

# Emerging literature on cognitive intervention techniques for early stage dementia

## Abstract

Dementia is a growing world-wide phenomenon, impacting more than six million people in the United States. Despite its high projected prevalence, it is a significantly under-represented phenomena, with (under)estimate ranging from 15-25% of the general population. The effect of the aging of the population and significant increase in life expectancy has combined to catapult dementia into the range of one of most alarming healthcare problems. Diverse and emerging literature in the area of cognitive prevention/intervention for mild cognitive impairment (MCI)/early stage dementia will be reviewed. Additionally, future research and clinical directions will be explored.

**Keywords:** mild cognitive impairment, dementia, alzheimer's disease, cognitive prevention, cognitive intervention

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## Introduction

The increasing prevalence of dementia has become a major topic in both neuropsychology and society alike. With an elderly person diagnosed with dementia every minute, there is an increasing personal and economic (in addition to professional) interest in this disease. Despite its increased prevalence and a significant increase in awareness and education, dementia is still a significantly under-represented phenomenon, with underestimate ranges from 15-25% of the general population. The combined effect of the aging population (caused primarily by baby boomers aging into the dementia generation) and significant increase in life expectancy, has combined to project dementia into the range of one of our field's (and our nation's) largest healthcare problems.<sup>1</sup> Worldwide, there is an estimated 47.5million people diagnosed with dementia (World Health Organization, 2015). By the year 2030, the number of adults over the over the age of 65 is expected to increase to approximately 86million, with this generation representing 20-25% of the US population.<sup>2</sup> Currently, there are about 87.7million people recently diagnosed with dementia. In the State of Arizona, there is a projected 44-72% increase in dementia.<sup>3</sup> Although researchers have begun to identify the significant and increasing prevalence of dementia in the average population, the early prevention and intervention of this disease has remained largely unchecked. This is highlighted by statements that "interventions that can prevent, slow, or even reverse the underlying pathology of these progressive neurodegenerative illnesses are desperately needed".<sup>4</sup> The current failure of science to adequately address this issue is significantly juxtaposed by this dramatic (sub) population increase.

## Literature review

Although research in this area certainly has been lacking, there has been a burgeoning and significant literature base. The most prominent studies will be reviewed here. Valenzuela and Sachdev.<sup>5</sup> in a literature review of 22studies involving approximately almost 30,000 individuals, found an overall risk reduction of 46% in individuals that were found to engage in a high level of regular cognitive activity. Perhaps more importantly, they found a dose-dependent relationship between cognitive exercise and reduction of dementia, which had not been found prior to publication of the study. Secondary to concerns about lack of established causality, the researchers performed a meta-analysis of cognitive intervention models (7 studies, about 3200

healthy participants). The main findings, published in the American Review of Geriatric Psychiatry, found that a dose of 2-3months of cognitive intervention (in the form of new and novel learning) may have long-lasting and persistent protective effects on cognitive aptitude over a number of years. The researchers found that combining cognitive intervention with physical exercise was of maximal benefit. Interestingly and importantly, they found that the cognitive intervention protocols used in the study appeared to generalize to cognitive and functional domains beyond those specifically designed for the intervention.

A large meta-analysis was conducted by Olazaran et al. In this study, 13 studies that were considered high quality were examined. Of these studies, seven demonstrated positive results in favor of cognitive intervention for MCI dementia prevention/intervention. The combined effects of cognitive intervention and family support were found to result in delaying cognitive decline and reducing the possibility of institutionalization and death of persons receiving care. Interestingly, the use of cognitive intervention was significantly improved when compared to psychopharmacological agents. There was no significant difference for other outcomes measures (including activities of daily living (ADL's), performance, and mood) when cognitive intervention was compared to pharmacological treatment. Additional research has found that cognitive stimulation has had increased beneficial effects on early-stage dementia when compared to medication. Specifically, Aguirre, Woods, Spector, and Orrell (2013) found that, in a review of 15 studies, participants who were grouped in cognitive intervention groups demonstrated significant improvement when compared to control groups across cognitive and quality of life measures. This was shown as significantly beneficial when compared to "anti-dementia" medication (e.g., Aricept). The results have translated to improved neurocognitive performance.

## Healthy participants

Literature has also focused on participants without confirmed diagnoses of dementia. Wilson et al. (2002), in a prospective study involving more than 700 non-demented participants, found that a person at the 90<sup>th</sup> percentile in cognitive activity, when compared to those at the 10<sup>th</sup> percentile, were 47 percent less likely to develop Alzheimer's-related dementia. Importantly, this effect was found independent of education or age.

## Types of cognitive intervention

In addition to the literature reviewed above, research has also focused on the benefits of cognitive strategies on psychosocial outcomes. Specifically, Sitzer, Twamley, and Jeste<sup>6</sup> examined the effects of two categories of cognition: compensatory and restorative strategies. Compensatory strategies were defined as developing new ways of performing cognitive tasks by working around their existing deficits, while restorative strategies involve more direct intervention in areas of impairment (e.g., memory, speed of processing). The researchers found that, overall, there were not significant differences between restorative and compensatory strategies; they concluded that although effect sizes were small, cognitive interventions can improve cognitive and functional outcomes with individuals with dementia of the Alzheimer's type. Interestingly, the researchers emphasized the importance of family members in providing assistance with cognitive stimulation activities. An additional study was conducted by Werd, Bolen, Rikkert, and Kessels.<sup>7</sup> In this particular study, researchers utilized an errorless learning protocol among individuals with dementia. Also utilizing functional tasks (e.g., teaching participants to use common devices), the researchers found that of 25 studies reviewed, 17 demonstrated significant improvement of participant performance when compared to control groups; these results were observed over time.

## Improvement on standardized scores

Additional research has demonstrated significant efficacy in improving standardized score performance. Yu et al (2009) found an average improvement of 1.5 points on the Mini Mental Status Examination (MMSE). This is in comparison to an average decline across 3 points. Ultimately, this resulted in a 4.5 point difference in participants, which was both clinically and statistically significant. Similar methodology was utilized in the present study. Jean, Bergerson, Thivierge, and Simarad<sup>8</sup> conducted a meta-analysis of 15 cognitive rehabilitation studies with MCI of the amnestic type, finding gains on 44% of standard neuropsychological assessment measures. Although many other studies (e.g., Gates, Sachdev, Fiatarone Singh, & Valenzuela<sup>9</sup>) have noted challenges in preventing memory reduction associated with dementia, the researchers found significant memory findings by utilizing techniques like mind mapping, visual imagery, face-name association, and other heuristics. In an excellent meta-analysis, Willis et al.,<sup>10</sup> examined over 3000 individuals. Participants were randomly assigned to one of three cognitive training intervention groups: memory, reasoning, and speed of processing. Main findings revealed significant and pervasive improvements, with cognitive and functional gains observed over a period of 5 years. Alternative studies have been completed examining cognitive interventions with MCI. In looking at a cognitive intervention methodology across 24 studies, significant improvements were noted for 2,299 participants. For both the healthy and MCI groups, the study showed significant effects for both the healthy and MCI groups. It should be noted that significant effects were only found for both immediate and delayed recall (amnestic MCI).

## Computerized cognitive intervention programs

In addition to traditional cognitive intervention program, these programs have translated to computerized-medium programs. Four trials of cognitive intervention have been analyzed. In examining the cognitive impairments in relation to Parkinson's disease, the

researchers found that a computerized cognitive intervention program resulted in significantly improved verbal fluency and immediate and delayed memory (as examined on the WMS-IV). In a comparison study between computerized cognitive training and memory strategy training, 50% of computerized training exercises were found to be effective, compared to 37% of memory strategy outcomes.<sup>9</sup> According to the authors, a dose-response relationship was also observed, with a greater volume of cognitive training revealing greater effect sizes. Additionally, and importantly, the multi-domain exercises were found to demonstrate greater efficacy than uni-dimensional methods. Importantly, this was the first study that examined the issues of multi-domain and dose-response relationship. Most certainly, more research in the area of computerized training for dementia prevention is certainly needed.

## Cognitive intervention and quality of life

In addition to the beneficial cognitive effects of cognitive intervention, researchers have increasingly examined quality of life (QOL). Quality of life (QOL) is consistently perceived by the elderly to be a more significant benefit than reduction in cognitive decline. The researchers found that cognitive intervention programs, ranging from at home to institutional intervention, were found to have both significant cognitive and quality of life effects. Additionally, researchers<sup>11</sup> examined the effects of a review of literature on cognitive stimulation therapy, administered via an occupational therapy focus. They noted enhanced quality of life, improved participant communication, and the secondary effects of reducing apathy and irritability.

## Clinical focus of cognitive intervention

### Alzheimer's-related dementia

Alzheimer's disease (AD), although not a new disease, was first diagnosed and conceptualized over 100 years ago, with the first reporting of the case occurring at meeting in 1906. At the most basic level, Alzheimer's disease is defined by neuro fibrillary tangles (NFT's) and neurotic plaques (NP's). The above combine to contribute to diffuse cortical atrophy. In addition to this, senile plaques and amyloid angioplasty is found in all brains of individuals with AD. The above neuropathological signs have been shown to be highly correlated with neuropsychological results and improvements daily functioning. Neuropsychological assessment is often seen as an essential part of Alzheimer's criteria. In this way, neuropsychology is often employed in the area of early stage dementia. The neuropsychological profile of mid to late-stage Alzheimer's dementia (AD) is typically anterograde amnesia, lower intellectual criteria, Performance IQ < Verbal IQ, constructional abilities, and variable language deficits (including confrontation naming). A more comprehensive neuropsychological assessment was found to be very helpful in diagnosing early-stage dementia. The future prevalence of AD is the subject of growing concern. Specifically, prevalence and incidence rates are shown to double every 5 years over the age of 65. Additional estimates indicate that 1 in 4 people over the age of 65 have a clinical diagnosis of dementia and as many as 1 in 2 people aged 85 or older meet criteria for AD. Although the future prevalence of this disorder is much-debated, a general consensus exists that the rate of this disorder will greatly increase over the next 10 years. A plethora of studies have been conducted in this area, focusing on the progression of MCI to dementia, with specific focus on identifying the factors that trigger individuals from MCI into dementia.

## Longitudinal research on aging

Many research issues exist in the study of normal and abnormal aging. With the main focus being the attempt to differentiate the presence of dysfunctional cognitive change from normal aging, there are many potential challenges, as well as solutions. One subject of importance is the most appropriate use of norms. As stated by Rush and Smith “the clinician must...consider a variety of demographic factors to determine if a person might be deviating from expected, typical, or benign cognitive change.” This need for normative referents creates a need for appropriate normative data. This is also explored by Busch, Chelune, and Suchy<sup>12</sup> in a chapter on utilizing norms in neuropsychological assessment of the elderly. The researchers point out, when interpreting norms, that one must examine the “life context” of the aging individual. These are also explored by other individuals, including changes in cognitive (e.g., cognitive slowing, memory difficulties, problems with executive functioning) and physical (e.g., hearing loss). Koltai & Branch<sup>13</sup> also point out that these physical issues are also associated with dementia. Typically the way norms are utilized in this population are to determine if an individuals’ scores significantly deviate from the scores of their population, and measures of central tendency are utilized. The researchers identify the following as potential confounds:

1. These norms assume that the measures are normally distributed across the reference (normative) group. This is particularly true in measures like the Dementia Rating Scale – Second Edition (DRS-2), which is prone to ceiling effects,
2. The composition of the normative sample can be biased, and
3. Population-based norms cannot, by themselves, be used to identify abnormal or impaired performance. Additionally, the Mayo criteria for MCI propose that a memory complaint must be present.<sup>14</sup>

## Technology and the elderly

In 2000, 25% of the elderly reported having a home computer and indicated using it significantly; with this number jumping significantly in 2016, with more than 65% of adults over the age of 65 having one (or more) Internet-connected technological devices that they use “very frequently.” Negative stereotypes of the elderly have typically focused on the elderly inability and unwillingness to learn computer technologies, although this does not appear to be accurate overall, as many individuals have been found to utilize technological devices “quite frequently”.<sup>15</sup> However, there does appear to be significant evidence that aging individuals will use less user-friendly interactive forms of technology (e.g., supermarket checkout scanners), which may indicate increased technological adaption. In fact, researchers found that elderly individuals often underestimate their own technological sophistication,<sup>16</sup> with the significant stigma of dementia possibly clouding their impression. Importantly, Jay and Willis<sup>17</sup> have indicated that elderly people use of technology has more to do with their technological sophistication than with age itself. Additional research shows that older adults did not show a particular aversion to technology.<sup>18</sup> In addition to user’s technological sophistication, the social aspects of Internet technology, as explored by researchers such as White et al. (2002), indicate that the majority of technology users utilized these mechanisms to reduce isolation and decrease depression. Bush & Martin<sup>19</sup> indicate that technologically-connected older adults can use Internet-based communications as part of an interactive adult community. Interestingly, among the majority of researchers in this area, cognitive change is seen as an inevitable part of aging.<sup>20,21</sup> The

majority of researchers agree that cognitive changes that accompany advanced aging typically involve a small amount of deposits of beta-amyloid peptide and neuro fibrillary tangles. According to researchers such as Fillit et al.,<sup>22</sup> this leads to the downward trend of loss of neural synapses and neurons, as well as dysfunction in neuro chemical input and neuronal networks.

## Research on cognitive intervention and aging

Studies of cognitive aging typically involve either cross-sectional (inter individual comparison) or longitudinal (intra-individual comparison) design. These studies include the fact that cross-sectional studies cognitive aging compares the performance of older adults to the performance of younger adults at a single point in time.<sup>20</sup> A major disadvantage to this approach is that between-groups comparison does not take into account cohort effects or selective attrition (i.e., the tendency for lower scoring members of a cohort to drop out of studies more rapidly). Overall, cognitive change involves misleading information, perhaps most predominantly in the area of functioning over time, including rates of decline in individuals. In contrast, longitudinal studies offer more improved information, offering detailed information on single individuals’ cognition over time. According to Attix and Welch-Bohmer<sup>20</sup> these studies advance our understanding of normative cognitive aging by allowing one to examine our individual differences in rate of cognitive change.

When examining cognitive change over time, researchers often employ reliable change index (RCI). These scores are often utilized to assess whether an individual’s change over time (often after an intervention) is significant. This is calculated for each test and, if applicable, should take into account the practice effects of the measure in question. This is often partnered with change scores, which are designed to measure the specific effect of this change over time. Whereas alpha levels are often designed to assess statistical significance, kappa coefficients are often utilized to further define clinical significance (Lakens, 2013). The above methodological and statistical structure is, fortunately, recognized by major and diverse bodies, including the Federal Trade Commission (most notably portrayed in their most recent Lumosity ruling – Federal Trade Commission, 1/5/16). As such, this type of statistical analysis is highly applicable for the current study.

## Outcome measurement in cognitive intervention with the elderly

When examining longitudinal research for cognitive intervention for the elderly, there are multiple outcomes that should be assessed:

1. Level of impairment, activity, or participation,
2. Activity measures are the most important outcomes for cognitive rehabilitation, and
3. Quality of life is best assessed as component domain rather than a single measure. These main points have significantly guided the current research study.

## Outcome measurement: concepts.

Measurement of outcome is primarily determined by the ICF World Health Organization (2001). In terms of dementia, they define the following concepts:

- A. “Body functions and deficits, which are defined as the loss or abnormality of psychological, physiological, or anatomical

structure or function" (in this area of study, this is meant to include cognitive deficits such as dementia),

B. Activity limitation (the difficulties an individual may have in executing activities of daily living (e.g., driving a car, taking medications), and

C. (And perhaps most importantly) participation and involvement in life situations at a social level (p. 15). This third quality (according to the authors) is perhaps the most elusive, and, interestingly, a highly-sought after one by the current authors.

### Selection of measures for aging individuals

Selection of measures for aging individuals is an important concept and one that will not be covered adequately in this paper. A brief overview reveals that measures are selected by

1. Psychometric properties,
2. Normative data available, and
3. The inclusion of ADL's (in collaboration with standardized measures of cognitive impairment). It is important to note that "in order for a cognitive assessment to be used as an outcome measure, it must be sensitive to changes over time but have minimal practice effects" (World Health Organization, 2001, p. 92), important advice was also taken into account in the current study. The authors also highlight the important of including ADL's as well as measures of mood, the latter is included in the current study. Limitations in selection measures in cognitive activities are also discussed.

### Processing speed

A major issue in aging is a significant decline in processing speed. The majority of studies have demonstrated that problems in speed of processing consequently lead to dysfunction in downstream performance and age-related changes in neurocognitive performance. Processing speed deficits lead to problems in attention/concentration, memory, and language.<sup>23,24</sup> In fact, some researchers believe that decreased processing speed is the "hallmark" of cognitive aging, although this is not a view necessarily shared by all scientists.

### Neuroplasticity and aging

#### Pharmaceutical interventions for aging and dementia (AD)

Despite recent progressions in the science, and significant personal and business amounts of money spent, there is reported "scant evidence" for the Food and Drug Administration (FDA)-approved treatments for Alzheimers disease significantly prevent and/or reduce the cognitive and/or psychological effects of dementia. This is hardly a knock on the researchers at work on this endeavor, as the neuropathological complexity of this disease state has only recently begun to be unraveled. The majority, if not all, drugs for dementia target enhancement of cholinergic activity by attempting to enhance the activity of this agent by providing precursors for acetylcholine, reducing the breakdown of this chemical via AchE inhibition. At present, there are 5 FDA-approved medications for the treatment of this treatment: donepezil (Aricept), Namenda, and Exelon (among others).

**Glutamate:** According to Ringman and Cummings,<sup>4</sup> the neurotransmitter glutamate has been found to play a potentially important role. As the major excitatory neurotransmitter in input

pathways to the hippocampus (via the entorhinal cortex) and in cortico-cortical pathways, this neurotransmitter was found to be a major role in memory and dementia (particularly Alzheimer's type) since the beginning of research. As stated by a variety of researchers, the pathways noted above have been demonstrated to be dramatically affected in AD. Research in the area of neurotransmitter systems and dementia has been less consistent, with most pathways ultimately affected later in the disease.<sup>4</sup>

## Cognitive intervention for aging and AD

### Computerized cognitive intervention

Given the advent of new technology, and many aging individuals increased familiarity with it, there has been increased research on the use of digitized cognitive exercise for early stage dementia.<sup>25</sup> notes that computer-based technology has provided wider accessibility, reaching those in normal aging or those trending into cognitive intervention for early stage dementia. One such program is the ACTIVE study, which found that a dose of two to three months of cognitive training may have "long-lasting and persistent protective effects on cognition over a period of years".<sup>26</sup> Perhaps most importantly, the researchers found that the results had transfer to gains in functioning as well and the ACTIVE trial is the only study deemed to be of "high quality."

**Home care:** A variety of studies have also focused on the applicability of cognitive intervention to home care environments. Researchers such as Galante et al.,<sup>25</sup> and Miniussi and Vallar<sup>27</sup> have pointed to the need for cognitive intervention in the home environment. The latter researchers argue for the important role of cognitive intervention when engaging in cognitive rehabilitation for neuropsychological disorders. Cognitive intervention in the elderly has mainly focused on memory. Research in this area relies on the potential neuroplasticity functionality of an aging brain, the heterogeneity of the aging population, and dependence on a complex biopsychosocial interaction. The following section will be divided into two broad sections, techniques designed to reduce memory decline in normal aging and interventions for pathological aging (i.e., dementia). The focus henceforth will be on cognitive intervention.

### Cognitive intervention techniques

#### Cognitive intervention for normal aging

Although there is certainly significant variability in the area of deficits for cognitive intervention for dementia, perhaps the largest problem area does appear to be in the area of episodic memory (i.e., memory of events experienced relatively recently). This area declines steadily in the 50's, then drops significantly "off the table" once the individual reaches their 70's and 80's. Prospective memory also has shown impairment. Additionally, difficulty in effortful tasks, such as free recall, also show significant impairment. As significantly more cognitive load appears to be demanded; deficits are also shown on working memory. This is in the context of relatively persevered delayed recall and recall of crystallized intelligence information. Cognitive intervention in this area focuses on "optimization" of existing functionality and prevention of cognitive decline. According to Glisky and Glisky (2008), these methods include (but are not limited to) encoding strategies (e.g., integrative encoding, visual imagery, substitution of intact function (e.g., errorless learning), and compensation for lost function (e.g., utilizing external memory aids). Encoding training strategies are utilized. The authors note that while many older adults do not, on their own accord, engage in these techniques, they can be taught to do so repeatedly. Somewhat

unfortunately, these techniques are thought to not likely be effective in Alzheimer's disease or other forms of dementia. Additional research comes from Hall et al.,<sup>28</sup> who examined 101 participants who were cognitively normal at baseline but developed dementia during the study. These researchers found that individuals in the upper quartile of cognitive activity had cognitive decline 1.3 years when compared to those in the lower quartile of activity. Further supportive research comes from Verghese et al.,<sup>29</sup> measured cognitive activity in 469 participants over 75 years of age. In this research, a 1-point increment in the cognitive activity outcome score was significantly affected with 7% reduction in dementia risk. Participants with scores in the highest third in measured cognitive activity had a risk of dementia that was 63% lower than that among those with scores in the lowest third.

### Cognitive intervention for MCI/Dementia

In contrast, the picture for Alzheimer's-type dementia is significantly different. These cognitive and functional changes, explored below, appear to be primarily the result of much distinct neuropathology. Specifically, whereas normal aging produces significant changes in prefrontal cortex and hippocampal volume (leading to memory decline), in Alzheimer's dementia the entorhinal cortex does appear significantly impacted early on, along with the hippocampus; white matter decline is evident in both normal aging and Alzheimer's dementia. Helzner, Scarneas, Consentio, Portet, and Stern<sup>30</sup> examined the range of cognitive decline among AD patients during follow-up. Similar to the current study, the authors utilized a standard neuropsychological battery as dependent variable(s). The predictor variable being utilized was self-reported leisure activity (classified as intellectual, physical, or social). Results revealed that lack of intellectual activity was associated with faster cognitive decline. Although episodic memory is also affected, it is impacted earlier and with much greater severity, with performance in this area often falling more than two standard deviations below the normative average (Glisky and Glisky, 2008). Perhaps the most notable problem is word-finding, with individuals with Alzheimer's-type dementia displaying significant problems in relating words to conceptual cues. Impaired conceptual and semantic priming is also noted. In terms of cognitive dysfunction, deficits in memory appear more attributable to atrophy or shrinkage in the prefrontal cortex and/or medial temporal lobes of the brain, changes in Alzheimers-related dementia appear specifically in the entorhinal cortex.<sup>31</sup> The atrophy then gradually spreads to the region of the cortex, including the parietal, lateral temporal, and prefrontal cortex. Although the use of cognitive intervention techniques for MCI and/or early stage dementia has not been a topic that has been addressed in a comprehensive manner, there has been select notable research on this topic at present. This includes foundational work by Wilson, Kopelman, & Kapur.<sup>32</sup> In their chapter, the authors note a few key points (selected from a list taken on page 522 of their text): structured teaching is often required to help memory-impaired individuals utilize memory aids, in addition to memory problems, many individuals will have other cognitive and emotional problems that need to be addressed and that these issues should be treated together, internal strategies (e.g., mnemonics and rehearsal techniques) can be effective and aging adults with dementia can/will use these with appropriate coaching. Additionally, the authors point out that new technology may be of significant assistance, including the use of the Internet (see below). The technique of errorless learning, adapted from work with individuals with learning disorders, has also been found to be effective in helping older adults with memory problems. Beginning with the work of Baddeley and Wilson,<sup>33</sup> a strong line of research has shown that amnestic patients with MCI have been shown to receive significant benefits in terms

of memory. Findings have revealed that this type of learning is far superior to trial-and-error type learning (Squires et al.,<sup>34</sup> Wilson & Evans, 1996). The above research, as well as others, form the basis on which the SMART Memory Program was created.

Acevedo and Lowenstein<sup>35</sup> also provide a fairly comprehensive detailing a multitude of interventions in the area of mild cognitive impairment (MCI). In cognitively normal adults, training often results in significant improvement (e.g., Backman, 1996). Although select research has found a lack of research efficacy in individuals with Alzheimer's Disease, the lack of research efficacy may be due in part to the reliance of episodic memory (Loewenstein & Acevedo, 2008), as episodic memory (secondary to hippocampal degeneration), is compromised early in the AD stage process. Nevertheless, there has been strong efficacy amongst a variety of techniques. While the earliest method of cognitive intervention in aging involved the spaced retrieval technique (SRT), first described in 1978 by Landauer and Bjork.<sup>36</sup> It is hypothesized, and research has supported, the fact that SRT is effective via engaging implicit, rather than explicit, priming, also decreasing reliance of declarative or semantic memory. Additionally, activation of procedural memory motor learning has demonstrated some research efficacy. This draws from research from Dick, Kean, and Sands,<sup>37</sup> who have shown that patients with various symptoms of AD with varying severities demonstrate improved recall of command sentences when they perform a requested action. Future research in this area does appear needed. As mentioned prior, errorless learning has also been shown to be somewhat effective. When used alone or in combination with SRT, errorless learning has been shown to improve the ability of patient with AD to use memory resources to improve orientation to time and face-to-face recognition (e.g.,<sup>38-42</sup> Similar to above, future research in this area does appear needed.

In addition to existing programs, Lowenstein and Acevedo (2008) have also started a cognitive rehabilitation intervention program for aging. Notably, their program was an intervention one, employing an orientation/time notebook and anchoring information. Also importantly, traditional cognitive measures were also employed (e.g., CPT, MMSE). Results were significant for positive gains at 3 and 6-month post-intervention time-points. Overall, these results reveal certain cognitive and functional skills can be effectively trained in individuals with MCI and early-stage AD and that, more importantly, these gains can persist at 3 and 6-month time points (Lowenstein & Acevedo, 2008). Overall, memory and functional skills in mildly and very mildly impaired patients with AD can be improved by the integrated utilization of SRT, dual cognitive support, and procedural motor activation. Research also demonstrates that training should focus on acquisition and maintenance of skills, as well as activities directly related to activities of daily living (ADL's).

### Existing cognitive intervention programs

Select major hospital centers have developed and/or incorporated their own cognitive training program. For example, Mayo Clinic, under the (former) direction of Dr. Glenn Smith and now under Neuropsychologist Dr. Donna Locke, has developed the HABIT program. This is a larger, more comprehensive program that incorporates "brain fitness" and "individual memory compensation training" in the context of a larger program, involving yoga, fitness, and nutrition (among other things). A pubmed search (6/4/16, 11:43 AM) revealed no published research on this topic. When many aging consumers think of cognitive brain training for dementia, they may think of Lumosity, a purported cognitive intervention product designed and advertised by Lumo Labs, Inc. Despite purchasing extensive advertising (e.g., CNN, Fox News, the History Channel,

National Public Radio, Pandora, Sirius XM, many radio outlets) and being backed by “neuroscientists,” the Federal Trade Commission (FTC) found that the company engaged in false advertising, with Lumo Labs being sued for \$50 million (with the company only being able to pay \$2 million of this suit) (Federal Trade Commission, 2016). Fortunately, a co-occurring statement was also issued, delineated the process and scientific support needed to make such claims in the future, authored by Commissioner Julie Brill.<sup>44-48</sup>

### Brain games for dementia prevention

In addition, a foundational paper was published prior to this, in which a statement was issued indicating that the majority of existing research did not support the efficacy of current brain games to reduce dementia. (Backman et al., 2008). The authors indicate that, as of 2009, current research did not support cognitive efficacy, there was significant reason for optimism. This is reflected in their statement: “Research shows that the brain is highly responsive to the environment and displays impressive capacity to compensate for damage. Indeed, many excellent scientists are investigating the potential of technology-based software products and other approaches, like physical exercise, that may be useful in maintaining cognitive fitness.”

According to Sherry Willis and colleagues at Pennsylvania State University brain exercises that focus on training reasoning skills do translate into long-lasting improvements in daily life. The team looked at the effects of three non-computerized cognitive training modules (designed to narrowly target memory, reasoning, or processing speed skills) versus a no-contact control group in a sample of 2,832 cognitively-intact elders. The subjects received 10 one-hour sessions plus a booster at months 11 and 35. Surprisingly, at two years, there was no benefit on daily activities. But after five years the group trained in reasoning showed better performance on daily activities (an effect that was made more noticeable by the fact that some in the control group showed a decline).<sup>49-53</sup> These results suggest that a short training session plus periodic boosters may induce long-lasting cognitive and functional benefits—sort of a “teaching a person to fish for life” effect. Nevertheless, there continues to be strong interest in the dawning potential of brain games. This includes two recent issues of *Scientific American* detailing this important topic (Scientific American, 2009).

### Assisted living/independent living centers

In 2010, there was an estimated 31,100 Assisted Living/Independent Living communities (AL/IL's) in the U.S. with a capacity of over 1 million (National Center for Assisted Living, 2010). In the Phoenix Valley (USA) alone, there are over 500 assisted living/independent living centers. Given that some 77 million baby boomers are set to retire (this wave referred to as the “Silver Tsunami”), this group is thought to control over 70% of US financial assets. The top 4 largest AL/IL companies are: Brookdale Senior Living, Inc., Sunrise Senior Living, Inc., Emeritus Corporation, Inc. (which merged with Brookdale Senior Living in 2014 and Atria Senior Living). Competition amongst this group is high as demand for these services increases with the combined synergy of the higher population and increased life expectancy. As one might expect, the websites of these companies cater to both clients and their families (e.g., <http://www.sbdcn.org/small-business-research-reports/assisted-living-facilities> ). Quite obviously, the need for these facilities is much greater in the future.

### Future directions

As hypothesized, the SMART Memory program produced positive cognitive changes at the conclusion of each training session. Unfortunately, at the conclusion of each training session the patient's

scores reverted to near-baseline levels. This is similar to other research in this area, which displayed temporary improvement post cognitive intervention. As the aging population continues to expand, this will certainly continue to be very necessary. One of the most notable results from the current study is that this SMART Program was found to significantly impact delayed memory. Delayed memory has been shown to be the primary hallmark in dementia progression and the most resistant to dementia decline. Based upon research that has found that neuropsychological tests have great utility in predicting performance, neuropsychologists are increasingly being called upon to offer intervention efforts based upon their initial assessment, similar to psychotherapy. Specifically, serial neuropsychological assessment has been emphasized to test treatment efficacy. The use of the SMART program may be reflective of neuropsychologists increasingly entering the arena of cognitive prevention and intervention for early stage. The existing literature, referenced above, indicates that there is a great deal of promise. Given the significant aging of the population, and the much higher probability of dementia, cognitive prevention and intervention are certainly needed.

This effort of prevention and intervention of early stage dementia will ultimately require an interdisciplinary approach. This team includes (but is not limited to) general practitioners, geriatricians, and geriatric psychiatrists, as well as neuropsychologists, speech-language therapists, and occupational therapists. Additional topics in this area include. Current “memory clinics” should be changed to address the growing need of dementia prevention/intervention. This may be particularly helpful and/or pertinent for patients at VA Healthcare Centers, where dementia (in particular, vascular dementia) is found in disproportionate numbers. There are several drawbacks to the current study. These include, but are not limited to. Although this study is certainly limited in the nature described above, the findings do have significant implications going forward. As the “silver tsunami” invades our world culture, we will need multiple avenues of dementia prevention and intervention. As Medicare does successfully reimburse for speech cognitive intervention for speech and language services (under multiple CPT and diagnosis codes), the SMART program (or other programs like it) may be reimbursable under the Medicare system. At present, the SMART Memory Program has approximately 10 clinics in the Phoenix Valley area, with the practitioners having reimbursed for multiple visits on the Memory Program under primary Medicare, Medicare-advantage, and commercial plans. Dementia prevention mechanisms may also incorporate valuable (and perhaps pertinent) on-line technology. The brain-game industry is certainly a large market, as delineated by their ported approximate 75 million users of Lumosity. Although this market has become increasingly competitive, at present, there are no medically-driven, empirically-supported models, as evidenced by Lumosity's recent lawsuit by the Federal Trade Commission (FTC). As delineated by Robertson and Fitzpatrick (2008), cognitive neuroscience may have an increasing role in the future of cognitive neurorehabilitation. The author's main point here is that future cognitive neuro-intervention studies should be able to not only empirically verify the effect of the program on the life of the individual, but to show these effects in the brain, potentially via neuroimaging. As noted in the above reviewed research, future research may bring an increased focus in the area of activities of daily living (ADL). This may also incorporate specific partner report. Additional measures, as well as subjective report, may be further utilized to address day-to-day improvement in functioning. Future research may also incorporate functional neuroimaging, including fMRI and/or SPECT neuroimaging. Both of these areas may serve to offer concurrent validity to standard neuropsychological assessment measures.

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## Conflicts of interest

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