carotenoids
  - higher amounts of conjugated linoleic acid (CLA), found to have many health benefits like fighting cancer and lowering insulin resistance
- Organic, free-range eggs:
  - contain two-thirds more vitamin A
  - two times more omega-3
  - three times more vitamin E
  - seven times more beta carotene
- Organic, pasture-raised meat had more omega-3 fats and polyunsaturated fats in general (Średnicka-Tober, 2016)

Specific Diets?

Conceptually, I am not a fan of recommending specific diets with official names because of the long-standing problems this creates for public perception. That said, the Mediterranean Diet, The MIND Diet (a merger of DASH diet and Mediterranean Diet principles), and a plant-focused ketogenic diet are all promising diets to follow for brain health. (Bredesen, 2020)

Toward Better

An essential takeaway is to nudge people's behavior toward taking the next sensible step towards health *and* to enjoy healthy eating. An essential foundation of this course is that we must no longer ignore the subjective experience people have during physical activity. Likewise, we humans are meant to feed ourselves healthfully and enjoy what we eat – the flavor, the smell, the appearance, and the context it is consumed in – hopefully with others.

Enjoyment and health are not mutually exclusive when it comes to eating, despite the common misconception that they are.

Far too often everywhere from the popular media to research journals, you see a reductionist approach to nutrition along the lines of "eat *this*, to get *this* or *that* vitamin or mineral." This is not helpful to the public when much improvement can be found in steering people toward a diet consisting of foods we know to be healthy and encouraging enough variety to "cover all of the bases" without creating anxiety over potentially missing a certain nutrient if a certain food is not eaten.

References for this Lesson

Abbasi J. (2019). Medical Students Around the World Poorly Trained in Nutrition. JAMA. 322(19):1852. https://doi.org/10.1001/jama.2019.17297

Bredesen, D. (2020) The End of Alzheimer's Program. Rockbridge Press.

Cunnane, S. (2006) Survival of the Fattest: the Key to Human Brain Evolution. World Scientific.

Eskelinen, Marjo H. and Kivipelto, Miia. (2010) Caffeine as a Protective Factor in Dementia and Alzheimer's Disease. Journal of Alzheimer's Disease. 20(s1):S167 – S174. https://content.iospress.com/articles/journal-of-alzheimers-disease/jad01404

De Fabiani, E. (2014), Lipids IN the brain: Crossing the "insurmountable" barrier for a fatty, happy life. Eur. J. Lipid Sci. Technol., 116: 941-942. https://doi.org/10.1002/ejlt.201400260

Fanaei H., Khayat S., Kasaeian A., Javadimehr M. (2016) Effect of curcumin on serum brain-derived neurotrophic factor levels in women with premenstrual syndrome: A randomized, double-blind, placebo-controlled trial. Neuropeptides. 56:25-31. https://www.ncbi.nlm.nih.gov/pubmed/26608718

Frison E., et al. (2021) Diabetes Mellitus and Cognition: A Pathway Analysis in the MEMENTO Cohort. Neurology. 10.1212 https://doi.org/10.1212/WNL.0000000000012440

Grammatikopoulou, M. G., Katsouda, A., Lekka, K., Tsantekidis, K., Bouras, E., Kasapidou, E., Poulia, K. A., & Chourdakis, M. (2019). Is continuing medical education sufficient? Assessing the clinical nutrition knowledge of medical doctors. Nutrition. 57:69–73. https://doi.org/10.1016/j.nut.2018.05.013

Hoffman, R., & Gerber, M. (2015). Food Processing and the Mediterranean Diet. Nutrients, 7(9), 7925–7964. https://doi.org/10.3390/nu7095371

Katz D. L. (2018). How to Improve Clinical Practice and Medical Education About Nutrition. AMA journal of ethics, 20(10), E994–E1000. https://doi.org/10.1001/amajethics.2018.994

Parkinson, L., & Keast, R. (2014). Oleocanthal, a phenolic derived from virgin olive oil: a review of the beneficial effects on inflammatory disease. International journal of molecular sciences, 15(7), 12323–12334. https://doi.org/10.3390/ijms150712323

Misciagna, G., De Michele, G., Cisternino, A. M., Guerra, V., Logroscino, G., & Freudenheim, J. L. (2005). Dietary carbohydrates and glycated proteins in the blood in non diabetic subjects. Journal of the American College of Nutrition. 24(1):22–29. https://doi.org/10.1080/07315724.2005.10719439

Morris, M. C., Tangney, C. C., Wang, Y., Sacks, F. M., Barnes, L. L., Bennett, D. A., & Aggarwal, N. T. (2015). MIND diet slows cognitive decline with aging. Alzheimer's & dementia: the journal of the Alzheimer's Association. 11(9):1015–1022. https://doi.org/10.1016/j.jalz.2015.04.011

Neshatdoust S., Saunders C., Castle SM., et al. (2016) High-flavonoid intake induces cognitive improvements linked to changes in serum brain-derived neurotrophic factor: Two randomized, controlled trials. Nutrition and Healthy Aging. 4(1):81-93. https://pubmed.ncbi.nlm.nih.gov/28035345/

Sarraf P., Parohan M., Javanbakht MH., Ranji-Burachaloo S., Djalali M. (2019) Short-term curcumin supplementation enhances serum brain-derived neurotrophic factor in adult men and women: a systematic review and dose-response meta-analysis of randomized controlled trials. Nutrition Research. 69:1-8. https://www.ncbi.nlm.nih.gov/pubmed/31279955

Schaefer, E. J., Bongard, V., Beiser, A. S., Lamon-Fava, S., Robins, S. J., Au, R., Tucker, K. L., Kyle, D. J., Wilson, P. W., & Wolf, P. A. (2006). Plasma phosphatidylcholine docosahexaenoic acid content and risk of dementia and Alzheimer disease: the Framingham Heart Study. Archives of neurology. 63(11):1545–1550. https://doi.org/10.1001/archneur.63.11.1545

Średnicka-Tober, D., Barański, M., Seal, C., Sanderson, R., Benbrook, C., Steinshamn, H., Leifert, C. (2016). Higher PUFA and n-3 PUFA, conjugated linoleic acid, α-tocopherol and iron, but lower iodine and selenium concentrations in organic milk: A systematic literature review and meta- and redundancy analyses. British Journal of Nutrition. 115(6):1043-1060. doi:10.1017/S0007114516000349

Srikanth, V., Maczurek, A., Phan, T., Steele, M., Westcott, B., Juskiw, D., & Münch, G. (2011). Advanced glycation endproducts and their receptor RAGE in Alzheimer's disease. Neurobiology of aging. 32(5):763–777. https://doi.org/10.1016/j.neurobiolaging.2009.04.016

Steele, E.M., Baraldi, L. G., Louzada, M. L., Moubarac, J. C., Mozaffarian, D., & Monteiro, C. A. (2016) Ultra-processed foods and added sugars in the US diet: evidence from a nationally representative cross-sectional study. BMJ open. 6(3):e009892. https://doi.org/10.1136/bmjopen-2015-009892

Valls-Pedret C., Sala-Vila A., Serra-Mir M., et al. (2015) Mediterranean Diet and Age-Related Cognitive Decline: A Randomized Clinical Trial. JAMA Internal Medicine. 175(7):1094–1103. https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/2293082

Williams, C. M., El Mohsen, M. A., Vauzour, D., Rendeiro, C., Butler, L. T., Ellis, J. A., Whiteman, M., & Spencer, J. P. (2008). Blueberry-induced changes in spatial working memory correlate with changes in hippocampal CREB phosphorylation and brain-derived neurotrophic factor (BDNF) levels. Free radical biology & medicine, 45(3), 295–305. https://doi.org/10.1016/j.freeradbiomed.2008.04.008

Yeh, T. et al. (2021) Long-term Dietary Flavonoid Intake and Subjective Cognitive Decline in US Men and Women. Neurology. 28 July https://doi.org/10.1212/WNL.0000000000012454

Lesson 5 - Exercise and Physical Activity

Lesson 5.1 - Exercise and Complete Physical Fitness

What is exercise? A seemingly unusual and abstract question to ask this far into the topic, but if we pull back our perspective far enough, this is a valid question to consider.

Exercise is physical activity performed at an intensity high enough to present a challenge to which the body responds by becoming more capable. As we already know, the adaptions comprising the body's response are specific to the demands placed upon it.

Intensity can be measured but is also subjective, but we are putting that aside for now in favor of consistency.

Irrespective of duration (which will be covered soon as the "150 minutes per week" guidelines are examined later), with advancing age, we need more consistent signaling to maintain fitness. In general, getting people to at least four days per week is critical. It means that for more than half of the days of the week, the body is getting a challenge. This sends a powerful signal to the body's cells and genes that it needs to be ready for a physical challenge more days than not. Our bodies get better at doing what we do more often.

Survival for most of human history came down to getting enough food, which required a lot of physical activity. If you were not physically active, you were likely taking up more caloric resources than you were generating. And, beyond reproductive years, this is biologically unsustainable for the species. Our muscles, motor nerves, joints, and neurons decay with aging – less quickly with regular use and more rapidly with disuse or infrequent use. It is biologically expensive to keep renewing cells. When we stop moving we send a message to our cells that they can decline more rapidly so we do not take up more resources than we are able to contribute. Nothing personal; it's just biology.

Complete Fitness

Fitness Characteristics – No single mode of physical activity by itself is "fitness." Not yoga, nor jogging. Alone, both are incomplete. Because no single fitness activity will deliver a sufficient challenge in all the fitness characteristics listed in the table below.

To ensure you are spending time maintaining or developing abilities spanning the full spectrum of human movement, you want regular time spent on both the primary and secondary fitness characteristics. The primary fitness characteristics are the ones we most commonly and obviously associate with fitness: endurance, speed, strength, and power. The rest are secondary fitness characteristics like agility, balance, coordination, reactivity. These secondary characteristics are less often the focal point of exercise despite most of them serving as a prerequisite for competence in the primary fitness characteristics.

In the context of brain health, the different characteristics of fitness use different skills and activates different parts of the brain so you are keeping more neurons relating to physical activity firing more often which strengthens connections and builds resiliency. We know that aerobic exercise enhances the health and function of the hippocampus and that strength training enhances executive function. (Landrigan, 2020) Resistance training, performed a minimum of twice per week, demonstrates increases in BDNF and other trophic factors and increases in human growth hormone with more vigorous training.

For tracking purposes, the table below provides an opportunity to visually ensure adherence to a multi-modality full-spectrum fitness experience.

Just tick off the boxes whenever you do an activity that challenges the fitness characteristics below. At the end of the week, as long as you have at least two tick marks in each row of characteristics, your fitness is likely well-rounded enough to give you the freedom to do the things you love with the people you love – and that is what complete fitness is really all about.

Fitness Characteristics	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
Agility							
Balance							
Coordination							
Endurance							
Flexibility (muscles)							
Mobility (joints)							
Power							
Reactivity							
Speed							
Strength							
Notes/Workouts							

Exercise and Memory

In an example of emerging research on the brain and fitness that we are likely to see more of in the future, exercising after learning a new skill has been shown to improve learning and memory of the new skill. (Del Maso, 2018) Subjects learned a new skill and then did 15 minutes of high-intensity interval training on a stationary bike and significant improvements in learning and skill retention were shown the sooner they exercised after learning the skill. And, even better, in another vote for proper sleep, subjects who did the practice, followed by exercise, and then got a good night's sleep enjoyed enhanced the retention of the new skill from the overnight memory-consolidation occurring during sleep.

This is noteworthy because these results were achieved even with temporal separation of exercise from the skill practice. The exercise strategies taught further in the course integrate the cognitive challenge with exercise so they are not separated in time, a more natural and intuitive way to learn for most of human history.

References for this Lesson

Del Maso, F., et al. (2018) Acute cardiovascular exercise promotes functional changes in cortico-motor networks during the early stages of motor memory consolidation. Science Direct. 174:380-392. https://doi.org/10.1016/j.neuroimage.2018.03.029

Landrigan, JF., Bell, T., Crowe, M. *et al.* (2020) Lifting cognition: a meta-analysis of effects of resistance exercise on cognition. *Psychological Research* 84:1167–1183 https://doi.org/10.1007/s00426-019-01145-x

Netz, Y. (2019). Is There a Preferred Mode of Exercise for Cognition Enhancement in Older Age?—A Narrative Review. Frontiers in Medicine, 6. https://doi.org/10.3389/fmed.2019.00057

Spartano, N., et al., (2019) Association of Accelerometer-Measured Light-Intensity Physical Activity with Brain Volume: The Framingham Heart Study. JAMA Network Open 2(4), e192745. https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2730790

Woodcock, J., Franco, O. H., Orsini, N., & Roberts, I. (2011). Non-vigorous physical activity and all-cause mortality: systematic review and meta-analysis of cohort studies. International Journal of Epidemiology, 40(1), 121–138. https://doi.org/10.1093/ije/dyq104

Lesson 5.2 - Physical Activity Outside of Exercise

Devoting dedicated time to exercise, as important as it is, is not where our physical activity efforts conclude.

If we were measuring physical activity like a radio signal, we should see several big spikes during the week representing workouts. What do we see between the workouts? For too many, people the signal reads zero. Ideally, there would be plentiful “background noise” of general, light physical activity as we go about our day.

We know now that even among those who exercise consistently, long periods of inactivity throughout the day are correlated with many negative health outcomes. Being physically active reduces the risk of all-cause mortality with the largest benefit in going from no activity to low levels of physical activity. (Woodcock, 2011)

Specific to brain health however, data from the Framingham Heart Study shows that each additional hour spent in light-intensity physical activity is associated with larger brain volume, equivalent to approximately 1.1 years less brain aging. Achieving 10,000 or more steps per day is associated with higher brain volume compared with those achieving fewer than 5,000 steps per day. (Spartano, 2019)

Further, light physical activity outside of exercise itself shows brain health benefits. In a study of people ages 60-78 who wore accelerometers to measure physical activity, those who engaged more often in light physical activity had greater structural integrity in the white matter of the temporal lobes, which play a key role in memory, language, and the processing of visual and auditory information. More sedentary people showed lower white matter structural integrity in the hippocampus. (Burzynska, 2014)

This incidental physical activity, in general, does not present a high enough challenge to be as daunting as “exercise” is to many people. The examples are endless: Walk the dog, dance to a favorite song, housework, play with pets/kids/grandkids/other adults. One problem posed by modern society is that many people hire someone else to do the yardwork, the gardening, the house cleaning, the car detailing and washing, etc. so many of the opportunities for incidental physical activity are removed from everyday life.

Look for opportunities to move more – and even better if they are enjoyable. Hiring people to do the housework is fantastic if you use the spare time to take your dog and/or kids or just yourself on a nature walk.

This is just my opinion, but I dislike the endlessly repeated cliché recommendation to park farther away from the store when running errands. The critical flaw in that approach is that the extra physical activity you get is not enjoyable – who likes a long walk through a parking lot? The top objective of fitness leaders needs to be changing people’s attitudes about physical activity for the better and not promoting participation in yet another aversive form of physical activity because it is “good for you,” or because you “should” do it. Park as close to the store as possible so you can get in and out quickly. Rather than forcibly adding unappealing extra physical activity to your day, get the chores out of the way as expeditiously as possible so you have time to add some enjoyable extra forms of incidental physical activity.

Yes, get your “big spikes” of exercise activity, but also make sure to get plenty of incidental “background noise” physical activity.

References for this Lesson

Burzynska AZ, Chaddock-Heyman L, Voss MW, Wong CN, Gothe NP, Olson EA, et al. (2014) Physical Activity and Cardiorespiratory Fitness Are Beneficial for White Matter in Low-Fit Older Adults. PLoS ONE 9(9): e107413. https://doi.org/10.1371/journal.pone.0107413

Spartano, N., et al., (2019) Association of Accelerometer-Measured Light-Intensity Physical Activity with Brain Volume: The Framingham Heart Study. JAMA Network Open 2(4), e192745. https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2730790

Woodcock, J., Franco, O. H., Orsini, N., & Roberts, I. (2011). Non-vigorous physical activity and all-cause mortality: systematic review and meta-analysis of cohort studies. International Journal of Epidemiology, 40(1), 121–138. https://doi.org/10.1093/ije/dyq104

Lesson 5.3 – Specific Elements to Include in Exercise and Physical Activity Programs

Decades ago, at the start of my fitness career, we began realizing the essential nature of strength training for everyone. We began promoting the benefits of strength training for the general population. Currently, most people understand the value of strength training to be as essential as aerobic training.

My hope and plan is that brain fitness training will follow a similar trajectory of nascent awareness to become an established paradigm of fitness in the public's consciousness. The result will be *truly* complete fitness that incorporates all the physical fitness characteristics and the elements of cognitive fitness identified previously.

Specific Elements to Include for Integrated Cognitive and Physical Fitness

We know that all exercise is good for the brain. We also now know that adding in certain elements are better for the brain:

- Acrobatic exercise boosts BDNF in rats higher than aerobic exercise does (Greenough, 1978) ('Acrobatic' rats climbed rope ladders and walked on balance beams and had a 35% higher amount of BDNF produced than aerobic rats who ran on a wheel.)
- Higher levels of BDNF help preserve the size of an animal's brain (Raichlen, et al. 2020)
- The same improvements in brain function with aging were reported by increasing BDNF with exercise in humans (Erickson, et al. 2015)

In a practical sense, the following specific elements are how we integrate cognitive and physical fitness:

Explicit Cognitive Challenge – while performing physical activity or an exercise, mentally recite alphabet skipping every other letter; count up/down to/from 100 by threes or sevens, count the number of various objects you see or things you hear.

Reactivity – sensory input produces motor output

- Visual – see something and then do something
- Auditory – hear something and then do something
- Kinesthetic – feel something and then do something

Coordination – all exercise or movement uses coordination. The right amount of coordination challenge is when you can mostly perform well with perhaps occasional mistakes.

Novelty – the right amount is essential. Insufficient novelty leads to boredom and disengagement while too much novelty leads to feeling overwhelmed and demotivated.

Partner Interactivity – social connection during physical activity. Video is good if it is the only option, but live and in person is preferred as our brains know the difference – and respond differently – to a video interaction versus an in-person one.

One study shows clearly that activities involving moving and socializing can enhance brain function. Sedentary people in their 60s and 70s who were sedentary at the start of the study were tested on aerobic fitness, memory, and processing speed and put into distinct activity groups: brisk walking, gentle stretching/balance, and dancing. After six months, the dancing group had the biggest improvement in processing speed and memory. (Burzynska, 2017)

An important aspect of partner interactivity is physical touch. We need it for healthy development as babies and for continued healthy mental function as adults. Babies deprived of touch experience all manner of developmental deficiencies. As adults, touch lowers cortisol (Coan, 2006) and can reduce stress, heart rate, and blood pressure. (Light, 2005)

Appropriate and comfortable touch during exercise is yet another layer of brain health benefit potentially added if used effectively. An additional side effect of the social isolation of the pandemic of 2020 was the revelation of the unequivocal role that physical touch plays in mental health and is also another feature of the human experience that is diminished with Alzheimer's. High-fives, hugs, and handshakes must always be part of the human experience and misguided efforts to remove them are once again altering social norms to be misaligned with what is optimal for humans – as we have already done for sleep, nutrition, physical activity, and other domains.

Friendly Competition – typically enhances effort automatically and adds an enjoyable element to physical activity. Some people like to compete to win *against* others while others derive enjoyment from competing *with* others. For the latter group, competition is more about collaboration than domination.

Interestingly, competition positively influences exercise intensity and leads to greater performance, even in people who identify as non-competitive. Groups of people were tested in competitive and non-competitive situations and in general all individuals – regardless of competitive preference – performed better. (Ives, 2020)

Why do we want to combine the above strategies with physical activity?

Because it is better. Physical activity is good – adding these elements simultaneously makes it better. Combined cognitive and physical challenge is superior to either done alone or if they are done concurrently (i.e., one after the other with no overlap) (Gheysen, 2018) Combining them allows us to optimize the brain benefits of physical activity.

Combining the specific elements described above with physical activity results in uncertainty. Uncertainty signals the brain that you're unsure of your environment, your skills, and this optimizes learning, attention, and focus. (Massi, 2018)

Unpredictable, uncertain situations might be uncomfortable, but they're also essential if you want to make the most of your brain. Too much stability and predictability is a shut off signal for your brain.

Anecdotally, we have seen this for years with the familiar scene of two people on adjacent weight machines in a gym, mindlessly going through the motions of the exercise while chatting over the details of a television show or current events in their lives.

Plentiful examples of how to implement these concepts in physical activity and exercise will follow in the practical section.

Open Skills and Closed Skills

An important distinction in types of movements involves open skills versus closed skills. Both have value yet most of traditional fitness involves closed skills. Here are the characteristics of both (American Council on Exercise, 2010):

Closed Skills (Predetermined Skills)

- Pre-programmed movement patterns where individuals know in advance the exact steps and movements required to execute the task(s).
- Finite sequences where the movement is performed systematically
- Allows for rehearsal and practice to master movement mechanics
- Examples are cycling, traditional weight training, figure skating

Open Skills (Reactive Drills)

- Sensory input is used to produce a response to external stimuli
- Can be combined with a closed skill movement to create reactive elements to determine specific actions within the closed skill
- More closely mimics real-life and sport which often presents unpredictability, surprise, and uncertainty
- Participants inherently produce more effort without prompting during open skills
- Examples are tennis, trail running, mountain biking, playing tag

In the practical module, plentiful examples of integrating the above elements with walking, aerobic, and strength training will be provided.

References for this Lesson

American Council on Exercise. (2010) *Sports Conditioning Manual*. ACE

Burzynska, A., et al. (2017) White Matter Integrity Declined Over 6-Months, but Dance Intervention Improved Integrity of the Fornix of Older Adults. Frontiers in Aging Neuroscience. 9:59 https://doi.org/10.3389/fnagi.2017.00059

Coan, J., Schaefer, H., & Davidson, R. (2006) Lending a Hand: Social Regulation of the Neural Response to Threat. Psychological Science. 17(12):1032–1039. https://doi.org/10.1111/j.1467-9280.2006.01832.x

Erickson, KI; Hillman, CH; Kramer, AF; (2015) Physical activity, brain, and cognition. Current Opinion in Behavioral Sciences. 4:27-32. https://doi.org/10.1016/j.cobeha.2015.01.005

Gheysen, F., Poppe, L., DeSmet, A. et al. (2018) Physical activity to improve cognition in older adults: can physical activity programs enriched with cognitive challenges enhance the effects? A systematic review and meta-analysis. Int J Behav Nutr Phys Act 15, 63. https://doi.org/10.1186/s12966-018-0697-x

Greenough WT, West RW, DeVoogd TJ (1978) Postsynaptic plate perforations: Changes with age and experience in the rat. Science. 202:1096–1098 https://pubmed.ncbi.nlm.nih.gov/715459/

Ives, J.C., et al. (2020) The Effects of Competitive Orientation on Performance in Competition. The Sport Journal. https://thesportjournal.org/article/the-effects-of-competitive-orientation-on-performance-in-competition/ (accessed Sept. 2021)

Massi, B., et al. (2018) Volatility Facilitates Value Updating in the Prefrontal Cortex. Neuron. 99(3):P598-608.E4 https://doi.org/10.1016/j.neuron.2018.06.033

Raichlen, D.A., Klimentidis, Y.C., Bharadwaj, P.K. et al. (2020) Differential associations of engagement in physical activity and estimated cardiorespiratory fitness with brain volume in middle-aged to older adults. Brain Imaging and Behavior. 14:1994–2003 https://doi.org/10.1007/s11682-019-00148-x

Lesson 5.4 – Secondary Fitness Topics

How Much Exercise Is Enough?

As you likely already know by now, the Physical Activity Guidelines for Americans recommend that adults get at least 150 minutes per week of “moderate” intensity or 75 minutes of “vigorous” intensity exercise. Putting aside the vague nature of how to interpret the intensity mentioned in the guidelines, there are significant problems with these guidelines – both conceptual and physiological.

Conceptual Problem

Imagine if I told you that you should brush your teeth 14 times *per week*? Not helpful. 150 minutes a week turns out to be a little more than 20 minutes a day. So why are we given weekly recommendations? This poorly crafted messaging has resulted in people who think 150 minutes in one day is enough and then can enjoy six days off.

We perform workouts on the scale of minutes or hours. In other words, on a daily – not weekly – basis, so weekly guidelines mean we must do math (another thing many people dislike) to figure out if we are meeting the guidelines.

Our brains often interpret guidelines – which are, by design somewhat nebulous and not absolute – as rules. Thus, if we do less than ‘enough’ our internal ‘pass/fail’ teacher gives us a failing grade.

Further, most of us mix moderate and vigorous intensities as we perform different forms of exercise during a week leaving us befuddled as to how to combine the two.

Physiological Problem

150 minutes of walking per week reduces your overall mortality rate by 7% compared with being sedentary. Walking for less – 60 minutes a week – drops your mortality rate about 3%. Walking more – 300 minutes a week – lowers overall mortality by 14%. Walking twice as long – 40 minutes a day compared with the recommended 20 daily minutes – yields twice the benefit. And an hour-long walk each day may reduce mortality by 24%. (Woodcock, 2011)

If we know more is better, why is the recommendation only about 20 minutes?

The exercise authorities seem to have fallen into the same trap as the nutrition authorities, recommending what they think may be achievable, rather than simply informing us what the science says and letting us make up our own minds on what to do with the information. (Greger, 2020)

Health authorities seem intent on softening the blow of the science on physical activity and health because as a society, we cannot handle the truth. Hunter-gatherer societies walk between 15,000-18,000 steps per day as part of *normal* levels of physical activity while we fight to fit in 10,000.

Even worse, there is not even agreement among major health authorities on physical activity recommendations. The U.S. Centers for Disease Control (CDC) recommends 30 minutes per day or 210 minutes a week. The 150 minutes per week recommended by the U.S. Dept. of Health and Human Services equals 21.4 minutes per day.

More specific to brain health, one hour a day of exercise for three months yielded four times the production of BDNF (Seifert, 2010) which we know to be a powerful mediator of a range of metabolic and neurological disorders. (Rothman, 2012) One hour a day = 7 hours a week = (gasp) 360 minutes. Clearly, more than 150 minutes is better, but that seems to be too much for people to hear.

Another Conceptual Problem

Going the other direction – less than 150 minutes – creates another motivation challenge for many people. Since our brains misinterpret guidelines as rules, many people feel like they have failed if they do 149 minutes or less of moderate physical activity in a week even though we know that the more you do the better it is. At the outset of adopting an exercise plan, it can be a struggle to work it into schedules while potentially experiencing discomfort and soreness only to feel like "you didn't do enough."

Further, people who have unhealthy attitudes about exercise and perceive it to be a chore or drudgery will try and outsmart the guidelines and do one 75-minute vigorous or 150-minute moderate workout and conclude that they are done their workouts for the week. Clearly this is not the intention of the guidelines nor will anyone enhance health or fitness by exercising one day per week and not exercising for six.

The 150-minutes of moderate exercise recommended in the guidelines are clearly arbitrary and chosen more as a compromise between what the science actually says and what the public is willing to hear.

The takeaway: this is not to say that since more is better no amount of exercise is enough. It is clear that using weekly guidelines for daily activities is inherently flawed and that softening the realities of the science into guidelines around minimal amounts leads many people to treat the minimum amount as if it is the optimum amount and not do one minute more. Regular exercise provides opportunities to move more and more enjoyably which naturally leads to moving more frequently.

Balance & Multi-directional Movement

Balance, always an important part of movement, becomes even more critical – and more of an overt concern – with advancing age.

One in four adults over age 65 in the U.S. suffer a fall, the leading cause of injury in this age group. (Bergen, 2016) To make matters worse, many of the drugs taken to control blood pressure, depression, or gastrointestinal disorders can negatively affect balance as a side effect. Further, balance training is often approached poorly.

Balance is a funny thing. We typically do not think about balance until we lose it. Yet, like any other fitness characteristic like speed, power, or strength, it can be developed and enhanced.

The Blind Leading the Balance Training

Balance training is often approached backwards. For example, **the usual test of balance is to stand on a single leg and keep your eyes closed. This is very demanding, but also makes little sense**. In life, you rarely *do* anything on your feet with your eyes closed – except for these ill-conceived balance tests. Also, when you are on one leg in real life, you are rarely motionless. This creates false fails and discouragement from a test that is unrealistically hard. Removing the visual sense from balance completely is like performing a strength test by starting with a 400-pound deadlift. You are starting at an almost impossibly hard level of challenge.

In life, we most often have our *eyes open* and we are *moving*, even if on a single leg. (Like walking, which is mostly a single leg activity, except for the brief time when both feet are on the ground.) And these movements are often done in response to something in the outside world – something we want to pick up, put down, go after, or move away from. It makes sense then to (1) train balance in realistic ways and (2) to integrate reactive training with balance training.

Balance training is best done first with eyes fixed on a distant stationary object, progressed to moving the limbs, then adding motion of the head (while keeping eyes fixed), then adding motion of the eyes (while keeping the head fixed) to moving the head and eyes simultaneously with extremities. After these are mastered – and only if it is somehow relevant to goals (which it rarely is) – would it be prudent to introduce eyes closed challenges.

The goal of balance training is not flawless performance on the exercise. To get stronger, we must make our muscles temporarily weaker through the challenge of strength training. To get better endurance, we must make ourselves temporarily out of breath through the challenge of aerobic training. Similarly, to improve our balance we must occasionally lose our balance while performing and exercise mostly well with occasional corrections or loss of balance.

Multi-Directional Movement

Just as training balance in motion is more lifelike, training for 360-degrees of movement more adequately prepares us for what life throws at us. The better we are at moving in different directions, the more equipped we are to successfully navigate the movement challenges presented by life – from dropping an expensive cell phone, to chasing a child or pet that runs into the street, and so on. In fitness programming, this is commonly and seamlessly achieved by ensuring that you are using movements in all three cardinal planes – sagittal, frontal, and transverse.

Seated Exercise

Use this only when *absolutely* necessary in situations where (1) it is too unsafe to stand or (2) the client is not confident enough to do an exercise standing. (Remember that protecting the positive subjective experience of the participant is a top priority.) We sit enough already in modern life and have no need of more time sitting. There are times when it is appropriate, but whenever possible, exercise while standing.

Assessments

We are not doing research here…so there's little value in or need for the complication or sophistication of formal assessments. You can use them if you prefer. People are all too often put through tests by allied healthcare professionals and the data/results from the test are not used in any meaningful way. More importantly, they are not relevant to what the client values. I have found it more effective to create my own assessments relating to something relevant to the client. This makes the assessment more meaningful – and thus valuable – to the client. Further, formal assessments typically generate questions from clients expecting a qualitative analysis: "How did I do?" These kinds of comparisons to standards have little value for a single person and can potentially be de-motivating. In the times when I do use formal assessments of movement, I explain prior to administration that I will not be discussing any comparisons other than a comparison to that client's previous assessment data.

Some examples of assessments used with individual clients include:

- 30-second chair squat test (prerequisite: acceptable squat technique)
    - Using a chair in the client's home or a bench at a fitness facility, count the number of squats performed in 30-seconds. (Butt tap lightly to chair)
    - Cognitive version: count backward from 100 by threes or sevens

(Note: chair height should be challenging but within current capabilities.)

- Get-Up and Go – designed to mimic multi-step real-life sequence of actions
    - Starting seated, stand up walk to a door and grab the handle as if opening it, turn around, walk back and sit back down. That is one rep. Time the client for anywhere from 3-5 reps or an even higher number if appropriate. Also note the general trends for how long each "lap" takes.
    - Cognitive version: recite alphabet skipping a letter
- Think, Get-Up and Go – similar to the above but the coach stands away from the client with a cone off to either side of the coach. Either time the client for a fixed number of reps or use a fixed amount of time and count the number of reps.
    - Point to a cone, the client stands, walks to, touches the cone, and then returns to seated.
    - Cognitive version: Using odd/even numbers for the right/left cones, coach calls out numbers and client taps the respective cone.
- Hands-and-Knees Get-Up – assesses ability to get up and down from the floor, commonly related to the goal of playing with children, pets, or grandchildren. Start from standing and track the time it takes the client to get down on the floor on hands and knees and back up again. If relevant, test can be done for a set number of repetitions.

Your intake forms will reveal opportunities for assessments that have particular relevance to the client.

References for this Lesson

Bergen G, Stevens MR, Burns ER. (2016) Falls and Fall Injuries Among Adults Aged ≥65 Years — 2014. CDC Mortality and Morbidity Weekly Report. 65:993–998. http://dx.doi.org/10.15585/mmwr.mm6537a2

Greger, Michael. (2020). What Exercise Authorities Don't Tell You About Optimal Duration https://nutritionfacts.org/2020/07/30/what-exercise-authorities-dont-tell-you-about-optimal-duration/

Rothman, S.M., Griffioen, K.J., Wan, R. and Mattson, M.P. (2012), Brain-derived neurotrophic factor as a regulator of systemic and brain energy metabolism and cardiovascular health. Annals of the New York Academy of Sciences, 1264: 49-63. https://doi.org/10.1111/j.1749-6632.2012.06525.x

Seifert, T., Brassard, P., Wissenberg, M., Rasmussen, P., Nordby, P., Stallknecht, B., Adser, H., Jakobsen, A. H., Pilegaard, H., Nielsen, H. B., & Secher, N. H. (2010). Endurance training enhances BDNF release from the human brain. American journal of physiology. Regulatory, integrative and comparative physiology, 298(2), R372–R377. https://doi.org/10.1152/ajpregu.00525.2009

Woodcock, J., Franco, O. H., Orsini, N., & Roberts, I. (2011). Non-vigorous physical activity and all-cause mortality: systematic review and meta-analysis of cohort studies. International Journal of Epidemiology, 40(1), 121–138. https://doi.org/10.1093/ije/dyq104

Module 5 – Living With Alzheimer's: Lost Connections

Before beginning the practical exploration of specific exercises, we need to examine the personal impact living with Alzheimer's on the quality of life of both patients and caregivers. This is especially relevant because the physical activity strategies forming the foundation of this course are designed to create a social, fun, and interactive movement experience that benefits both patients and caregivers from a physical, emotional, and mental health perspective.

Lesson 1 – Patients

Starting with a loss of neurons in the hippocampus and progressing out to other brain regions where long-term autobiographical memories reside and eroding access to memories of various skills, facts, events, personal experiences, spatial orientation, location, relationships between objects, and eventually the body's ability to "remember" how to keep itself alive, Alzheimer's is ultimately a terrifying journey that begins with a loss of neurons and ends with a loss of self and identity.

There are not many diseases that feature this additional layer of misery. With the majority of other diseases, even terminal ones, you are aware of who you are and who you love throughout most of the time with the disease – at least until the very end.

Behavioral Problems

Numerous behavioral problems surface with AD, potentially further isolating patients from friends and family and disturbing unpaid caregivers when witnessing what the patient says or does. Professional caregivers are trained to expect aggressive, potentially offensive behavior and not to react to it so are likely to be less significantly affected. Nevertheless, humans are not robots and even professional caregivers can be negatively affected by these experiences.

Behavioral problems often include the following:

- Anger and frustration
- Delusion
- Suspicion
- Anxiety
- Hyper- or Hypo-sensitivity to touch
- Loss of peripheral vision
- Decreased awareness of personal space boundaries
- Hearing: difficulty filtering out background noises and differentiating salience of sounds
- Offensive speech including use of foul language and insulting or racist comments in people not known for harboring those attitudes or tendencies. It is a form of lashing out when experiencing confusion or frustration.

Additionally, people with Alzheimer's at some point will experience "The 5 A's of Alzheimer's:"

1. Absence of Cognitive Function – poor decision-making, judgment, awareness of consequences
2. Amnesia – loss of memory, lack of ability to make new memories. Includes a type of amnesia known as anomia, inability to recall the names of everyday objects.
3. Aphasia – loss of expressive and receptive language
4. Apraxia – loss of connection between brain and muscles making even everyday actions like tying shoes difficult or impossible to perform
5. Agnosia – loss of ability to process sensory information (e.g., inability to perceive a dangerous smell such as natural gas)

All these experiences affect both patients and the caregivers who help manage the symptoms.

Lesson 2 - Caregivers

In another striking example of the significance of the role of lifestyle in dementia, life partners of dementia patients have a 600% higher risk of getting dementia – a clear indication of how sharing numerous risk factors can influence dementia. (Vitaliano, 2011) Given that over 60% of caregivers are married, living with a partner or in a long-term relationship with the patient, this is an enormous problem.

Professional caregiving requires a special type of person, especially with Alzheimer's. The U.S. government's proposed 2021 American Jobs Plan included a one-time $400 billion USD infusion to expand in-home and community-based healthcare and would start at addressing the problem and improving the "care economy." (The White House, 2021) However, as is unfortunately all too often the case – even with obviously sensible measures intended to do clear good and with no reasonable objections – there nevertheless was enough short-sighted resistance to drop these measures from the American Jobs Plan. Improving the wages and training for professional caregivers would enhance the appeal of this profession and hopefully result in a higher number of higher caliber employees choosing this profession as it is certain to be an increasing need with the population skewing older and the projections for Alzheimer's disease.

Unpaid caregivers in the U.S. total over 11 million people providing care for the more than 6 million people with Alzheimer's. The term "unpaid" only describes part of the heavy burden. They are unpaid because they are often a family member or close friend. The addition of the personal connection to the person whose mind is slowly eroding adds another layer of misery. In general, in the U.S. 83% of help provided to older adults comes from family members, friends, or other unpaid caregivers. (Alzheimer's Association. 2021)

In terms of family caregiving beyond just that limited to Alzheimer's, there are about 48 million family caregivers in the United States providing an estimated 34 billion hours of care to an adult with limitations in daily activities. Sixty-one percent of them provide this caregiving while still holding a full-time job. The estimated economic value of their unpaid contributions was approximately $470 billion.

The Credit for Caring Act introduced in May 2021 would provide a U.S. federal tax credit of up to $5,000 USD for working family caregivers. Families typically spend an average of $7,242 USD – 26% of their income – on out-of-pocket expenses for caregiving. (AARP, 2021) However it plays out, hopefully something official will be done about this life- and personal finance-altering situation that too many people and families find themselves in.

Social Isolation

Social isolation is both a contributing factor for Alzheimer's and can be an exacerbating force once diagnosed (e.g., loss of driving privileges leads to less social contact, further accelerating cognitive decline).

Alzheimer's and other dementia deaths increased 16% during the Covid-19 pandemic of 2020. Even without the intentional, purposeful social isolation that was a by-product of limiting physical contact with others during the pandemic, social isolation becomes a self-propagating problem for both patients and caregivers. For patients, their social world begins to shrink while for caregivers, the time and mental energy required of caregiving duties take up time for other areas of life.

Sadly, even interactions between patients and familial caregivers are potentially no longer socially gratifying since progressively more of the interactions are of a purposeful, functional nature or are drained of enjoyment through the difficulties in managing symptoms and the situations when they manifest.

With the experience of every Alzheimer's symptom one that is shared by the patient *and* caregiver(s) – who often need to help navigate the experience as best as possible – the toll this takes on caregivers spans many domains. The financial, emotional, cognitive, and physical effects of caregiving are staggering.

The financial impact is monumental from (1) the direct expense on caregiving costs and (2) the direct impact of missed time from work for unpaid caregivers, and (3) the decrement to work performance on unpaid caregivers from the stress, anxiety, loss of sleep and loss of leisure time, and the general demands and strain of caregiving. A deep analysis of the financial costs is beyond the scope of this material and is readily available publicly.

Emotional, Cognitive, and Physical Effects

Caregivers of individuals with Alzheimer's report more subjective cognitive problems (for example, problems with memory) and experience greater declines in cognition over time. (Dassel, 2017) Caring for people with dementia with four or more behavioral and psychological symptoms (for example, aggression, self-harm and wandering) represents a "tipping point" for family caregivers, as they are more likely to report clinically meaningful depression and negative emotional reactions to providing care. (Arthur, 2018)

Depression and anxiety are higher among dementia caregivers than among non-dementia caregivers. The type of relationship was the strongest predictor of caregiver depression. Caregivers of spouses with dementia had two-and-a-half times higher odds of having depression than caregivers of people with dementia who were not spouses. (Sallim, 2015)

Given that the number of ADLs which the patient requires assistance with expands as the disease progresses – as well as the amount of effort that assistance requires – the deleterious effects on caregivers expands concurrently.

Bring the Hope

The ultimate aim of this material and the specific exercise concepts presented is to equip medical fitness professionals to coach clients, patients, and caregivers how to use the benefits of cognitively challenging physical activity integrated with play, fun, music, and social interaction to improve the emotional state of anyone dealing with the weight of disease or of caregiving for it.

References for this Lesson

AARP. (2021) 2021 Caregiving Out of Pocket Costs Study. https://doi.org/10.26419/res.00473.001

Alzheimer's Association. (2021) Alzheimer's Disease Facts and Figures. Alzheimers Dement 17(3).

Arthur PB, Gitlin LN, Kairalla JA, Mann WC. (2018) Relationship between the number of behavioral symptoms in dementia and caregiver distress: What is the tipping point? International Psychogeriatrics 30(8):1099-107. https://jhu.pure.elsevier.com/en/publications/relationship-between-the-number-of-behavioral-symptoms-in-dementi

Dassel KB, Carr DC, Vitaliano P. (2017) Does caring for a spouse with dementia accelerate cognitive decline? Findings from the Health and Retirement Study. Gerontologist 57(2):319-28. https://reference.medscape.com/medline/abstract/26582383

Sallim, A. B., Sayampanathan, A. A., Cuttilan, A., & Ho, R. (2015). Prevalence of Mental Health Disorders Among Caregivers of Patients With Alzheimer Disease. Journal of the American Medical Directors Association, 16(12), 1034–1041. https://doi.org/10.1016/j.jamda.2015.09.007

The White House. (2021, March 31). FACT SHEET: The American Jobs Plan.[press release] https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/

Vitaliano, P.P., Murphy, M., Young, H.M., Echeverria, D. and Borson, S. (2011). Does Caring for a Spouse with Dementia Promote Cognitive Decline? A Hypothesis and Proposed Mechanisms. Journal of the American Geriatrics Society. 59:900-908. https://doi.org/10.1111/j.1532-5415.2011.03368.x

Lesson 3 – Emotional Fatigue and Remedies-Play, Music, Fun and Fitness

Introduction

Play, music, and fun should provide the foundation for any approach to fitness with Alzheimer's. They relieve some of the emotional burden as well as enhance the brain health benefits of physical activity. And with the power of music to elevate emotions and activate areas of the brain otherwise cut off by Alzheimer's, fitness professionals, already well-versed in the use of music in exercise, are ideally suited to combine these modalities and encourage the use of music by participants to enhance both the subjective experience of exercise and its brain health benefits.

Play

Play enhances learning (i.e., short-term memory and skill-development) almost surreptitiously. In a state of play you are learning without realizing it consciously.

"Play is intensely pleasurable. It energizes us and enlivens us. It eases our burdens. It renews our natural sense of optimism and opens us up for new possibilities." – Stuart Brown, author of *Play*

The book *Play* details the properties of play:

- Apparently Purposeless (done for its own sake)
- Voluntary
- Inherent attraction
- Freedom from time
- Diminished consciousness of self
- Improvisational potential
- Continuation desire

It can seem strange at first to describe play in such abstract terms. When reflecting on personal experiences of play, it is easy to understand how all of this adds up to the often repeated saying "time flies when you are having fun." And conversely, this is why traditional exercise seems to take too much time to many people.

The text goes on to point out the reactions we experience when in a state of play. Play involves the following:

- Anticipation – slight uncertainty or risk, but not so great that it overwhelms the fun
- Surprise – the unexpected, a discovery, a new sensation or idea
- Pleasure, understanding, strength, poise

And just when it may seem as if the science of play is about to overtake the concept of play there is this passage: "There is no way to really understand play without also remembering the feeling of play. If we leave the emotion out of the science, it's like throwing a dinner party and serving pictures of food."

This is what the fitness industry has done for too long – admonish people to keep doing fitness in a way they do not enjoy until they get fit enough to enjoy it. For too long we have remained stuck on the science of exercise and ignoring the experience of it for our participants. It is time for this to change.

As it pertains to brain health and development, the amount of play is correlated to the development of the brain's prefrontal cortex, which is important for cognition. The period of maximum play in each species is tied to the rate and size of growth of the cerebellum (back, bottom of brain, has more neurons than rest of brain, responsible for movement but also attention, language processing, sensing musical rhythm, and more.) (Brown, 2009)

When play is:

- AEROBIC it increases the size of the hippocampus
- NOVEL it increases neural growth and BDNF levels
- COMPLEX it increases the speed of information exchange between brain hemispheres

In our brains, the circuits for play and hunger are both in the deep survival centers of our brain. Further, children will often ignore hunger, thirst, or fatigue when captivated by a state of play. The need and drive for the state that play puts us in can be greater than other essential biological needs for a time.

Although the frequency of need for play does diminish into adulthood for mammals, it does not disappear. We often just erroneously eschew it for a focus on 'adult' things like work.

The Opposite of Play is Not Work

The opposite of play is depression. Consider the emotional state of play: one of expansiveness, possibility, and excitement. These are the opposite of depression where the emotional state is one of limitations, lack of opportunity, and dullness.

This is another of the key themes from *Play* and makes it clear that play can blend well with the "serious" work of fitness. The following passage from *Play* eloquently explains the inherent and essential value of both play and work:

"…play and work are mutually supportive; neither can thrive without the other. We need newness of play, its sense of flow, and being in the moment. We need the sense of discovery and liveliness that it provides. We also need the purpose of work, the sense that we are doing service for others, and most of us need to feel competent." (Brown, 2009)

Both play and work are an essential part of the human experience.

Play then, provides both the internal emotional foundation and the external, shared experience capable of altering perception of exercise and physical activity favorably for individuals who will never be drawn to the traditional approach to fitness as well as a myriad of long-term brain health benefits for those who are actively seeking cognitive results from their fitness experience.

Music

As noted earlier, dementia patients who were exposed to music that they had previously enjoyed demonstrated much higher levels of functional connectivity in several regions of the brain. Thus, personally meaningful music is a potential alternative for communicating with patients who have Alzheimer's disease. (King, 2019) Familiar, enjoyable music, even from long ago, provides a means to access otherwise unavailable or forgotten memories.

Fitness professionals are in a uniquely opportunistic position to employ the power of music and combine it with physical activity since it is an innate part of leading fitness classes.

Once when I was an indoor cycling instructor I subbed for another instructor's "senior cycle" class and she gave me the music to play which was a playlist of up-tempo, fun oldies. The people in that class were more into the music than any other class I had ever taught or attended.

Further, fitness professionals can advance the use of music beyond the passive enjoyment of personally meaningful music and provide active strategies for making the music itself a part of the fitness experience. For example, as a final fitness and team challenge at the end of a large group workout I was leading at a fitness conference, participants had elastic tubing with ankle cuffs. I chose a specific song to play which has numerous sections where there is whistling. ("Love Generation (radio edit)" by Bob Sinclair) Their instructions were to squat continuously at the start of the song and then, when the whistling starts, they had to squat-walk around the room, high-fiving fellow participants and stating the name of the person that are dedicating the workout to.

This combination of social connection with the people in the room, emotional connection to the person the workout is dedicated to, and music left the participants on a particularly high emotional note as they concluded the workout. (See the short video shown in the presentation of this experience.)

Fun

Different than play and perhaps more nebulous, fun presents still more opportunities to enhance the subjective emotional experience of physical activity and to lighten the emotional load of life – with or without the burden of disease.

Examples:

- Use different words for “Stop” and “Go” in workouts. Choose words or have participants choose words to let them in on the process. There are endless options like “coconut” and “chicken.” There is an extra split-second of mental processing when using different trigger words to stop and start an exercise.
- If using timed sets and you commonly use a countdown like “3-2-1,” try doing this in foreign languages every once in a while. This has never been easier with foreign language translator apps which also come with audible pronunciations. Here are some sample 3-2-1 countdowns with some pronunciation guides in parentheses:
    - German: drei, zwei(tsveye), eins
    - Turkish: üç (ooch), iki, bir
    - Italian: tre, due, uno

Tying It All Together

The expectation is that you will teach many of the fun, playful fitness examples you will see in the next module to caregivers and patients and people seeking to maximize the brain benefits of exercise so they can use them any time. And to encourage them to use personally meaningful music while doing so. A statement which has defined how I approach fitness leadership is as follows: “Teaching is the process of making yourself unnecessary.” This also ties in with an abundance or growth mindset.

The hope and aim are that these strategies are ones that you impart to the people you influence so that they own them forever – not just when they are with you. Patients and caregivers can then use the seemingly magical combination of fun, fitness, and social interaction with music added where appropriate to lighten the emotional load and have cherished experiences together today while trying to live with life-changing illness.

References for this Lesson

Brown, S. L., & Vaughan, C. C. (2009). Play: how it shapes the brain, opens the imagination, and invigorates the soul. New York: Avery. pp. 17,19-20,34,126

King, J., Foster, N., et al. (2019) Increased functional connectivity after listening to favored music in adults with alzheimer’s dementia. Journal of Prevention of Alzheimer’s Disease. 6(1):56-62. https://healthcare.utah.edu/publicaffairs/news/2018/04/alzheimer.php

Module 6 – Exercise Examples - Introduction

“The brain appears to be designed to solve problems related to surviving in an unstable environment, and to do so in nearly constant motion.”

- John Medina, *Brain Rules*

This excellent quote has stood out in my mind since reading that book in the nascent days of my interest in the brain.

What led to the development of the brains we have today illustrates what we can do to keep them healthy.

For our ancestors, living in an environment with major challenges for energy acquisition (i.e., getting enough food for survival), required us to be alert and cognitively sharp.

We got here by combining high levels of physical activity while problem-solving to survive.

When using exercise to improve brain health, the starting point must be: *What brain structures are the most responsive to exercise?*

The hippocampus and PFC, where exercise strengthens existing neurons.

Numerous studies show an increase in BDNF, new hippocampal neurons, increased hippocampal size, and increased performance on memory tasks with exercise.

To provide more practical implications to what, specifically, we should be doing during physical activity to optimize brain health, the critical question is this: What cognitive challenges posed by physical activity lead to this adaptive response in our brains?

The answer is eloquently explained in an article in Scientific American by David Raichlen and Gene Alexander (Alexander, 2020) and based on research which led to their introduction of the Adaptive Capacity Model in 2017 in *Trends in Neuroscience*. (Alexander, 2017)

The Adaptive Capacity Model proposes that the brain responds to the combination of aerobic activity with control of motor systems, spatial navigation and memory, executive functions, and the control of sensory and attentional systems with a neuroplastic adaptive response by increasing capacity to lower energy costs.

The specific form that the above cognitive challenges took in human development were first bipedalism, then the hunter-gatherer lifestyle, and finally agriculture.

Bipedalism

Transitioning form four legs to two dramatically changed the brain's tasks. It suddenly had to perform the following:

- Enhance balance, body control, and coordination in our gait pattern
- Faster processing of sensory input as the consequences of falling are greater when you become taller
- Process (and remember) more visual information with an expanded view of our surroundings

Hunter-Gatherer Lifestyle

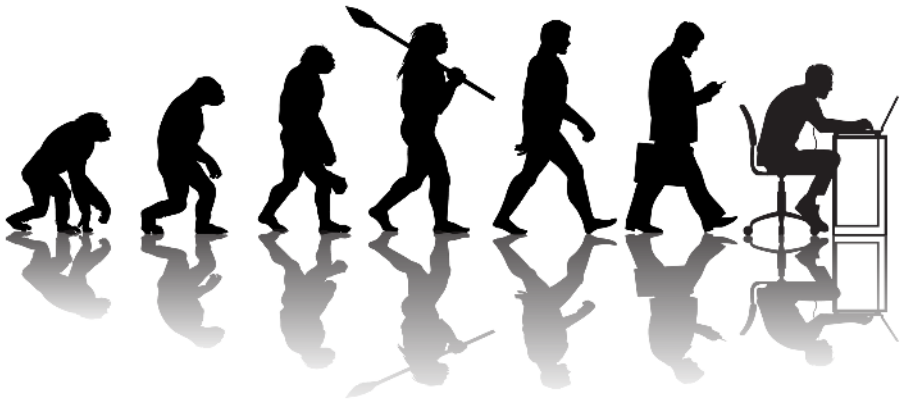
As we shifted from sedentary vegetarians to mobile, omnivorous hunter-gatherers in a climate that was getting cooler and drier and the ensuing long-range foraging and hunting, our brains now had to do the following:

- Physically multi-task in the form of carrying things or manipulating tools with our upper body while walking or running.
- Enhance endurance (of muscles but also of memory) while covering great distances in search of food with a need to remember where you are and how to get home
- More efficiently process fuel to run a brain requiring more of our caloric energy to run itself

Agriculture

As our big, fancy brain got better at problem solving, we figured out how to shift from foraging to farming. Take a moment to consider the significant problem-solving task in migrating from a hunter-gatherer lifestyle to an agricultural one. Learning how to do it had big benefits in terms of allowing a more consistent – and more geographically favorable – food supply. Agriculture was still a lot of physical work requiring balance, coordination, endurance, power, reactivity, strength, etc.

Until now.

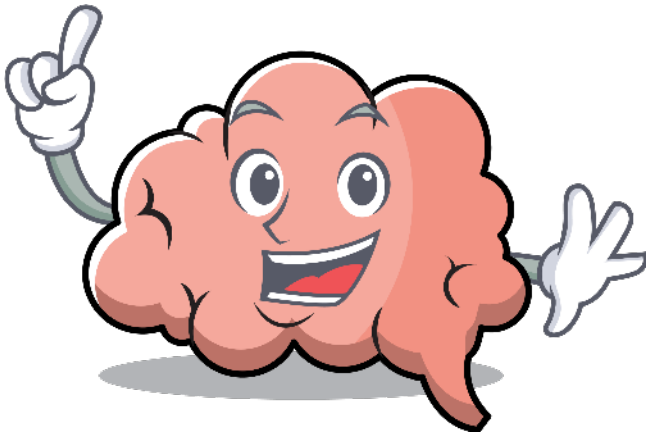


As we kept getting smarter, we kept problem-solving, and coming up with what would now be called "life hacks" to make things easier. You could easily argue that our brains got so smart that we have now outsmarted ourselves. We have continually problem-solved and adapted to the world around us and developed ways of making it ever easier to survive. In essence, we have made it so easy to survive in the short term that we are less likely to thrive in the long term. It is now so easy to live that our bodies increasingly outlast our brains.

The oldest parts of our brain are the most essential to survival since they are responsible for memory and movement. They are also the most susceptible to damage since they are unaccustomed to lasting as long as our physical lives now do. We need complexity, challenge, and purpose to optimize brain capacity and cognitive ability well into old age. (Sherzai, 2019) And most significantly, we need to have those elements **combined with physical activity, not sitting still**.

Every major resource and authority on Alzheimer's disease mentions the importance of exercise and of mentally stimulating activities. And they are always presented the same way: (1) go exercise, (2) learn a language, to play a musical instrument, read, etc. There is always a distinction between the physical activity and mental stimulation. It is as if someone gave you a pair of shoes with instructions to ensure that you spend some time each day with one shoe on the left foot only and with a shoe on the right foot only – never both at the same time. The obvious solution (and more enjoyable experience) to wear both shoes simultaneously is somehow never presented. That changes now with the exercise strategies presented here.

And this is where you come in.



What follows is an extensive exercise library illustrating ideas for how to re-think exercise and physical activity. Re-integrating the types of challenges listed above which caused our brains to get good at doing all the stuff they have to do is the way to use exercise most effectively to give us the best chance of keeping our brains sharp for as long as possible. ***This course is useless without you.***

> The exercises (and this course) are seeds. You are the farmer. By taking these ideas and experimenting with them, advancing them, and adapting them to your way of doing things with your equipment with the specific personalities under your influence in delivering fitness, you can cultivate a fertile field of ideas from the seeds provided here.

Three Key Notes:

- For many participants unfamiliar with integrated cognitive and physical challenge, getting overwhelmed is highly likely if you use too many of these strategies at once or present too complex of a challenge in a single exercise. The emotional response to the exercise experience is perhaps the most important consideration in what we do. Frustration reduces participation.
- In most of the examples, you will likely see more than one characteristic on display (for example, an exercise illustrating Auditory Reactivity may also challenge Coordination) as it is impossible to completely isolate a single characteristic. Where possible, exercise examples are chosen which feature the given characteristic more prominently. This is to aid in your understanding of the characteristic.
- Versatility: the exercises and concepts are designed to maximally versatile to allow their introduction to as many people and in as many settings as possible.
    - *Versatility of Equipment*: Options using anything from no equipment to more sophisticated equipment will be shown during the exercise library. There will be a resource list provided for more information on any item used in the videos.
    - *Versatility of Modality*: These strategies will work in one-on-one and small-group training, and group exercise and with weight training, aerobic training, and almost any modality of exercise where there is allowance for uncertainty.

References for this Lesson

Alexander, G.; Raichlen, D. (2017) Trends in Neurosciences, July 2017;40(7):408-421
https://doi.org/10.1016/j.tins.2017.05.001

Alexander, G.; Raichlen, D. (2020). Scientific American. January 2020;322(1):26-31
https://www.scientificamerican.com/article/why-your-brain-needs-exercise/

Medina, J. (2009). *Brain Rules*. Pear Press. p. 4-5

Sherzai, D., Sherzai, A. (2019) *The Alzheimer's Solution: A Breakthrough Program to Prevent and Reverse the Symptoms of Cognitive Decline at Every Age*. HarperOne

Lesson 1: Walking

There are brain health benefits to be found in any form of physical activity, so we start with one of the most widely available forms achievable by most people: walking.

The overarching concept is to avoid "just" walking. Add a different element to the walking than just putting one foot in front of the other. Many people have already been doing this without realizing it by walking and texting! However, the strategies shown here are far safer and far more interesting for brain health.

Exercises / See the Videos

- "Hard Way" Walk / "Long-Cut" Walk – take the path of *increased* resistance: walk while balancing on the curb for a few steps, weave around signs, utility poles, trees or benches. Step on a crack (or don't step on a crack).
- Explicit Cognitive Challenge
    - Mentally recite alphabet skipping every other letter, every third letter
    - Count backwards from 100 by threes, or sevens, etc.
    - Count the number of various objects you see or things you hear
    - Mentally recite as many words as you can that start with a specific letter
- Ball Toss – toss a ball to yourself or a partner while walking
    - Bounce every third toss in the air
    - Toss quickly back and forth between hands or between yourself and a partner
    - Toss increasingly higher until you miss a catch
    - Toss over tree branches, off walls, signs, etc.
    - "Snowflake" toss – each toss is unique (behind the back, under the legs, around torso, etc.)

- Numbered Ball Toss (write numbers on tennis ball with dark permanent marker)
    - Count up – start at zero, toss and catch, adding the number most visible.
    - Count down – start at a predetermined number (e.g., 100) and subtract the number most visible on each catch
    - Group version (3 or more people) – adds pressure to calculate quickly with other people participating; tosses are random between participants.
    - Count up/down (2 or more people) – rules same as above but add the number if the ball is tossed in the air (“up”) and subtract if it is bounced between partners (“down”). Or use the opposite rule: up is subtract and down is addition.
- Object Toss (stick, rubber chicken, reaction ball, etc. variable objects require more attention and focus to catch successfully) – toss to yourself or a partner
    - Stick – regular catch or flip it end-over-end then catch. Option to add one more flip with each catch (i.e., flip one revolution, two revolutions, three revolutions…once stick is dropped start over)
    - Reaction ball – hard rubber ball with bumps on it / also version with numbers on it
    - Rubber chicken (or similar fun, random object)
    - Foam Dice – toss/catch & add or subtract the numbers

- Alphabet Walk: either define a rectangular space with cones or just use an obvious space given where the participant is. Walk or the letters accordingly following the ideas below. (Note: in addition to the varied physical movements and thinking required to move through the letters, all the items chosen will also generate a positive emotional response.)
    - Name of loved ones or pets
    - Name of favorite movie(s)
        - Favorite when you were a kid
        - As an adult
        - Favorite category movie: comedy, horror, drama, etc.
    - Musical Artist
        - Favorite now/when you were in high school
        - First concert/most recent concert
        - Artist you would like to see in concert but have yet to
    - Vacation Spot
        - Favorite place you have been
        - Place you most want to go that you have not yet visited

Lesson 2: Aerobic Training

Treadmill vs. Trail

Regardless of the specific mode of aerobic training chosen, a useful way to conceptually understand and remember how to optimize aerobic training is to remember 'Treadmill vs. Trail.' Performing aerobic training on a treadmill – a controlled, predictable environment with each step on an identical surface – is less of a sensory challenge than doing so on a trail – a highly varied environment with each step on a different surface, variable stride length, and perhaps even speed changes due to variations in angle of the trail.

Once again, all aerobic training is good for brain health, but certain types are better. In keeping with this, 'Treadmill vs. Trail' is not 'bad vs. good' but rather 'good vs. better.'

Whatever mode of aerobic activity chosen, including elements that make it more reactive, interactive, and cognitively challenging will enhance the benefit as long as those elements are included in the optimal amounts.

How Much Is Enough?

As clearly outlined previously, the best recommendation is to put aside figuring out what 'enough' is and do as much as you can since more is better. This is another reason creating and protecting the positive subjective experience of physical activity for participants is essential and is the only way to ensure future success through consistent participation in fitness. The more positive someone finds an experience the more likely they are to be drawn to it.

Blood Flow Makes the Brain Grow

Since inadequate blood flow to the brain and the resulting loss of fuel for neuronal firing and drop in nutrients for neuronal maintenance causes loss of brain function, sensible dementia prevention efforts must include exercise – the most effective way to increase the growth of new blood vessels. Anything that increases blood flow to the brain may stimulate growth of new blood vessels and brain cells. (Boldrini, 2018)

Aerobic Intensity and Correlation to Brain Health

Are there different degrees of benefit for different aerobic intensities? And, what opportunities do each intensity present for integrating cognitive challenges?

Exercise induces an acute, physiological stress on the body that brings about these changes:

- Low-to-moderate intensity aerobic activity shows small increases in BDNF. Lower intensity potentially allows for a higher amount of concurrent cognitive challenge. The lower physical effort provides the opportunity for more attentional resources to be directed toward a secondary cognitive task.
- Moderate-to-vigorous intensity aerobic activity demonstrates larger increases in BDNF and other trophic factors. Further, higher-intensity effort typically results in enhanced processing speed since this is an inherent quality of performing high-intensity physical effort.

The point? Nearly any intensity shows positive brain health effects. And it is once again essential to remember one of the principal concepts of this course: that the subjective experience you create for your participants during exercise is as important – or possibly more so – as the objective measures of the “correct” intensity. Psychology matters as much as physiology. The mindset someone has about a certain intensity can affect the experience they have.

One study found that people were in a better mood when they picked their own intensity level instead of using a prescribed moderate-effort workout. Some people love high-intensity, some low, and some moderate. (Brellenthin, 2017) When starting someone out on exercise, it is better to use the intensity an individual will find more agreeable as the ensuing consistent participation will likely enhance not just the capacity for, but the willingness to participate in, other intensities than the initially preferred one.

Consistent participation leads to enhanced abilities, which leads to greater capacity for, and psychological tolerance of, higher intensities.

The Forest for the Trees

Before we get too lost in worrying about the right intensity of aerobic training that most benefits brain health, it is important to keep perspective. Aerobic training is by far the mode of exercise most featured in the research because it lends itself well to research. This does not mean that is (or that it is not) the best form of exercise for brain health. It only means it is the one we have the most data on. Resistance training shows some improvements to cognitive function as well and also produces more BDNF. (Kelty, 2019)

It essential to keep in mind the foundational reason we have the complex brains we do. Namely, that **our brains must solve problems and remember things while we are moving**. If we keep this concept in mind, exactly *what* we do gets easier to implement. *Think and move*. That movement may involve aerobic activity, strength or power, or any other fitness characteristic. Recall the treadmill versus trail discussion previously for another quick way to keep the big concept front of mind.

If we integrate decision-making, memory, and uncertainty into our exercise modalities, we can derive brain benefits when working on endurance, balance, strength, power, agility, speed, or nearly any component of fitness that is part of the human experience. As demonstrated previously, we should be doing some amount of all of the different components of fitness anyway so while it is important to examine which ones may have more brain benefit, they all will have some, and will likely involve different brain regions. The takeaway is to avoid the overthinking common when we start to ask, “What is best?” for this or that part of the brain and apply the cross-training methodology we already know to be sensible from a physical fitness perspective to our brain-based fitness training. Spending time on the complete list of fitness characteristics identified previously will, when integrating cognitive challenge, use all brain regions relevant for moving and thinking well.

In essence, you can ‘cover all the bases’ without needing to know each base in high detail.

It is of course important and valuable for research professionals to design studies to further parse out specific effects so we can become more refined in our approaches. Yet we already know enough to act. If we use common sense and model our movement training according to the need to solve problems in a somewhat unpredictable, complex environment while moving, we need not worry about whether this or that study substantiates the specific approach you use. And we absolutely cannot wait until more research is done. There is no time.

With Alzheimer's the fastest growing cause of death, we need to implement strategies that we know enhance brain health to immediately enhance participation in a known prevention strategy to improve people's odds of not getting this disease. To exactly what degree this or that form of physical activity enhances brain health is for future research to answer and for non-practitioners to concern themselves with. **We know that all forms of exercise are good for the brain and that including some measure of simultaneous cognitive challenge makes it better. That is *all you need* to begin.** There is someone out there right now, today, that can benefit from your delivery of fitness integrated with cognitive challenge.

If we combine physical fitness with "motor training" – through the use of the coordinative, interactive, and reactive elements introduced in this course – we then we enhance physical as well as cognitive health in advanced age. (Netz, 2019)

Measuring Aerobic Intensity

You usually encounter formulas using age and/or Maximum Heart Rate (MHR) as a starting point for determining heart rate training zones. They are popular because they are easy to use. However, they are best avoided as they are too inaccurate to be useful. What makes them easy to use is what makes them inaccurate.

The problem with age is self-evident – every 50-year old cannot possibly have the same training range. There are 50-year old Ironman triathletes and 50-year old tin-man couch potatoes and everything in between. Common formulas using age typically start with some version of 220 minus age calculation to determine MHR. So if you see a formula including '220 – age' keep looking.

Some formulas take a step in the right direction by including resting heart rate (RHR), but unfortunately are still troublesome. Some try to vary the contribution of age in the formula. These factors do reduce the error because now we are at least getting more specific to the individual, especially with the use of RHR. However, there is one major issue with all of these formulas. They start from a questionable assumption – the existence of a Maximum Heart Rate as a fixed quantity.

Here are all of the factors that affect and determine Maximum Heart Rate:

- Genetics
- Heart size (yes, there are different sizes – and size does matter)
- Altitude where the training occurs
- Type of activity being performed

In addition, use of MHR is poorly correlated with performance and varies even among people of the same age. MHR does not show a consistent 1-bpm drop with each year of age. Your MHR is highly variable due to factors specific to you as an individual and factors specific the nature and location of your activity. In fact, the one standard deviation error for these formulas is 12 bpm. Meaning, that your heart rate is only accurate to plus or minus 12-bpm – a span of 24-bpm – an unacceptible level of error. (American Council on Exercise, 2014). The bottom line is that, as a measuring tool for exercise intensity, MHR is a mess. We need something better. Enter ventilatory threshold aerobic training.

Ventilatory Threshold - A Superior Method for Monitoring Intensity

When exercising, the heart rate at which your breathing rate and depth begins to make continuous speech uncomfortable or challenging is your first ventilatory threshold (VT1). This point represents a metabolic marker where your fuel use during activity is evenly mixed between fats and carbohydrates. As such, it is a more reliable measure of intensity for a given individual.

There is a second ventilatory threshold (VT2) at which point more lactate is produced from activity than the body can successfully neutralize, a point also referred to as the anaerobic or lactate threshold. Use of VT2 is beyond the scope of this material and is most often used for the purposes of training for competitive aerobic events.

The use of ventilatory threshold as a measure of intensity has been shown to result in superior improvements in VO_2 Max over exercise using the more familiar intensity measures. (Dalleck, 2016)

How to determine VT1 HR using a field test

Subjects will attempt to speak continuously for 30-seconds at progressively more challenging intensity. Since it is impossible for talk for 30 seconds through a breath hold, this length of time will help you accurately locate your VT1 HR. Note that "continuous speech" refers to the normal pacing and rhythm of speech. The result we are looking for in this test is to note that no more than a several words come out at once (perhaps 4-6) before the need to take a breath.

Instructions:

Step 1: warm-up for 3-5 minutes at a heart rate less than 120 beats per minute (HR < 120 bpm)

Step 2: Continue at that pace

Step 3: Speak continuously for 30 seconds.

Step 4: Note the HR during the last 15 seconds of each stage.

Step 5: Increase intensity to elicit an increase in HR of approximately 5 bpm that is stable for 60 seconds, then repeat steps 3 and 4.

Step 6: Repeat step 5 until VT1 or “talk threshold” is reached

How to speak continuously for 30 seconds: To ensure validity, it is best to pre-script the 30 seconds of talking. Suggestions are to use either of the alphabet scripts provided or simply instruct the subject to count numbers. When unable to get through 30 seconds of continuous talking without pausing to take a breath (especially during the last 15-seconds of the 30-second speaking segment), you are at VT1 HR. At lower intensities, you should be able to breathe and talk without the breathing interrupting the flow of words. Thirty seconds is too long to speak through a breath-hold – even if someone tries to – when you are at VT1 HR intensity. (Ross, 2011)

You will need to measure heart rate continuously during the test. Through the use of a chest strap heart rate monitor (ideal), access to a machine that has heart-rate sensing handles (less ideal), or a wrist-worn heart rate monitor or smart watch (least ideal).

Note about heart rate monitoring: To Smart Watch or Not to Smart Watch?

Despite the popularity and ubiquity of smart watches and of wrist-mounted activity trackers with heart rate monitoring capabilities, wrist-measurement of heart rate is the least accurate so is best avoided for testing of heart rate unless there is no other viable option. The best option is to use a chest strap which sends the heart rate data to a smartphone app via Bluetooth or to an exercise machine display via telemetry. In general, you can measure your heart rate *either* more conveniently *or* more accurately.

What about someone who cannot use heart rate to track intensity?

Due to the side effects of some medications or a lack of ability to use or preference to use heart rate monitoring equipment, it may be advisable to use rating of perceived exertion (RPE) as subjective measures of exercise intensity.

The table below summarizes how to use HR and RPE at various intensities of exercise.

Intensity	*Light*	*Moderate*	*Vigorous*
HR in relation to VT1	**HR = Up to 10-15 bpm < VT1**	**10-15 bpm below VT1 < HR < VT1**	**HR ≥ VT1 by no more than 10-15 bpm**
RPE (0-10)	**1-2**	**3-4**	**5-7**
%VO_2 Max	**37-45%**	**46-63%**	**64-90%**

Suggested Scripts to Use for VT1 HR Field Test

"Civilian" Alphabet Script	"Military" Alphabet Script
A is for Apple	A is for Alpha
B is for Boy	B is for Bravo
C is for Cat	C is for Charlie
D is for Dog	D is for Delta
E is for Egg	E is for Echo
F is for Fish	F is for Foxtrot
G is for Girl	G is for Golf
H is for Hand	H is for Hotel
I is for Ice Cream	I is for India
J is for Jet	J is for Juliet
K is for Kite	K is for Kilo
L is for Lamp	L is for Lima
M is for Man	M is for Mike
N is for Nose	N is for November
O is for Orange	O is for Oscar
P is for Pen	P is for Papa
Q is for Queen	Q is for Quebec
R is for Rain	R is for Romeo
S is for Sugar	S is for Sierra
T is for Tree	T is for Tango
U is for Umbrella	U is for Uniform
V is for Van	V is for Victor
W is for Water	W is for Whiskey
X is for Xmas	X is for X-ray
Y is for Yellow	Y is for Yankee
Z is for Zoo	Z is for Zulu

Additional Examples of Integrated Explicit Cognitive Challenges for Aerobic Training:

- Count make, model, color of specific car types
- Make a mental list of all types of birds you see
- Count the number of white cars, squirrels, etc. you see – remember numbers of multiple items for a bigger challenge
- Count backwards by seven, four, etc.
- If watching a video or listening to audio, add or subtract a predetermined number every time you hear someone say “brain” or any other word you expect to hear with some regularity
- Mentally recite alphabet skipping one or two letters; recite alphabet backwards
- Spell a familiar name while omitting the vowels. (e.g., “Jonathan” becomes “Jnthn”)

Non-Traditional Aerobic Training

Example: Wide World of Sports – sequence or series of moves mimicking skills of a specific sport

- Requires no experience or history playing the sport
- Short-term memory challenge to remember the sequence in order
- Reactive version: call out the specific moves to use rather than executing them from a pre-set order
- Video Example: Tennis and volleyball

Walking Section Strategies Adapted for Aerobic Training

Use any strategy from the "walking" section that can potentially apply to this section based on the type of aerobic training and the environment you are performing aerobic training in, and of course, keeping in mind safety considerations. (These are re-listed with minor adjustments appropriate to aerobic activity.)

- "Hard Way" Run – take the path of increased resistance: walk while balancing on the curb for a few steps, weave around signs, utility poles, trees or benches. Step on a crack (or ONLY step on a crack)
- Explicit Cognitive Challenge
    - Mentally recite alphabet skipping every other letter, every third letter
    - Count backwards from 100 by threes, or sevens, etc.
    - Count the number of various objects you see or things you hear
    - Mentally recite as many words as you can that start with a specific letter
- Ball Toss – toss a ball to yourself or a partner while running, on stationary bike, etc.
    - Bounce and catch
    - Toss back and forth between hands or between partner(s)
    - Toss over tree branches, off walls, etc.
- Numbered Ball Toss (write numbers on tennis ball with black permanent marker)
    - Count up – start at zero, toss and catch, adding the number most visible.
    - Count down – start at a predetermined number (e.g., 100) and subtract the number most visible on catch
    - Count up/down (2 or more people) – rules same as above but add the number if the ball is tossed in the air ("up") and subtract if it is bounced between partners ("down"). Or use the opposite rule: up is subtract and down is addition.

- Object Toss (stick, rubber chicken, reaction ball, etc. variable objects require more attention and focus to catch successfully) – toss to yourself or a partner
    - Stick – regular catch or try to flip it end-over-end then catch.
    - Rubber chicken (or similar fun, random object)
    - Foam Dice
- Alphabet Run (note that this is the same content from the previous lesson with "run" replacing the word "walk"): either define a rectangular space with cones or just use an obvious space given where the participant is. Run the letters accordingly following the ideas below. (Note: in addition to the varied physical movements and thinking required to move through the letters, all of the items chosen will also generate a positive emotional response.)
    - Name of loved ones or pets
    - Name of favorite movie(s)
        - Favorite when you were a kid
        - As an adult
        - Favorite category movie: comedy, horror, drama, etc.
    - Musical Artist
        - Favorite now/when you were in high school
        - First live concert/most recent concert
        - Artist you would like to see in concert but have yet to
    - Vacation Spot
        - Favorite place you have been
        - Place you most want to go that you have not yet visited

References for this Lesson

American Council on Exercise (2014). ACE Personal Trainer Manual (5th ed.). San Diego: American Council on Exercise.

Boldrini, M., Fulmore, C., Tartt, A., et al. (2018) Human Hippocampal Neurogenesis Persists throughout Aging. Cell Stem Cell. 22:4, 589-599.e5 https://doi.org/10.1016/j.stem.2018.03.015

Brellenthin, A. G., Crombie, K. M., Hillard, C. J., & Koltyn, K. F. (2017). Endocannabinoid and Mood Responses to Exercise in Adults with Varying Activity Levels. Medicine and science in sports and exercise, 49(8), 1688–1696. https://doi.org/10.1249/MSS.0000000000001276

Dalleck, L., Haney, D. Buchana, C., Weatherwax, R. (2016) Does the ACE Integrated Fitness Training Model Enhance Training Efficacy and Responsiveness? Journal of Fitness Research. https://www.acefitness.org/education-and-resources/professional/certified/january-2017/6184/ace-sponsored-research-does-the-ace-integrated-fitness-training-model-enhance-training-efficacy-and-responsiveness/ (accessed July 2021)

Kelty, T., et al. (2019) Resistance-exercise training ameliorates LPS-induced cognitive impairment concurrent with molecular signaling changes in the rat dentate gyrus. Journal of Applied Physiology. 127:1, 254-263 https://journals.physiology.org/doi/abs/10.1152/japplphysiol.00249.2019

Netz, Y. (2019). Is There a Preferred Mode of Exercise for Cognition Enhancement in Older Age?—A Narrative Review. Frontiers in Medicine, 6. https://doi.org/10.3389/fmed.2019.00057

Ross, J. (2011). Abs Revealed - Chapter 2: The Power of Cardio. pp. 14–18. Human Kinetics.

Lesson 3: Auditory Reactivity (auditory input with motor output)

Movement is determined by auditory cues (words or sounds) introduced by a coach or partner. The participant hears the cue and produces the appropriate movement in response.

Complexity Concerns

If a movement is already familiar, then it will be easier for participants to begin using unfamiliar or novel verbal cueing to dictate the specifics of performance. In contrast, if the movement is unfamiliar or novel, a complicated verbal cueing strategy will likely create a feeling of being overwhelmed.

Example 1: Familiar movement (Squat), more complex verbal cues

- Squat with Side Arm Raise – call out
  - Left/Right Arm
  - Assign positive even/odd numbers for L/R arms
  - Choose a category of noun (e.g., *animals* = left and *vegetables* = right)

Example 2: Familiar movement (Plank), more complex verbal cues

- Plank with Limb Lift – call out
    - Left/Right Arm/Leg
    - Assign numbers to Left/Right Arm/Leg (1-2-3-4) and call out number (after a few sets, change the numbering pattern – increases difficulty)
    - Clock Plank – call out number between 1-12, P1 reaches to corresponding clock hour with correct hand (R-hand hours 1-5; L-hand 7-11; 6 and 12 use opposite of previous rep). Additional options:
        - 24-hour time
        - Months of the year – call out randomly or use important life events (e.g., month when you had your first child, etc.)

Sounds: clap, snap, stomp, rubber chicken squeak, whistle, cough

Use sounds as a command within an exercise, to stop or start an exercise, or as a specific cue for a specific exercise.

Example: Stomp, clap, snap (Good warm-up exercise)

Produce a series of the three sounds in random order. Start easier (one of each sound) and progress by adding one after participant(s) successfully mimic you. Once recall errors begin, reduce the numbers of sounds used in the sequence so you end on a successful performance for all participants.

Methods

Words in ascending order of complexity

- “forward” “back” “right” or “left” to move in those directions
- Odd or even numbers to move left or right (use larger 3 or 4 digit numbers at times)
- Use more abstract representations for left/right/forward/back – requires more cognitive processing to determine correct movement (e.g., call out animals = move left and vegetables = move right). Note that any category of nouns can be used. Feel free to pick some most relevant to the participants. More examples:
    - Musical instruments
    - Fruit
    - Nuts
    - Vehicles (bus, airplane, truck – also can use specific brand names)
    - Clothing
    - Appliances (toaster, blender – also can use specific brand names)
    - Movies or TV shows
    - Tools
    - Body Parts
- Trigger/Magic Word: Perform one exercise continuously and use a single trigger word to perform a second movement followed by a return to the continuous exercise
    - Simple: Call out “switch”
    - More abstract: Call out “tree”

      Allows potential for use of distractor words (e.g., “switch” “go” or “free” to make it rhyme with “tree” which adds more challenge)

Example 1: Single rep performed on trigger word: Medicine Ball Squat (continuous) to Slam (single rep on trigger word)

Example 2: Trigger word used to toggle between two continuous movements: Scissor Kick / Flutter Kick

- Four Corners / Box: Designate four corners with the numbers 1-2-3-4 (Note: can also use same concept with cardinal directions N-S-E-W)
    - Standing: Number call out 1-2-3-4 = Left Arm, Right Arm, Left Leg, Right Leg, respectively
        - *Example 1*: Squat and reach with arm or lift leg
        - *Example 2*: Boxing – punch or kick with corresponding arm or leg
    - Standing: 1-2-3-4 = Left front corner, Right front corner, Left back corner, Right back corner, respectively*Example*
      : Diagonal Lunge to corresponding number with number call out

    - *Optional*: once participants have done several sets with a set pattern, change the numbering pattern to increase the cognitive demand of "unlearning" the old pattern to use the new pattern. For example:

	Initially (odd #s left side)	**Becomes (lower #s left side)**
1	**Left Arm**	**Left Arm**
2	**Right Arm**	**Left Leg**
3	**Left Leg**	**Right Arm**
4	**Right Leg**	**Right Leg**

Exercises / See the Videos

- 3-point box jump – call out a L/R hand/foot and partner jumps on the box using the 3 other limbs, eliminating the one called out
- 3-Point Squat Thrust – call out L/R Arm or Leg (1 of these 4 options) and each eliminate that limb from the push-up position on the squat thrust.
- Med Ball Squat to Slam – use trigger word to initiate slam
- 360 Degree Med Ball Swing Slam – use trigger word to initiate slam
- Hand Spin Lunge with Med Ball Slam – call out trigger word to initiate slam by partner, who is performing a spinning medicine ball toss and step back lunge continuously between slams.
- Rubber Chicken Body Part Catch – call out a body part (head/body/feet) that both catch; stays the same until new body part is called. Next set other partner leads calls. (option: do jumping jacks while doing this)
- Lunge to Corner – standing in center of "box" on the floor. 1-2-3-4 represent corners: left-front, right-front, left-rear, right-rear
- Clock Lunge – call out hours around the clock dial call out number between 1-12, P1 reaches to corresponding clock hour with correct foot (R-foot hours 1-5; L-foot 7-11; 6 and 12 use opposite of previous rep). Additional options:
    - 24-hour time
    - Months of the year – call out randomly or use important life events (e.g., month when you had your first child, etc.)
    - Phone Number (clock lunge using your phone number – or any phone number; optional to add a memory challenge)
- Sitting Squat – random call out to determine range-of-motion: "bar stool, chair, toilet"

- Squat with Side Arm Raise
    - Left/Right Arm
    - Assign positive even/odd numbers for L/R arms
    - Choose a category of noun (e.g., *animals* = left and *vegetables* = right)
- Plank with Limb Lift
    - Left/Right Arm/Leg
    - Assign 1-2-3-4 to LA-RA-LL-RA
    - Clock Plank
        - 12-hour time
        - 24-hour time
        - Months of the Year
- Plank – call out to determine knees on the floor: 2 knees, 1 knee, zero
- Elevator Push-Up (pause at top, bottom, middle of range-of-motion based on callout of numbers, letters, objects, or just “top, bottom, middle”)
- Elevator Squat (pause at top, bottom, middle of range-of-motion based on callout of numbers, letters, objects, or just “top, bottom, middle”)
- Figure-8 (Bottle) Pass – use a water bottle (or any object) to perform a sitting figure-8 pass of the object between and under the legs. Use verbal “switch” command to change direction on the object pass.

Lesson 4: Visual Reactivity (visual input with motor output)

Movement is determined by visual cues introduced by an object, coach, or partner. The participant sees the cue and produces the appropriate movement in response.

With more brain resources devoted to our visual sense than any other sense, visual reactivity is nearly impossible to discreetly differentiate from other forms of cognitive stimulus. Visual reactivity is heavily correlated with almost all other forms of reactivity and integrated physical/cognitive challenges.

Below are some examples that put visual reactivity as the main focus but note that it will be part of nearly every exercise shown in this course.

Pointing: The most obvious form of visual reactivity where one person points the direction to move and the other follows that direction.

Example: Side Lunge, increasingly complex visual cues

- Side Lunge
  - Point Left/Right with finger - predictably
  - Point Left/Right with finger – unpredictably (hand/arm in different positions, use different fingers, etc.)
  - Point Left/Right with any body part – fingers, entire hand, head, feet, knee, elbow, butt
  - Point Left/Right with instruction to pay attention only to what you SEE (allows practice ignoring irrelevant stimuli as leader can now point one direction while saying the other) or to a specific body part

Throwing-Catching: Throwing and catching is a common form of visual reactivity already in use in many every day and common fitness situations. Even when throwing a familiar object in a predictable fashion there is always some variance in speed, direction, and position when catching. Higher amounts of reactivity are introduced by using odd-shaped objects (stick, rubber chicken, stuffed animal, dumbbell.)

Example 1: Side Lunge with Toss-Catch

- Side Lunge with
  - Rubber Chicken
  - Soft Hand Weight
  - Kettlebell

Example 2: Catch-and-Release Row – Dumbbell or Kettlebell

Switching: Two people simultaneously perform a movement. When the person designated the leader switches sides or movements, the other person does as well.

Example 3: Wide Stance Kettlebell Single Arm Catch & Release Row – when the leader switches arms, so does the partner. (Note that this shows two layers of visual reactivity and illustrates an upcoming concept of partner interactivity. This exercise can be done solo without following a partner.)

Complexity Concerns

If a movement is already familiar, then it will be easier for participants to begin using unfamiliar or novel verbal cueing to dictate the specifics of performance. In contrast, if the movement is unfamiliar or novel, a complicated visual cueing strategy will likely create a feeling of being overwhelmed.

Exercises / See the Videos

- Side Lunge
    - Left/Right - point with finger
    - Left/Right - point different fingers; arm positions
    - Left/Right - point with any body part
    - Left/Right - mixed cues (auditory & visual - ignore verbal)
- Offense-Defense Drill
- Single Arm Toss & Catch
    - two of same object
    - single leg stand
    - two different but similar objects
    - two vastly different objects
- Reverse Wall Ball
- Double Slam
- Step Back Lunge Toss-Catch
- Side Lunge Toss-Catch
    - Static feet
    - Dynamic Feet
- Catch-and-Release Row
- Wide Stance Catch-and-Release Row
- ROX Plank Tap
    - Same side hand to side light
    - Opposite hand to side light
- ROX Plank Tap – middle ROX forward; specific colors for left/right hands
- ROX Side Run Tap (2 colors – one each for left/right hands)
- ROX Side Run Tap (2 colors – one each for hands/feet)
- ROX Balance Tap (2 colors – one each for hand/feet)

Lesson 5: Memory, Attention, and Problem-Solving

Memory, attention, and problem-solving challenges become part of the exercise experience.

There are several ways to directly apply these as the focus of an exercise. However, these components of cognition present a nearly endless myriad of opportunities to integrate them into partner exercises, as we will see in the next lesson. The examples shown here use these components of cognition directly and in some cases are not done concurrently while exercising while in others, the cognitive challenge is happening while the exercise is ongoing. The latter is more demanding, which is also what makes it potentially more beneficial.

The explicit memory challenges used here of involve **sequenced information recall**. Participants are tasked with remembering things (objects, words, names, etc.) in a specific order. For example, you could use a sequence of names such as “Ian, Norma, Sanjay, Killian, Rose, David” and ask participants to recall them either verbally or in writing. Note that using random names would be more challenging and using names relevant to the participants (such as the same people in the workout or names of family members of well-known people) would present less challenge.

- **Show and Tell** (works very well for streaming workouts): Show objects, your participants tell you what they were.
    - *Option 1*: Instructor-only. Show your participants a group of objects in order several times during breaks in your workout. At the end of the workout, have participants send you (not all online meeting attendees) a direct message listing as many of the objects they can remember in order.
    - *Option 2*: All participants. (1) tell attendees to bring an item for the workout to show. (2) have them tell you in advance what they will bring (so you can know the full list to check answers). (3) During breaks in the workout, have several people show their object in 30 seconds or less. You could also have everyone hold up their objects for a set amount of time at once. (4) At the end of the workout, have participants send you (not all online meeting attendees) a direct message listing as many of the objects they can remember as possible. The order of the objects does not matter. Optional: have them attempt to recall which person showed which object.

NOTE: The goal of this exercise is to have all attendees either successfully recall all or nearly all of the objects. As such, the number of items should be large enough to prevent it from being too easy and small enough to prevent undue frustration from having it be too hard. Consider your participants when choosing the number of objects to use.

NOTE 2: More common, everyday objects will be harder to remember (e.g., umbrella) while more unique or personal items (e.g., rubber chicken, first album you bought) will be easier to remember.

- **White Board List** (works well in both streaming or in-person workouts): Written list of objects in order on a white board.
    - List options:
        - Related items – grocery store items; hardware store items, etc.
        - Unrelated, but similar items – for example: bus, bicycle, dump truck, helicopter, kayak, airplane. These are all “vehicles” but are relatively dissimilar so present a bigger challenge
        - Unrelated, grossly dissimilar items – for example: wrench, tree, toaster, book, dumbbell, tablecloth. With no theme or pattern to the objects, this will be harder to remember.
    - Remind participants to occasionally look at the board during the workout because you will erase them at some point. Then quietly erase them (i.e., do not announce that you are erasing them) at some point mid-workout. Quiz participants individually at the end of workout by having them come over to you and whisper the list of objects or have everyone write them down on a small piece of paper and give to you.

Exercises / See the Videos

- Dice (roll to determine exercise and reps) (eg., EVEN – Star Jumps; ODD – Table Top/Push-Up/Plank Shoulder Taps-any exercise on the ground)
- Left-Right-1-2
- Coin Flip Directional Movement – flip a coin to determine direction of movement (e.g., heads = right-left axis; tails = front-back axis) flip and move that direction (use any movement: step, lunge, shuffle, jump)
- Single Arm Med Ball Slam (high level of attention and coordination required to perform)
    - Single arm repeating (same arm to build the skill)
    - Single arm alternating - alternating left and right arm single arm slams
- ROX Plank Tap w/Switch Color (3 colors)
- ROX Side Run Tap w/Switch Color (3 colors)
- ROX Triathlon (3 colors; one representing each exercise)

Lesson 6: Partner Interactivity

If you had to choose only one category of exercises to use from this course, this would be the one. It combines many of the concepts of reactivity, coordination, attention and problem-solving and puts them together with partner interaction. This social – and sometimes physical – connection is essential for the physical health of the brain and the mental health of its owner.

We are social animals who, to varying degrees, need social and physical contact with other humans to thrive. Social and physical contact develops and maintains physical and emotional health.

Further, the partner interaction creates a subjectively more favorable emotional response to exercise. This subtle shift has a significant positive impact on people's attitudes and feelings about exercise and creates a shift from perceiving it as a bore and a chore to something they desire to do more and more.

You will inevitably encounter people who say they "do not like partner workouts." To a certain extent, they have convinced themselves that this learned response is innate. It is hard-wired into humans to crave interaction, social connection, and fun with other humans. Of course, there is significant variability in the amount of desire or need for interaction that any one person has. But no one's is at zero (even if they have deluded themselves into believing it is).

I have personally witnessed many occasions where someone who expressed a distaste for partner exercise at the outset of using the strategies presented here, experienced a massive change in perspective from a single workout after some gentle encouragement to have an open mind and give it a try.

This different reaction is due to the different methodology of partner exercise introduced here. Unlike most partner exercise, partners must *rely on each other* for a successful experience, to interact with each other in a fun, relaxed, and playful manner, while simultaneously experiencing the benefit of a natural rise in effort level whenever working out with a partner.

In many ways, partner exercise done to maximize brain health is done in such a way as to make successful performance of an exercise dependent upon partners working together and coordinating movement successfully. It is, in essence, a form of teamwork. In contrast, most of the partner exercise people say they don't like is nothing more than two people doing an exercise at the same time.

This first sample exercise illustrates the difference between 'partner exercise' that many people do not enjoy and partner exercise that a majority of people will. Further, it illustrates all of the previous elements discussed which we use in exercise to maximize the brain health benefits: verbal and visual reactivity, attention, memory, and problem-solving.

Finally, you have no doubt noticed that many of the exercises used previously were also indicative of partner interaction. Correct – and this is another example of the relative impossibility of isolating the variables when mixing cognitive fitness with physical fitness.

Example 1: Duck Under with Addition – use a barbell, PVC, tree branch, sign, or any object that is suitable in or out of the gym. Partner 1 ducks under the bar right to left. Every time Partner 1 stands up, Partner 2 provides a number. Partner 2 adds it to the running total. Start at zero.

- Verbal Reactivity – show a number with hands, flash cards, playing cards, dice, etc.
- Visual Reactivity – call out a number (gives you the option of using very big numbers)
- Mixed Visual and Verbal Reactivity – more challenging for both participants
- Subtraction – in general, this would be harder than addition

Exercises / Watch the Videos

- Duck Under with Addition
    - Visual Reactivity – show a number with hands, flash cards, playing cards, dice, etc.
    - Verbal Reactivity – call out a number (gives you the option of using very big numbers)
    - Mixed Visual and Verbal Reactivity – more challenging for both participants
    - Subtraction – in general, this would be harder than addition
- Plank Reach High-5: One partner performs a plank; reaching out to one side. Other partner low-5s, then shuffles around to the other side while partner one switches arms
- Earthquake Plank – one person taps the other to make the plank reactive
- Two Butts & A Ball – two people sit on a stability ball; one stands up and sits down, then the other
- Surf Jumps (bodyweight only or straddling step, risers optional) – partner uses verbal, visual, or cognitive processing commands (odd/even numbers for left/right, etc.) to determine direction to face when 90-degree turn jumping onto step
    - Point L/R
    - Call out odd/even numbers to turn L/R
    - Dice Roll: Add to determine odd/even L/R
- Hand Slap Squat
    - Alternating hands, facing each other
    - High-Ten Squat – face each other; one partner reaches overhead while other partner squats & floor tap, switch continuously and high-10 on the way up/down
- Partner Plank Squat – hold ankles of partner in plank / use their bodyweight for squat
- Plank Medicine Ball Roll (figure-8 pattern around and under bodies)
- Side Slam Ball Tap
- Single Arm Med Ball Slam

- Teamwork Wall Ball – 2 variations
    - Stand in same spot; angle toss
    - Quick side shuffle to catch your partner's toss
- Reverse Wall Ball – Partner version (can also do a solo version where you retrieve the ball)
    - Straight toss
    - Angle Toss
- Pass-and-Roll (2 medicine balls)
- Catch-and-Replace (2 medicine balls)
    - horizontal toss
    - vertical toss – much harder
- Double Slam (3 oversized medicine balls: 1 heavy and 2 lighter for slamming): Heavy ball placed on the floor between participants who face each other. One slams the lighter ball into the heavier ball and catches it. The other participant slams in the same manner. Partners continuously alternate slams.
- Step Back Lunge Toss-Catch
    - Sandbell
    - Softbell – more weight, different catching surfaces
- Step Back Lunge Toss-Catch
- Toss Squat Tap
- Side Lunge Toss-Catch
    - static feet; follow-the-leader w/direction change
    - dynamic feet; follow-the-leader w/direction change
- Follow-the-Leader Ropes
    - "Zorro" shuffle
    - Single end slams/waves
    - Lateral Shuffle; follow-the-leader w/direction change; uses rope like agility ladder

- Rope Snake Charmer – in/out rope movement coordinated with separate movement by partner
- Rope Carioca-Slam – One participant holds rope in handshake grip, performs a slam and holds the rope low to the floor. Partner performs a carioca movement over the rope and back to the start position. Repeat
- Rope Over-Under
- Rope Duck Under
- Rope Rotational Slam-Partner Squat

Lesson 7: Friendly Competition

Competition gets a bad reputation. Mostly this comes from someone who is too competitive and takes a fun game too seriously in trying to win. But this only tells half the story of competition. While some enjoy competition *against* the other team, many other people enjoy competing *with* their teammates.

For the latter type of person, the value in competing comes from the sense of belonging to a team and competing together with teammates. This duality of competition is perhaps best summarized by a quote from one of my participants in one of the games featured here.

"I want to win, but I feel bad if the other team loses."

This is the essence of friendly competition and it works a kind of magic: it creates a subjectively elevated emotional experience while creating an objectively harder effort – and one that is nearly effortless on the part of the professional.

On the individual level, there is also an internal self-competition manifesting as a drive to perform well for self-efficacy.

Higher Intensity Made Easy(er)

Once there is competition, you rarely must ask people to work harder. It happens automatically. The nature of competition generates a self-selected intensity that is chosen from a desire to do well in that competition – either to win or to do your best for your teammates depending on the person's competition style. This typically results in the participant working harder without requiring a push or encouragement to.

Example: Rubber Chicken Foot Toss – using one or two feet, partners toss a rubber chicken (or any suitable object) to each other, catching with their hands. Count the successful catches. If using this in a one-on-one setting, simply try to beat the score on your previous set. The sudden level of competitiveness you often see on display in this exercise is fascinating.

- Competitive options for small group workouts. See which pair of partners has the highest:
  - Number of consecutive catches without a drop
  - Number of total catches in a single set
  - Number of total catches of all sets summed together

Interestingly, some people new to this exercise will be so caught up in the performance of it and in trying to successfully catch and throw the rubber chicken that they will forget to count (which makes it more relevant as an exercise in partner interaction if the participants pay less attention to the competitive elements). They are also usually laughing wildly, which is a form of winning in its own way.

Exercises / See the Videos

- Chicken Bucket
- Wall Ball Chase
- Disc Dodge
- ROX Partner Plank Tap – tap light before your partner
- ROX Partner Side Run Tap – tap light before your partner
- ROX Partner Squat Tap – tap your own color and the challenge color before your partner
- ROX Partner Speed Tap – tap your own color and the challenge color before your partner

Games & Relay Races – varying intensity; use for finishers, warm-up, or cool-down as appropriate

- Word Spell Relay Race – use letter foam dice; same number of letters in each word
  Option to assign an exercise(s) that must be completed after each letter – gives team members something to do while another team member searches for the next letter

- Medicine Ball Bumper Ball relay race: Use one ball to throw into the other one on the ground, knocking it forward. (Can vary the weight of the ground ball to add or reduce difficulty)
- Memory Twister (no video; description only) – play Twister where you do not stay on the board but rather touch the colored dot with the corresponding body part. Next person spins and performs first move, then their own move. Third person spins, performs the first two players' moves, then their own move. And so on. Once someone forgets or gets one of the moves wrong, they are out. (3-6 people)
- Medicine Ball Bocce (no video; description only)
  Play bocce using oversized medicine balls – with a tennis ball or other small ball as the pallino. A small single hand medicine ball works particularly well for this. Play multiple rounds quickly and keep score for which team wins.

- Kettlebell/Dumbbell Tic-Tac-Toe

Module 7 – Business Module

"Do Well By Doing Good"

This quote captures the idea behind delivering essential and valuable services to create financial success in your fitness career that is generated from the gratifying feeling of witnessing the impact you have on someone on a consistent basis. When it comes to job satisfaction with fitness – the bigger the challenge, the greater the reward.

Whether you use the strategies here with clients diagnosed with existing disease, those interested in avoiding it, or some combination of the two, there is ample opportunity for you.

Potential Clients

In general, there would be two main categories of client for your services as an Alzheimer's Disease Fitness Specialist.

- **Pre-clinical, Undiagnosed, Brain-Health Concerned Individuals** - Many people in this category may not want to identify as someone who has SCI, MCI or undiagnosed dementia (even if, in reality, they are aware of some issues). The terrifying prospect of dementia makes denial a common and understandable reaction to these concerns. As a result, it can be difficult to market yourself directly targeting these individuals with a focus on brain disease. With this population, it can be more effective to convey that you are a brain fitness specialist.
- **Diagnosed Individuals** – Having likely come to accept the reality of what they are dealing with, individuals in this category are much more likely to respond favorably to a message directly addressing fitness coaching for Alzheimer's.

ACSM's Top 20 Worldwide Fitness Trends for 2021:

- Exercise as Medicine is #7
- Fitness Programs for Older Adults is #9

Create a list of people you know who have Alzheimer's. (Current clients, family, friends, neighbors) Let them all know about your medical fitness focus on Alzheimer's fitness and prevention.

- Have any existing clients with AD – Can they give you a testimonial (preferably a video)? Ask them a specific question about some aspect of the benefits they have received that they have mentioned previously. (Makes it easier for them to know what to say…and it shows you've been listening.)
- Ask for referrals – we hear it all the time, but it works.

In a relatively short period of time, you may not need to ask for referrals as much. I recall that, in the early days of my fitness career, it was a real struggle. Before I had my first client, I struggled to get one. I was working the floor in a gym, puzzled by the numerous trainers (not really appropriate to call them fitness professionals) who were unprofessional or inattentive yet seemingly had an ample client list. There were some good ones too, of course. Once I got the first client, and the second, and the third…it more quickly became ten. The struggle to go from zero to one client was much harder than going from ten to twenty.

After reflecting on it, I realized that once you start doing great work, people either notice and approach you or the people you are working with start talking about you – a lot – to the people in their social and professional circles. Once you become known for something, the need to ask for referrals diminishes. *You become known for knowing something*. Of course, it does not mean you should stop asking if you need or want more clients in general or in a certain demographic, but the same thing can happen when you begin to specialize in Alzheimer's fitness.

Support Groups (in-person)

- At the start of my fitness career, my father had just died and my mother participated in numerous grief support groups for widows and widowers. I did countless free talks for fitness tips, etc. (and even though I was new in my fitness career and had very little public speaking experience, it was still productive and enjoyable.)
- Do your relevant connections mentioned previously belong to any local support groups?
    - Could they refer you directly to group members?
    - Could they connect you to the group leader?
    - Arrange to meet the group leader and attend a meeting.
    - Offer to do a short presentation on exercising with their disease or condition.
    - Include short handouts with useful tips from your presentation
    - Offer to do a brief workout segment weekly at the meeting.

Small, Independent Care Facilities

I discovered many years ago that there are a good number of privately owned and managed assisted-living facilities set-up in single family homes in regular neighborhoods. They may be located around you and you may not even know it as these are often in homes without signs out front. They are perfectly legal but due to zoning requirements, there is no signage. (I learned of this by having a client that owned one of these companies in my area. Her business owned several houses in different neighborhoods.)

These smaller, non-corporate-chain entities are often far more open to having someone like you come in and provide services. In addition, the ‘red tape’ is often far less onerous as it often is with larger, corporate care facilities.

Connect with Allied Health Professionals

Many physical therapists, functional medicine doctors, and other wellness practitioners operate outside of the insurance system as fee-for-service providers (just like you do.) These types of professionals and the small, independent businesses and studios they own and operate are ideal both as a bi-directional referral source and as a location for brain-based fitness coaching. Their clients are people who have the means to afford out-of-pocket services, are used to that model in that business, and are often motivated enough to see the types of improvements you can deliver to make your services easier to sell.

This is often a much easier path than connecting with traditional doctors or other insurance-based facilities and professionals.

Marketing to Doctors

Doctors don't know enough to prescribe exercise (just like we are unqualified to prescribe medical treatments). When a client asks us about what is ultimately a medical concern, our response needs to be some version of, "You should see a medical professional." Similarly, when a patient asks a doctor a specific exercise question, the doctor's response needs to be, "You should see a fitness professional."

We have no place discussing specific medical conditions or treatments and doctors have no place discussing detailed fitness programming. This is a good thing and an opportunity. Everyone brings their own field of expertise to bear on making people better.

It is time we elevate our self-perception as competent professionals with a valuable role to play in health and wellness and in disease management with fitness where appropriate. We can position ourselves as professionals who are able to solve a problem for doctors – to help them avoid addressing a topic they are unable to discuss in a specific enough way to be helpful to their patients. Further, we can position ourselves to be easily referrable so it is positive reflection on the doctor.

How do you start?

Revisit your list of current clients, family, friends, neighbors affected by Alzheimer's…and even those that have not been affected by Alzheimer's.

- The next time you have a client that reports that their doctor said "Whatever you are doing, keep it up!" at their most recent doctor visit, get in touch with that doctor as soon as possible. Ask client for contact info and ask if it the client is agreeable to you your contacting their doctor and reviewing some specifics of what you did with the client, the fitness/health coaching plan you used, and changes to any measurements or assessments. This has happened to me dozens of times and I always attempt to follow-up and connect with the doctor as quickly as possible.
- Second best option is to have your client (the doctor's patient) recommend that the doctor contact you (give your client an extra copy of your workout plan and health coaching points – and have your name and contact info on every page of anything submitted.) This more passive option puts the control of contact with someone other than you – and that can be unpredictable or take longer than expected.

If you have no clients with dementia or Alzheimer's…

And have not yet had an experience similar to the first bullet point above (where a doctor tells the patient "Whatever you are doing, keep it up."):

- Find doctors in your area who specialize in this area or general practitioners who have recently set-up their practice (meaning, they may need patients). Likewise, you can do a search on many insurance websites as they have a "Find a Provider" link and steer clear of any that list "not accepting new patients" as these practices are likely very busy so it will make it harder to have meaningful communication with anyone in that practice.
- Explain that you would like to learn about what they do with patients that have Alzheimer's or dementia so you can build a referral network for your clients. In essence, you are interviewing them to assess their suitability to be able to refer your clients to them.
- Research Allied Health Professionals and repeat the process:
    - Physical Therapists
    - In-Home Aides or Nurses
    - Chiropractors
    - Functional Medicine Doctors
    - Dietitians
    - Massage Therapists
- Steer Clear of…
    - Doctors with "medically supervised weight loss" programs. (What would you think of "Fitness Trainer Supervised Medical Plans?")
    - Doctors who have a "if it hurts, don't do it" mindset as this type of medical professional is unlikely to value movement and exercise as a viable modality for disease management.
- Health fairs, charity events, etc. – there are often a myriad of local events
- Get educated on corrective exercise, posture, etc. so you can deliver full-spectrum fitness coaching apart from any specific disease concerns. Most people in the populations who are concerned about or have Alzheimer's will likely have one or more secondary orthopedic or postural concerns which can be effectively addressed with postural or movement corrections. Many people have 'pain but no pathology.'

If you do get a meeting with the doctor (phone or in-person are both viable):

- Make your meeting about your client/their patient. Note: doctors cannot talk to you about their patient without written consent from their patient – so have that ready either in hand or if the client is facilitating (as in the second bullet above, have the client give the ok when they mention meeting with you to the doctor.)
- Have your intake/on-boarding process for new clients documented and ready to present.
- Explain your system by using a copy of your client's program. Give that to the doctor and a copy of your resume (a one page-streamlined version, not a three-page curriculum vitae.)
- Ask for the doctor's preferred means of communication and preferred frequency of updates about your client/their patient.

How MedFit Network and Education Foundation Help You

Whenever someone completes a course, a portion of the course fee goes to a boosted Facebook post in a 15-mile radius of the zip code to people that make over $75K who have the conditions that you now specialize in to announce that there is someone in the area that can help them. These posts get seen by thousands of local potential clients. When you complete this course that will happen for you in your geographical area. Given that the average Facebook user skews older, it is a good fit for the population you are likely to serve with the material in this course.

MedFit Network has an ongoing Google AdWords grant for $10,000 per month to drive consumer traffic to the MedFit Network site. This increases the chances of someone looking for a fitness professional providing services which accommodate the medical condition that person has landing on the MedFit Network website and thus searching for local professionals.

Social Media Marketing

At this point, if you do not have expertise in this area, it is advisable to hire someone who is. The numerous platforms that are available, the level of sophistication and dynamic nature of the algorithms and policies for marketing on each platform, and the time it takes to absorb all of this and create a sensible, effective strategy worthy of the time investment is most likely beyond the reach of the average fitness pro.

Given that the typical client for the type of services you will provide as an Alzheimer's Disease Fitness Specialist will tend to be older, this would warrant a higher priority of efforts in this area toward the platforms used by this demographic in your area.

In general, social media marketing will be an adjunct to your in-person and word-of-mouth efforts. The power of the personal connection when you are a member of someone's allied healthcare team is more powerful than social media connections.

Consider that when most people need a massage therapist, physical therapist (outside of an insurance model), or fitness professional, people often ask someone they know who has previously mentioned how great the professional they have previously used is.

Get Involved

There is an abundance of charity events that would appreciate someone leading a group warm-up or providing people a few fun 'ice-breaker' exercises. One of the few upsides of the ever-rising rate of Alzheimer's is that more and more organizations are devoted to managing it. And this means there are an ever-increasing number of community events where you can volunteer and get in front of people who are likely prime candidates for your services.

Alzheimer's Disease Fitness Specialist Course - Outroduction

Congratulations! I am proud of you and grateful for the time you have spent with the material and the positive impact you will have on people's lives as a result. Because of you, these concepts will reach and benefit many more people.

You are now ready to help take people's brains on a journey from **'fragile to agile.'**

Thank you…from that future person you will help by providing a fitness experience that is above and beyond just the physical. You are now ready to deliver fitness that

- enhances the health of the brain
- strengthens social connections
- and delivers an emotionally satisfying and enjoyable experience

All at the same time!

I approached this course from a **"pracademic" perspective – to make academic stuff practical**. This was achieved through providing a substantial grounding in science while equally weighting the time spent on application and keeping the instruction practical, accessible, and giving you what you need to begin using these strategies rapidly.

And remember, this course is just a seed – you are the farmer!

Alzheimer's doesn't come out of nowhere – it comes out of everywhere! We covered the major areas that you can influence as a fitness coach: stress, sleep, social isolation, nutrition, and exercise and physical activity.

Once a life is burdened by the weight of Alzheimer's, every bit you can nudge someone towards better physical, brain, and emotional fitness will be hard-earned. Go help people earn the 'hard yards!'

You can now transform, enhance, and expand the effect of fitness on people's brains but also on their in-the-moment experience: "Make Today Better." String enough good days together and you can create a future that is better than it would have been for someone with Alzheimer's and likewise make it less likely that other people will get it.

And that starts today!

Additional Resources

Fitness Equipment

Everything you saw used in the course can be found here – along with several valuable, fun tools not featured in the videos from the course: Funtensity.com/ADFSequipment/

General

Funtensity Blog – published every two weeks by this course's author with a brain health, fun fitness or similarly-related topic. (Noticeable gap in the publishing schedule in the summer of 2021 is when this course was getting made!) Funtensity.com/blog/

AARP Brain Health Assessment – Assessment only: $14 for AARP members; Non-members can purchase membership in the Staying Sharp program (which includes the assessment) for $60/year. https://stayingsharp.aarp.org/assessment/

Age-U-Cate Training: Dementia Live Program - A transformative dementia simulation and empathy training experience that empowers staff, families, and the community at large. A unique experience and highly recommended for anyone seeking to approximate the actual experience of dementia or Alzheimer's.
https://ageucate.com/index.php?main_page=dementia_live

Alzheimer's Prevention & Research Foundation – one of my favorite organizations as the focus is more weighted towards prevention
https://alzheimersprevention.org/

Alzheimer's Association's "Walk to End Alzheimer's" – held annually in more than 600 communities in the U.S., the Walk to End Alzheimer's is the world's largest event to raise awareness and funds for Alzheimer's care, support and research. www.alz.org/walk

Alzheimer's Association "Longest Day" Events – every year for the summer solstice. People from across the world will fight the darkness of Alzheimer's through a fundraising activity of their choice. Whether you're participating at home, online or in-person, there are plenty of fun ideas to engage family and friends in The Longest Day.
www.alz.org/thelongestday

Krembil Brain Institute – devoted to fighting brain disease. Publishes a free magazine available as a pdf document.
www.uhn.ca/KNC

Inside the Brain: a tour of how the mind works (and how it is affected by Alzheimer's)
https://www.alz.org/alzheimers-dementia/what-is-alzheimers/brain_tour

Global Council on Brain Health – Resource List (Reports and Infographics)
https://www.aarp.org/health/brain-health/global-council-on-brain-health/resource-library/

More Education

Never Leave the Playground – Stephen Jepson
I first found Stephen's program about a decade ago and he is an endless source of clever ideas for integrating fun movement, balance, and coordination challenges into everyday life. His message syncs up with the Alzheimer's Disease Fitness Specialist course in that his core teachings are that we should always play and that it is never too late to improve.
https://neverleavetheplayground.com/

Hand Eye Body – fun, challenging programming ideas for integrating eye-hand coordination exercises either as a stand-alone warm-up or cool-down in a workout, or just an engaging challenge for a movement break anytime. Additionally, many of the exercises could potentially integrate into many common exercises already used in fitness programming. Has a great Instagram feed with many interesting videos. @handeyebody
https://www.handeyebody.com/

Brain Health Trainer – A thorough examination into the neuroscience and neurobiology of exercise and its implications for brain health. Provides a more advanced understanding of the brain science supporting the exercise variations and practical methodologies used in the Alzheimer's Disease Fitness Specialist course. https://www.brainhealthtrainer.com/

Total Brain Health – packages of games and tools for creating fun, explicit cognitive challenges. Supplies many ideas which you could integrate into exercise experiences for individuals or groups. Toolkits are used in some assisted living facilities, presenting a potential collaboration opportunity for a fitness professional familiar with them. Toolkits available for individuals, communities, and for professional education.
www.totalbrainhealth.com
TBH Toolkit 365 (save 10% w/code TBH10)
TBH Quiet the Mind: Free Video series on stress relieving activities -
www.Totalbrainhealth.com/quietthemind
TBH on Demand: Free Video Series – www.totalbrainhealth.com/tbh-on-demand

Z-Health Education – excellent, in-depth and highly-detailed neurology-based movement training methodologies. Excellent material but requires significant time and financial investment at a level the typical fitness professional will find challenging to see a return on. For those in a clinical setting or other specialized work location, or where perhaps an employer sponsors part of the course fee, it may be more feasible. https://zhealtheducation.com/

The BioMechanics Method – top recommendation for a biomechanics course allowing you to become proficient in addressing most postural, muscular imbalance, and corrective exercise concerns. Offers a Level 1 and Level 2 course. The level 1 course will help you address the most common biomechanics problem and may be adequate. Level 2 course includes expanded strategies and covers the less common biomechanical dysfunctions. The best part about this program is that it has just enough education and is heavy on practical application and you will be able to use what you are learning right away and even while you are learning it. https://www.thebiomechanicsmethod.com/

Caregiver Resources

AARP Caregiving and Health Programs, www.aarp.org/caregiving/, support line 877-333-5885

Alzheimer's Association 24/7 Support Line: 800-272-3900

Family Caregiver Alliance, www.caregiver.org

Sundowning: Alzheimer's Association tips for managing sundowning and mitigating the symptoms. https://www.alz.org/help-support/caregiving/stages-behaviors/sleep-issues-sundowning

Music Therapy

Documentary Film: "Alive Inside" Alive Inside Foundation (www.aliveinside.org)

Music and Memory (www.musicandmemory.org) – Dan Cohen; charity that purchases and donates music players loaded with favorite music of nursing home residents. (Dan is featured in the film "Alive Inside")

Institute for Music Therapy, Neuroscience, Research, and Funding (www.imnf.org)

TimeSlips – using the arts, dance, music, etc. to bring connection and joy to caregivers and patients https://www.timeslips.org/

Books

101 Brain Boosters by Terry Eckmann

The Alzheimer's Solution by Dean and Ayesha Sherzai

The End of Alzheimer's Program by Dale Bredesen

The Joy of Movement by Kelly McGonigal

Deep Nutrition by Catherine Shanahan (one of the better books on general nutrition you will find – not quite oversimplified enough to ever find its way to widespread public awareness)

Save Your Brain by Michael Colgan

Behave: The Biology of Humans at Our Best and Worst by Robert Sapolsky

Brain Rules by John Medina

Spark by John Ratey

Your Brain on Nature by Eva Selhub & Alan Logan

Play by Stuart Brown

The Power of When by Michael Breus

About the Author

His “800 Pounds of Parents” directly inspired Jonathan’s prolific fitness career. He is a multiple Personal Trainer of the Year Award-Winner (ACE, IDEA, and PFP Magazine), creator of Funtensity™, brain fitness expert, blogger and master trainer for the American Council on Exercise (ACE). His book, Abs Revealed, delivers a modern, intelligent approach to abdominal training. A former astronomer, Jonathan used to study stellar bodies – now he builds them – and just may be the first Astro-Fitness-ist!

There is well over a decade of study of brain health, human behavior, and motivation leading to the methodology delivered in this course. Jonathan aimed to practically apply the brain science so you don't get needlessly bogged down in the at times complicated science which is overkill for most practitioners. When you combine the long-term benefit to brain health and the short-term boost to mood and brain function with the fun inherent in this style of fitness you can know you have maximized the potential positive influence of fitness on people's lives.

He is all about the heart and the science of fitness and has hopefully given you enough of both to inform and inspire you to become a future fitness leader creating unparralleled brain fitness in the people you influence.

Contact

AionFitness.com - main site for all things fitness: coaching, training, speaking, classes

Funtensity.com - Jonathan's fitness program combining reactivity, coordination, partner interactivity and friendly competition. One-day workshop brings the concept into your club or studio and will separate you from those continuting to offer only the traditional approach to fitness.

Social Media: @JonathanRossFit and @Funtensity **YouTube Channels**: Funtensity General