Boosting Brain Health

Interventions for the Prevention and Treatment of Mild Cognitive Impairment and Early Neurodegenerative Disease

Mary Lu Bushnell, PsyD, ABPP-CN[a,*], Nicole A. Roberts, PhD[b], Kristen Caraher, PsyD, ABPP-CN[c]

KEYWORDS

• Brain health • Mild cognitive impairment treatment • Cognitive rehabilitation
• Dementia prevention • Perceived memory impairment

KEY POINTS

- A brain healthy lifestyle that includes managing modifiable medical risk factors, lifestyle factors, socio-emotional factors, and cognitive interventions have the potential to improve neurocognitive functioning in all individuals, including those with mild cognitive impairment (MCI) or early neurodegenerative disease.
- Even small lifestyle changes can have a positive impact on brain health.
- Medical providers are in an ideal position to share information about multi-modal interventions with patients.
- Brain Boosters is an example of a multi-modal psychoeducational program to assist patients with brain health and optimization of cognition and daily functioning.

INTRODUCTION

While some aspects of cognition are expected to decline over time, other areas are expected to remain intact well into advanced age in healthy adults. However, a subset of the population will experience neurodegenerative processes such as mild cognitive impairment (MCI) or dementia (described later). In these cases, neuropathologic changes are associated with measurable cognitive and functional deficits. In this paper, the authors describe approaches to managing, compensating for, and preventing these changes. The authors focus on current evidence demonstrating that lifestyle

[a] Phoenix VA Health Care System, Psychology 116B, 650 East Indian School Road, Phoenix, AZ 85012, USA; [b] School of Social and Behavioral Sciences, Arizona State University, 4701 West Thunderbird Road, MC 3051, Glendale, AZ 85306, USA; [c] Department of Psychiatry, University of Iowa Hospitals & Clinics, 200 Hawkins Drive, Iowa City, IA 52242, USA
* Corresponding author. 650 East Indian School Road, Phoenix, AZ 85012.
E-mail address: mary.bushnell@va.gov

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factors (eg, physical activity, nutrition, and management of health conditions) and socio-emotional factors (eg, mental health, social support), as well as cognitive interventions (eg, compensatory strategies) have benefits for brain health, including lowering risk, and possibly slowing progression, of MCI and dementia. Finally, the authors discuss 1 specific intervention, Brain Boosters, which targets whole brain health through a group psychoeducational approach. Brain Boosters provides a model of how to integrate these factors through a holistic approach to improve outcomes for individuals with a range of early- and moderate-stage cognitive deficits and functional decline. The strategies introduced in Brain Boosters also can benefit those without objective cognitive deficits.

Dementia and Mild Cognitive Impairment

More than 55 million people have dementia worldwide, and it is considered a leading cause of disability among older adults globally.[1] Dementia, also known as major neurocognitive disorder, is defined as, "*evidence of significant cognitive decline from a previous level of performance in one or more cognitive domains*," and is marked by *"cognitive deficits [that] interfere with independence in everyday activities"* (see Kharine R. Jean and Vonetta M. Dotson's article, "Dementia: Common Syndromes and Modifiable Risk and Protective Factors," in this issue). Dementia has a profound negative impact for the individual with the condition, as well as families, caregivers, and for public health services.[2–4] Further, the expectation of progressive deterioration and loss of autonomy may create considerable fear or worry about receiving a dementia diagnosis, even among cognitively healthy adults.[5]

MCI, also known as mild neurocognitive disorder,[6] is considered a transitional period between healthy aging and dementia[7] (see Kevin Duff's article, "Mild Cognitive Impairment: Quantifying a Qualitative Disorder," in this issue). Similar to dementia, to meet criteria for MCI, there must be a decline from a prior level of performance in 1 or more cognitive domains. However, in MCI, the evidence is "modest" as opposed to significant cognitive decline. Additionally, an important aspect that differentiates MCI and dementia is that in MCI the *"cognitive deficits do not interfere with capacity for independence in everyday activities"*.[6]

Etiology of MCI and dementia can be broad and caused by neurodegenerative processes, acute events such as stroke, brain injury, tumor or resection, and other systemic or medical conditions. There are currently no treatments to reverse or cure dementia. While some individuals with MCI progress to dementia, some will remain stable over time, and some will revert to normal cognition.[8] Although medications for mild to moderate Alzheimer's disease (AD) are prescribed in individuals with MCI off-label, there are no disease-modifying agents specifically for MCI.[9–11] Early intervention offers the best opportunity to reduce or slow disease progression.[12]

Lifestyle Factors Influence Brain Health and Neurocognitive Functioning

While there is a misconception that little that can be done to prevent dementia,[13] evidence suggests that up to 40% of dementia risk may be attributable to potentially modifiable behavioral and environmental risk factors; these are detailed in a comprehensive report published by *The Lancet Commission* in 2020 on "Dementia prevention, intervention, and care".[14,15] As depicted in **Fig. 1** (reprinted with permission from the report), mitigating such risk factors can be beneficial in all stages of life.[14] Further, lifestyle interventions in the early stages of cognitive decline can stave off or slow the course of progressive decline.[16] Recent clinical trials have shown a powerful relationship between healthy lifestyle habits and enhanced brain health. The science behind brain health and lifestyle has been incorporated into guidelines

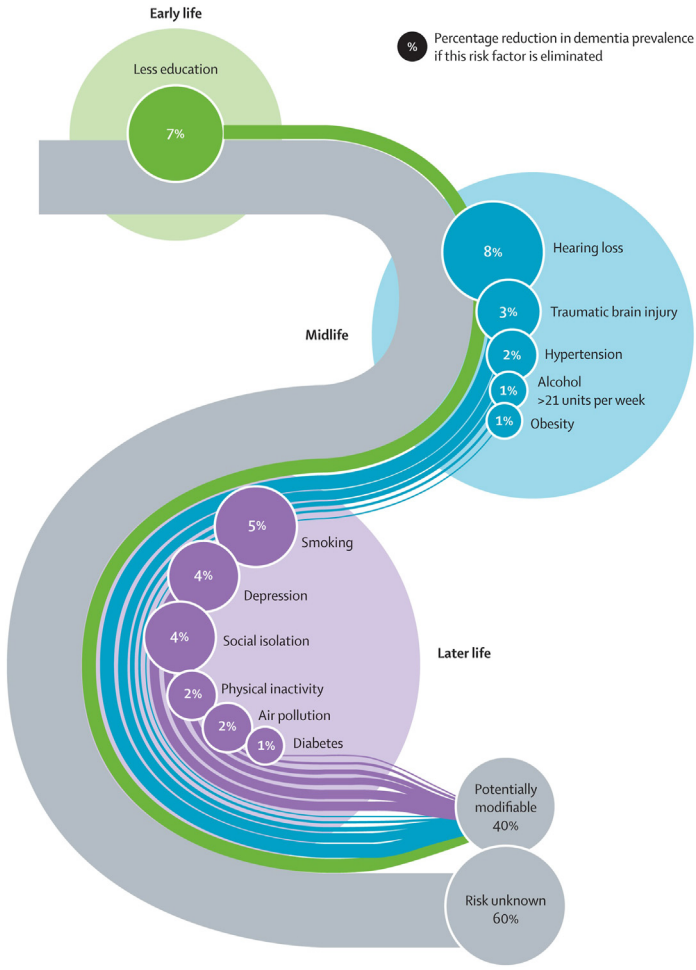

Fig. 1. Lifestyle factors that influence brain health and neurocognitive functioning. (*Reprinted with* permission from Elsevier. The Lancet, 2020;396(10248):413-446.)

from several leading national and international organizations, including Centers for Disease Control and Prevention, World Health Organization (WHO), National Institutes of Health, American Associations of Retired Persons, and Alzheimer's Association, and more.[2–4]

Interestingly, neuropsychological interventions for these populations go beyond cognitive strategies only, and often target multiple domains, including cognitive training alongside lifestyle interventions.[17–19] As the general population ages, there is an increased need for psychoeducation, behavioral intervention, and resources for individuals with MCI. Additionally, there is a large public interest in brain health and preserving cognitive functioning even in individuals without objective cognitive deficits or concerns.

All medical providers, including neurologists, can play an important role in educating patients on lifestyle behavior modification strategies. Further the authors outline some

of the most significant lifestyle strategies that have the potential to make an impact when it comes to dementia or MCI prevention and treatment.

Managing health conditions

Many medical conditions impact brain health, and their management can decrease risk and improve cognitive functioning. Vascular disease is recognized as a major contributing factor in dementia, often co-occurring with AD, and neurovascular health is essential for brain health and cognitive functioning.[20–24] Management of hypertension reduces risk of cognitive decline and dementia.[25,26] Addressing other medical factors, such as preventing obesity[27] and wearing hearing aids in response to hearing loss[28] also reduce risk.[14] Careful medication management is critical to cognitive functioning. For example, medications with a high anticholinergic burden can contribute to reversible cognitive impairment in older adults and should be avoided or minimized when possible.[8,29] Providing patients the education and tools to manage health conditions, especially, vascular risk factors, can make a significant impact on the treatment of MCI, dementia reduction, and prevention.

Physical activity

Despite ample evidence demonstrating that greater amounts of physical activity are associated with a reduced risk of cognitive decline, physical activity is rarely discussed by health care professionals for the prevention or treatment of medical conditions affecting the brain.[30] Exercise has been shown to reduce cognitive decline in individuals with MCI and dementia.[31–33] In fact, exercise has been shown to be the most promising lifestyle intervention when it comes to brain health. In one study,[34] individuals reporting some physical activity had a 25% to 38% lower risk for AD, while individuals reporting much physical activity had a 33% to 48% lower risk for AD. Despite this, nearly half of the adults aged 45 and older do not meet the aerobic physical activity guidelines.[35] Encouraging regular physical activity is critical for reducing dementia risk and improving brain health and is recommended as part of MCI treatment.[8]

Nutrition

The WHO recommends a healthy, balanced diet for all adults.[25] Three diets have been shown to have neuroprotective effects: the Mediterranean Diet, the Dietary Approaches to Stop Hypertension (DASH) diet and the Mediterranean-DASH Intervention for Neurodegenerative Delay (MIND) diet.[36] All are primarily plant-based and include vegetables, fruits, whole grains, legumes, nuts, seeds, healthy fats, fish, and poultry. They minimize red meat, sweets, processed foods, and sugary drinks that are often associated with Western diets.[37] Unique to the MIND diet are green vegetables and berries, which are independently reported to offer protection against neurodegeneration.[38] All are associated with a lower risk of AD and less cognitive decline.[37,39] In a prospective study of 923 participants, aged 58 to 98, high adherence to any of these 3 diets reduced AD risk; however, even mild adherence to the MIND diet also decreased AD risk.[37]

Sleep

Insomnia is a common problem in older individuals, especially those with MCI.[40] Insomnia and other sleep disorders can lead to cognitive inefficiency[41] and compound ongoing cognitive impairment due to other (eg, neurodegenerative) processes. The association between sleep and dementia is complex. Brain pathology underlying dementia may lead to disturbed sleep, and sleep disturbance may contribute to the development of cognitive impairment and dementia.[42,43] People in their 50s and 60s

who get 6 or less hours of sleep per night are 30% more likely to be diagnosed with dementia than people who get at least 7 hours per night.[44] Sleep interventions may slow progression from MCI to AD.[45] Cognitive behavioral therapy for insomnia (CBT-I) is the treatment of choice for insomnia.[46] Since sleep represents a clear, modifiable risk factor that plays a significant role in neurodegenerative conditions, it is a potential target for intervention.[42,47]

Alcohol and smoking

Excessive alcohol use and smoking lead to general poor health outcomes, and this extends to neurocognitive functioning.[48,49] High-level alcohol consumption (>14 units/week) impairs cognition and is linked to increased dementia risk.[50] Smoking contributes to a variety of vascular disorders and tobacco smoke contains known neurotoxins that could contribute to AD risk.[51] Alcohol and tobacco cessation should be offered to adults, regardless of age, to reduce risk of cognitive decline and dementia, in addition to the other health benefits that result from stopping or reducing these behaviors.

Social support and mental health

Socio-emotional health plays a substantial role in enhancing neurocognitive functioning and well-being.[25,52] Quality social connections act as a protective factor for stress, which itself can impair cognition.[53] Social connection is associated with cognitive functioning in healthy, older adults[54,55] and decreased risk of MCI and dementia[12,56,57]; however, social isolation might also occur as part of the dementia prodrome.[14] Assessing and addressing risk of isolation is an important step to helping patients reduce or prevent related cognitive decline.[30] Providers can educate patients on the importance of social support and make recommendations for expanding connections such as via volunteering or participation in community, recreational, or faith-based organizations.

Psychological distress, anxiety, and depression have been identified as risk factors for MCI and dementia.[58–60] Depression may be a part of the prodrome and early stages of dementia.[14,61] Interventions addressing anxiety and depression symptoms are associated with delayed or reduced incidence of all-cause dementia.[62,63] Clinicians should assess behavioral or mood and neuropsychiatric symptoms in MCI and neurodegenerative disease and treat with pharmacologic or nonpharmacologic approaches as indicated.[8]

Cognitive Intervention

Various cognitive interventions can help those with memory and other cognitive difficulties, reducing disability, and improving functioning and well-being. As described later, cognitive rehabilitation and training have yielded mixed results in terms of patient outcomes, whereas compensatory strategies and cognitive stimulation, especially when integrated with lifestyle interventions, are most promising.

Rehabilitation and training

There is considerable research on cognitive rehabilitation in dementia or MCI, yet outcomes are inconsistent due in part to large variability in the types of intervention studied. Restorative approaches, which aim to reinforce, strengthen, or restore impaired skills, such as via repeated exercises targeting specific cognitive domains, have generally yielded mixed outcomes, especially in neurodegenerative conditions.[64–66] Similarly, computerized cognitive training has not been shown to lead to generalized cognitive improvement.[14,67] However, cognitive training can be beneficial for a general older population related to preservation of daily functioning and delay of dementia.

Specifically, in the Advanced Cognitive Training for Independent and Vital Elderly trial, cognitive training was administered to community dwelling older adults for 10 to 14 weeks.[68] Training targeted memory, reasoning, and speed-of-processing. Significant improvements were found in cognitive abilities and preserved functional status 10 years later, compared to those who did not receive the training.[69] It was noted that memory, reasoning, and speed improvements were not sustained over time, but functional improvements were. Reasons might be that training may result in increase in activities and socialization that may improve functional maintenance. Other research has generally mirrored this pattern that cognitive training in older adults who are generally healthy can find benefit in specific, focused intervention, resulting in improvements in cognition, but evidence is less robust regarding sustained cognitive improvement in those with degenerative conditions.[70]

Compensatory strategies

In contrast, interventions that focus on compensatory approaches or ways of "working around" or adapting to the impaired function, have been shown to be effective.[71,72] Examples include using external aids such as calendars, assistive technologies (eg, Alexa), alarms, mnemonics, and investing more time and attention into a particular task. Regardless of degree of cognitive impairment, the more an individual uses compensatory strategies in day-to-day life, the higher level of functional independence.[71] Using daily external strategies to improve memory and other areas of cognition can benefit all populations, particularly for those experiencing cognitive decline. Additionally, assistive technology has the potential to support autonomy and safety for individuals with dementia.[73]

Cognitive stimulation

Cognitive stimulation is defined as an engagement in a range of activities aimed at general enhancement of cognitive and social functioning and often occurs in a social context. While there are a variety of types and duration of cognitive stimulation, higher frequency of cognitive activities is associated with slower cognitive decline and lower dementia risk.[74–76] Cognitive stimulation groups for people with dementia aim to improve cognition and quality of life and reduce risk and trajectory of cognitive decline. Cognitive stimulation is also recommended for individuals at increased risk of cognitive decline.[30] Examples of cognitively engaging activities include puzzles, reading, using the computer, playing games, and playing musical instruments.[77]

In sum, addressing modifiable risk factors might prevent or delay up to 40% of dementia cases, and it is never too early or too late for these interventions[12,14] (see Clinics Care Points). Older adults who adhere simultaneously to 4 or 5 healthy behaviors (ie, high-quality diet, engagement in cognitive activities, regular physical activity, light to moderate alcohol intake, and not smoking) had 60% lower risk of developing Alzheimer dementia than individuals with 0 or 1 healthy behaviors.[78] If providers can assist patients in implementing even small healthy lifestyle changes, they can help lower dementia risk[16] and enhance cognitive performance (see **Fig. 1**). Changes in multiple risk factors, even smaller magnitude changes, lead to protective effects on cognition.[79] (**Fig. 2**).

A BRAIN HEALTH LIFESTYLE INTERVENTION: BRAIN BOOSTERS

Overview

Brain Boosters is a holistic, multi-modal psychoeducational lifestyle intervention program developed at the Phoenix Veterans Affairs Health Care System in 2007 by neuropsychologists, Drs. Mary Lu Bushnell and Kathleen Goren. It is a strength-based, interactive program that allows Veterans and their care partners to learn about

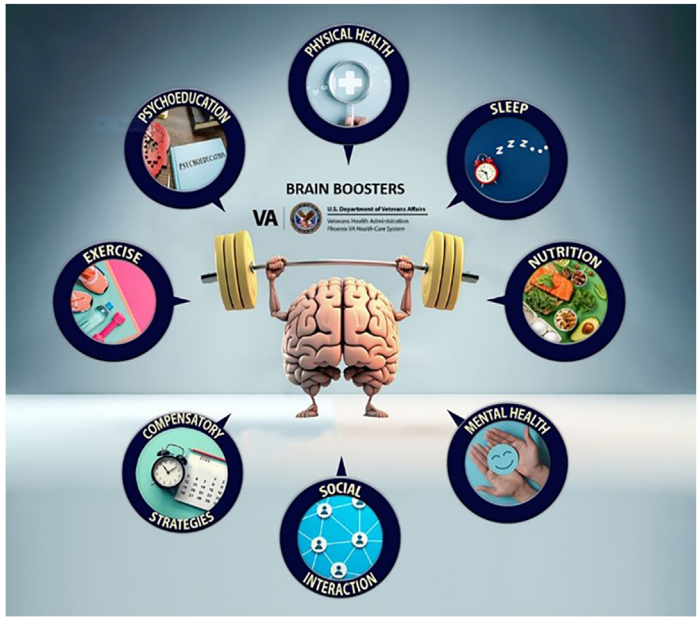

Fig. 2. Alzheimer's disease continuum. (This figure was created by the medical media department at the Phoenix VA for the Brain Boosters program.)

the lifestyle factors that impact brain health, as well as compensatory and proactive strategies, in a supportive group environment (**Box 1**). Brain Boosters is open to participants with or without cognitive diagnoses, as well as those aiming to proactively learn how to improve brain health. The program has been manualized and distributed to over 70 Veterans Affairs (VA) facilities over the past 15 years.

While the group was developed for Veterans, the concepts can be applied to and are beneficial for the general population. For example, Brain Boosters has been modified and implemented with a general population by Dr. Kristen Caraher through the University of Iowa.

Group Format

Brain Boosters is an 8-week program with weekly 90-min sessions that combine psychoeducation and experiential activities. Participants are given session handouts and optional homework. Guest speakers from different specialties are an important component and present on topics such as insomnia, nutrition, post-traumatic stress disorder (PTSD), and more (**Table 1**). In addition to education, the speakers also

Box 1
Key elements of the brain booster program

1. Provide evidence-based information about brain health in an interactive and digestible manner
2. Provide the social environment and support that allows patients to interact and learn from others who share common concerns
3. Provide access to resources to successfully implement brain health changes

inform participants of related VA resources and programs, which is a non-threatening way to introduce patients to services they might not be aware of nor necessarily seek out on their own (eg, mental health treatment).

The group format is especially beneficial because of the sharing of ideas, group discussion, and support offered by the group members. The group format enables participants to realize that others are experiencing similar challenges.[80] Allowing care partners to participate along with the Veteran increases participation. Additionally, lifestyle behavior change is more likely to occur when it is attempted collaboratively with a support person or family member.[81]

A virtual format, which was implemented in 2020 in response to the coronavirus disease 2019 pandemic, has continued to be a successful method of delivery and well received by patients and their care partners. Groups are held synchronously, and the exercises and materials are distributed virtually through a secure messaging platform. Anecdotally, the group facilitators have seen fewer no-shows and an increase in care partner participation with the virtual groups. The connection among group members, albeit virtually, has been especially strong, as indicated by participants' regular exchange of phone numbers, words of support, and appreciation of shared experiences.

At the Phoenix VA, 3 groups run concurrently on a year-round basis, with approximately 5 to 15 participants per group. Groups are "closed," such that participants all begin the first session on the same date and are expected to commit to attending for the full 8 weeks. Various disciplines serve as referral sources, such as primary care, mental health, social work, neuropsychology, and neurology.

Brain Boosters Sessions

Content of each session is listed in **Table 1**. As with any group treatment, some attrition occurs. With that in mind, the order of the sessions is intentional with information on diet, exercise, sleep, and the importance of managing vascular risk factors covered in the first 3 sessions. The group facilitators address PTSD toward the end of the program. By this time, the group members have been together for several weeks and have a greater comfort level discussing more personal information.

Brain Boosters' Supporting Evidence

Initial results of Brain Boosters based on 24 groups delivered between 2007 and 2011 showed that participants reported less memory impairment, especially among the younger Veterans in the sample, and fewer attention problems and depression symptoms irrespective of age after participating in Brain Boosters. Insomnia and PTSD symptoms did not change based on participation in Brain Boosters alone.[82] A key target for these original groups was improving memory self-efficacy, or confidence in one's memory ability,[83,84] given that positive expectancies about memory enhance the effectiveness of memory training interventions[85] and mitigate memory-related worry that paradoxically causes memory interference.[86,87] While memory self-efficacy continues to be a focus of the subsequent Brain Boosters groups as well, it has been augmented to a greater extent with more health behavior or lifestyle intervention components, which are currently being studied and will be evaluated in future research.

Neuropsychologist Role in Treatment or Intervention

Neuropsychologists have always been instrumental in facilitating behavior change, and routinely deliver brain health information in a variety of ways. The most common method is individually during feedback sessions following a neuropsychological evaluation. They provide information related to diagnoses, etiology of difficulties, and

Table 1
Brain boosters sessions

Session & Topic	Overview
1: Introduction, Overview & Education	The format, rationale, and group expectations are discussed. The group facilitators let participants know what they can expect to over the 8 weeks and that the goal of the program is to focus on what is within our control regarding short- and long-term brain health. Basic psychoeducation is provided on MCI, dementia, stroke,TBI, and other common causes of cognitive difficulties. Participants introduce themselves and come up with personal goals for the program. Finally, an interactive cognitively stimulating activity is completed as a group.
2: General Health & Stress Management	Lifestyle factors that impact brain health are discussed including exercise, nutrition, and the importance of managing vascular risk factors ("What's good for the heart is good for the brain."). The importance of regular medical checkups, medication compliance, and communication with health care providers is addressed. The group discusses various ways to incorporate exercise, even when pain or physical limitations may be present. A VA dietician provides an overview of the importance of diet on brain health and shares how group members can schedule an appointment with a dietician to learn more about nutrition. The impact stress has on cognitive and mental health functioning is also discussed, including reviewing and practicing a variety of relaxation strategies, including guided imagery, diaphragmatic breathing, and progressive muscle relaxation.
3: Sleep	A VA health psychologist leads this session. Insomnia is explained and sleep hygiene tips and strategies are reviewed. The health psychologist discusses the relationship between insomnia and brain health and cognitive functioning. Participants are introduced to the treatment, CBT-I, and are given the opportunity to enroll in this treatment if desired.
4: Medications, Neuroanatomy and Attention	This session covers medications, neuroanatomy, and attention. At the beginning of the session, a VA pharmacist discusses the impact medications can have on cognition, both positive and negative. Group participants learn how they can schedule an appointment with pharmacy should they have individual questions about their medications. Basic neuroanatomy is also reviewed, including what areas of the brain are responsible for which cognitive functions. Finally, the different types of attention are discussed, as well as how attention impacts memory. The group facilitators discuss some of the different factors that can negatively impact attention, such as pain, stress, and mental health conditions. Finally, attention compensatory strategies are reviewed and practiced
5: Memory and Memory Strategies	In this session, the different types of memory are discussed, and a range of memory compensatory strategies are reviewed such as the use of mnemonics, lists, alarms, calendars, and technologies such as voice-assisted devices (eg, Alexa). The benefits of routine and structure are also reviewed. A VA Speech Language Pathologist (SLP) discusses SLP's role in compensatory strategy training and the types of services offered by the SLP department. Within our VA, SLPs are the

(*continued on next page*)

Table 1
(continued)

Session & Topic	Overview
	primary clinicians to deliver individualized compensatory strategy training and help patients learn how to more effectively use external and internal strategies to improve daily functioning. Participants can request an individual referral to SLP or elect to participate in one of their cognitive skills groups if desired.
6: Executive Functioning	The concept of executive functioning is explained, as well as a discussion of what occurs when executive functioning is disrupted. Goal setting and the importance of routine and habits are presented. Specific strategies for goal setting are discussed and reviewed with the group, and a collaborative group goal setting exercise is completed. Additionally, effective vs ineffective ways to implement some of the brain health habits that were taught in prior groups are shared.
7: PTSD	This presentation is led by a VA PTSD psychologist from the PTSD Clinical Team (PCT). The PCT psychologist discusses the symptoms of PTSD and how PTSD and other mental health conditions can impact cognitive functioning. Evidence-based PTSD treatments, including Cognitive Processing Therapy, Prolonged Exposure and Eye Movement Desensitization and Reprocessing are reviewed and participants are informed about how they can be referred for individual or group psychotherapy. While the authors focus on PTSD for the Veteran population, addressing mental health, the importance of treatment, and treatment options is applicable to a general population as well.
8: Emotions, Communication Skills & Wrap Up	The final week discusses emotions, communication, and emotional regulation. Strategies for communication, including how to effectively communicate with health care providers, are discussed. The importance of socialization and leisure activities is also addressed, including the fact that social support and social connection have widespread and tangible effects on well-being, brain health, physical health, and cognitive functioning. Finally, group members are encouraged to consider additional activities that they can engage in to promote lifetime brain health. The authors briefly review the material covered in prior sessions, revisit the goals discussed in session 1, and review VA resources that may be beneficial as participants continue their brain health journey.

discuss recommended interventions, including those pertaining to brain health and lifestyle. Brain health information is also shared in a psychoeducational group format, such as the Brain Boosters program. CogSmart, another VA-manualized intervention, is widely used with multiple populations, including traumatic brain injury (TBI), psychiatric illness, MCI, and other conditions[88] (see Thomas F. Bergquist and colleagues' article, "Traumatic Brain Injury," in this issue). Further mentioned are additional resources developed by neuropsychologists with the goal of sharing brain health education widely (**Box 2**).

Box 2
Clinical resources for providers and patients

- *The Brain Health Book* by Dr. John Randolph[89]
- *High-Octane Brain* book by Dr. Michelle Braun[2]
- *Keeping Your Wits about You* book by Dr. Vonetta Dotson[90]
- *NavNeuro Brain Health Series* podcasts by Drs. Ryan Van Patten and John Bellone[91]

CLINICS CARE POINTS

- A brain healthy lifestyle that includes managing modifiable medical risk factors, lifestyle factors, socio-emotional factors, and cognitive interventions have the potential to improve cognition in all individuals, including those with MCI or early neurodegenerative disease.
- Even small lifestyle changes can have a positive impact on brain health.
- Medical providers are in an ideal position to share this information will all patients, including those with cognitive impairment.

DISCLOSURE

The authors have nothing to disclose.

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