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Brain Boosters: Evaluating a Pilot Program for Memory Complaints in Veterans

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This study investigated the feasibility and preliminary effectiveness of a pilot program designed to address subjective memory complaints among Veterans. The program, Brain Boosters, consisted of 10 once-weekly group sessions, during which psychoeducation and cognitive enhancement strategies were used to target memory concerns and related processes, specifically attentional difficulties. Given that memory complaints often are associated with psychiatric comorbidities, sessions also incorporated strategies for reducing symptoms of depression, posttraumatic stress, and insomnia. Controlling for age, we examined pre- to posttreatment change in symptom ratings for 96 Veterans (aged 22 to 87 years) who participated in the Brain Boosters program. The effect of Brain Boosters on memory complaints interacted with age: younger (but not older) Veterans reported reductions in memory impairment from pre- to posttreatment. Additionally, irrespective of age, from pre- to posttreatment Veterans reported fewer attentional difficulties and fewer depression symptoms. Ratings of posttraumatic stress and insomnia symptoms did not change, although insomnia was negatively associated with age. Linear regression controlling for age revealed that reductions in attention problems predicted reductions in perceived memory impairment. Findings from this exploratory, uncontrolled pilot study suggest that a psychoeducational cognitive enhancement group is feasible to conduct in a heterogeneous Veteran population, and may be associated with improvements in perceived memory functioning for younger Veterans, and in attention and depression symptoms for Veterans across age groups.

Keywords: Veterans, subjective memory complaints, psychoeducation, posttraumatic stress, depression

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"*The prospects of a life dominated by catastrophic forgetting further increase our preoccupations with memory*" (Schacter, 2002, p. 2).

The experience that one's memory or other cognitive capacities are lacking can be quite disconcerting. The host of reasons for perceived memory impairment range from normal aging, sleep disruptions, and stress to mild cognitive impairment and early Alzheimer's disease (Abdulrab & Heun, 2008; Clarnette, Almeida, Forstl, Paton, & Martins, 2001; Fortier-Brochu & Morin, 2014; French, Lange, & Brickell, 2014; Metternich, Schmidtke, & Hüll, 2009). As such, perceived memory impairment may reflect actual compromises in cognitive functioning due to neurological or medical factors, impairment due to more malleable psychological factors, or a combination; it may also even reflect unsubstantiated concerns. Further, an individual may experience a sense of impairment for reasons that may not map onto the origin of the complaints.

Irrespective of the source of memory complaints and nature of underlying problems, perceptions and beliefs about memory and other psychological factors or comorbid conditions play a substantial role (Berryman et al., 2013; Brustrom & Ober, 1998; Douglas & Porter, 2009; Kinzer & Suhr, 2016; Ross, Putnam, Gass, Bailey, & Adams, 2003; Waters & Bucks, 2011; Zlatar, Moore, Palmer, Thompson, & Jeste, 2014). Knowledge about memory ("metamemory"; Cavanaugh & Perlmutter, 1982; Chua & Bliss-Moreau, 2016) and enhanced confidence in one's memory ability ("memory self-efficacy"; Bandura, 1989; Berry, West, & Dennehey, 1989) can mitigate complaints and may improve memory functioning. Conversely, worry about memory can foster a cycle of negative attitudes about one's cognitive capacities that ironically may perpetuate memory difficulties (Metternich et al., 2009; Sohlberg & Mateer, 2001).

War Veterans may be particularly susceptible to memory complaints, given their exposure to traumatic events and increased prevalence of mental health conditions including posttraumatic stress disorder (PTSD) and depression (Zinzow, Britt, McFadden, Burnette, & Gillispie, 2012), which are associated with perceived and/or actual memory impairment (Binder, Storzbach, Anger, Campbell, & Rohlman, 1999; Brewin, Kleiner, Vasterling, & Field, 2007; Vasterling, Brailey, Constans, & Sutker, 1998; Vasterling et al., 2002). Estimates of the prevalence of self-reported memory problems among Veterans vary widely, ranging from 34% for Gulf War Veterans assessed for medical or mental health symptoms (Department of Defense, 1996) to 92% among Operation Iraqi Freedom and Operation Enduring Freedom (OIF/OEF) Veterans evaluated for traumatic brain injury (TBI; Scholten, Sayer, Vanderploeg, Bidelspach, & Cifu, 2012). Both actual and perceived memory impairment have real consequences, from patient distress to difficulty engaging in interventions where memory has a central role, such as recalling a traumatic event in trauma-focused exposure treatments (Verfaellie & Vasterling, 2009). Thus, such complaints are important to address.

The purpose of the present study was to evaluate the effectiveness of a group treatment for Veterans that addressed memory complaints of heterogeneous origin. As cognitive and emotional processes are intertwined, the focus of the treatment was on improving perceptions of memory functioning by providing psychoeducation about learning, memory, emotional health, and their intersections, including strategies to facilitate attention and memory.

Memory Complaints: Relationship to Attentional Difficulties and to Psychiatric Symptoms Among Veterans

Attentional Difficulties

Complaints about memory may stem from impairment in cognitive processes that are closely related or contribute to memory, most notably attention. Although relationships between attention and memory are complex and beyond the scope of the present paper, we note that to remember information, it must be encoded into memory in the first place, which requires some form of attention (Chun & Turk-Browne, 2007). Attention difficulties also may be one mechanism through which psychological disorders, such as depression and PTSD, result in memory deficits.

Depressive Symptoms

Among both Veterans and civilians, depression is associated with perceived memory impairment due to processes such as poor concentration, poor effort, low motivation, and low self-efficacy (Antikainen et al., 2001; Burt, Zembar, & Niederehe, 1995; Giuli et al., 2016; Lahr, Beblo, & Hartje, 2007; Porter, Bourke, & Gallagher, 2007; Verfaellie, Lafleche, Spiro, & Bousquet, 2014). Maintaining negative perceptions about one's memory abilities can contribute to memory complaints (e.g., "I can't remember anything anymore"), and can influence actual memory performance (Beaudoin & Desrichard, 2011). Conversely, treating depression (e.g., with antidepressants) is associated with objective improvements in cognitive performance, such as on tests of recent memory (Fann, Uomoto, & Katon, 2001). Comorbid depression also accounts for verbal learning and memory deficits among Veterans with PTSD in some studies (Burriss, Ayers, Ginsberg, & Powell, 2008; Nijdam, Gersons, & Olff, 2013).

Posttraumatic Stress

An extensive literature documents perceived and actual memory difficulties among individuals with versus without PTSD. First, memory deficits may be a preexisting characteristic and predisposing factor for developing PTSD (see Samuelson, 2011 for a review). Further, existing PTSD is characterized by deficits in attention, verbal learning, visual recall and recognition, and working memory (e.g., Johnsen & Asbjørnsen, 2008; Samuelson et al., 2009; Yehuda, Harvey, Buchsbaum, Tischler, & Schmeidler, 2007), with greater PTSD symptom severity relating to greater deficits (Vasterling et al., 2002). Memory impairments associated with PTSD are seen in longitudinal studies (Samuelson et al., 2009), even after controlling for verbal or general intelligence (Vasterling et al., 2002; Yehuda et al., 2007). Finally, individuals with verbal memory deficits may be less likely to respond to cognitive–behavioral treatment for PTSD (Wild & Gur, 2008). All of these issues underscore the notion that providing strategies to address memory issues may also enhance the treatment of PTSD.

Insomnia

Insomnia may be present alone or co-occur with conditions such as PTSD or depression (Harvey, 2008), and is associated with both objective memory impairment and subjective memory complaints. Meta-analysis suggests that individuals with insomnia show impaired cognitive performance, including episodic and working memory (Fortier-Brochu, Beaulieu-Bonneau, Ivers, & Morin, 2012). Among individuals with insomnia, those with subjective cognitive complaints show poorer neuropsychological performance than those without such complaints (Fortier-Brochu & Morin, 2014). Insomnia is common among OIF/OEF Veterans; in one study it was rated most severe among all self-reported PTSD symptoms (Hoge, Terhakopian, Castro, Messer, & Engel, 2007; Lew et al., 2010; McLay, Klam, & Volkert, 2010).

Memory Complaints in OIF/OEF Veterans

Memory and other cognitive complaints have received much attention among OIF/OEF Veterans, particularly in the context of PTSD and mild TBI (mTBI). More than in previous conflicts, many OIF/OEF Veterans have survived explosive blasts (Hoge et al., 2008). As a result, PTSD and mTBI are prevalent and considered the "signature injuries" of the conflict (Combs et al., 2015; Hoge et al., 2008; Lew et al., 2008; Schneiderman, Braver, & Kang, 2008), afflicting approximately 13–17% (for PTSD) and 12–16% (for mTBI) of Veterans (Stein & McAllister, 2009). By definition, with mTBI, cognitive functioning is expected to return to preinjury capacities in the weeks or months following the injury; however, Veterans' complaints of memory difficulties often persist (Bigler, 2008; Karr, Areshenkoff, & Garcia-Barrera, 2014; Rohling et al., 2011).

Although subjective memory complaints can be linked with impaired memory performance (e.g., in Gulf War Veterans; Chao, 2017), and can foreshadow later cognitive decline (e.g., as measured prospectively in civilian samples; Kaup, Nettiksimmons, LeBlanc, & Yaffe, 2015), this is not always the case. Rather, residual cognitive complaints among Veterans with mTBI often are related to psychiatric distress, rather than objective indicators of cognitive performance (reviewed in Dolan et al., 2012; see also French et al., 2014; Roca & Freeman, 2001; Soble, Spanierman, & Smith, 2013; Spencer, Drag, Walker, & Bieliauskas, 2010; Vasterling, Verfaellie, & Sullivan, 2009).

The neuropsychologists at the Phoenix VA recognized an unmet need for education and strategies to assist OIF/OEF Veterans suffering from mTBI or memory complaints, and developed a group intervention to address this lack. Although the original goal was to serve these then-returning Veterans, as discussed below, the program gained popularity among a wide range of patients at the VA, including a number of older Veterans.

Psychoeducation and Memory Training Groups: Improving Memory Self-Efficacy and Expectancies

Psychoeducational groups can be effective in a number of domains. Although such research among Veterans is relatively limited, evidence from non-Veteran populations indicates that psychoeducational groups incorporating memory strategy training can effectively address subjective memory complaints. For example, in a randomized controlled trial of healthy older adults with subjective memory complaints, compared with wait-list controls or an individual-level intervention, those in a collective group training program that provided both memory skills training and information about how memory works showed improvements in subjective memory complaints (as well as memory-related anxiety and stress) and objective memory performance (Valentijn et al., 2005). Other studies have supported an education component; in a meta-analysis, subjective memory complaints among older adults without dementia improved most when memory training techniques (e.g., mnemonics) were coupled with positive expectancies resulting from explanations and background information about the techniques (Floyd & Scogin, 1997). In addition, a group memory training intervention administered to older adults with subjective memory complaints was efficacious both in those with and those without objective memory impairment (De Vreese, Belloi, Iacono, Finelli, & Neri, 1998).

Although these studies focus on older adults, we reasoned that such an approach—targeting metamemory and memory self-efficacy processes—would be useful for younger OIF/OEF Veterans as well, given the pervasiveness of memory complaints, seemingly low memory self-efficacy, and comorbid physical and psychological symptoms among this population.

Current Study

The experience that memory is suffering may contribute to worry and a sense of inadequacy, perpetuating symptoms of anxiety and depression and exacerbating attentional and memory difficulties in a cyclical fashion. To help break this cycle, a 10-week group intervention, Brain Boosters, was developed for Veterans with subjective memory complaints. The intervention encompassed psychoeducation and interactive strategies to improve attention and memory, while raising awareness about co-occurring mood and clinical symptoms (i.e., depression, PTSD, and insomnia). The present study examined the feasibility and preliminary effectiveness of Brain Boosters based on Veterans who participated in the groups and completed symptom measures at both pretreatment and posttreatment. We hypothesized that (a) Veterans would report reductions in perceived memory impairment from pre- to posttreatment, (b) these effects would be more pronounced among younger Veterans, for whom the treatment was originally designed, and (c) any reduction in symptoms of attentional difficulties, depression, PTSD, or insomnia would contribute to reductions in perceived memory impairment.

Method

Participants

Participants in this study were individuals receiving services through the Veterans Health Administration (VHA). Veterans experiencing memory difficulties were self- or provider-referred to the Brain Boosters groups, which were advertised via flyers and word of mouth. Between 2007 and 2011, 24 groups were delivered to a total of approximately 240 individuals. Veterans were not specifically recruited for this study or any other research purposes; rather, they were referred solely on the basis of potential clinical utility. As part of routine clinical practice, pre- and posttreatment self-report questionnaires were administered (see Procedure).

One hundred eighty Veterans filled out at least one pretreatment and/or posttreatment measure, and of these, 96 Veterans filled out at least one matching pretreatment/posttreatment questionnaire set (the other 84 provided some data, but no matching sets). Therefore, our final dataset consisted of 96 Veterans (78 men, 18 women) who filled out both the pretreatment and the posttreatment questionnaire for at least one of the five dependent measures. The majority of these participants (70%; $n = 67$) provided pre- and posttreatment data for all five measures (22 participants provided data for four measures; 3 for three measures; 3 for two measures; and 1 for one measure). The large proportion of missing pre- and/or posttreatment responses may be attributable to the fact that Veterans were not encouraged nor even expected to complete the measures. To avoid creating Veteran burden or discomfort, the measures were described as optional, and to be used to help the clinicians get a preliminary sense of the symptoms characterizing the Veterans in the groups and the effectiveness of the treatment.

On average, participants in our final dataset attended 85.4% of the Brain Boosters sessions offered ($SD = 13.3\%$), with all 10 sessions as the modal number attended. Mean numbers of group members at the first and last sessions were 12.9 ($SD = 7.2$) and 9.5 ($SD = 5.4$), respectively.

Participants were aged 22 to 87 years ($M = 54.3$, $SD = 15.3$). The majority identified as White (88.4%; $n = 84$), with the remaining identifying as Black/African American ($n = 5$), Hispanic/Latino ($n = 5$), or Native Hawaiian/Pacific Islander ($n = 1$). Race/ethnicity was not reported for one participant. Approximately half the sample was married (49.5%, $n = 47$); marital status was not available for one participant. Twenty-four percent ($n = 23$) identified as part of the OIF/OEF cohort of Veterans; membership in other cohorts was not assessed.

Although we were unable to obtain formal clinical diagnoses for our sample, based on pretreatment clinical cut-off scores for the self-report measures used (described below), 75.5% of participants met or exceeded a clinical cut-off score of 10 on the Patient Health Questionnaire–9 (PHQ-9), suggesting at least moderate symptoms of depression (Kroenke, Spitzer, & Williams, 2001). Approximately half of the sample (49.2%) met or exceeded a clinical cut-off score of 50 for PTSD based on the PTSD Symptom Checklist–Military Version (PCL-M) for *DSM–IV*, suggesting at least moderate symptoms of PTSD (National Center for PTSD, 2018; Weathers, Litz, Herman, Huska, & Keane, 1993; Weathers, Litz, Huska, & Keane, 1994). With respect to insomnia symptoms, 59.6% of participants met or exceeded a clinical cut-off score of 15 on the Insomnia Severity Index (ISI), indicating clinical levels of insomnia with at least moderate symptom severity (Morin, Belleville, Bélanger, & Ivers, 2011).

Approximately half of participants had received neuropsychological testing (47% $n = 45$); 41 completed testing and had valid results. Based on the concluding summaries from the neuropsychological reports for these Veterans, type of memory impairment could be categorized broadly as follows: 25% organic/medical; 20% functional; 15% both organic/medical and functional; and 25% inconclusive. We considered complaints to be functional when they were accompanied by objective deficits, but the pattern of deficits suggested that the cause was psychological or medical, rather than a neurological condition with a deteriorating progression. For the remaining 15%, no cognitive impairment was detected by neuropsychological testing.

As noted above, 84 Veterans were not included in our sample because we did not have a pre–post questionnaire match. As these individuals did fill out at least one pretreatment ($n = 64$) or posttreatment ($n = 20$) questionnaire, we were able to compare their demographic and clinical characteristics to those of the 96 Veterans included in our final sample. The two groups did not differ in age, gender, or marital status (all $ps > .05$). Groups differed in ethnic composition, $\chi^2(4, N = 176) = 10.03$, $p = .04$, with fewer Hispanic/Latino individuals in our final sample (5.2%) than in the group who were not included due to filling out only pretreatment questionnaires (19.4% Hispanic/Latino) or only posttreatment questionnaires (10.5% Hispanic/Latino). Not surprisingly, Veterans in our final sample attended significantly more Brain Boosters sessions than those who had filled out only pretreatment ($M = 3.7$ sessions, $SD = 2.8$) or only posttreatment ($M = 7.2$ sessions, $SD = 2.1$) measures ($ps < .05$). Importantly, those in our final sample did not differ in pretreatment symptom levels from those excluded from our final sample due to lack of posttreatment measures (all $ps > .05$).

Procedure

The present study was based on a chart review of archival data. All procedures were approved by the Phoenix VA Institutional Review Board (IRB) and conducted in accordance with APA ethical guidelines. Self-report questionnaires were administered routinely during the first and last Brain Boosters group sessions to assess perceived memory impairment, perceived attentional difficulties, and symptoms of depression, posttraumatic stress, and insomnia. (Questionnaires about combat exposure and future group topics participants would like to see offered also were given.) All data were collected via paper and pencil. Although the questionnaires were optional, it later became apparent that enough Veterans filled out the measures for a more systematic evaluation of these data to be conducted, and therefore an IRB application to review these archival data was submitted and approved. Responses subsequently were entered into an Excel database and were fully de-identified. The IRB application was approved for analysis of chart review based purely on archival data from completed groups, rather than from current or ongoing data collection. Given that it took time to enter and check the data from the self-report measures, several more groups were completed in the interim. Thus, to allow access to these additional data, one modification was filed and approved for the analysis of data from these subsequently completed groups.

Treatment

The Brain Boosters program initially was developed by neuropsychologists at the Phoenix VA to address subjective memory complaints among Veterans returning from Iraq and Afghanistan with mTBI. Despite the frequent concerns about memory expressed by this population, there was no established treatment at the VA to directly address those concerns. As noted in the Participants section, due to the substantial interest in the Brain Boosters program by other Veterans with subjective memory complaints (e.g., who saw flyers posted or learned about the program through word-of-mouth), other Veterans were allowed to participate. Consequently, most participants were not OIF/OEF Veterans. The purpose of the program was described to Veterans as "retraining the brain to function more efficiently," and "providing exercise for the brain."

The treatment consisted of 10, once-weekly 90-min group sessions. Sessions were structured and provided psychoeducation and cognitive-enhancement strategies. Specifically, each session included didactic and experiential components, and optional computerized and paper-and-pencil at-home exercises were given. Group members were encouraged to apply the knowledge and skills gained to their daily lives and, if appropriate, to subsequently enter additional evidence-based VHA treatment programs (e.g., for insomnia, PTSD, depression) through mental health referrals. Topics for each week were as follows: (1) Course introduction and overview (e.g., course structure, education about TBI and other types of neurological insults; Sudoku practice); (2) general health and stress management (e.g., exercise, nutrition, progressive muscle relaxation); (3 and 4) memory and learning new information (e.g., cognitive rehabilitation, compensatory memory strategies, visual memory) with one of the sessions facilitated by a VA speech pathologist; (5) neuroanatomy and attention (e.g., role of attention in memory; enhancing focused attention); (6) executive functions and reasoning (e.g., cognitive set-shifting exercises); (7) sleep education and hygiene (facilitated by a VA sleep specialist); (8) PTSD (facilitated by a VA psychologist who specializes in PTSD); (9) emotions, personality, and communication skills (e.g., improving communication, emotion regulation, and relationships to improve cognitive functioning); (10) wrap up (e.g., feedback, "graduation certificates," refer to follow-up groups or VA services).

Measures

Clinical chart review. Participants' age, gender, ethnicity, marital status, and OIF/OEF cohort status were obtained from the clinical charts. Number of Brain Boosters sessions participants attended, which group they were in (designated with an arbitrary code number), and whether a formal neuropsychological assessment had been conducted also were obtained from the charts.

Perceived memory impairment. A 15-item self-report measure was put together by the senior author (K. Goren) to evaluate perceived memory impairment at the beginning and end of the Brain Boosters program. Although many established measures of perceived memory impairment exist, the goal was to put together a short, "user friendly" questionnaire that reflected the kinds of memory complaints reported in the TBI Clinic during routine clinical practice. This measure was labeled, *Checks and Balances: Strengths and Weaknesses*. Instructions were as follows: "Take a few moments to reflect on your personal feelings about how you are functioning mentally. Check on your strengths and weaknesses. Circle the number to rate your abilities." Each item (e.g., remembering names and faces; remembering what you did yesterday; following directions) was rated on a 1 to 8 scale anchored by *no problem at all* and *significant problem*. In our sample, Cronbach's alpha coefficients were .904 at pretreatment and .891 at posttreatment.

Perceived attentional difficulties. We used a 12-item self-report measure of attention that was part of the Attention Process Training 2 (APT-2; Sohlberg, Johnson, Paule, Raskin, & Mateer, 2001; Sohlberg & Mateer, 2001) training kit. The APT-2 is designed for clinicians working with those with mild cognitive dysfunction due to acquired brain injury, including Veterans (Sohlberg et al., 2001). Sample items include, "Can't keep mind on activity or thought because mind keeps wandering," "Easily distracted by surrounding noise," and "Easily lose place if task or thinking is interrupted." Response options for each item are as follows: *Not a problem or no change from before*; *only gets in the way on occasion (less than once a week)*; *sometimes gets in the way (about 1–3 times per week)*; *frequently gets in the way (is a problem most days)*; and *is a problem all the time (affects most activities)*. In our sample, Cronbach's alpha coefficients were .943 at pretreatment and .951 at posttreatment.

Depressive symptoms. We used the Patient Health Questionnaire-9 (PHQ-9; Kroenke et al., 2001). The PHQ-9 is a 9-item self-report measure of depressive symptoms experienced over the past 2 weeks. Items correspond to *DSM–IV* criteria and are rated on a 0 to 3 scale anchored by *not at all*, *several days*, *more than half the days*, and *nearly every day*. The PHQ-9 is a reliable and valid indicator of depressive symptom severity (Kroenke et al., 2001). In our sample, Cronbach's alpha coefficients were .907 at pretreatment and .856 at posttreatment.

Posttraumatic stress disorder symptoms. We used the PTSD Symptom Checklist-Military Version (PCL-M; National Center for PTSD, 2018; Weathers et al., 1993, 1994). The PCL-M for *DSM–IV* is a 17-item self-report measure of posttraumatic stress symptoms experienced during the past month, such as reexperiencing, numbing, and avoidance. Ratings use a 1 to 5 scale anchored by *not at all*, *a little bit*, *moderately*, *quite a bit*, and *extremely* and are made with reference to "a stressful military experience." The PCL-M has been established as a reliable and valid measure (Wilkins, Lang, & Norman, 2011). In our sample, Cronbach's alpha coefficients were .949 at pretreatment and .938 at posttreatment.

Insomnia symptoms. We used the Insomnia Severity Index (ISI; Morin, 1993; Morin et al., 2011). The ISI is a 7-item self-report measure of insomnia symptoms, specifically difficulty falling asleep, staying asleep, or awakening too early. The ISI shows adequate reliability and validity (Bastien, Vallières, & Morin, 2001). In our sample, Cronbach's alpha coefficients were .902 at pretreatment and .914 at posttreatment.

Data Analysis

Approximately 7.8% of data were missing from the final sample of 96 individuals. To address potential biases in estimation and loss of statistical power due to missing data, we first generated 10 data sets through multiple imputation at the individual item level, using a predictive mean-matching approach (Graham, 2009). Subsequent analyses were carried out using imputed data. Because the participants received the Brain Boosters treatment in separate groups, the data were next examined to determine the extent of group-level clustering (nonindependence) in outcome scores. Group-level intraclass correlation coefficients (ICCs) were negligible (ICCs $< .0005$). Therefore, group-level clustering was not accounted for in the main data analyses.

To examine change in outcomes from pretreatment to posttreatment, we employed a generalized estimating equation (GEE) model for repeated measurements of each outcome (nested within participants) using Time (pretreatment vs. posttreatment), Age (in years, centered around the sample mean to ensure a meaningful intercept), and a Time × Age interaction term. We included age in our analysis given the wide age range in our sample and its potential both to influence symptoms directly and to moderate the impact of the Brain Boosters treatment. The Time × Age interaction term was meant to address the possibility of age-related differences in the magnitude of change from pretreatment to posttreatment. For all GEE models, an exchangeable within-person correlation structure was specified, and model-based standard errors were used for tests of model parameters. As recommended by Morris and DeShon (2002), effect sizes were reported as the mean difference between pretreatment and posttreatment scores, divided by the standard deviation (*SD*) of the pretreatment scores. By using the *SD* of the pretreatment scores rather than the change scores, this effect size metric avoids bias due to interaction between participants and treatment. These standardized mean difference effect sizes are interpreted similarly to Cohen's *d*, with .20, .50, and .80 corresponding to small, medium, and large effects, respectively (Cohen, 1988).

Multiple imputation was conducted in R Version 3.3.1 using Version 2.46.0 of the *mice* package (van Buuren & Groothius-Oudshoorn, 2011). ICCs were computed using variance component estimates from PROC MIXED, and GEE models were estimated using PROC GENMOD with PROC MIANALYZE, all in SAS Version 9.4. Hierarchical linear regression was carried out in SPSS Version 23; R^2 and adjusted R^2 values for the regression were estimated using Fisher's *r* to *z* transformation as recommended in Harel (2009). Alpha was set at .05 for all tests.

Results

Change From Pre- to Posttreatment

For each measure, individual items were summed to obtain pretreatment and posttreatment scores, respectively. Pretreatment and posttreatment means, standard deviations, *p* values for the difference between the means, and effect sizes are displayed in Table 1; coefficient estimates, confidence intervals, *p* values, and effect sizes are shown in Table 2.

Perceived memory impairment. Memory complaints showed a small, but nonsignificant, increase from pretreatment to posttreatment ($p = .278$), which was qualified by a significant Time × Age interaction ($p = .034$). This interaction was probed by estimating simple slopes for the Time effect at 1 *SD* below the sample mean age (39.0 years old), at the sample mean age (54.3 years old), and at 1 *SD* above the sample mean age (69.6 years old) as described by Aiken and West (1991; see Figure 1). For relatively younger participants, the decrease from pretreatment to posttreatment (a decrease of 5.23 points, $p = .023$) was larger than that for mean age participants (a decrease of 1.75 points, $p = .278$). Relatively older participants showed a nonsignificant increase in complaints from pretreatment to posttreatment (an increase of 1.73 points, $p = .455$).

We also explored how this effect differed between OIF/OEF and non-OIF/OEF cohorts. We found that OIF/OEF Veterans, who as a group were significantly younger than non-OIF/OEF Veterans, $F(1, 95) = 65.02$, $p < .001$ ($M = 36.9$, $SD = 11.5$ years vs. $M = 59.8$, $SD = 12.0$ years), showed large reductions in perceived memory impairment from pretreatment to posttreatment (average decrease of 9.35 points, $p = .005$), whereas non-OIF/OEF Veterans showed virtually no change (average increase of 0.71 points, $p = .703$), a difference reflected in the significant Cohort × Time interaction effect, $b = -10.053$, 95% CI (−16.588, −3.518), $p = .008$.

Other symptoms. The Time effect was significant for measures of attention and depression, with both measures showing significant decreases of approximately 2.5 points from pretreatment to posttreatment ($p = .006$ and $p < .001$, respectively). Specifically, Veterans reported fewer attentional difficulties and fewer symptoms of depression from pre- to posttreatment. The main effect of Time was not significant for symptoms of PTSD or insomnia (see Table 2).

The effect of Age was significant for insomnia symptoms, such that younger age was associated with more insomnia symptoms. There was not a significant effect of Age for the other measures. The Time × Age interaction was not significant for any measure aside from perceived memory impairment, as described above (see Table 2).

Contributions to Changes in Perceived Memory Impairment

Pearson correlations among age and changes in symptom measures are illustrated in Table 3. Using hierarchical linear regression, we tested whether reductions in perceived memory impairment from pre- to posttreatment could be accounted for by reductions in other symptoms (see Table 4). Because of the relationship between aging and memory, we controlled for participant age on Step 1. Given the close links between memory and attention described earlier, we entered change in reported difficulties with

Table 1
Pretreatment and Posttreatment Means (SD) and Effect Sizes for Study Outcomes

Measure	Pretreatment mean[a] (*SD*)	Posttreatment mean[a] (*SD*)	p_{diff}	d^c
Perceived memory impairment[b]	73.30 (19.04)	71.55 (18.83)	.278	.09
Perceived attentional difficulties (APT-2)	38.33 (11.42)	35.60 (11.83)	.006	.23
Depressive symptoms (PHQ-9)	14.98 (7.46)	12.55 (6.33)	<.001	.38
PTSD symptoms (PCL-M)	48.36 (16.60)	46.70 (15.72)	.167	.11
Insomnia symptoms (ISI)	15.66 (7.38)	14.80 (7.46)	.137	.12

Note. $p_{diff} = p$ value for difference between means.
[a] These numbers represent means across participants of sum scores for each measure for each participant. [b] Per Strengths and Weaknesses questionnaire. [c] d = effect size = posttreatment mean−pre-treatment mean/standard deviation of pretreatment value.

Table 2
Coefficient Estimates, Confidence Intervals, and Effect Sizes from Generalized Estimating Equation Models Relating Time, Age, and the Time × Age Interaction to Study Outcomes

	Model term		
	Time[a]	Age[b]	Time × Age
Outcome	*b* (95% *CI*) *d*[c]	*b* (95% *CI*) *d*[c]	*b* (95% *CI*) *d*[c]
Memory	−1.75 (−4.92, 1.41) −.09	−.09 (−.35, .16) .00	.23* (.02, .44) .01[d]
Attention	−2.72** (−4.66, −.79) −.24	−.08 (−.24, .07) −.01	.04 (−.09, .17) .00
Depression	−2.42*** (−3.47, −1.38) −.33	−.07 (−.16, .02) −.01	.01 (−.06, .07) .00
PTSD	−1.66 (−4.01, .69) −.10	−.15 (−.37, .06) −.01	.06 (−.09, .21) .00
Insomnia	−.86 (−1.99, .27) −.12	−.12* (−.22, −.02) −.02	.06 (−.01, .14) .01

Note. Memory = perceived memory impairment per our Strengths and Weaknesses questionnaire; attention = perceived attentional difficulties per the APT-2; depression = self-reported depressive symptoms per the PHQ-9; PTSD = self-reported PTSD symptoms per the PCL-M; insomnia = self-reported insomnia symptoms per the ISI.
[a] Pretreatment vs. posttreatment; negative coefficients indicate reduction in symptoms from pretreatment to posttreatment assessments. [b] Age in years, centered around the sample mean. [c] *d* = effect size = posttreatment mean−pretreatment mean/standard deviation of pretreatment value. [d] Effect sizes for age tertiles: younger*r* = .27; mid-aged = .01; older*r* = .03.
* $p < .05$. ** $p < .01$. *** $p < .001$.

attention on Step 2. Changes in symptoms of depression, posttraumatic stress, and insomnia were entered together on Step 3.

Significance tests are not yet available for R^2 values or changes in R^2 derived using multiple imputed data sets; we therefore reported the range of *p* values for R^2 and ΔR^2 in the 10 imputed data sets. Together, the predictors accounted for a significant amount of the variance in change in perceived memory impairment (16.4%; see Table 4). Decrease in perceived attentional difficulties at Step 2 was a significant predictor of decrease in memory complaints above and beyond age (entered at Step 1). Together, the psychiatric predictors (Step 3) were not significant, but there was a trend toward change in insomnia as an individual predictor of change in perceived memory impairment (see Table 4).

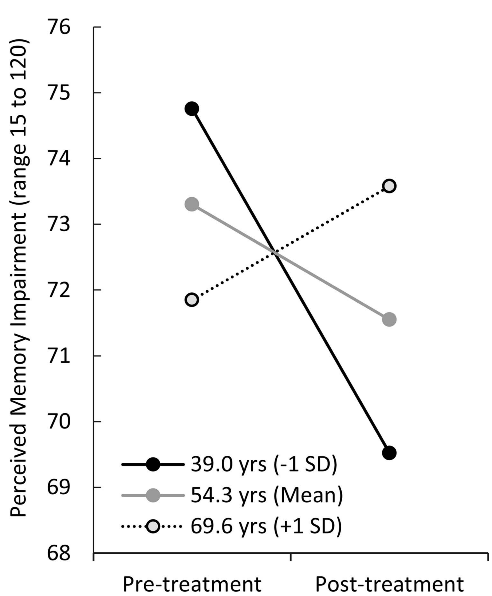

Figure 1. Figure illustrates significant interaction between age and time in accounting for change in perceived memory impairment from pre- to posttreatment. Pre- and posttreatment means of memory impairment are plotted for 39.0 years (1 *SD* below mean age), 54.3 years (mean age), and 69.6 years (1 *SD* above mean age). The change was significant for relatively younger participants ($p = .023$) but not mid-aged ($p = .278$) or older ($p = .455$) participants.

Discussion

The present study explored the feasibility and preliminary effectiveness of Brain Boosters, a 10-session group psychoeducation and hands-on strategy-based intervention to address memory complaints among Veterans. For younger Veterans, perceived memory impairment was lower at the end of treatment than at the beginning. Irrespective of age, self-reported symptoms of attention and depression were lower at the end of treatment than at the beginning. Insomnia symptoms, which were higher among younger Veterans, did not show a change from pre- to posttreatment. Further, improvement in perceived attention predicted improvement in perceived memory impairment; together, improvement in other symptoms did not contribute.

Improvement in Perceived Memory Impairment

Effects of age: Younger Veterans. We hypothesized that the effects of the Brain Boosters treatment on perceived memory impairment would be more pronounced among younger Veterans, who were the initial target population for the treatment (i.e., returning OIF/OEF Veterans with potential blast injury and residual cognitive complaints). The treatment was in fact associated with reduced perceived memory impairment among the younger Veterans—and among OIF/OEF Veterans, when assessed as a cohort—in our sample, suggesting that the nature of the intervention was more likely to address the needs of this group. Brain Boosters aimed to reduce memory complaints via psychoeducation and skills-based components. As younger Veterans were unlikely to be experiencing underlying age-related memory deficits, their memory complaints may have been more psychological in origin,

Table 3
Pearson Correlations Among Age and Study Outcome Change Scores (Δ)

Measure	Δ Perceived memory impairment	Δ Perceived attentional difficulties	Δ Depressive symptoms	Δ PTSD symptoms	Δ Insomnia symptoms
Age	.21*	.06	.02	.09	.17
Δ Perceived memory impairment	—	.35**	.16	.12	.31**
Δ Perceived attentional difficulties		—	.33**	.24*	.25*
Δ Depressive symptoms			—	.45***	.29**
Δ PTSD symptoms				—	.22†

Note. Change scores calculated as post-treatment minus pre-treatment ($N = 96$).
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

and therefore more amenable to the Brain Boosters approach. As noted earlier, this kind of intervention potentially could exert its effects by providing knowledge about memory, enhancing memory self-efficacy, improving actual memory performance, and/or improving other mental health symptoms.

Among OIF/OEF Veterans, who are likely aware that mTBI is a signature injury of these conflicts, knowledge that the brain can recover from injury and that memory can improve with attention, practice, and the use of compensatory strategies may be especially useful. Receiving a diagnosis with a name suggesting that one's brain is injured, as is the case with mTBI, can create a distressing expectation for long-term cognitive impairment, which in turn may heighten both subjective and actual impairment in cognitive functioning (Suhr & Gunstad, 2002). Changing such expectations through psychoeducation may help to minimize memory difficulties, and even allow for actual memory improvement, via greater effort and attention. Again, although only approximately one fourth of Veterans in our sample reported being part of the OIF/OEF cohort, this group appeared to benefit the most in terms of improvement in perceived memory impairment. This is consistent with a growing body of evidence from Gulf War Veterans as well as OIF/OEF Veterans indicating that residual cognitive complaints after mTBI are largely accounted for by psychological factors (Binder et al., 1999; Spencer et al., 2010), which are an important target for intervention. Treatment to directly address any psychiatric symptoms of course is crucial; in addition, a treatment that can provide an overarching framework for thinking about memory (and, where applicable, to understanding mTBI) may have a number of additional benefits.

Effects of age: Older Veterans. For older Veterans, it is possible that actual memory performance remained low, or even declined, over the 10 weeks of the study, and therefore receiving psychoeducation, exerting more effort, or achieving a more positive attitude were not sufficient to offset their perceived memory challenges. Drawing their attention to issues regarding memory, and/or participating in a group with younger Veterans, also potentially may have backfired, to the extent that one or both of these created an even more negative impression of, or outlook on, their own memory abilities. Although prior research suggests that a group format and psychoeducational approach to teaching memory enhancement strategies are effective among older adults with and without cognitive decline (De Vreese et al., 1998), the heterogeneous make-up of our groups with respect to age, or the unique nature of our sample, may have resulted in less benefit to older Veterans with respect to perceived memory than in prior studies. Older Veterans nevertheless may have benefited from the treat-

Table 4
Predicting Pre- to Posttreatment Change (Δ) in Perceived Memory Impairment from Change in Other Symptoms

Step number and predictors	*B*	*SE B*	β[a]	*p*	R^2	ΔR^2
Step 1					.046[b]	
Age	.227	.109	.213	.038		
Step 2					.158	.112[c]
Age	.204	.105	.192	.051		
Δ Perceived attentional difficulties	.567	.167	.337	.001		
Step 3					.201	.043[d]
Age	.172	.105	.161	.101		
Δ Perceived attentional difficulties	.484	.177	.288	.006		
Δ Depressive symptoms	.013	.374	.004	.973		
Δ PTSD symptoms	−.011	.172	−.007	.951		
Δ Insomnia symptoms	.587	.299	.208	.050		

Note. $N = 96$ for the regression analysis. Regression coefficients are pooled across analyses of 10 multiply-imputed datasets. Age was mean-centered.
[a] β = *B* derived from regression using standardized predictors and outcome. [b] For R^2 at Step 1, *p* values across 10 imputations ranged from $p = .014$ to $p = .064$. [c] For change in R^2 from Step 1 to Step 2, *p* values across 10 imputations ranged from $p < .001$ to $p = .003$. [d] For change in R^2 from Step 2 to Step 3, *p* values across 10 imputations ranged from $p = .071$ to $p = .302$.

ment in other ways, given reports by participants overall of fewer attentional difficulties and fewer depression symptoms at the end of treatment than at the beginning.

Effects of attention. Irrespective of age, improvement in attentional difficulties over the course of the Brain Boosters treatment predicted improvement in perceived memory difficulties. This echoes a large literature demonstrating that attention is a cornerstone of memory, as information must be perceived, at least implicitly, to be encoded and remembered (Chun & Turk-Browne, 2007). Thus, strategies for improving attention, as delivered via programs such as Brain Boosters, may be a key means through which to improve perceptions of, and perhaps actual, memory performance. Improvement in mental health symptoms (depression, PTSD, and insomnia) collectively did not predict improvement in perceived memory impairment above and beyond attention. Future studies with larger samples can test more fully the components of Brain Boosters that contribute to its effects, and the possible indirect as well as direct paths to symptom improvement. For example, it is possible that improvements in symptoms of depression (described below) might lead to reductions in perceived memory impairment via improvements in attentional difficulties.

Mental Health Symptoms

As noted above, Veterans reported fewer symptoms of depression at the end of the Brain Boosters program than at the beginning. These mood improvements may have been attributable to the social contact via weekly group participation, the behavioral activation aspect of attendance (e.g., having a scheduled place to go; Jacobson, Martell, & Dimidjian, 2001), social support or empathy received from group members or facilitators, the psychoeducation and skill-building techniques regarding mood, and/or a reduction in other symptoms such as anxiety (Persons, Roberts, & Zalecki, 2003).

There was not a change in reports of PTSD symptoms from the beginning to the end of treatment. As Brain Boosters was not an evidence-based treatment focusing on PTSD symptoms (e.g., exposure treatment; Karlin et al., 2010), it follows that there was not an apparent reduction in symptoms. Although psychoeducation generally is considered an important element in PTSD treatment, the effectiveness of psychoeducation alone in treating PTSD has not been empirically established (Department of Veterans Affairs & Department of Defense, 2010). Thus, Brain Boosters may be useful insofar as it encourages Veterans to pursue referrals for dedicated PTSD treatment, a process that could be tracked in future research.

Although one of the Brain Boosters sessions focused on sleep education and hygiene, symptoms of insomnia did not show a significant change from the beginning to the end of the Brain Boosters program. This was not surprising, given that sleep education and hygiene are known to have limited efficacy as standalone therapy for insomnia (Irish, Kline, Gunn, Buysse, & Hall, 2015). Veterans in Brain Boosters suffering from insomnia ideally pursued VHA-based cognitive–behavioral therapy for insomnia, per the facilitators' recommendations. This may be especially important for the younger Veterans in our sample, as insomnia symptoms were inversely associated with age. There was a trend toward improvement in insomnia symptoms predicting improvement in perceived memory in this context, which is consistent with a large body of research on the relationship between sleep quality and waking cognitive functioning (Waters & Bucks, 2011).

Limitations

Importantly, the present study aimed to serve as a feasibility or pilot test of our treatment, and should be viewed in this light. Treatment effects of the groups cannot be determined without a control group, as the introduction of medication, adjunct treatment, a "halo" effect at the end of treatment, or countless other factors including placebo effects and the passage of time may have contributed to symptom reductions, or to a lack of symptom change. For example, if Veterans entered an adjunct treatment for insomnia, it may have resulted in improvement in insomnia symptoms and attention, and in turn lower posttreatment ratings of perceived memory impairment, apart from the effects of Brain Boosters attendance. This is a significant confound that we did not assess and therefore were unable to disentangle.

The sample was relatively small, and there clearly was a selection bias, in terms of who elected to attend the groups and to fill out measures at both the first and the last group sessions. The Veterans in our final sample, who completed both pre- and posttreatment measures, did not differ in initial clinical symptom levels or most demographics from the Veterans who only filled out pretreatment measures and therefore were not included in our final sample; still, all of these Veterans are characterized by a referral to the groups and a willingness to participate and fill out an initial set of forms. Similarly, the mean number of sessions attended was notably high, because we included in our final dataset only those participants who provided at least one matching pre–post questionnaire set. Thus, by definition, these individuals were likely to persist with and have completed the treatment. Analyses are based on a perhaps particularly conscientious sample, and/or on those more open to sharing their experiences and symptoms. Anecdotally, Veterans who persisted until the third Brain Boosters session tended to stay for the remainder of the sessions, but there was some degree of attrition at the beginning. This is consistent with the fact that Veterans who only completed pretreatment measures attended a mean of 3.7 sessions.

We did not have formal clinical diagnoses for those in our sample. Self-report ratings suggest high mean symptom levels on average, but given our lack of available diagnoses and small sample size, we were unable to conduct analyses on the basis of diagnosis. Furthermore, we had neuropsychological evaluations for only a subset of Veterans in our sample, as these were not required nor automatically recommended for Brain Boosters' participants. Of those, testing results often reflected a combination of functional (e.g., pain or disruptions in sleep or mood) and organic (e.g., possible hypoxia, brain bleed, or long-term alcohol use) etiologies for Veterans' memory complaints. Given the small sample size and large number of potential diagnostic categories, we could not assess whether Brain Boosters was most effective for those with (or without) solely functional memory complaints, and/or with TBI (although there is evidence from prior research that neuropsychological performance does not differ among those with mTBI and comorbid PTSD or other psychiatric conditions, vs. those with mTBI [Gordon, Fitzpatrick, & Hilsabeck, 2011] or PTSD [Soble et al., 2013] alone). Perhaps subgroups of older Veterans with and without measureable cognitive deficits would have differed in change in perceived memory impairment in this context. We also did not assess whether Brain Boosters was helpful in terms of improving objective memory functioning. Finally, we used self-report to assess difficulties with attention, depression, PTSD, and insomnia, and we did not assess other constructs (e.g., chronic pain) that may have contributed to memory complaints or improvement. In a larger sample, we will be better able to test models that assess the reciprocal effects of depression, PTSD, and other symptoms on perceived memory complaints before and after treatment, to perhaps begin to disentangle the driving factors.

Conclusion

We examined the feasibility and preliminary effectiveness of Brain Boosters, a weekly 10-session group treatment for Veterans to address memory complaints and related mental health concerns. In light of the aforementioned limitations, it is encouraging that those who persisted with the program by participating in a majority if not all of the sessions, and were willing to fill out questionnaires about their symptoms, did report experiencing a reduction in symptoms of depression and attentional difficulties. In turn, perceived improvement in attentional difficulties predicted perceived improvement in memory. Additionally, the younger Veterans in our sample, who largely belonged to the OIF/OEF cohort, reported fewer memory complaints at the end of treatment than at the beginning. If these findings are borne out in a larger sample, it would suggest that Brain Boosters can be an important intervention for this population.

An additional implication of these preliminary results is that a program such as Brain Boosters may serve as a nonthreatening or nonstigmatizing means through which to address subjective memory impairment and related mental health issues. Supporting this, participants in our sample on average attended approximately 85% of the Brain Boosters sessions. Brain Boosters therefore is a good avenue when a direct referral to a psychiatrist or other mental health treatment is disconcerting for the Veteran. Moreover, a referral based on subjective memory complaints may be a useful way to identify and assist Veterans who are struggling with a range of mental health concerns and to triage them into evidence-based, VHA-administered mental health treatments (Karlin et al., 2010; Zeiss & Karlin, 2008). Conversely, even for those already in evidence-based treatments for psychological symptoms, Brain Boosters may be a useful adjunct treatment that focuses on improving memory and related cognitive processes in daily life.

Finally, regardless of the origin or multifaceted nature of Veterans' memory complaints, from a clinical perspective, the primary goal is to promote improved functioning in daily life (Hutchinson & Marquardt, 1997). Since achieving a precise diagnosis can be a challenging endeavor, and neuropsychological tests unto themselves may or may not reveal certain kinds of subtle cognitive dysfunction (Dolan et al., 2012), an intervention that helps regardless of the source and objective confirmation of the complaints can be a valuable clinical tool.

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