Engage Your Brain:

GCBH Recommendations on Cognitively Stimulating Activities

Global Council on Brain Health℠
A COLLABORATIVE FROM AARP

BACKGROUND: ABOUT GCBH AND ITS WORK

The Global Council on Brain Health (GCBH) is an independent collaborative of scientists, health professionals, scholars and policy experts from around the world working in areas of brain health related to human cognition. The GCBH focuses on brain health relating to people's ability to think and reason as they age, including aspects of memory, perception and judgment. The GCBH is convened by AARP with support from Age UK to offer the best possible advice about what older adults can do to maintain and improve their brain health. GCBH members come together to discuss specific lifestyle issue areas that may impact people's brain health as they age with the goal of providing evidence-based recommendations for people to consider incorporating into their lives.

We know that many people across the globe are interested in learning, first, that it is possible to influence their own brain health and, second, what can be done to maintain their brain health as they age. We aim to be a trustworthy source of information, basing recommendations on current evidence supplemented by a consensus of experts from a broad array of disciplines and perspectives.

COGNITIVELY STIMULATING ACTIVITIES AND BRAIN HEALTH

Cognitively stimulating activities are mentally engaging activities or exercises that challenge a person's ability to think. Many people wonder if you can maintain your thinking abilities as you age by stimulating your brain through various intellectual activities. On March 19-21st, 2017, members of the GCBH met in Washington, DC to examine the impact of cognitively stimulating activities on brain health for adults age 50 and older. Throughout the discussion, experts examined the evidence on whether engaging in cognitively stimulating activities has been shown to: (1) influence people's brains in a positive way, (2) help maintain or improve people's cognition, or (3) help people function better in everyday life. Participants are listed in Appendix 1.

The terms for cognitively stimulating activities run the gamut: mental challenges, mind teasers, games, education and learning, using your brain, discovery, intellectual stimulation—the list goes on. Whatever terms we use, people believe that it is good for brain health to keep an active mind as the aging process continues. But when you begin to look for the scientific evidence about what works to maintain mental functioning as the brain changes over time, things get a little more complicated.

The GCBH took up the challenge of trying to sort through the mountains of conflicting messages and scientific information on the topic of cognitive stimulation because we know adults are looking for reliable ways to enhance their well-being and brain function as they age. AARP's 2015 Survey on Brain Health showed that a large majority of Americans age 50 and older (92%) think that challenging the mind with games and puzzles is important to maintaining or improving brain health. A majority (66%) also think that playing online games designed for brain health is important for maintaining or improving brain health. Commercial claims of the benefit of online training commonly called "brain games" are everywhere, so consumers naturally think these products will be helpful.

Unfortunately, the evidence today regarding the benefits of what most people consider "brain games" is weak to non-existent. Games can be fun and engaging. But often, the claims made by companies promoting the benefits of these games are exaggerated. With that in mind, we think it is important to let people know the current state of the scientific evidence, given that there are many activities that people do for work and/or leisure-time which evidence *has,* in fact, shown to be good for brain health.

The GCBH provides recommendations based on its own experts' research as well as the wider body of evidence across various fields of expertise in the areas of cognitive aging and neuroscience. The good news is that cognitively stimulating activities that are mentally engaging and challenge your ability to think over your life can provide benefits for your brain health. The phrase 'use it or lose it' captures the importance that the GCBH experts give to the value of cognitively stimulating activities. While it's never too late, the sooner you start the better because education and learning are known to enhance cognitive reserve[1], making you less susceptible to the effects of age or disease-related brain changes.

This paper summarizes the consensus reached by the experts and describes the major points of discussion that led to their recommendations for adults age 50 and older. It also identifies gaps in our knowledge about these activities and cognition, provides a glossary defining terms used in the document, and lists resources for additional information. This paper is not intended to be a systematic, exhaustive review of all pertinent scientific literature on the topic. Rather the selected references provided at the end of the document give helpful background material and present a sizeable sample of the current evidence base underpinning the GCBH consensus in this area.

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1 "Cognitive reserve" is defined in the attached Glossary in Appendix 2.

CONSENSUS STATEMENTS

These consensus statements and following recommendations are based on scientific evidence from well-designed randomized controlled trials (RCTs) and epidemiological observational studies[2] with substantial sample sizes, the results of which were published in peer reviewed journals and replicated by other scientists so that the experts have confidence in the results.

1) Throughout life, the brain is dynamic and constantly changing.

2) You can impact how your brain changes as you age. Across the lifespan, the brain continues to develop new neurons and new neural connections. The connections between your nerve cells can also change in many different parts of your brain.

a. Actions you take can affect how these nerve cells and the connections between them develop and can impact how well your brain functions, including your memory, attention, thinking, language and reasoning skills.

b. The physical and social environment in which you live can also influence the development of your brain and cognitive functioning into old age.

3) Cognitively stimulating activities over the life course, such as engaging in formal or self-initiated informal educational activities, continuing to engage in work experiences, learning a new skill, or engaging in leisure activities that are mentally challenging, provide benefits for adults' brain health.

a. Cognitively stimulating activities are mentally-engaging activities or exercises that challenge a person's ability to think.

b. These activities can help you maintain your brain and cognitive abilities, such as your memory, thinking, attention and reasoning skills as you age.

c. Observational studies suggest that cognitively stimulating activities may enhance a person's cognitive reserve.

i. Enhancing cognitive reserve may allow people to cope better with age-related brain changes; and

ii. Enhancing cognitive reserve may reduce a person's risk[3] of developing dementia due to Alzheimer's disease and reduce the severity of symptoms if a person develops the disease; and

iii. Enhancing cognitive reserve may reduce the severity of symptoms of other brain diseases, such as Parkinson's Disease, and lessen the damaging effect of stroke and traumatic brain-injuries.

2 Randomized controlled trials and epidemiological observational studies are defined in the Glossary in Appendix 2. An overview of the differences, strengths and limitations of two study types in humans is listed in Appendix 4.

3 "Risk" and "risk reduction" are defined in the attached Glossary in Appendix 2.

4) Cognitive training[4] refers to a range of programs designed to teach strategies and provide guided practice for improving a particular cognitive ability. (See Table 1 for a description of different forms of cognitive training.)

5) Cognitive training on a specific cognitive ability (e.g., memory, speed of processing, etc.) may improve that specific ability. (See Table 2 for a list of cognitive abilities and how those skills are used in everyday activities.)

a. There is limited evidence that training focused on one cognitive ability (e.g. memory) significantly improves another cognitive ability (e.g. speed of processing);
b. There is mixed evidence on whether training on one cognitive ability improves a person's ability to use that skill to maintain or improve function in everyday activities;
c. Nevertheless, the more similar the training is to the skills you use in everyday life, the more likely that training will help you in everyday activities.

6) Most commercial products marketed as "brain games" are not what the GCBH means when discussing the benefits of cognitive training. If people play a "brain game," they may get better at that game, but improvements in game performance have not yet been shown to convincingly result in improvements in people's daily cognitive abilities. There is insufficient evidence that improvements in game performance will improve people's overall functioning in everyday life. For example, we do not have evidence establishing that getting better at playing Sudoku will help you manage your finances any better.

7) Training on a specific cognitive ability may improve that ability even when a person has mild cognitive impairment (MCI). However, it has not been established that training can improve cognitive ability in patients with clinical diagnosis of dementia (e.g. due to Alzheimer's disease) or alter the underlying course of the disease that may be causing it.

8) Many cognitive training studies have shown that a person can improve the ability for which they are being trained. A few studies examining the long-term effects of cognitive training have shown continued benefit even after training stops. However, the weight of evidence suggests that you need to continue to apply the strategies learned during the training in order to maintain or improve the ability over time.

9) Simply engaging in more cognitively stimulating activities is not necessarily better. The quality of the activities (including novelty, variety, level of engagement, cognitive challenge imposed and degree of enjoyment) is important. Moreover, the duration of time in which you spend doing the activity plays an important role in the extent to which those activities will maintain or improve your brain function.

10) More research is needed on the impacts that cognitively stimulating activities have on the brain, but we have sufficient evidence to conclude that it is beneficial to remain mentally active and to continue learning over the course of your lifespan.

4 The ACTIVE Cognitive Training Trial, a multi-site randomized, controlled trial training for memory, reasoning, or speed-of-processing formed the basis for much of our discussion surrounding cognitive training. ACTIVE outcome assessments spanned ten years.

Table 2 is intended to show how the cognitive abilities people try to improve through different types of cognitive training described in Table 1 relate to everyday activities in peoples' lives.

TABLE 1. TYPES OF COGNITIVE TRAINING

SETTING	COGNITIVE ABILITIES TARGETED FOR TRAINING
• Individual • Group • Computerized	• Attention • Declarative Memory • Episodic Memory • Executive Function (working memory, ability to switch from task to task) • Language • Speed of Processing • Visuospatial Skills • Working Memory

TABLE 2. COGNITIVE ABILITIES AND HOW THEY RELATE TO EVERYDAY ACTIVITIES

EXAMPLES OF COGNITIVE ABILITY PRIMARILY USED IN EVERYDAY ACTIVITIES	EXAMPLES OF EVERYDAY ACTIVITIES
Attention	Driving, concentration on tasks
Declarative Memory	Recalling grocery lists, names of people or places
Episodic Memory	Remembering where you parked your car; Remembering an event that happened at a particular place and time such as your wedding
Executive Function	Planning out a future activity; working out the best solution to a problem
Language	Finding the right word that was on the tip of your tongue
Speed Of Processing	Reacting quickly when driving if a car suddenly stops in front of you, catching a dropping object, or quickly verifying you have received the correct change
Visuospatial Skills	Map reading, furniture layout
Working Memory	Memorizing a phone number long enough to write it down; doing mental calculations in a store to calculate check out total

RECOMMENDATIONS

1) Incorporate enjoyable cognitively stimulating activities as part of a healthy lifestyle to help maintain your brain health and reduce the risk of cognitive decline as you get older.

2) Don't wait until later life to try to maintain your brain health. Start today; the younger you start challenging yourself with cognitively stimulating activities, the better your brain function will be as you age.

3) Be flexible in choosing activities because there are many types of activities which may be helpful. We don't have good evidence that one particular cognitively stimulating activity is more effective than another for maintaining your brain health.

a. If you are not currently engaging in cognitively stimulating activities, seek out a new activity that challenges the way you think.

b. If you already engage in some cognitively stimulating activities, continue those you enjoy and try to add one or two new activities into your life.

c. If you are already very active, consider new ways to challenge yourself such as volunteering to serve as a companion or mentor to others in your community. Mentally stimulating activities that incorporate social engagement and a purpose in life combine many different elements that have been shown to be beneficial for brain health.

d. There are many different examples of cognitively stimulating activities that may help adults maintain or improve their cognition or well-being. Consider practicing tai-chi, taking photography classes, designing a quilt, investigating your genealogy, juggling, cooking, gardening and learning how to play a musical instrument. Other examples include learning new technologies, communicating in a different language or learning a new one, creative writing, making art, and community volunteering.

4) Find ways to re-engage in old activities that you once found to be cognitively stimulating which you may have given up. These may help to promote sustained interest and resurface enjoyable memories.

5) Don't let age limit the scope of your cognitively stimulating activities or intellectual life. Your attitude plays an important role and can shape outcomes even when there are physical limitations to overcome.

6) Seek out new activities that are challenging and will lead to the development of new skills and encourage social engagement. It is the activity itself–and not how well you may perform it—that should be the main goal.

7) Be realistic, there is no miracle to guarantee brain health.

PRACTICAL TIPS

1) **Find new ways to stimulate your brain.** Novelty is important to continually challenge the brain and is an element in what makes even routine cognitive activities interesting and challenging.

2) **Engage your brain along with someone else.** Pick a skill or hobby that you want to learn and find a mentor, friend, or companion to help you do it. Social aspects of activities that challenge your brain can help inspire you to continue your efforts. If being with other people motivates you as it does for many people, join a group activity.

3) **Choose an activity that you enjoy.** This will make it easier to stay motivated and committed over time.

4) **Make it easy on yourself.** Select activities which fit in well with your schedule and are easily accessible so you can stay engaged in the activity.

5) **Aim for purposeful (deliberate) practice.** This will help you to improve performance over time. If you are taking up a new challenging hobby such as learning a new musical instrument or learning a new language, feedback from an instructor, coach or mentor can give you encouragement and keep you learning.

6) **Find an activity where someone will notice whether you are present.** Someone who checks up on you if you miss a session can be an additional motivating factor to keep you going.

7) **Use life stages and transitions to change things up.** Think about the changes in your life as you age, such as moving, changing careers, or retiring as opportunities to try new forms of cognitive stimulation. Maybe the new neighborhood has glass-blowing classes, hiking trails, or a different music group to try out.

8) **Study something you are interested in.** Enroll in continuing education classes at a local community college or university. Set achievable goals, enjoy the process, and reward yourself along the way with something you find relaxing in order to gradually increase your involvement in the activity.

9) **Choose activities involving both mental and physical engagement.** Physical activity has been shown to improve cognition in adults, so choosing activities such as dancing or tennis that involve both mental engagement and physical exercise is a wise use of your time. (See *The Brain-Body Connection: GCBH Recommendations on Physical Activity and Brain Health* for more information on how physical activity helps brain health.)

PROCESS USED TO PRODUCE THE CONSENSUS AND RECOMMENDATIONS

Issue specialists from around the world were selected to participate with the GCBH because they are considered leaders in their fields. These experts have conducted research that has significantly contributed to the body of evidence linking different stimulating activities with brain health amongst older adults. The diverse areas of their expertise represent different perspectives and disciplines including gerontology, neuropsychology, neurology, neuroscience, psychology, public health and speech-language pathology.

Thirteen issue specialists from four continents were asked to critically examine the state of the science as of March 2017. They discussed findings from both observational and epidemiological studies to randomized controlled trials. The experts considered the cumulative body of evidence to determine whether it is sufficient to issue recommendations for individuals to maintain and improve brain health.

The issue specialists considered 11 different questions as a framework to guide their deliberations. The complete list is available in Appendix 3, but the major questions they addressed were: Does engaging in cognitively stimulating activities as an adult age 50 and older 1) impact cognition, 2) impact the brain, and 3) have the ability to positively impact an adult's everyday life?

After an in-depth moderated discussion, several follow-up conference calls and an exchange and refinement of drafts, the issue specialists arrived at 10 consensus statements to summarize the impact of cognitively stimulating activities on brain health. Based on their consensus, they made seven recommendations related to stimulating activities in the context of brain health and reducing the risk for cognitive decline. They further agreed on practical tips to help people around the world adopt behaviors to promote their brain health.

Liaisons from civic and non-profit organizations with relevant expertise in brain health were invited to provide input and technical feedback during the Issue Experts and Governance Committee's refinement of the draft recommendations.

Nine Governance Committee members participated during the in-person meeting. The entire Governance Committee reviewed and finalized the document during subsequent conference calls and emails from March to June 2017. The Governance Committee issuing the recommendations are independent health professionals representing diverse expertise across three continents in epidemiology, psychology, public health, neurology, psychiatry, geriatrics, cognitive neuroscience, neuropsychology, pharmacology, medical ethics and health policy and neurodegeneration.

The Governance Committee applied their expertise to determine whether they concurred with the statements and to evaluate the objectivity and feasibility of the proposed recommendations. The GCBH Governance Committee reviewed this summary document to decide whether it accurately reflected the expert opinions expressed and the current state of science in the field. The Governance Committee approved the document on June 30, 2017.

DISCUSSION

There are differences in the way people's brains age, with some older people having fewer changes in their brain structure and functioning than others. We all know people who seem to thrive as they age and keep their mental functioning sharp. Figure 1 shows individual variability in different people, with some people in their 80s having the same hippocampal volume as people in their 30s. Given that hippocampal volume is correlated with cognitive decline, this figure helps illustrate both that cognitive decline is not inevitable as we age, and that the rate of decline is not the same for all individuals.

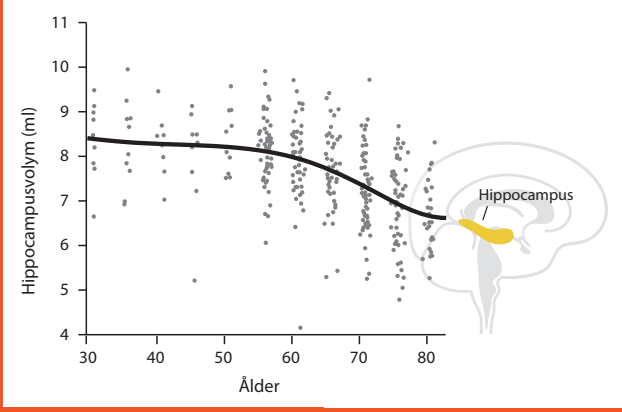

Figure 1 – (Det Åldrande Minnet/The Aging Memory, by Nyberg, Nilsson, Letmark, published by Natur & Kultur, 2016, in Swedish.) Note: Ålder is Age in Swedish

The GCBH agrees that there are many things people can do to promote their brain health as they age. Healthy aging is a highly active process. Engaging in cognitively stimulating activities can help you avoid cognitive decline, delay it, and deal better with it should you eventually experience it. For example, continuing to work in a job you enjoy and that stimulates your thinking has been demonstrated to result in healthier brain aging. Scientific studies have established a link between participation in self-initiated, cognitively stimulating activities and better brain health in aging adults. Life experiences including education, occupation and engaging in leisure activities and learning are known to enhance cognitive reserve, and better cognitive function is associated with greater well-being.

It is never too late to benefit from cognitively stimulating activities, and you can learn new things at any age. In the same way that you need to maintain exercise for physical strength, you need to participate in mental activities to support the health of your brain. There are many ways to incorporate such activities into your daily life. For example, deliberately engaging and challenging your brain over time long after your formal schooling is over results in better cognitive aging for adults. Education is key, not only formal education as a youth, but life-long learning.

The dynamic or "plastic" nature of your brain refers to the remarkable ability of your brain to respond to changes within the body or the external environment over the course of a lifespan. Brain plasticity therefore describes a process through which the brain can modify its structure and function. Seeking out cognitively stimulating activities is a powerful example of an action that a person can take to positively influence his or her brain health. So what are the expected benefits of engaging in cognitively stimulating activities? As one ages, there are expected changes in cognitive functions in several areas such as memory, speed of processing and attention, so activities that help to maintain these and other cognitive functions over time can be beneficial. There is increasing evidence that participation in cognitively stimulating activities may contribute to lowering the risk of dementia and cognitive impairment as one ages. And, to this end, research has also shown that cognitive decline may accelerate when people stop engaging in cognitively stimulating activities. Therefore, it is especially important to keep up cognitively stimulating activities in the transition from work to retirement.

RANGE OF ACTIVITIES TO SEEK OUT

Cognitively stimulating activities may be characterized by novelty, requiring attention and focus, and a depth of engagement. Given this definition, activities that you do regularly in your life can be cognitively stimulating if they involve the characteristics above. Playing with grandchildren, gardening, playing cards and playing chess are all activities that can include elements of novelty and concentrated attention. Calligraphy, or "Shufa" the art of brush writing, is an example of an activity common amongst Asian cultures. It stimulates the brain through intensive attention and planning, and in addition, it involves immediate sensory feedback as one makes the brush strokes. There are many examples of cognitively stimulating activities that people from a range of cultures engage in.

IMPORTANCE OF POSITIVE FEEDBACK FROM OTHERS

Receiving feedback from friends and family appears to motivate people to continue with activities that stimulate the brain. Negative results can discourage people from engaging in or maintaining cognitively stimulating activities. Training in groups where a person receives encouraging coaching from a formal coach or friend seems to improve results. Simply doing the cognitively stimulating activity in the presence of others may help to encourage one to continue participating.

COMPUTER-BASED COGNITIVE TRAINING PROGRAMS

It is widely understood that healthy older adults seek out a range of strategies to maintain their brain function in the face of normal cognitive aging and the associated expected decline. The computer interface offers participants progressively challenging and adaptive interventions as opposed to other types of cognitive interventions which are more static and are not personalized. Computer-based cognitive training programs offer adaptive training as a key feature. Adaptive training can be personalized and introduces elements of novelty and difficulty. Improved adherence and motivation to advance to the next level has been reported in individuals participating in computer-based cognitive training activities. Evidenced-based, cognitive training that has been made into a game on the computer to progressively challenge the mind can be a good way to engage in cognitively stimulating activities. But as noted above, not all commercially-developed brain training games have a sufficient evidence base to support the claims that companies and entities have promoted. Therefore, the GCBH urges people to look carefully at what such games offer and examine the evidence base when considering choosing a computer based training. It is also important to consider other cognitively stimulating choices such as participating in a book club or learning a new language.

MEASURING EFFECTIVENESS AND OUTCOMES OF COGNITIVE TRAINING PROGRAMS

When trying to measure how well a cognitive training program serves to promote brain health and whether it could help you maintain cognitive function as you age, it is important to consider whether the activities that you are engaging in will improve your everyday functioning. There is good evidence that brain training targeting a specific cognitive ability such as memory, reasoning, vocabulary and speed of processing can improve that particular ability, but relatively little evidence exists that such improvements result in maintaining independence or quality of life.

Researchers have observed that better performance can be generated by merely telling people they are participating in training to enhance cognition. This suggests a placebo effect or an effect due to the expectation that we have about the effectiveness of the training in which we are engaged. One recent study, for example, reported that participants who were recruited for a study using flyers that included terms such as "Brain Training and Cognitive Enhancement" showed a 5 to10 point increase in performance after a one hour session of cognitive training as compared to participants who participated in the study but who had not seen the flyer containing the words "Brain Training and Cognitive Enhancement."

COGNITIVE TRAINING FOR INDIVIDUALS WITH DEMENTIA

For people with a diagnosis of dementia, there may be specific treatments that could help maintain their functioning over time. General forms of cognitively stimulating activities can be beneficial for keeping people living with dementia engaged and alert. For instance, it

is very helpful to have people engaged in music or craft activities. In addition, engaging in routine activities related to daily living can help support the person's ability to engage in and manage these activities. 'Cognitive rehabilitation' or 'reablement' are terms used to describe efforts focused on addressing the impact of cognitive impairments on everyday life. For people with mild to moderate dementia, cognitive rehabilitation aimed at helping people carry out specific every day, self-care activities can improve their ability to complete those tasks. Group sessions that involve discussion among small groups of people can provide a different form of cognitive stimulation for individuals with dementia. Psychological and pharmacological interventions may also be implemented to address specific difficulties. However, for individuals with Alzheimer's disease or other dementias, there is evidence that cognitive training programs aimed at providing strategies or practicing focused cognitive abilities like episodic memory or speed of processing are unlikely to be helpful. It is advisable to discuss treatment options with your health care professional.

Family members and friends of loved ones with dementia often want to know what they themselves can do to help. It is very important for people with dementia to maintain positive relationships with family and friends. Friends and family can help their loved one to remain as socially engaged as possible and can encourage opportunities to engage in activities that the person with dementia finds interesting and enjoyable. This can improve mood and support psychological health. It is also important for caregivers themselves to keep engaged in cognitively stimulating activities.

COGNITION AND SPEAKING MORE THAN ONE LANGUAGE

A great deal of research has been conducted in the area of cognition and bilingualism. While there is research showing that learning and using more than one language has a beneficial impact on the brain and on cognition, the evidence from studies in this field is mixed. Some research has demonstrated that adult foreign language learning is accompanied by increases in gray matter in the regions of the brain related to language. Some research has also shown that older people who speak more than one language are better at making decisions when faced with competing information as compared to other similar individuals who only speak one language. When a person can speak more than one language, she or he must choose which language to speak in a particular conversation; this choice strengthens the decision-making capability of the brain. Such reinforcement is particularly apparent when multiple languages are used frequently by the individual. There is also research that suggests that bilingualism may help people cope with brain changes.

As noted above, however, despite a large number of studies showing the benefits of bilingualism, the evidence base is mixed. There are some studies which did not find any brain health advantages from speaking more than one language. Some researchers believe that studies failing to establish a bilingual advantage are also less likely to be published as is often a concern in research not finding significant differences in outcomes between groups tested. Moreover, it has been argued that it is not bilingualism itself, but other factors associated with speaking more than one language that may help protect against brain and cognitive decline. Some researchers argue that bilingualism is associated with higher socio-economic status and education, which are both associated with healthier lifestyles; it may be that such a lifestyle correlates with better cognitive and brain health rather than bilingualism alone. However, recent work has shown that the advantages of bilingualism can extend to some individuals in low-educated and low socio-economic level populations. Therefore it appears that bilingualism might represent a protective shield against cognitive decline, independent of literacy and education.

THE IMPACT OF COGNITIVELY STIMULATING ACTIVITIES ON THE BRAIN

There have been brain-imaging studies investigating the effect of cognitive training on the size, shape, structure and function of the brain and nerve cells. A few brain imaging studies found that cognitive training can increase cortical thickness and the integrity of the white matter. Cognitive training also changes functional brain measures; that is, cognitive training modifies which brain regions will be active when performing a task. Finally, there is some evidence of changes in the chemistry of the brain. While these are interesting findings, much remains to be known regarding the pattern and any short and long term impact of those brain changes attributed to cognitive training.

MYTHS ABOUT THE AGING BRAIN

During the discussion, the GCBH issue experts set forth some of the common myths about aging brains and then described why they were false.

MYTH #1: YOU ARE BORN WITH ALL THE NEURONS YOUR BRAIN WILL EVER HAVE.

While most of the neurons in the brain are created before birth, some areas of the brain do create new neurons throughout life in a process called neurogenesis. For example, studies have shown that new neurons can be created in the region of the brain involved in learning and memory in the adult brain. Moreover, it is thought that the addition of new neurons later in life may actually enhance the formation of new memories as those new neurons are more 'plastic' in nature and thus can more easily modify their connections and store memories. There is hope that understanding the biological basis of how new neurons are created will inform research aimed at helping individuals with neurodegenerative diseases or brain injuries.

MYTH #2: YOU CANNOT LEARN NEW THINGS WHEN YOU ARE OLD. ("YOU CAN'T TEACH AN OLD DOG NEW TRICKS.")

Actually, there are many ways in which you may be able to positively influence your brain health at any age through engagement in cognitively stimulating activities (refer to the "Practical Tips" section of this report). Seeking out new social connections, for example, involves learning new names and information about the new people you encounter. Getting involved in new activities often involves learning procedural details; such novel learning can be beneficial for brain health at any age. Education and many life experiences including those on the job and during leisure activities are known to enhance cognitive reserve (see Glossary, Appendix 2), and better cognitive function is associated with better well-being.

MYTH #3: WE DON'T REALLY KNOW HOW THE BRAIN WORKS.

Great strides have been made in recent decades in understanding the structure and function of the brain. Although the brain is very complex and there is still a great deal to learn, new therapeutic treatments are underway to treat a range of neurological conditions. Researchers are optimistic that the field of neuroscience is at the cusp of many new and exciting breakthrough discoveries in brain health and underlying links to behavior.

MYTH #4: DEMENTIA IS AN INEVITABLE CONSEQUENCE OF OLD AGE.

Dementia is not inevitable and it is not a normal part of aging, although it is an age-related condition. Dementia can be caused by Alzheimer's disease or other age-related disorders, such as stroke. Cognitive decline is associated with aging, but it is important to draw a distinction between typical age-related changes in the brain and those that are abnormal, which in some cases can progress to dementia.

MYTH #5: ONLY YOUNG PEOPLE CAN LEARN A NEW LANGUAGE.

While it is true that children exposed to a new language can usually become fluent with greater ease than adults, people can learn a new language at any age. Part of the barrier for language learning in adults may be cultural customs. For example, in some countries such as Sweden, it is common for retired people to take language classes for a new language, whereas it is not as common in the United States. Children may find it easier as language and grammatical sentence structure for children tend to be less complex, and kids are often less self-conscious while trying new endeavors. That said, it is indeed possible to acquire a new language at any age. It is particularly helpful to reinforce these language skills by seeking out individuals in your community who speak that language to practice.

MYTH #6: OLDER PEOPLE ARE DOOMED TO FORGET THINGS.

Some people have an easier time remembering details than others; this is true of people of all ages. No matter your age, many people find it helpful to use different strategies to remember names, facts, etc. For example, making lists and writing down the names of items you must remember can be effective ways to remember items to pick up at the market. Visual cues are another way to tap into your memory. Take time to examine visual characteristics of your surroundings and people around you. A lot of what people attribute to poor memory is not paying close attention.

MYTH #7: A PERSON WHO HAS MEMORY TRAINING NEVER FORGETS.

Maintaining your skills requires you to continue to practice those skills. While it is important to recognize that there is no miracle cure to guarantee brain health, continually challenging your brain can help to maintain it. "Use it or lose it" applies to memory training as well as to maintaining your physical health.

KNOWLEDGE GAPS

GCBH members identified areas where more research is needed to better understand the impact of cognitive stimulating activity on brain health in adults.

WHICH ASPECT OF COGNITIVELY STIMULATING ACTIVITIES CONTRIBUTES TO BRAIN HEALTH?

Many activities have different aspects or components to them which could be contributing to a beneficial effect on the brain. For example, most cognitively stimulating activities also incorporate social engagement and/or physical activity aspects into the activity which researchers call "multi-modal." We have yet to fully understand which aspect of the chosen activity contributes on its own to brain health. The component parts may moderate the effect of each activity, and it may be the combination of factors taken together that generates the most benefit. Further research on the independent contribution of all the elements involved in the activities could shed more light on this issue.

DO LEISURE BASED INTERVENTIONS HAVE SIMILAR EFFECTS AS COGNITIVE TRAINING AND CAN THEY COMPLEMENT EACH OTHER?

We do not know whether cognitively stimulating leisure-time activities, for example, calligraphy or gardening, have the same benefits for cognition as cognitive training programs specifically designed to teach strategies and provide guided practice for improving a particular ability. Further comparative research into what are the most effective forms of cognitively stimulating activities could help people choose among many options.

WHAT ARE THE UNDERLYING BIOLOGICAL MECHANISMS THAT ARE IMPACTED BY COGNITIVELY STIMULATING ACTIVITIES?

While we have some knowledge of the neural basis of benefits of cognitively stimulating activities such as impacting neural networks and activating neurotransmitters, more research is needed to better understand the underlying mechanisms involved in cognitive stimulation. More theories are being developed and tools, including neuroimaging techniques and animal models, will be critical in our pursuit to understand how learning and transfer of skills work within the brain.

HOW DO INDIVIDUAL DIFFERENCES IMPACT THE WAY PEOPLE RESPOND TO COGNITIVELY STIMULATING ACTIVITIES?

We know very little about how certain factors such as gender, disease status, education, age and genetics contribute to differences in the effects of cognitively stimulating activities on brain structure and function. Nor do we have a good understanding of why some people engage or adhere to a cognitive training program and others do not. While we know that cognitive functioning is influenced by a wide range of factors that have socio-economic underpinnings, more work on how to mitigate the harmful effects of low socio-economic status needs to be accomplished.

HOW WELL CAN COGNITIVE TRAINING PROGRAMS TRANSLATE TO IMPROVEMENTS IN EVERYDAY FUNCTION?

Some methodological challenges exist in studies that have been conducted to assess the effects of cognitive training programs. One major problem is how to measure the benefit of these programs on activities of daily living. As researchers do not usually observe every moment in people's everyday life, they rely on questionnaires which might fail to capture the true effect of the training in the context of people's complex daily life situations. It is difficult to assess cognitive training programs impact on everyday activities that tap into executive function abilities such as driving, planning an activity, changing a strategy when necessary, and dealing with several sources of information. Therefore, developing research methods that appropriately measure applicability to peoples' everyday life and conducting this research could help us answer this question.

WHAT IS THE OPTIMAL DURATION OF COGNITIVELY STIMULATING ACTIVITIES?

Because this field of study is still in an early stage of development, we do not have sufficient information regarding how much (what dose of) cognitive stimulation is the most effective for improving cognitive functioning. Studies should explore how much training is needed to generate benefit, such as total hours of exposure, as well as how often, such as daily, weekly, or monthly. Further, we know relatively little about how long the training's effects last after the training ceases. More developed theory about how cognitive training affects the brain could guide exploration of these dose factors. It may be that different cognitive processes may require different amounts of training to reach an optimal level of performance. However, it is best to maintain a variety of cognitively stimulating activities throughout your life.

IS NON-INVASIVE BRAIN STIMULATION SAFE AND EFFECTIVE FOR MAINTAINING COGNITIVE FUNCTION?

Non-invasive brain stimulation (NIBS) is rapidly growing in acceptance as a tool in neuroscience research and clinical applications. Transcranial magnetic stimulation or TMS, and transcranial current stimulation or tCS, are the most common forms of NIBS at present. NIBS applies electric or electro-magnetic energy through the scalp to impact brain function. NIBS may be useful as a therapeutic device for several psychiatric and neurological diseases. The United States Food and Drug Administration has cleared several TMS devices for therapeutic use in major depression and migraines, and these applications are covered by insurance companies for these purposes. NIBS can impact cognitive processing in the brain, may improve performance in cognitive tasks, and may enhance the effects of cognitive training. There are clinics in several countries offering expensive treatments combining cognitive training and NIBS. However, there is insufficient scientific evidence to conclude that NIBS can lower the risk of cognitive decline, and there are open questions about long-term safety, mechanisms of action, and potential lasting impact on the brain. Therefore, NIBS should only be used for cognitive enhancement in research settings under supervision. Direct-to-consumer devices and do-it-yourself approaches are gaining popularity, but people should be cautious and should seek professional advice and consultation before using NIBS.

CONCLUSION

Your brain has the remarkable ability to respond to changes within the body or the external environment over the course of your lifespan. The aging brain shows plasticity allowing it to modify its structure and function at all ages when faced with the challenges of mental activities. Seeking out cognitively stimulating activities is a powerful way for a person to positively influence their brain health as they age. The GCBH has identified many cognitively stimulating activities you may already be doing. If so, keep it up and challenge yourself to do more complex versions of the stimulating activities you already love. Or try new and different ones. If you aren't currently engaging in any of the suggested activities, consider branching out and challenging yourself.

The consensus statements and recommendations above are based on the current state of science as of March 2017. Immediately before the GCBH approved these recommendations, the National Academies of Science, Engineering and Medicine (National Academies) issued their report, "Preventing Cognitive Decline and Dementia: A Way Forward" on June 22, 2017. This report was sponsored by the National Institute on Aging (NIA) of the National Institutes of Health (NIH), U.S. Department of Health and Human Services. It was based in large part on a systematic review of experimental evidence on the effectiveness or harm of interventions for preventing, slowing, or delaying the onset of clinical Alzheimer's-type dementia, mild cognitive impairment, and/or age related cognitive decline. The evidence review was also supported by the NIA, and conducted by the U.S. Agency for Healthcare Research and Quality (AHRQ).

The National Academies committee found that the "AHRQ systemic review did not identify any specific interventions with enough evidence to justify mounting an assertive public health campaign to encourage people to adopt them for preventing cognitive decline and dementia." Based on findings from the systemic review and other supplemental data sources, however, the National Academies committee concluded that "beneficial effects of the following three classes of interventions are supported by encouraging, although inconclusive evidence: cognitive training, blood pressure management in people with hypertension, and increased physical activity." Cognitive training was defined as including "a broad set of interventions, including those aimed at enhancing reasoning...memory, and speed of processing. Such structured training exercise may or may not be computer based." It also said that it "is appropriate for public health practitioners and health care providers to include mention of the potential cognitive benefits of these interventions when promoting their adoption for the prevention or control of other diseases and conditions." The committee identified the need for improvements in methodologies of future research as well as the need for the NIH and others to support further research to strengthen the evidence base on these interventions as well as others. The GCBH endorses the need for and importance of such research.

The National Academies' Report Highlights concluded that "[c]linical trials and other studies have yielded encouraging data for some interventions, and the public should have access to this information to inform choices on how to invest time and resources to maintain brain health with aging." The GCBH has provided such information. Based on their knowledge of the relevant observational epidemiological evidence, clinical trial evidence from randomized controlled trials, and their own experience and expertise in the field, the GCBH concluded they could reliably recommend that people incorporate enjoyable cognitively stimulating activities as part of a healthy lifestyle to help maintain their brain health and reduce the risk of cognitive decline as people age. It is worth repeating the tenth and final GCBH consensus statement. More research is needed on the impacts that cognitively stimulating activities have on the brain, but we have sufficient evidence to conclude that it is beneficial to remain mentally active and to continue learning over the course of your lifespan.

As further developments occur in the study of the impact of stimulating activities on brain health, the GCBH will periodically revisit these recommendations and provide updates when appropriate.

APPENDICES

1. PARTICIPANTS

Members of the Global Council on Brain Health are independent health care professionals and experts coming from a variety of disciplines. The cognitive activity issue specialists and Governance Committee members formulated these recommendations, and the Governance Committee approved them.

ISSUE SPECIALISTS

ANA INÉS-ANSALDO, Ph.D.
University of Montréal, Canada

DAVID BARTRÉS-FAZ, Ph.D.
University of Barcelona, Spain

SYLVIE BELLEVILLE, Ph.D.
University of Montréal, Canada

NEIL CHARNESS, Ph.D.
Florida State University, USA

SHEUNG-TAK CHENG, Ph.D.
The Education University of Hong Kong

ARTHUR F. KRAMER, Ph.D.
Northeastern University, USA

FACUNDO MANES, Ph.D.
Facaloro University of Buenos Aires, Argentina

LARS NYBERG, Ph.D.
Umeå University, Sweden

ALVARO PASCUAL-LEONE, M.D., Ph.D.
Harvard Medical School,
Beth Israel Deaconess Medical Center, USA

GEORGE REBOK, Ph.D.
Johns Hopkins University, USA

BARBARA J. SAHAKIAN, DSC, FMedSci
University of Cambridge, UK

YAAKOV STERN, Ph.D.
Columbia University, USA

SHERRY L. WILLIS, Ph.D.
University of Washington, USA

GOVERNANCE COMMITTEE

MARILYN ALBERT, Ph.D.
Johns Hopkins University, USA (Chair)

LINDA CLARE, Ph.D. Sc.D.
University of Exeter, UK (Vice Chair)

KAARIN ANSTEY, Ph.D.
Australian National University, Australia

MARTHA CLARE MORRIS, Sc.D.
Rush University, USA

PEGGYE DILWORTH-ANDERSON, Ph.D.
University of North Carolina–Chapel Hill, USA

S. DUKE HAN, PH.D., ABPP-CN
University of Southern California, USA

YVES JOANETTE, Ph.D.
University of Montreal, Canada

JASON KARLAWISH, M.D.
University of Pennsylvania, USA

MIIA KIVIPELTO, M.D., Ph.D.
Karolinska Institutet, Sweden

JESSICA LANGBAUM, Ph.D.
Banner Alzheimer's Institute, USA

JACOBO MINTZER, M.D., M.B.A.
Roper St. Francis Clinical Biotechnology Research Institute, USA

RONALD PETERSEN, M.D., Ph.D.
Mayo Clinic, USA

KATE ZHONG, M.D.
Global Alzheimer's Platform Foundation, USA

MODERATOR

JACKIE JUDD
Health Media Journalist

STAFF

NICHOLAS BARRACCA
AARP

LINDSAY R. CHURA, Ph.D.
AARP

JAMES GOODWIN, Ph.D.
Age UK

CARL LEVESQUE
AARP

WILLIAM HU, M.D., Ph.D.
Emory University, and Consultant to GCBH

SARAH LENZ LOCK, J.D.
AARP

DEBRA WHITMAN, Ph.D.
AARP

LIAISONS

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LIBBY ARCHER
World Dementia Council

MATTHEW BAUMGART
Alzheimer's Association

DOUG BROWN, Ph.D.
Alzheimer Society

MELINDA KELLEY, Ph.D.
National Institute on Aging*

LISA MCGUIRE, Ph.D.
Centers for Disease Control and Prevention*

JANE TILLY, Dr.PH
Administration for Community Living*

MOLLY WAGSTER, Ph.D.
National Institute on Aging*

JOAN WEISS, Ph.D., RN, CRNP
Health Resources and Services Administration*

**Participation in this activity by these individuals does not necessarily represent the official viewpoint of the U.S. Department of Health and Human Services, the National Institutes of Health, or the National Institute on Aging.*

PARTICIPANT AND LIAISONS' LIST OF ADDITIONAL RESOURCES

THE DISCONNECTED MIND PROJECT – FUNDED BY AGE UK
ageuk.org.uk/about-us/what-we-do/the-disconnected-mind/

PREVENTING COGNITIVE DECLINE AND DEMENTIA: A WAY FORWARD
doi.org/10.17226/24782

THE BRAIN HEALTH RESOURCE FROM THE ADMINISTRATION ON COMMUNITY LIVING (ACL)
acl.gov/node/293

2. GLOSSARY

The glossary highlights how the GCBH used these terms within the context of their discussions and in this document.

ATTENTION
The concentration of awareness in a focal and perceptive way.

BRAIN HEALTH
A state of having good underlying neural mechanisms to support high functioning mental processes of cognition and that supports well-being.

BRAIN MAINTENANCE
Individual differences in the manifestation of age-related brain changes and pathology that allow some people to show little or no age-related cognitive decline.

BRAIN RESERVE
Individual differences in the brain size or neuronal count which allows resilience or adaptability of some people (and not others) to curb age- or disease-related brain changes.

COGNITION
The ability to attend (pay attention to something), think, learn, and remember. It is the basis for how we reason, concentrate, plan, exercise judgment, and organize.

COGNITIVE DECLINE
The Institutes of Medicine (IOM) in 2015 defined a similar term, cognitive aging, as the lifelong process of gradual and ongoing, yet highly variable, change in cognitive functions that occur as people get older. Cognitive decline is a term used by the experts to describe losing cognitive abilities over time as people age absent a specific disease or condition.

COGNITIVE MAINTENANCE
Individual differences in cognitive abilities and health due to upkeep or re-engagement that allow some people to show little or no age-related cognitive decline.

COGNITIVE RESERVE
Individual differences in the resilience or adaptability of cognitive processes, such as memory, reasoning and attention, that together help explain why some people are more susceptible than others to age- or disease-related brain changes.

COGNITIVE RESILIENCE
The brain's ability to respond more adaptively to stress.

CONFOUNDER
A situation in which the effect or association between an exposure and outcome is distorted by the presence of another variable.

CORTICAL THICKNESS
A measure used to describe the thickness of the layers of the cerebral cortex (outer layer of neural tissue) in humans and other mammals.

DAILY LIVING ACTIVITIES (ACTIVITIES OF DAILY LIVING – ADL)
An umbrella term that refers to activities or tasks that people undertake routinely in their everyday life, including self-care.

DEMENTIA
Dementia isn't a specific disease. Instead, dementia describes a group of symptoms related to memory, thinking and social abilities and affecting them severely enough to interfere with daily functioning. Though dementia generally involves memory loss, memory loss has different causes. So memory loss alone doesn't mean you have dementia. Alzheimer's disease is the most common cause of a progressive dementia in older adults, but there are a number of causes of dementia. Depending on the cause, some dementia symptoms can be reversed.

EFFICACY
The degree to which an intervention accomplishes the desired or projected outcomes.

EPIDEMIOLOGICAL STUDIES
(which can be cross-sectional or longitudinal). In these studies, which are observational in nature, scientists try to establish a link between lifestyle activities over time (e.g., education) and long-term outcomes (brain health with aging).

EXECUTIVE FUNCTION
The mental process needed when you use working memory, or undertake planning, problem-solving and decision making.

FLEXIBILITY
The readiness with which a person's focus changes selectively in response to the environment.

GREY MATTER
A description of the brain tissue that processes information. (See also, white matter definition.)

INTERVENTION

Any measure whose purpose is to improve health or alter the course of disease.

LANGUAGE

A formal system of communication which involves the combination of words and/or symbols, whether written or spoken, as well as some rules that govern them.

LITERACY

The ability to read and write.

LONGITUDINAL STUDIES

In longitudinal research, scientists observe changes over an extended period of time to establish the time-sequence in which things occur or the effect of a factor over time.

MEMORY

The mental faculty of retaining and recalling past experience based on the mental processes of learning, retention, recall and recognition.

DECLARATIVE MEMORY

The conscious remembering of factual information (semantic memory) or previous experiences (episodic memory).

EPISODIC MEMORY

Memory of autobiographical events. The storage of unique events or experiences associated with a specific time and place.

SEMANTIC MEMORY

A portion of long-term memory that holds the knowledge of facts.

WORKING MEMORY

The ability to hold information in mind long enough to integrate or reorder information.

NETWORK

The series of neuron connections which control a person's abilities and responses.

PLASTICITY

The process in the brain that allows learning to occur.

RANDOMIZED CONTROLLED TRIAL (RCT)

In a typical randomized controlled trial, people are randomly selected to receive either the intervention or a control condition. In a double-blind trial, both the participants and the researchers are unaware of (or "blinded" to) which person received the intervention until after the results are analyzed.

REASONING

The thought process behind an action or judgment.

RISK

Risk is the chance or probability of a particular event happening in a group of people with similar characteristics or traits, compared with those not having that characteristic or trait. Making up an individual's overall risk of having a condition is the cumulative effects of factors that increase the chance of developing the condition (risk factors) as well as factors that decrease the chance of developing the same condition (protective factors).

RISK REDUCTION

Reducing risks for cognitive decline or impairment in the abilities to think, reason, and remember means lowering your chances of experiencing loss in those abilities. A person's overall risk may also be reduced by increasing factors that protect against cognitive decline or dementia. Dementia (due to Alzheimer's disease or another related disorder) is one condition, and cognitive decline (the slowing of thinking and memory in the absence of a major brain disease) is another condition. When scientists study risk reduction strategies for cognitive decline, they are looking for factors that can reduce the risk of impairment to cognitive functions in the population in general. Therefore, some activity or intervention that reduces risk for a particular condition or disease means that a smaller proportion of people who engage in that activity are likely to have the condition or disease. However, risk reduction strategies are not the same as preventing any one individual from getting the condition or suffering from disease. For example, research has long shown that wearing a seatbelt reduces – but does not eliminate – the chance of injuries among people who are involved in automobile accidents and we nevertheless now recommend people wear seatbelts while they are driving.

SPEED OF PROCESSING

How quickly you carry out simple decision-making. For example, how quickly you can take in a bit of new information, reach some judgment on it and then formulate a response.

TRAINING

A specific practice or intervention of a cognitive ability, usually in the academic or research setting, which improves a specific cognitive ability and may transfer to improvement in everyday outcomes.

VISUOSPATIAL SKILLS

The ability to mentally combine visual and spatial information for successful completion of a spatial task.

WHITE MATTER

A description of the brain tissue, covered in a white fatty protein, used to connect areas of the brain with are farther apart. These are "highways" transmitting information from one area of grey matter to another.(See also grey matter definititon.)

3. DISCUSSION QUESTIONS FRAMING THE DELIBERATIONS

1) Can cognitively stimulating activities maintain or improve mental abilities such as memory and reasoning skills in adults without cognitive impairment as they age?

a. What evidence do we have on specific types of cognitively stimulating activity that lead to maintaining or improving cognition?
b. Is there evidence concerning the likely duration, intensity and frequency necessary for cognitively stimulating activity to achieve the greatest cognitive benefit?
c. Is there evidence that there must be an increase in mental exertion, or novelty, or deliberate, active participation for the activity to maintain or improve cognitive function?
d. Can cognitively stimulating activities impact age-associated cognitive decline?

2) Can cognitively stimulating activities affect the course of decline associated with age-related neurological diseases, such as the dementias?

3) Are there specific cognitive activities you would encourage or discourage for the purpose of reducing the risk of or delaying age-related cognitive decline or age-related neurological disorders (e.g., stimulating activities that people should engage in such as taking up new or novel activities, promoting flexible thinking, or mixing physical activity with cognitive activity such as tai chi)?

4) What are the limitations in our scientific knowledge about the ages/types/conditions of people who can benefit from cognitive activity (e.g., only literate people have been evaluated so we don't know about those who can't read, or if individuals reach a certain age it is too late to benefit from cognitive training, or if an individual has had a stroke or is already experiencing dementia, he or she will not benefit from cognitive training, etc.)?

5) Do certain aspects of cognitive training (e.g., repeated exposure through practice) have an impact on how the brain responds?

a. Is there neuropsychological, structural (MRI), or functional (PET, fMRI) evidence of the impact of short and long-term cognitive training?
b. What are the best standards and practices for evaluating such cognitive training interventions?

c. What is the opportunity cost of engaging in cognitive-training games? That is, what is the relative impact of improving performance on games one purchases versus engaging in other life style activities thought to promote brain health?

d. What do we know about the duration and scope of training necessary to maintain cognitive function over time?

6) What is the impact of education on cognitive health? There is speculation that declining rates of dementia are linked to more educated populations in many regions of the world. Is there research to support this? And what is the evidence for the benefit of formal education for individuals when they are young vs. the impact of educational programs across the lifespan?

7) What is known about social determinants of health and individual differences as well as factors that can modulate responses to cognitive activities?

8) To what extent does cognitive training impact a person's ability to maintain his or her independence in their communities? (i.e., is there evidence that cognitive training that improves performance on a specific task can support maintenance or improvement in daily activities?)

9) What role does non-invasive brain stimulation play in brain [cognitive?] plasticity and the potential for rehabilitation in individuals with cognitive decline?

10) What does research say about the advantages of bilingualism in cognitive aging?

a. What types of advantages have been documented, in regards to brain function and cognitive skills?

b. Is it the fact of being bilingual that explains these advantages, or could they result from other factors generally associated with bilingualism, such as education and socio-economic status?

c. How does age of second language acquisition affect the bilingual advantage?

d. What is the impact of bilingualism on cognitive health in cases of dementia?

e. Would you recommend older people learn a new language?

11) If we have a sufficient basis for recommending cognitive activity to adults, what evidence exists for how to motivate adults to engage and sustain these cognitive activities if they are not already participating in these activities?

4. DIFFERENCES, STRENGTHS AND LIMITATIONS OF TWO STUDY TYPES IN HUMANS

	EPIDEMIOLOGICAL (OBSERVATIONAL) STUDIES	RANDOMIZED CONTROLLED TRIALS (RCTS)
PURPOSE	To observe a group of people in their natural surroundings (often over extended periods of time), and to identify personal characteristics, behaviors, and conditions which predict someone's chance of developing a condition or a disease.	To determine, in a controlled setting, whether implementing a change (in behavior, diet, medication, etc.) can definitively lead to a specific outcome. This compares those engaging in an activity with those not engaging in the activity.
EXAMPLE	Researchers who survey and follow women living in Metropolis show that women who run weekly have fewer incidents of heart attack in their 60s.	Researchers at University Medical Center wish to recruit 500 women in their 60s to determine whether having them run weekly can reduce their chance of heart attack during the one year study compared to those who don't run.
STUDY DURATION	Years to decades	Weeks to months, sometimes years
STRENGTHS	• Usually larger number of people • Can take into account influences from many more factors and personal characteristics and disease states • Can assess many dose levels and durations of behavior. • Can detect slow or cumulative changes over time • Where observational studies are representative of the population, they have greater external validity which means that the findings can be applied to a wider range of people.	• Helps to prove causal link and to better understand mechanisms. • Randomization can eliminate many competing hypotheses as why the change actually happened (because confounding factors have an equal probability of occurring in all groups). • Can test whether different dose of the intervention (e.g., exercise frequency, drug dose) can lead to different outcomes. • Uses detailed and objective measurements and assessments.
LIMITATIONS	• Does not prove any specific causal link. • May not capture all characteristics which influence health. • Any characteristic may reflect another more important factor (e.g., people who take expensive medications may have better access to health care). • Selective drop-out of those less socially advantaged and less healthy. • Difficult to generalize from one region to another due to differences in diet, environment, healthcare, etc. • Often cannot collect detailed information due to the large numbers of participants and measures. • Expensive to set up and run, especially over long periods. • Some studies rely on self-reported behavior which may be inaccurate. • People who partake in a study to be followed for long periods of time might bias inclusion.	• Usually smaller number of people. • While an RCT attempts to control for confounding factors, it may not capture all characteristics which influence health. • The study may be too limited in size or duration to detect subtle effects. • Difficult to test conditions which scientists cannot change (e.g., gender, genetics, past exposure). • Difficult to generalize from one region to another due to differences in diet, environment, healthcare, etc. • In smaller RCTs, outcomes can be biased by accidental inclusion of people who are much more or much less likely to respond to the intervention. • Effects are restricted to defined dose and intervention type. • RCTs usually have very strict inclusion and exclusion criteria so the samples are often unrepresentative and results cannot be as widely generalized. • Attrition rate during the course of the RCT could bias the results. • Outcome reporting bias can influence results in which primary outcomes are changed, introduced or omitted since the original protocol. • Short time frame limits capacity to examine long term interventions which is particularly relevant for lifestyle changes that may lead to small, cumulative effects over years and decades such as cognitively stimulating activity.

5. DISCLOSURE STATEMENT OF POTENTIAL FINANCIAL CONFLICTS OF INTEREST

All of the twenty-six GCBH experts participating in the formulation of this paper were asked to disclose potential conflicts of interest. Twenty-three of the experts who participated in the meeting and contributed to the formulation of the recommendations attested they had no conflicts of interest. Three disclosed on-going relationships which have the potential to raise perceived financial conflicts of interest involving consulting with for-profit companies. Dr. Petersen declared part-time consultation with several pharmaceutical companies. Dr. Sahakian declared consulting with a pharmaceutical company, as well as with a cognitive assessment company, Cambridge Cognition, and a mobile brain training company, Peak. Dr. Pascual-Leone declared participating on scientific advisory boards for several companies developing transcranial stimulation methods, as well as a computer-based cognitive training company, Constant Therapy. Dr. Pascual-Leone also holds numerous patents relating to transcranial stimulation. These disclosures are available upon request by contacting staff of the Global Council on Brain Health. The authors are unaware of any affiliation that affected the objectivity of this paper and its recommendations.

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7. SELECTED RESOURCES

Arpino, B. and V. Bordone (2014). "Does Grandparenting Pay Off? The Effect of Child Care on Grandparents' Cognitive Functioning." J Marriage Fam 76(2): 337-351. doi.org/10.1111/jomf.12096.

Ball, K., et al. (2002). "Effects of cognitive training interventions with older adults: a randomized controlled trial." JAMA 288(18): 2271-2281. doi.org/10.1001/jama.288.18.2271.

Beddington, J., et al. (2008). "The mental wealth of nations." Nature 455(7216): 1057-1060. doi.org/10.1038/4551057a.

Beddington, J. et. al. (2011). Brain Waves Module I: Neuroscience, society and policy London, The Royal Society.

Belgrave, M. (2011). "The effect of a music therapy intergenerational program on children and older adults' intergenerational interactions, cross-age attitudes, and older adults' psychosocial well-being." J Music Ther 48(4): 486-508. doi.org/10.1093/jmt/48.4.486.

Belleville, S., et al. (2011). "Training-related brain plasticity in subjects at risk of developing Alzheimer's disease." Brain 134(Pt 6): 1623-1634. doi.org/10.1093/brain/awr037.

Berroir, P., et al. (2017). "Interference control at the response level: Functional networks reveal higher efficiency in the bilingual brain." J Neurolinguistics 43(A): 4-16. doi.org/10.1016/j.jneuroling.2016.09.007.

Bidelman, G. M. and C. Alain (2015). "Musical training orchestrates coordinated neuroplasticity in auditory brainstem and cortex to counteract age-related declines in categorical vowel perception." J Neurosci 35(3): 1240-1249. doi.org/10.1523/jneurosci.3292-14.2015.

Bruhl, A. B. and B. J. Sahakian (2016). "Drugs, games, and devices for enhancing cognition: implications for work and society." Ann NY Acad Sci 1369(1): 195-217. doi.org/10.1111/nyas.13040.

Cagney, K. A. and D. S. Lauderdale (2002). "Education, wealth, and cognitive function in later life." J Gerontol B Psychol Sci Soc Sci 57(2): P163-172. doi.org/10.1093/geronb/57.2.p163.

Carlson, M. C. (2011). "Promoting healthy, meaningful aging through social involvement: building an experience corps." Cerebrum 2011: 10.

Carlson, M. C., et al. (2015). "Impact of the Baltimore Experience Corps Trial on cortical and hippocampal volumes." Alzheimers Dement 11(11): 1340-1348. doi.org/10.1016/j.jalz.2014.12.005.

Cheng, S. T. (2016). "Cognitive Reserve and the Prevention of Dementia: the Role of Physical and Cognitive Activities." Curr Psychiatry Rep 18(9): 85. doi.org/10.1007/s11920-016-0721-2.

Clare, L., et al. (2016a). "Bilingualism, executive control, and age at diagnosis among people with early-stage Alzheimer's disease in Wales." J Neuropsychol 10(2): 163-185. doi.org/10.1111/jnp.12061.

Clare, L. et al. (2016b). "Executive control in older Welsh monolinguals and bilinguals." J Cogn Psychol 28(4): 412-426. doi.org/10.1080/20445911.2016.1148041.

Corbett, A., et al. (2015). "The Effect of an Online Cognitive Training Package in Healthy Older Adults: An Online Randomized Controlled Trial." J Am Med Dir Assoc 16(11): 990-997. doi.org/10.1016/j.jamda.2015.06.014.

de Bruin, A., et al. (2015). "Cognitive advantage in bilingualism: an example of publication bias?" Psychol Sci 26(1): 99-107. doi.org/0.1177/0956797614557866.

Foroughi, C. K., et al. (2016). "Placebo effects in cognitive training." Proc Natl Acad Sci USA 113(27): 7470-7474. doi.org/10.1073/pnas.1601243113.

Hertzog, C., et al. (2009). "Enrichment effects on adult cognitive development." Psychol Sci Public Interest 9(1): 1-65. doi.org/10.1111/j.1539-6053.2009.01034.x.

Jarrott, S. E. and K. Bruno (2003). "Intergenerational activities involving persons with dementia: an observational assessment." Am J Alzheimers Dis Other Demen 18(1): 31-37. doi.org/10.1177/153331750301800109.

Litwin, H., et al. (2016). "Cognitively stimulating leisure activity and subsequent cognitive function: A SHARE-bases analysis." Gerantologist. 00. 1-9. doi.org/10.1093/geront/gnw084.

Martensson, J., et al. (2012). "Growth of language-related brain areas after foreign language learning." Neuroimage 63(1): 240-244. doi.org/10.1016/j.neuroimage.2012.06.043.

Morita, K. and M. Kobayashi (2013). "Interactive programs with preschool children bring smiles and conversation to older adults: time-sampling study." BMC Geriatr 13: 111. doi.org/10.1186/1471-2318-13-111.

Mukadam, N., et al. (2017). "The Relationship of Bilingualism Compared to Monolingualism to the Risk of Cognitive Decline or Dementia: A Systematic Review and Meta-Analysis." J Alzheimers Dis 58(1): 45-54. doi.org/10.3233/jad-170131.

National Academies of Sciences, Engineering, and Medicine. 2017. Preventing Cognitive Decline and Dementia: A Way Forward. Washington, DC: The National Academies Press. doi.org/10.17226/24782.

Nyberg, L., et al. (2012). "Memory aging and brain maintenance." Trends Cogn Sci 16(5): 292-305. doi.org/10.1016/j.tics.2012.04.005.

Rebok, G. W., et al. (2014). "Ten-year effects of the advanced cognitive training for independent and vital elderly cognitive training trial on cognition and everyday functioning in older adults." J Am Geriatr Soc 62(1): 16-24. doi.org/10.1111/jgs.12607.

Simons, D. J., et al. (2016). "Do "Brain-Training" Programs Work?" Psychol Sci Public Interest 17(3): 103-186. doi.org/10.1177/1529100616661983.

Stern, Y., et al. (2011). "Space Fortress game training and executive control in older adults: a pilot intervention." Neuropsychol Dev Cogn B Aging Neuropsychol Cogn 18(6): 653-677. doi.org/10.1080/13825585.2011.613450.

Unverzagt, F. W., et al. (2007). "Effect of memory impairment on training outcomes in ACTIVE." J Int Neuropsychol Soc 13(6): 953-960. doi.org/10.1017/s1355617707071512.

Willis, S. L. and S. Belleville (2016). Handbook of the Psychology of Aging K. Warner Schaie and S. L. Willis. E-book, Academic Press 219-243. doi.org/10.1016/c2012-0-07221-3.

Willis, S. L., et al. (2006). "Long-term effects of cognitive training on everyday functional outcomes in older adults." JAMA 296(23): 2805-2814. doi.org/10.1001/jama.296.23.2805.

Wurzman, R., et al. (2016). "An open letter concerning do-it-yourself users of transcranial direct current stimulation." Ann Neurol 80(1): 1-4. doi.org/10.1002/ana.24689.

Xu, M., et al. (2013). "Cognitive-neural effects of brush writing of Chinese characters: cortical excitation of theta rhythm." Evid Based Complement Alternat Med 2013: 975190. doi.org/10.1155/2013/975190.