



## Memory – how to boost it !

The brain has a limitless ability to learn and store information in our memories. Every day is a new adventure, and more memories are made. Having a good memory is an advantage in school, university, work, and all facets of life. Yet as we age, our memory seems to be not as good as it was – where did I leave the car keys? Are there ways to improve our memory to our advantage during every stage of our lives? Is there anything we can do to slow down or prevent memory loss as we get older? What are the facts?

Information on memory and its impact on our lives is hard to quantify – we just know it's a real asset having a good memory. In older people, memory loss is one of the greatest problems facing modern society. Concerns about declining thinking and memory skills rank among the top fears people have as they age. The first part of this module considers ways in which we can improve our memories throughout our lives, from pre-school to old age. The last section deals with dementia and Alzheimer's disease, and what we may be able to do while we are young to prevent it impacting our memory as we age.

*Improving your memory today:-*

### **What we know works -**

**Sleep-** Could our memory benefit by us simply doing nothing?

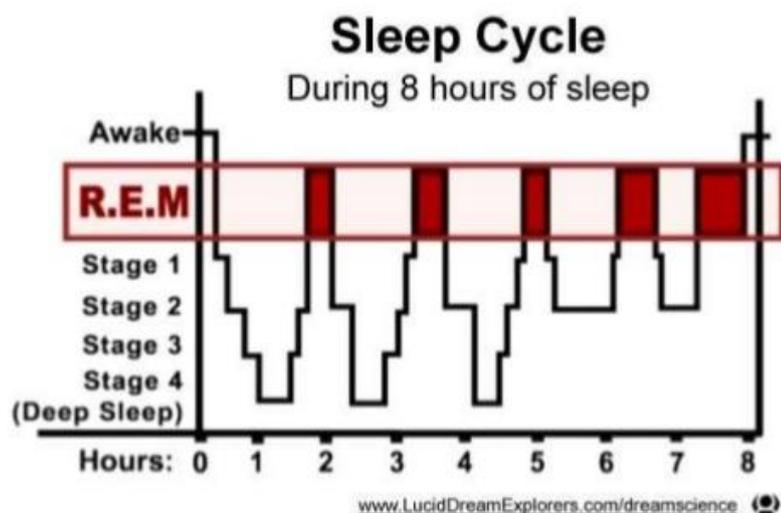
Sleep is a proven memory aid, both before learning, to prepare the brain for initially making new memories, and after learning to cement those memories and prevent forgetting. While we are awake the brain is constantly acquiring and absorbing new information as fact-based learning – memorizing a phone number or where we parked the car. This information is temporarily stored in the Hippocampus in the brain, but it has a limited capacity, like a memory stick. Sleep, even naps, allow the Hippocampus to transfer information (learned memories) to the frontal cortex, for the long term. If we sleep poorly on the night before learning (whether facts or just living a life) we don't fully empty the Hippocampus, and our ability to learn/memorize things the next day is lessened. Brain scans show that the same fact recalled will come from the hippocampus on the day it is learned, and from the cortex on the next day and onwards. After a good night sleep yesterday's experiences are filed away safely in the frontal cortex, and you have regained your hippocampus short term capacity for new learning. Studies show a 20% improvement in the ability to remember facts after a quality sleep, compared to if sleep is poor. For adults, at least 7 hours sleep is optimal for this. Memories, once transferred to the frontal cortex, are consolidated, or saved, for the long term. This consolidation occurs in deep non-REM sleep, and the more N-REM sleep we get, the better we perform on memory tests the next day. Even daytime naps of 20 minutes can offer a memory consolidation advantage, as long as it contains enough non-REM sleep, as it allows the Hippocampus to transfer memories to the frontal

cortex, and then be able to absorb more information. If you don't sleep well the night after learning something (e.g. tonight after learning about sleep and memory) you lose forever the chance to consolidate these memories, AND you may not remember as effectively the information that you learn tomorrow. Catch up sleep later on does not help memory consolidation.

The second benefit of sleep for memory comes AFTER learning. For memory involving physical skills, such as playing the piano, the memories are stored below the conscious level, to create automated routines while we sleep, almost like instinct. While "practice makes perfect", it is now clear that practice, followed by a good night's sleep, make even more perfect. Motor skills learnt in a day, and tested for accuracy that day, improve by about 1/3<sup>rd</sup> for accuracy and fluency on the NEXT day after a good night's sleep! We learn to do things – build instinctive habits - while we are asleep! HOWEVER, it is non REM sleep in the 6<sup>th</sup>-8<sup>th</sup> hours of sleep that cause this to occur. Which is the period of sleep most people lose when woken by an alarm. This is equally important in music, sports and neurosurgery, and it seems that the adage needs to change to "you don't snooze, you lose ....".

As an aside, with sport, apart from affecting learning how to do things, getting less than 8 hours sleep a night, and especially less than 6 hours sleep, means that time to exhaustion decreases by 10-30%, aerobic output and muscle strength decrease, and the risk of injury doubles.

What does this mean for me, or my children, in real life?



In younger children sleep loss causes a range of schooling problems, including naughtiness and poor concentration. In older children and teenagers sleep deprivation can blunt impulse control, which leads to risk-taking behaviors. Sleep problems in teenagers are associated with increased risk of disorders such as depression and attention deficit hyperactivity disorder (ADHD). (See the LiveLife training module on sleep deprivation for more information on the consequences of a lack of sleep).

For memory, evidence from large studies in the USA showed that high school students who regularly score C, D or F in school tests and assignments get, on average, half an hour less sleep per night than high school students who regularly get A and B grades.

For university students, accounting for differences in study habits, health and socioeconomic backgrounds, students who generally get a good night's sleep perform better on exams. The grades of students who sleep seven hours each night during the exam period were nearly 10 percent higher than those of students who got less sleep. Students who extended their sleep duration from six to seven hours saw an average increase of 10% for each exam. Another study showed that decreased nocturnal sleep time, late bedtimes during weekdays and weekends, catch-up sleep on weekends and increased daytime sleepiness are negatively associated with academic performance in medical students. New knowledge is integrated into our existing knowledge base while we sleep, and not getting enough sleep impairs our ability to remember things, short and long term. Studying anything, at any age, and not getting enough sleep, is not as effective for learning as studying and then getting a full night's sleep.

**Fish Oil** - Lipids, a collective term for fats and oils, make up about 50 to 60 percent of the brain's dry weight, and DHA, an omega-3 polyunsaturated fatty acid found in fish, is the most abundant fatty acid found in the cell membranes of the brain's grey matter. It is well known that Omega-3's are essential for healthy pre-natal eye and brain development. It is estimated that 90 % of Australians are not getting enough of these essential (can't be made in our bodies) fatty acids. But does DHA supplementation help us, or our children, to learn?

The DOLAB study by University of Oxford researchers, using a sample of nearly 500 schoolchildren, found that levels of Omega-3 fatty acids in the blood significantly predicted a child's behaviour and ability to learn. Higher levels of Omega-3 in the blood, and DHA in particular, were associated with better reading and memory, as well as with fewer behaviour problems as rated by parents and teachers. Those with the lowest DHA blood levels also had very little fish in their diet. Fish is known as a "brain food", perhaps for good reason.

A 2013 American review of studies on DHA and learning in children found that "DHA-related improvements in school performance were detectable in some of the studies. In particular, reading performance improved in DHA-supplemented children with poor reading skills, and spelling performance was maintained in a DHA-supplemented group while the control group experienced a loss of skills. Over half of the studies reported a favourable role for DHA or long chain omega-3 fatty acids in at least one area of cognition or behaviour,

although it was unable to determine whether memory or attention improvement led to the academic improvement.

**Exercise** – A 2016 systematic review on the relationship between physical activity (PA), fitness, cognitive function, and academic achievement in children found “evidence to suggest that there are positive associations among PA, fitness, cognition (memory recall, learning new information, understanding), and academic achievement. However, the findings are inconsistent, and the effects of numerous elements of PA on cognition remain to be explored, such as type, amount, frequency, and timing.” A 2015 systematic review of the literature to examine the effects of *school-based* physical activity interventions on academic achievement and cognitive outcomes found that a large majority of the studies showed positive results in terms of academic achievement and, above all, cognitive skills. “This review highlights the effectiveness of school-based physical activity interventions on academic achievement and, above all, on youths' cognitive performance.”

According to the Harvard Medical School “Exercise helps memory and thinking through both direct and indirect means. The benefits of exercise come directly from its ability to reduce insulin resistance, reduce inflammation, and stimulate the release of growth factors—chemicals in the brain that affect the health of brain cells, the growth of new blood vessels in the brain, and even the abundance and survival of new brain cells. Indirectly, exercise improves mood and sleep, and reduces stress and anxiety. Problems in these areas frequently cause or contribute to cognitive impairment. Many studies have suggested that the parts of the brain that control thinking and memory (the prefrontal cortex and medial temporal cortex) have greater volume in people who exercise versus people who don't. Engaging in a program of regular exercise of moderate intensity over six months or a year is associated with an increase in the volume of selected brain regions. Regular aerobic exercise, the kind that gets your heart and your sweat glands pumping, appears to boost the size of the hippocampus, the brain area involved in verbal memory and learning. Resistance training, balance and muscle toning exercises did not have the same results.”

We all know that aerobic exercise is beneficial for healthy ageing. It should follow that the benefits of aerobic exercise for children and younger adults on memory should help to maintain good cognitive function in older age. A Cochrane review in 2015 found: - “We found no evidence in the available data that aerobic physical activities, including those which successfully improve cardiorespiratory fitness, have any cognitive benefit in cognitively healthy older adults..... However, it remains possible that it may be helpful for particular subgroups of people, or that more intense exercise programs could be beneficial. Therefore further research in this area is necessary.”

**Blueberries-** There is anecdotal evidence that blueberries may improve memory and concentration. Older rats fed a diet containing blueberries for eight months did better on tests of memory, learning, and coordination than rats that were maintained on non-supplemented diets. When aged rats that already had impairments on these tests were given blueberry extract, their performance improved or even returned to normal. A 2015 British study published in the European Journal of Nutrition reveals that when children consume wild blueberries they show greater memory and better concentration. Each child was randomly given one of three beverages containing different amounts of wild

blueberries or none at all on one day. The study suggests a strong correlation between the intake of wild blueberries and performance with the high dose leading to the best performance and the placebo to the least effective during the test sessions. For example, one test focused on delayed recognition, where the children were asked to remember 15 words from a list of 50 approximately 20 minutes after hearing them. When compared to performance at baseline, the children recognized more words following consumption of the high dose wild blueberry drinks (a 9% improvement) as compared to the placebo (a 3% decrease). Improved performance on a further task where the children were required to ignore distracting stimuli indicated that concentration levels in the wild blueberry rich groups also increased.

**Social networks** – An Australian longitudinal study, published in 2010, was set up to examine the relationship between different types of social networks and memory over 15 years of follow up in a large cohort of older Australians who were cognitively intact at study baseline. The specific aims were to investigate whether social networks were associated with memory, determine if different types of social networks had different relationships with memory, and examine if changes in memory over time differed according to types of social networks. It followed 706 participants with an average age of 78 years at baseline. It demonstrated that larger friend's social networks and overall social networks had significant benefits for memory in a population-based cohort of participants who were cognitively intact at baseline and followed for an average of 15 years. The results suggested a gradient in the effect of social networks, so that participants in the upper tertile (top third) of friends or total social networks had better memory scores than those in the mid tertile, who in turn had better memory scores than participants in the lower tertile (bottom third) of social network. The results also suggested that the observed effects of total and friends social networks were slightly larger for females than for males. Notably, they did not find any significant effects of social networks with children, relatives, or confidants on memory – just friends and social networks.

The mechanisms through which different types of social networks affect cognitive function remain unclear. The finding in the study that social networks with friends had specific effects on memory suggests other ways that social relationships may promote cognitive function. Friends may encourage health seeking and health promoting behaviour, such as physical activity, which may in turn have beneficial sequelae for cognitive health. It is possible that health advice is better received by individuals when it is offered by friends, rather than family or confidants. It is well established that friends can have effects on other psychological measures including depression, self-efficacy, self-esteem, coping and morale, and sense of personal control. I expect this is true all throughout our lives.

*What may help to improve our memory:-*

**Ginkgo Biloba**- The most popular claim made for the use of Ginkgo is to enhance memory and brain function. In healthy adults, despite some studies showing an improvement in short term memory and recall, there does not appear to be a significant improvement in working memory. Attention or focus does not appear to be significantly influenced by ginkgo supplementation. Ginkgo has not been shown to slow or prevent dementia.

**Brahmi** - Traditional knowledge suggests that brahmi (*Bacopa monnieri*) enhances cognitive performance. A 2012 systematic review aimed to examine the scientific evidence as to whether *Brahmi* can enhance cognitive performance in subjects without cognitive impairment or dementia. It found that "There is some evidence to suggest that *Brahmi* improves memory free recall with evidence for enhancement in other cognitive abilities... Across studies, *Brahmi* improved performance on 9 of 17 tests in the domain of memory free recall." In 2008, Choice magazine stated ""The current evidence for Brahmi isn't convincing enough to warrant paying for supplements," .

*What does not seem to work to improve our memory:-*

**Brain training games** – There have been suggested cognitive benefits from brain training games, but the scientific evidence to date suggests that in healthy adults the games do little beyond make people better at the specific tasks involved in game-play. Data obtained so far doesn't seem to show that working memory capacity was expanded after working memory training. What is more consistently observed is that improvements are noted on the trained task and other tasks that share the same specific skills/processes engaged as the trained task.

So far we have looked at what may *improve or maintain* our memory throughout our lives. Memory loss is particularly prevalent as we age, so is there anything we can do during our lifetimes that may limit or prevent the devastating impact of *dementia and memory loss*?

### *Dementia and Alzheimer's disease*

Dementia is a name given to a group of symptoms which result from failing brain functions. The major signs are memory loss, confusion, disorientation and lessening of intellectual functioning. The symptoms of dementia can result from many different causes, although Alzheimer's disease accounts for 70% of all cases of dementia. Dementia is the second leading cause of death of Australians contributing to 5.4% of all deaths in males and 10.6% of all deaths in females each year. In 2016 dementia became the leading cause of death among Australian females, surpassing heart disease which has been the leading cause of death for both males and females since the early 20th century. Females account for 64.4% of all dementia related deaths.

Three in 10 people over the age of 85 and almost one in 10 people over 65 have dementia. Dementia is the single greatest cause of disability in Australians over the age of 65. Given that YOUR life expectancy, on average, should be into your eighties, this is a real issue for you, even though for you personally that is quite a long time away. Can you minimise your chances of getting dementia, or Alzheimer's disease?

Although there is extensive worldwide research being conducted, there is as yet no cure or viable treatment for Alzheimer's disease. Almost all treatments target beta-Amyloid (a protein that causes plaque on brain cells causing Alzheimer's disease) , but it appears that we need to start treating people a decade before dementia appears –it's too late once Alzheimer's becomes evident. The molecules tested on Alzheimer patients may be effective,

but trials are needed in healthy patients to see if they prevent the onset of dementia. With that news, what can we do to stop ourselves from getting dementia, if anything?

**Brain training in dementia-** A Cochrane review included 11 trials of cognitive training and a single trial of cognitive rehabilitation. They found no evidence for the efficacy of cognitive training in improving cognitive functioning, mood or activities of *daily living in people with mild to moderate Alzheimer's disease or vascular dementia*. The University of Sydney's Brain and Mind Centre performed an analysis of clinical trials, including nearly 700 participants. Of those studies, 17 included adults with mild cognitive impairment (MCI)—a decline in thinking and memory that has not yet affected daily living skills—and 12 included adults with full-blown dementia. When the researchers combined and analysed data only involving people with MCI, they found that brain training led to improvements in global cognition, memory, learning and attention, mood, and self-perceived quality of life. However, when they added in data from the 12 studies on people with dementia, that association disappeared. Brain training may be helpful well before dementia starts, but there is no evidence that it prevents or delays dementia.

**Sleep** – (see also the LiveLife sleep deprivation module). People with sleep apnoea (OSA) have chronically disrupted sleep, waking up many times throughout the night, and are at risk for developing mild cognitive impairment an average of 10 years earlier than people without the sleep disorder. Mild cognitive impairment is an early warning sign for Alzheimer's disease, which is caused by a build-up of toxic beta-Amyloid on brain cells. Sleep apnoea (OSA) may be particularly prevalent in people with Alzheimer's disease, with some estimates as high as 70 to 80 percent. It has been found that biomarkers for beta-Amyloid increase over time in elderly adults with OSA in proportion to OSA severity. Individuals with more apnoeas per hour had greater accumulation of brain Amyloid over time. The link between OSA and Amyloid burden in these very early stages of Alzheimer's suggests that CPAP, positional therapy and other treatments for sleep apnea could delay cognitive impairment and dementia in many older adults. There is some evidence that a lack of sleep, or poor quality sleep, as caused by OSA, but also for any reason, contributes to the build-up of beta-Amyloid plaques in the brain. These Amyloid plaques build up in areas of the brain that trigger sleep, and so a cycle builds over time where poor sleep quality leads to Amyloid build up which leads to quality sleep being less likely. Those of us who don't have OSA also need to maintain good sleep patterns throughout life from a young age to minimize the buildup of Amyloid, which may then help maintain those same good sleep patterns perpetually – and our memory.

All adults, including older people, are recommended 7-8 hours' sleep a night, but we tend to sleep less well as we age. Sleep may be disrupted due to other health conditions, daytime dozing, etc. We know that memories are forged when we sleep well, and older people with more disrupted sleep have been shown to have poorer memory retention than the better sleeping peers, and are affected much more than younger sleep deprived people. Older people tend to have less non-REM sleep, and hence tend to have a decreased ability to retain information and memories. In people with Alzheimer's, the capacity to reach or stay in deep n-REM sleep is much less than in unaffected people of the same age, and results from memory tests show that the more Amyloid buildup there is, the less deep sleep there is, and the worse a person does on memory tests. It appears that getting too little sleep

across the adult life span will significantly increase your risk of developing Alzheimer's disease. It may be that your good sleep patterns and 8 hours sleep each night NOW , and from now on , preventing the build-up of beta Amyloid plaques in the brain, may maximise your memory and quality of life in 30,40,50,60 years from now .....

**Fish oil- DHA.** DHA makes up 25% of the fatty component of the brain tissue. A 10 year study of 899 people from the Framingham study, with an average age of 76 and none of whom had signs of dementia, were followed for 9 years. The researchers found that men and women in the quarter of people with the highest DHA (an Omega 3 fatty acid) blood levels had a 47 percent lower risk of developing dementia and 39 percent lower risk of developing Alzheimer's disease than the other three quartiles with lower DHA levels. On average, this top quartile ate fish three times a week, much higher than the people in the other 3 quartiles. The level of DHA in the brain has been shown to be very important for learning ability and memory in early life in studies of rodents, baboons and humans. Inadequate DHA leads to impaired learning .The DHA composition of the brain decreases with age as a result of increased oxidative damage to the lipid membranes. Research indicates that consuming more DHA in the diet later in life increases DHA levels in the aging brain. However, more studies are needed to determine whether omega-3 supplements could prevent dementia.

Research from observational studies has suggested that increased consumption of fish oils rich in omega-3 long-chain polyunsaturated fatty acids (omega-3 PUFA) may reduce the chance of developing dementia .A Cochrane review in 2012 , which included 3 studies with 3536 participants over 24-40 months , with healthy participants over the age of 60 years who were cognitively healthy at the start of the study, found :- " Authors' conclusions: Direct evidence on the effect of omega-3 PUFA on incident dementia is lacking." We do know that omega-3's are good for people with coronary heart disease, and supplementation is useful in older Australians for this reason alone.

**Blueberries-** A way to study Alzheimer's disease is to use transgenic mice that are genetically engineered to have variations in amyloid precursor protein (APP) and presenilin-1 (PS1), proteins that are important in producing the brain pathology characteristic of Alzheimer's disease. Because of the APP mutation, transgenic mice have increased amounts of amyloid-beta. When transgenic mice were maintained on a blueberry-supplemented diet, the levels of two neuroprotective chemicals, extracellular signal-regulated kinase and protein kinase C, which are involved in learning and memory, were found to be increased. Transgenic mice fed a blueberry-supplemented diet were also better able to navigate a maze than their counterparts fed a control diet, even though both groups of animals developed brain plaques.

A 2015 study involved 47 adults aged 68 and older, who had mild cognitive impairment, a risk condition for Alzheimer's disease. The researchers gave them either freeze-dried blueberry powder, which is equivalent to a cup of berries, or a placebo powder once a day for 16 weeks. There was improvement in cognitive performance and brain function in those who had the blueberry powder compared with those who took the placebo. The blueberry group demonstrated improved memory and improved access to words and concepts. The

team also conducted functional magnetic resonance imaging (fMRI), which showed increased brain activity in those who ingested the blueberry powder.

In a study in 16000 women in Boston between 1995 and 2001, researchers measured the mental function of women with an average age of 74 and had not had a stroke. When researchers compared women who ate the **most blueberries** and **strawberries** to those who ate the fewest, they found that those who ate the most had a slower rate of developing memory problems, even when adjusted for exercise and income. The difference was equal to about two-and-a-half years of aging. On average, they were eating a single half-cup serving of blueberries or two half-cup servings of strawberries each week.

**Ginkgo Biloba** - The GEM study is the largest double blind randomly controlled study ever to evaluate Ginkgo and its effect on dementia, following 3000 people for 6 years. Researchers found that in this study, ginkgo at 120 milligrams twice a day was neither effective in lowering the overall incidence rate of dementia nor Alzheimer's disease incidence in normal elderly or elderly people with mild cognitive impairment. But does it help if you already have dementia? A 2009 Cochrane review compared Ginkgo with placebo for their effects on people with acquired cognitive impairment, including dementia, of any degree of severity. It concluded that "The results from the more recent trials showed inconsistent results for cognition, activities of daily living, mood, depression and carer burden. Overall, evidence that Ginkgo has predictable and clinically significant benefit for people with dementia or cognitive impairment is inconsistent and unreliable."

*So what do we remember from this information?*

To optimize your memory today, and that of the people you care for- your family and friends, it is clear that getting a good night's sleep, and regular exercise, are essential. We can all do that, but do we? Adding fish to our diet, or fish oil supplements, is sensible, and maybe adding some blueberries (fresh or powdered for juices/smoothies) will be helpful. Most other "memory boosters" appear to not be worth the money. Maintaining a social network with friends also appears to be very helpful. The saying that "you can make new old friends" is very true – make and keep as many solid friends as you can, throughout life – they will help you in many ways, including maintaining your memory.

What about reducing our chances of getting dementia when we are older? Brain training appears to be useful before we get dementia, but not after. Sleep is essential, throughout our lives, to stave off Alzheimer's disease, so we should all be maximizing that now. Eating fish regularly, or supplementing with fish oil (recommended for cardiovascular health also, 90 % of Australians are not getting enough DHA, and supplements are the cheapest way of getting DHA) seems sensible, despite limited data. Eating blueberries and strawberries regularly throughout our life may also help.