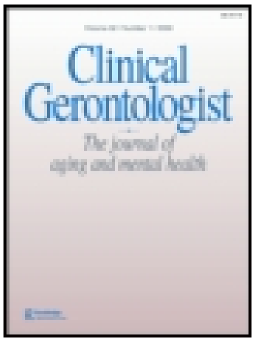

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Cognitive Training Program to Improve Working Memory in Older Adults with MCI

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ABSTRACT

Objective: Deficits in working memory (WM) are associated with age-related decline. We report findings from a clinical trial that examined the effectiveness of Cogmed, a computerized program that trains WM. We compare this program to a Sham condition in older adults with Mild Cognitive Impairment (MCI).
Method: Older adults (*N* = 68) living in the community were assessed. Participants reported memory impairment and met criteria for MCI, either by poor delayed memory or poor performance in other cognitive areas. The Repeatable Battery for the Assessment of Neuropsychological Status (RBANS, Delayed Memory Index) and the Clinical Dementia Rating scale (CDR) were utilized. All presented with normal Mini Mental State Exams (MMSE) and activities of daily living (ADLs). Participants were randomized to Cogmed or a Sham computer program. Twenty-five sessions were completed over five to seven weeks. Pre, post, and follow-up measures included a battery of cognitive measures (three WM tests), a subjective memory scale, and a functional measure.
Results: Both intervention groups improved over time. Cogmed significantly outperformed Sham on Span Board and exceeded in subjective memory reports at follow-up as assessed by the Cognitive Failures Questionnaire (CFQ). The Cogmed group demonstrated better performance on the Functional Activities Questionnaire (FAQ), a measure of adjustment and far transfer, at follow-up. Both groups, especially Cogmed, enjoyed the intervention.
Conclusion: Results suggest that WM was enhanced in both groups of older adults with MCI. Cogmed was better on one core WM measure and had higher ratings of satisfaction. The Sham condition declined on adjustment.

KEYWORDS
Cognitive training; mild cognitive impairment; older adults; working memory

There is an essential tension between the advocates of brain training and those who are more skeptical. In 2010, Americans spent $265 million on brain fitness software and web-based programs that claim to boost brainpower

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(Reichman, Fiocco, & Rose, 2010). This is likely to increase measurably. Several reviews, as addressed below, are now suggesting that cognitive training (CT) is helpful for impaired older adults. This change is in spite of many studies that caution the application of CT (e.g., Owen et al., 2010).

If aging compromises the basic operating characteristics of biological hardware, then CT and experience may benefit many from decompensating further into a degenerative disease (Mayr, 2008). For normal older adults, there is a constantly adapting central nervous system as the aging brain seeks to compensate for deficits—plasticity, brain reserve, and enriched environments (Bryck & Fisher, 2012; Reuter-Lorenz & Park, 2010). Targeting cognitive tasks that are more encompassing (e.g., executive functioning, set shifting, inhibition, updating) can make a difference in functional or far-transfer outcomes (Dahlin, Neely, Larsson, Bäckman, & Nyberg, 2008). This has been labeled as working memory (WM) training. In addition, more "holistic" CT can provide benefits that extend beyond attention and WM if applied to complex goal-directed activity (e.g., Basak, Boot, Voss, & Kramer, 2008; Stine-Morrow, Parisi, Morrow, & Park, 2008).

In this article we address the impact of a CT computer program, Cogmed, on older adults with mild cognitive impairment (MCI). We conducted a clinical trial on Cogmed against a Sham condition, and assessed whether such training can make a difference in cognition and adjustment. First, we briefly discuss overall cognitive training, then consider WM and problems with training of older adults, and last discuss Cogmed.

Overall training

Recent reviews from the National Institute of Health Conference for Alzheimer's Disease and Cognitive Decline (2011) that assessed 6,713 studies on risks and protective components for factors related to cognitive decline, found that CT and behavioral factors are associated with sizable risk reduction for cognitive decline. Accumulating research continues to demonstrate that older adults who are impaired benefit from CT (e.g., Belleville et al., 2011; Jean, Bergeron, Thivierge, & Simard, 2010; Loewenstein, Acevedo, Czaja, & Duara, 2004; Olazarán et al., 2010). The majority of studies targeted episodic memory while many addressed other cognitive domains: attention, speed of processing, language, visual spatial abilities, and executive functioning. Several involved computerized programs facilitating an individual approach (see Hyer, Mullen, & McKenzie, 2015).

In addition to many reviews of the value of CT on normal older adults (e.g., Valenzuela & Sachdev, 2009) and increasingly on dementia (e.g., De Werd, Boelen, Rikkert, & Kessels, 2013), there are now several reviews addressing MCI and the value of CT (Belleville, 2008; Buschert et al., 2011; Jak, Seelye, & Jurick, 2013; Jean et al., 2010; Li et al., 2008; Melby-Lervåg & Hulme, 2013;

Mowszowski, Batchelor, & Naismith, 2010; Rebok, 2008, Simon, Yokomizo, & Bottino, 2012; Sitzer, Twamley, Patterson, & Jeste, 2008; Stott & Spector, 2011; Valenzuela & Sachdev, 2009; Woods, Aguirre Spector, & Orrell, 2011). The overall conclusion of these reviews was that amnestic-MCI patients are capable of learning new information and memory strategies. However, there is a complex interaction between cognitive reserve (education, occupation, IQ, leisure, CT), and biomarkers of neuronal injury and neurodegeneration that are modulated by the benefits of CT. In summary, Jak and colleagues (2013), note that researchers are examining how CT packages can alter the negative cognitive aging outcomes, combat cognitive consequences of medical conditions, and improve mental sharpness in day-to-day life. Additionally, comprehensive or multifactorial training programs have been found to be successful in elderly adult populations (Floyd & Scogin, 1997; Rebok, Carlson, & Langbaum, 2007; Verhaeghen, Marcoen, & Goossens, 1992).

Working memory/durability/function

Training of WM has been identified as one of the main factors underlying cognitive impairment in old age as well as dementia (Bäckman, Jones, Berger, Laukka, & Small, 2005; Bäckman & Small, 2007; Baddeley, Bressi, Della Sala, Logie, & Spinnler, 1991; Craik & Bialystok, 2006; Salthouse, 2001). WM is a capacity limited mental workspace (Morrison & Chein, 2011) that serves as an active short-term maintenance of information in the service of more complex tasks such as mental arithmetic, language comprehension, planning, and problem-solving (Cowan et al., 2005; Shah & Miyake, 1999).

Clinical trials examining the effects of WM strategies in healthy older adults are generally positive (Ball et al., 2002; Cavallini, Pagnin, & Vecchi, 2003; Ercoli, Siddarth, Harrison, Jimenez, & Jarvik, 2005; Ercoli et al., 2007; Smith et al., 2009; Valentijn et al., 2005; Willis et al., 2006). CT in the form of WM training improves speed of processing (Ball et al., 2002), attention (e.g., Bherer et al., 2008; Smith et al., 2009), fluid intelligence (Engle, Kane & Tuholski, 1999), language acquisition (Baddeley et al., 1991), reading comprehension (Chein & Morrison, 2010; Daneman & Carpenter, 1980), problem-solving (Logie, Gilhooly, & Wynn, 1994), reasoning (Kane et al., 2004), and cognitive control (Chein & Morrison, 2010; Klingberg et al., 2005; Klingberg, Forssberg, & Westerberg, 2002). Thus, WM may serve as a domain-general cognitive resource that modulates ability in a number of seemingly disparate areas of cognitive performance.

Results of these articles varied based on the type of task used in training, duration, condition of subjects (age and health), use of an active control group, and nature of training (verbal, visual, spatial, combined). Virtually all studies reported gains in the trained task (e.g., Borella, Carretti, Riboldi, & De Beni, 2010; Borella, Carretti, Zanoni, Zavagnin, & De Beni, 2013) and some showed gains in far transfer tasks (e.g., Jaeggi et al., 2010). Few studies have evaluated

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functional outcomes, such as activities of daily living (ADLs) (Belleville et al., 2006; Kurz, Pohl, Ramsenthaler, & Sorg, 2009; Rozzini et al., 2007; Willis et al., 2006). It has been argued that more performance-based tasks related to instrumental activities of daily living (IADLs) should be applied in training and used as outcome measures (Acevedo & Loewenstein, 2007).

Cogmed and MCI

Cogmed focuses on WM training, specifically on the ability to hold and manipulate information for short periods of time. The computer program (Cogmed QM©) draws on the integrity of the prefrontal cortex, which demonstrates pronounced morphological alterations across the adult life span. The intervention involves challenging adaptive training on various non-verbal WM tasks (Westerberg et al., 2007). All tasks involve: (1) maintenance of multiple stimuli at the same time, (2) short delays, during which the representation of stimuli should be held in WM, (3) unique sequencing of stimuli in each trial, and (4) the adaptive difficulty as a function of individual performance.

Recent studies using Cogmed or Cogmed-like tasks show that training leads to improvements on trained tasks and some have demonstrated generalization of improvements that were not part of the training (Buschkuehl et al., 2008; Dahlin et al., 2008; Jaeggi, Buschkuehl, Jonides, & Perrig, 2008; Klingberg et al., 2005; Persson & Reuter-Lorenz, 2008; Westerberg et al., 2007). Research on older adults has been limited to only a few studies on community samples (Brehmer, Westerberg, & Bäckman, 2012; McNab et al., 2009; Olesen, Westerberg, & Klingberg, 2004), adults after stroke (Westerberg et al., 2007), and adults with cognitive deficits as a result of brain injury (Johansson & Tornmalm, 2012; Lundqvist, Grundström, Samuelsson, & Rönnberg, 2010; Westerberg et al., 2007).

In this study, we report findings from a clinical trial that examined the effectiveness of Cogmed on older adults with MCI compared to a Sham condition. Participants met criteria for MCI (see below). Participants were randomized to either Cogmed or to a Sham non-adaptive cognitive computer program; 25 sessions were completed over five to seven weeks. Measures included a battery of cognitive and functional scales that were administered pre, post, and 12 weeks following the intervention. This study also evaluated subjective memory and satisfaction.

Method

Participants

All participants were older adults (≥ 65 years of age) who presented with memory complaints and demonstrated some impairment upon screening

(Repeatable Battery for the Assessment of Neuropsychological Status, RBANS; Delayed Memory Index) and did not have difficulties with ADLs. A core criterion for inclusion was meeting generally accepted criteria for MCI (Andreescu et al., 2014). This construct has been traditionally defined as amnestic-MCI (a-MCI) and non-amnestic MCI (non-aMCI). For our purposes, the former group had a RBANS Delayed Memory score of <85, one standard deviation lower than average. Those who scored below 2 standard deviations, ≤70, were excluded from the study. The non-aMCI met different criteria (see below).

Participants were residents of the local community, had a Mini Mental State Examination score >24, and met criteria for MCI. The average MMSE score was 26. To rule out dementia, the Diagnostic and Statistical Manual of Mental Disorders-IV-Text Revised (American Psychiatric Association & American Psychiatric Association, 2000) and the National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA) (McKhann et al., 1984) guidelines were applied as diagnostic criteria.

The average RBANS Delayed Memory for the participants in the a-MCI group was 77.6, *SD* = 6.8, of which 75% met this criteria. For the other 25% who met criteria for non-aMCI, (*n* = 16; RBANS Delayed Memory Index *M* = 91.4; *SD* = 5.4), two criteria were required: (1) Clinical Dementia Rating scale (CDR) score of .50 (questionable impairment), and (2) lower scores on RBANS Immediate Memory (a new learning task, < 85). These two MCI types were combined for group randomization. On core measures at post-follow-up, there were no differences between these two MCI types.

The MINI International Neuropsychiatric Interview (Sheehan et al., 2010) was utilized to screen for depression and anxiety diagnoses. While many presented with such symptoms, none met full criteria for these diagnoses. Participants were referrals from medical school physicians in a large family health clinic. Medical records of potential participants were reviewed for other diagnoses, medications, results of CT or MRI scans, and general medical history. Individuals with psychiatric diagnoses and/or taking cognitive enhancers were excluded from the study. All participants had access to a caregiver. One hundred ten older adults were referred for memory problems. Forty-two were excluded due to having either severe or no objective memory problems (RBANS Delayed Memory Index ≤ 70 or > 85, respectively).

There were a total of 68 participants who completed the study; 34 in Cogmed and 34 in Sham conditions. Participants were considered "completers" when they attended 80% of training sessions and competed assessments at each time point. Nine participants dropped out of the study; five from Cogmed and four from Sham. Dropouts occurred due to compliance (four), hospitalization (three), travel issues (one), and issues with caregivers (one). There were no differences between the groups on demographic markers (see Table 1).

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Table 1. Descriptive Data of Cogmed and Sham Conditions.

Demographics	Cogmed: M (SD) (*n* = 34)	Sham: M (SD) (*n* = 34)
Age, years	75.1 (7.4)	75.2 (7.8)
Total # Medications	4.5 (2.4)	4.9 (3.2)
# Psychiatric Medications	.06 (.25)	.03 (.18)
Marital Status:		
Married	20	22
Single	4	3
Widowed	10	9
Gender: Male/Female	17/17	15/19
Ethnicity: White/Black	32/2	29/5
General Pain: Yes/No	7/24	10/22
Depression Scale Sum	2.3 (2)	3.5 (3.2)
Education: % HS or >	70	66

The average age of study participants was just over 75 years, most were married, white, had at least a high school education, and presented with few depressive symptoms. Participants reportedly took an average of four medications and rated their health as good.

Measures

The RBANS Delayed Memory (or Immediate Memory for the non-MCI), as well as the CDR, were utilized for inclusion criteria. Participants completed a series of assessments and questionnaires prior to the intervention, one-week following the completion of the intervention, and three months post intervention. Measures included Wechsler Memory Scale-Third Edition Span Board subtest (Wechsler, 1997a), Trail Making (Parts A and B) (Reitan & Wolfson, 1993), and the Wechsler Adult Intelligence Scale-Third Edition Letter Number Sequencing subtest (Wechsler, 1997b). Adjustment and satisfaction measures included the Functional Activities Questionnaire (FAQ) (Pfeffer, Kurosaki, Chance, Filos, & Bates, 1984) and the Cognitive Failures Questionnaire (CFQ) (Broadbent, Cooper, FitzGerald, & Parkes, 1982). The Cogmed Satisfaction Questionnaire (6 questions) was administered at post intervention, as we were only interested in this at the end of CT.

Procedure

After meeting study requirements, each subject was informed of the study, signed consent forms, and was randomly assigned to one of the two groups; Cogmed or Sham condition. All subjects believe that they were receiving a valued new computerized CT program and the study was to determine which CT program was better.

Sessions (25) were completed over a 5- to 7-week period for approximately 40 minutes per day. The exercises were divided between 8 different tasks each

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day that selected from a bank of 13 tasks. For Cogmed, each training task involved the temporary storage and manipulation of sequential visuospatial and/or verbal information. The comparison condition (Sham) involved the same training program as Cogmed without adaptivity. The difficulty level remained constant across the entire intervention, never increasing to three iterations above baseline. Participants completed the training at the clinic or at their home using a personal computer. To assure blindness to condition, all brand names were removed from the training software. Those in the Sham condition were offered the Cogmed training after completion of the study.

Each participant (Cogmed and Sham) had a coach; a person who assured that the tasks were completed properly, in a timely manner, and had rewards distinct for each person as part of the process (e.g., special meal or snack). Coaches were asked to employ these as incentives for compliance. Coaches consisted of spouses/significant others (82%), adult children (16%) and friends (2%). Each group also had a group coach who monitored daily results and could respond immediately. This coach worked with the individual coaches of both groups on a weekly basis to assure compliance and ease of the process.

Statistical analyses

The study targeted three cognitive markers of the value of intervention group (Cogmed or Sham): Span Board, Trails B, and Letter Number Sequencing. These assessments represent core cognitive abilities subserving executive functioning, verbal and non-verbal working memory, as well as speed of processing. Age correction was applied for Span Board and Letter Number Sequencing as this correction better reflected the distribution of scores. This was not the case for Trails B. We also addressed function of adjustment (FAQ, as far transfer) and subjective memory (CFQ). For these targets, we performed a univariate repeated measures analyses on pre, post, and follow-up measures using group and time as the main effects.

Results

There were no significant differences on any of the pre-measures for Cogmed and Sham conditions. Results of the univariate repeated analysis on cognitive measures can be found in Table 2. While all measures indicated improvement, it is noteworthy that Span Board; perhaps closest to the content of Cogmed (non-verbal WM), was statistically significant. Importantly, improvement of both groups on cognitive measures suggests that any training is beneficial for individuals with MCI (see Figure 1).

This same analysis was performed on overall IADLs and adjustment utilizing the FAQ (Table 3). Results demonstrate that Cogmed outperformed

Table 2. Repeated Univariate Analysis Results of Cognitive Measures for Group and Time.

	Mean Scores Over Time				
Scales	Pre (*SD*)	Post (*SD*)	3-month Follow-up (*SD*)	Main Effect F-Statistic (*p*)	Interaction F-Statistic (*p*)
Trails B					
Cogmed	132.38 (47.92)	118.92 (43.49)	102.92 (32.98)	Within 24.4 (<.001)	1.31 (ns)
Sham	133.97 (41.56)	112.57 (39.74)	112.87 (32.15)	Between 0.03 (ns)	
LNS					
Cogmed	9.63 (3.13)	10.90 (2.38)	10.83 (3.02)	Within 3.52 (.04)	0.76 (ns)
Sham	10.00 (2.85)	10.53 (2.46)	10.37 (2.50)	Between 0.07 (ns)	
SpanBoard					
Cogmed	8.79 (2.48)	11.54 (3.37)	12.13 (3.46)	Within 15.87 (<.001)	4.59 (.01)
Sham	9.73 (3.10)	10.77 (3.07)	10.63 (3.12)	Between 0.4 (ns)	

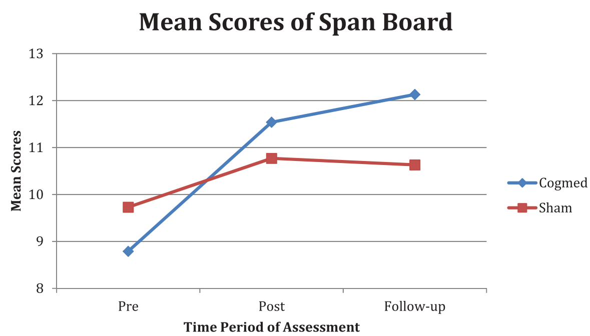

Figure 1. Non-Verbal Memory Outcomes for Pre-, Post-, and Follow-up Assessment.

Table 3. Repeated Univariate Results of Overall Adjustment and Memory Complaint Measures.

	Mean Scores Over Time				
Scales	Pre (*SD*)	Post (*SD*)	3-month Follow-up (*SD*)	Main Effect F-Statistic (*p*)	Interaction F-Statistic (*p*)
Functional Activities Questionnaire					
Cogmed	1.72 (3.59)	1.83 (3.47)	1.33 (3.18)	Within 0.71 (ns)	3.50 (.04)
Sham	2.06 (2.49)	1.82 (2.79)	3.12 (4.53)	Between 0.79 (ns)	
Cognitive Failures Questionnaire					
Cogmed	43.22 (11.81)	40.48 (13.60)	35.35 (11.50)	Within 9.9 (.004)	0.023 (ns)
Sham	44.67 (15.60)	40.17 (11.97)	39.58 (13.34)	Between 0.68 (ns)	

Sham. Specifically, adjustment as measured by everyday functioning was better at follow-up for Cogmed over Sham. Those in the Cogmed condition maintained their level of functioning whereas those in the Sham condition declined (Figure 2). Ratings were completed by the consensus of participant and caregiver at interview.

Cogmed also showed a significant change on the CFQ (Table 3). This scale represents changes in memory complaints and subserves a subjective view of

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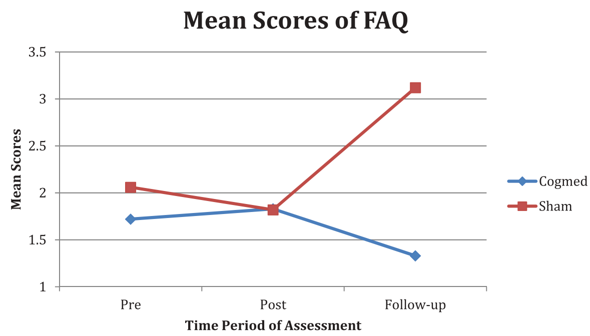

Figure 2. Adjustment and Far-Transfer Outcomes for Pre-, Post-, and Follow-up Assessment.

memory performance; and therefore, compliments the objective measures. Additionally, Cogmed performed better than Sham condition on satisfaction at post intervention ($t = 4.5$, $p < .01$).

Discussion

Considerable evidence exists that cognitive stimulation activities can bolster mental skills in healthy older adults (Jak et al., 2013). These benefits can persist for extended periods of time even after training has terminated. The investigation continues for specific activities that can be utilized to stave off negative cognitive aging outcomes, combat cognitive consequences of medical conditions, and improve mental sharpness.

The present study evaluated a newer computer-based CT program, Cogmed, that addresses non-verbal WM. The present study is the first to use Cogmed with older adults who have MCI. Participants were trained on Cogmed (or Sham) five days a week for five to seven weeks. Repeated analyses revealed that both Cogmed and Sham conditions improved: Cogmed outperformed Sham on one of the three core cognitive measures, accounting for tasks highly related to WM (Span Board). Participants in the Cogmed condition also responded in a more improved manner on memory complaints and outperformed Sham subjects on overall adjustment and satisfaction.

Conclusions based on these results are subject to interpretation. The improvement observed in both groups suggests that any CT may be of value, which is congruent with previous research. The power of placebo or non-specific effects is considerable, especially among older adults with cognitive impairment. This may be one reason that the Sham condition demonstrated general improvement in cognitive tasks. These results also occurred with Rebok and colleagues (2012) study where MCI patients and nondementing patients improved after non-specific training. An extension of this interpretation is that both groups improved because of interest and motivation.

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Our study comprised MCI participants. The results further support the current literature showing improvement in cognitive impairment in older subjects with both MCI and mild dementia. In this study, both a-MCI (75%) and non-aMCI (25%) subjects were included. There were no effects of occupation and education on cognitive outcomes (data not shown); thus brain reserve (Karp et al., 2009; Perneczky et al., 2011) was not influential.

Our findings loosely support the idea that engaged caregivers can be beneficial. Both Cogmed and Sham conditions had an active caregiver as well as a group coach who attended to adherence and rewarded success. Stepankova, Lukavsky, Kopecek, Steinova, and Ripova (2012) showed that the use of significant others assisted in subjective memory and self-confidence for positive changes from CT. While this factor was not specifically assessed, there were no differences between groups based on compliance since virtually all participants were compliant with the study requirements. Additionally, while both groups liked the cognitive training, the Cogmed group liked the experience more than Sham. This was a positive experience.

Importantly, Cogmed outperformed Sham on overall adjustment at follow-up. Participants in the Cogmed group largely remained stable over time whereas those in the Sham condition slightly worsened over time (Figure 2). Hutchens and colleagues (2012) found that CT resulted in benefits for MCI subjects for use of memory strategies in the context of everyday life tasks. The cognitive tasks selected as outcomes in the present study subserve general executive function and WM skills, reflective of far transfer. Therefore, training with Cogmed may be especially appealing to an older brain where this type of cognitive challenge is within the scope of ability and is novel. Naturally, the vagaries of training involve many other features, such as motivation, study design, type of population, that are not addressed here.

There are several limitations to this study. The sample is small due to issues of recruitment. The targeted population is a difficult-to-train group, MCI. Given that various definitions of MCI are often used, we studied the two most agreed upon types, amnestic and non-amnestic types (Smith & Bondi, 2013). There were no differences between these groups, regardless of the training condition. Additionally, a control group was not employed. It cannot be said that non-specific effects were not influential since changes reflected in both groups could reflect the passage of time for older adults. This is relevant given that many individuals with MCI segue into a dementia over a year's time, although some improve or remain stable.

Several participants had not used computers prior to the study (n = 9). However, they were able to understand and master the program requirements quickly. Of interest, the few subjects who used the lab for this study did not differ from those who used computers within their own homes. Clearly, there are many less direct effects that older adults have that may influence results, possible lack of technology being one.

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Sustainment of training benefits and far transfer effectsare difficult to achieve. While ecologically associated markers were not assessed, an executive function scale was utilized, the FAQ. There were no negative changes on this scale for Cogmed, whereas Sham declined over time. Other studies have reported far transfer effects within older adults (Buschkuehl et al., 2008; Mahncke et al., 2006; Richmond, Morrison, Chein, & Olson, 2011). These findings are encouraging; but as Noack, Lövdén, Schmiedek, and Lindenberger (2009) caution, these results are not the norm and few studies report transfer effects for tasks dissimilar enough from the trained tasks to suggest transfer at a broad level of abilities. This study's results apply only to the extent of the self-report FAQ representing real world far transfer; however, performance-based tasks were not administered.

A similar limitation can be applied to durability. The study examined effects of three months post intervention. Out of the cognitive measures, Span Board was significant. Previous research has also shown gains extending a few months (Kinsella et al., 2009; Rozzini et al., 2007; Troyer, Murphy, Anderson, Moscovitch, & Craik, 2008), with some gains as far as two (Unverzagt et al., 2007) to five years (Oswald, Gunzelmann, Rupprecht, & Hagen, 2006). It was concluded by Simon and colleagues (2012) that amnestic-MCI participants are able to maintain effects over time, especially with booster sessions.

The present study was labor intensive. Issues related to the acquisition of the subjects, caregiver buy-in, and everyday struggles of living (doctor appointments, travel, etc.), were problematic. The usage of Sham was also interesting as participants enjoyed the intervention. Within a week, the authors became aware of the blind as subjects reported ease of training. Both procedures were seen as friendly and likeable. We also had small amounts of data missing (no more than 10% per scale) and did not use imputation methods.

In sum, most research suggests that older adults require higher levels of effort for thinking as declining neurobiological efficiency accumulates. The bulk of evidence is now implying that CT can change targeted behaviors in individuals with MCI, especially areas that subserve WM. However, the level of generalizability, length of time after CT training, reasons for change (e.g., placebo individual specificity, actual target training, type of training, and type of MCI population), among other factors, are far from clear (Le Couteur & Sinclair, 2010). Even small changes in core capacities, however, can lead to large changes in complex behavior (Salthouse, 2001). From this and other studies, accumulating evidence suggests that CT does cause change and can generalize to some untrained cognitive abilities. To date, we agree with Jak and colleagues (2013); generalizability of improvements on trained tasks or untrained cognitive abilities to ecologically valid tasks of everyday cognitive and functional status have not been routinely examined or proven. Cogmed should now be favorably considered in this grouping of CT techniques. Only further study will better define the best parameters for such conclusions.

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References

Acevedo, A., & Loewenstein, D. A. (2007). Nonpharmacological cognitive interventions in aging and dementia. *Journal of Geriatric Psychiatry and Neurology*, *20*(4), 239–249. doi:10.1177/0891988707308808

ACTIVE Study Group; Willis, S. L., Tennstedt, S. L., Marsiske, M., Ball, K., Elias, J., & Koepke, K. M. (2006). Long-term effects of cognitive training on everyday functional outcomes in older adults. *JAMA: The Journal of the American Medical Association*, *296* (23), 2805–2814.

American Psychiatric Association, & American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders: DSM-IV-TR* (4th ed.). Washington, DC: American Psychiatric Association.

Andreescu, C., Teverovsky, E., Fu, B., Hughes, T. F., Chang, -C.-C. H., & Ganguli, M. (2014). Old worries and new anxieties: Behavioral symptoms and mild cognitive impairment in a population study. *The American Journal of Geriatric Psychiatry: Official Journal of the American Association for Geriatric Psychiatry*, *22*(3), 274–284. doi:10.1016/j.jagp.2012.09.010

Bäckman, L., Jones, S., Berger, A.-K., Laukka, E. J., & Small, B. J. (2005). Cognitive impairment in preclinical Alzheimer's disease: A meta-analysis. *Neuropsychology*, *19*(4), 520–531. doi:10.1037/0894-4105.19.4.520

Bäckman, L., & Small, B. J. (2007). Cognitive deficits in preclinical Alzheimer's disease and vascular dementia: Patterns of findings from the Kungsholmen Project. *Physiology & Behavior*, *92*(1–2), 80–86. doi:10.1016/j.physbeh.2007.05.014

Baddeley, A. D., Bressi, S., Della Sala, S., Logie, R., & Spinnler, H. (1991). The decline of working memory in Alzheimer's disease. *A Longitudinal Study. Brain: A Journal of Neurology*, *114* (Pt 6), 2521–2542.

Ball, K., Berch, D. B., Helmers, K. F., Jobe, J. B., Leveck, M. D., & Marsiske, M.; . . . Advanced Cognitive Training for Independent and Vital Elderly Study Group. (2002). Effects of cognitive training interventions with older adults: A randomized controlled trial. *JAMA: The Journal of the American Medical Association*, *288*(18), 2271–2281. doi:10.1001/jama.288.18.2271

Basak, C., Boot, W. R., Voss, M. W., & Kramer, A. F. (2008). Can training in a real-time strategy video game attenuate cognitive decline in older adults? *Psychology and Aging*, *23* (4), 765–777. doi:10.1037/a0013494

Belleville, S. (2008). Cognitive training for persons with mild cognitive impairment. *International Psychogeriatrics/IPA*, *20*(1), 57–66. doi:10.1017/S104161020700631X

Belleville, S., Clement, F., Mellah, S., Gilbert, B., Fontaine, F., & Gauthier, S. (2011). Training-related brain plasticity in subjects at risk of developing Alzheimer's disease. *Brain*, *134*(6), 1623–1634. doi:10.1093/brain/awr037

Belleville, S., Gilbert, B., Fontaine, F., Gagnon, L., Ménard, &., & Gauthier, S. (2006). Improvement of episodic memory in persons with mild cognitive impairment and healthy older adults: Evidence from a cognitive intervention program. *Dementia and Geriatric Cognitive Disorders*, *22*(5–6), 486–499. doi:10.1159/000096316

Downloaded by [Orta Dogu Teknik Universitesi] at 13:35 09 March 2016

Bherer, L., Kramer, A. F., Peterson, M. S., Colcombe, S., Erickson, K., & Becic, E. (2008). Transfer effects in task-set cost and dual-task cost after dual-task training in older and younger adults: Further evidence for cognitive plasticity in attentional control in late adulthood. *Experimental Aging Research*, *34*(3), 188–219. doi:10.1080/03610730802070068

Borella, E., Carretti, B., Riboldi, F., & De Beni, R. (2010). Working memory training in older adults: Evidence of transfer and maintenance effects. *Psychology and Aging*, *25*(4), 767–778. doi:10.1037/a0020683

Borella, E., Carretti, B., Zanoni, G., Zavagnin, M., & De Beni, R. (2013). Working memory training in old age: An examination of transfer and maintenance effects. *Archives of Clinical Neuropsychology: The Official Journal of the National Academy of Neuropsychologists*, *28*(4), 331–347. doi:10.1093/arclin/act020

Brehmer, Y., Westerberg, H., & Bäckman, L. (2012). Working-memory training in younger and older adults: Training gains, transfer, and maintenance. *Frontiers in Human Neuroscience*, *6*, 63. doi:10.3389/fnhum.2012.00063

Broadbent, D. E., Cooper, P. F., FitzGerald, P., & Parkes, K. R. (1982). The Cognitive Failures Questionnaire (CFQ) and its correlates. *The British Journal of Clinical Psychology/the British Psychological Society*, *21*(1), 1–16. doi:10.1111/bjc.1982.21.issue-1

Bryck, R. L., & Fisher, P. A. (2012). Training the brain: Practical applications of neural plasticity from the intersection of cognitive neuroscience, developmental psychology, and prevention science. *The American Psychologist*, *67*(2), 87–100. doi:10.1037/a0024657

Buschert, V. C., Friese, U., Teipel, S. J., Schneider, P., Merensky, W., Rujescu, D., & Buerger, K. (2011). Effects of a newly developed cognitive intervention in amnestic mild cognitive impairment and mild Alzheimer's disease: A pilot study. *Journal of Alzheimer's Disease: JAD*, *25*(4), 679–694. doi:10.3233/JAD-2011-100999

Buschkuehl, M., Jaeggi, S. M., Hutchison, S., Perrig-Chiello, P., Däpp, C., Müller, M., & Perrig, W. J. (2008). Impact of working memory training on memory performance in old-old adults. *Psychology and Aging*, *23*(4), 743–753. doi:10.1037/a0014342

Cavallini, E., Pagnin, A., & Vecchi, T. (2003). Aging and everyday memory: The beneficial effect of memory training. *Archives of Gerontology and Geriatrics*, *37*(3), 241–257. doi:10.1016/S0167-4943(03)00063-3

Chein, J. M., & Morrison, A. B. (2010). Expanding the mind's workspace: Training and transfer effects with a complex working memory span task. *Psychonomic Bulletin & Review*, *17*(2), 193–199. doi:10.3758/PBR.17.2.193

Cowan, N. (2005). Working-memory capacity limits in a theoretical context. In C. Izawa & N. Ohta (Eds.), Human learning and memory: Advances in theory and application: The 4th Tsukuba International Conference on Memory. (pp. 155–175). Mahwah, NJ: Erlbaum.

Craik, F. I. M., & Bialystok, E. (2006). Cognition through the lifespan: Mechanisms of change. *Trends in Cognitive Sciences*, *10*(3), 131–138. doi:10.1016/j.tics.2006.01.007

Dahlin, E., Neely, A. S., Larsson, A., Bäckman, L., & Nyberg, L. (2008). Transfer of learning after updating training mediated by the striatum. *Science (New York, N.Y.)*, *320*(5882), 1510–1512. doi:10.1126/science.1155466

Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning and Verbal Behavior*, *19*(4), 450–466. doi:10.1016/S0022-5371(80)90312-6

De Werd, M. M. E., Boelen, D., Rikkert, M. G. M. O., & Kessels, R. P. C. (2013). Errorless learning of everyday tasks in people with dementia. *Clinical Interventions in Aging*, *8*, 1177–1190. doi:10.2147/CIA.S46809

Engle, R. W., Kane, M. J., & Tuholski, S. W. (1999). Individual differences in working memory capacity and what they tell us about controlled attention, general fluid intelligence and functions of the prefrontal cortex. In A. Miyake & P. Shah (Eds.), *Models of working*

Downloaded by [Orta Dogu Teknik Universitesi] at 13:35 09 March 2016

memory: Mechanisms of active maintenance and executive control (pp. 102–134). New York: Cambridge University Press.

Ercoli, L., David, S., Siddarth, P., Miller, K., Dunkin, J., Kaplan, A., … & Small, G. (2007). Memory enhancement training effects in healthy older adults compare to health education and wait list conditions. Paper presented at the 12th Annual UCLA Research Conference on Aging.

Ercoli, L., Siddarth, P., Harrison, T., Jimenez, E., & Jarvik, L. F. (2005). Similar neurocognitive performance of adults with and without a history of parental Alzheimer's disease: A pilot study. *Journal of Geriatric Psychiatry and Neurology*, *18*(4), 208–212. doi:10.1177/0891988705281866

Floyd, M., & Scogin, F. (1997). Effects of memory training on the subjective memory functioning and mental health of older adults: A meta-analysis. *Psychology and Aging*, *12* (1), 150–161. doi:10.1037/0882-7974.12.1.150

Hutchens, R. L., Kinsella, G. J., Ong, B., Pike, K. E., Parsons, S., Storey, E., & Clare, L. (2012). Knowledge and use of memory strategies in amnestic mild cognitive impairment. *Psychology and Aging*, *27*(3), 768–777. doi:10.1037/a0026256

Hyer, L., Mullen, C., & McKenzie, L. (2015). Cognitive training for mildly impaired older adults. In P. Lichtenberg, B. T. Mast, B. D. Carpenter & J. Loebach Wetherell (Eds.), *APA Handbook of Clinical Geropsychology Vol. 2: Assessment, treatment, and issues of later life* (pp. 341–368). Washington, DC: American Psychological Association. doi:10.1037/14459-013

Jaeggi, S. M., Buschkuehl, M., Jonides, J., & Perrig, W. J. (2008). Improving fluid intelligence with training on working memory. *Proceedings of the National Academy of Sciences of the United States of America*, *105*(19), 6829–6833. doi:10.1073/pnas.0801268105

Jaeggi, S. M., Studer-Luethi, B., Buschkuehl, M., Su, Y.-F., Jonides, J., & Perrig, W. J. (2010). The relationship between n-back performance and matrix reasoning — Implications for training and transfer. *Intelligence*, *38*(6), 625–635. doi:10.1016/j.intell.2010.09.001

Jak, A. J., Seelye, A. M., & Jurick, S. M. (2013). Crosswords to computers: A critical review of popular approaches to cognitive enhancement. *Neuropsychology Review*, *23*(1), 13–26. doi:10.1007/s11065-013-9226-5

Jean, L., Bergeron, M.-È., Thivierge, S., & Simard, M. (2010). Cognitive intervention programs for individuals with mild cognitive impairment: Systematic review of the literature. *The American Journal of Geriatric Psychiatry: Official Journal of the American Association for Geriatric Psychiatry*, *18*(4), 281–296. doi:10.1097/JGP.0b013e3181c37ce9

Jean, L., Simard, M., Wiederkehr, S., Bergeron, M.-E., Turgeon, Y., Hudon, C., & Van Reekum, R. (2010). Efficacy of a cognitive training programme for mild cognitive impairment: Results of a randomised controlled study. *Neuropsychological Rehabilitation*, *20*(3), 377–405. doi:10.1080/09602010903343012

Johansson, B., & Tornmalm, M. (2012). Working memory training for patients with acquired brain injury: Effects in daily life. *Scandinavian Journal of Occupational Therapy*, *19*(2), 176–183. doi:10.3109/11038128.2011.603352

Kane, M. J., Hambrick, D. Z., Tuholski, S. W., Wilhelm, O., Payne, T. W., & Engle, R. W. (2004). The generality of working memory capacity: A latent-variable approach to verbal and visuospatial memory span and reasoning. *Journal of Experimental Psychology. General*, *133*(2), 189–217. doi:10.1037/0096-3445.133.2.189

Karp, A., Andel, R., Parker, M. G., Wang, H.-X., Winblad, B., & Fratiglioni, L. (2009). Mentally stimulating activities at work during midlife and dementia risk after age 75: follow-up study from the Kungsholmen Project. *The American Journal of Geriatric Psychiatry: Official Journal of the American Association for Geriatric Psychiatry*, 17 (3),227–236. doi:10.1097/JGP.0b013e318190b691

Downloaded by [Orta Dogu Teknik Universitesi] at 13:35 09 March 2016

Kinsella, G. J., Mullaly, E., Rand, E., Ong, B., Burton, C., Price, S. … Storey, E. (2009). Early intervention for mild cognitive impairment: A randomised controlled trial. *Journal of Neurology, Neurosurgery & Psychiatry*, *80*(7), 730–736. doi:10.1136/jnnp.2008.148346

Klingberg, T., Fernell, E., Olesen, P. J., Johnson, M., Gustafsson, P., Dahlström, K., & Westerberg, H. (2005). Computerized training of working memory in children with ADHD–a randomized, controlled trial. *Journal of the American Academy of Child and Adolescent Psychiatry*, *44*(2), 177–186. doi:10.1097/00004583-200502000-00010

Klingberg, T., Forssberg, H., & Westerberg, H. (2002). Training of working memory in children with ADHD. *Journal of Clinical and Experimental Neuropsychology*, *24*(6), 781–791. doi:10.1076/jcen.24.6.781.8395

Kurz, A., Pohl, C., Ramsenthaler, M., & Sorg, C. (2009). Cognitive rehabilitation in patients with mild cognitive impairment. *International Journal of Geriatric Psychiatry*, *24* (2), 163–168. doi:10.1002/gps.2086

Le Couteur, D. G., & Sinclair, D. A. (2010). A blueprint for developing therapeutic approaches that increase healthspan and delay death. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, *65A*(7), 693–694. doi:10.1093/gerona/glq048

Li, S.-C., Schmiedek, F., Huxhold, O., Röcke, C., Smith, J., & Lindenberger, U. (2008). Working memory plasticity in old age: Practice gain, transfer, and maintenance. *Psychology and Aging*, *23*(4), 731–742. doi:10.1037/a0014343

Loewenstein, D. A., Acevedo, A., Czaja, S. J., & Duara, R. (2004). Cognitive rehabilitation of mildly impaired Alzheimer disease patients on cholinesterase inhibitors. *The American Journal of Geriatric Psychiatry: Official Journal of the American Association for Geriatric Psychiatry*, *12*(4), 395–402. doi:10.1097/00019442-200407000-00007

Logie, R. H., Gilhooly, K. J., & Wynn, V. (1994). Counting on working memory in arithmetic problem solving. *Memory & Cognition*, *22*(4), 395–410. doi:10.3758/BF03200866

Lundqvist, A., Grundström, K., Samuelsson, K., & Rönnberg, J. (2010). Computerized training of working memory in a group of patients suffering from acquired brain injury. *Brain Injury: [BI]*, *24*(10), 1173–1183. doi:10.3109/02699052.2010.498007

Mahncke, H. W., Connor, B. B., Appelman, J., Ahsanuddin, O. N., Hardy, J. L., Wood, R. A., & Merzenich, M. M. (2006). Memory enhancement in healthy older adults using a brain plasticity-based training program: A randomized, controlled study. *Proceedings of the National Academy of Sciences of the United States of America*, *103*(33), 12523–12528. doi:10.1073/pnas.0605194103

Mayr, U. (2008). Introduction to the special section on cognitive plasticity in the aging mind. *Psychology and Aging*, *23*(4), 681–683. doi:10.1037/a0014346

McKhann, G., Drachman, D., Folstein, M., Katzman, R., Price, D., & Stadlan, E. M. (1984). Clinical diagnosis of Alzheimer's disease: Report of the NINCDS-ADRDA Work Group* under the auspices of Department of Health and Human Services Task Force on Alzheimer's Disease. *Neurology*, *34*(7), 939–939. doi:10.1212/WNL.34.7.939

McNab, F., Varrone, A., Farde, L., Jucaite, A., Bystritsky, P., Forssberg, H., & Klingberg, T. (2009). Changes in cortical dopamine D1 receptor binding associated with cognitive training. *Science (New York, N.Y.)*, *323*(5915), 800–802. doi:10.1126/science.1166102

Melby-Lervåg, M., & Hulme, C. (2013). Is working memory training effective? A meta-analytic review. *Developmental Psychology*, *49*(2), 270–291. doi:10.1037/a0028228

Morrison, A. B., & Chein, J. M. (2011). Does working memory training work? The promise and challenges of enhancing cognition by training working memory. *Psychonomic Bulletin & Review*, *18*(1), 46–60. doi:10.3758/s13423-010-0034-0

Mowszowski, L., Batchelor, J., & Naismith, S. L. (2010). Early intervention for cognitive decline: Can cognitive training be used as a selective prevention technique? *International Psychogeriatrics/IPA*, *22*(4), 537–548. doi:10.1017/S1041610209991748

Downloaded by [Orta Dogu Teknik Universitesi] at 13:35 09 March 2016

National Institutes of Health. (2011). *NIH state of the science conference: Preventing Alzheimer's disease and cognitive decline*. Bethesda, MD: U.S. Department of Health and Human Services.
Noack, H., Lövdén, M., Schmiedek, F., & Lindenberger, U. (2009). Cognitive plasticity in adulthood and old age: Gauging the generality of cognitive intervention effects. *Restorative Neurology and Neuroscience*, *27*(5), 435–453. doi:10.3233/RNN-2009-0496
Olazarán, J., Reisberg, B., Clare, L., Cruz, I., Peña-Casanova, J., Del Ser, T., & Muñiz, R. (2010). Nonpharmacological therapies in Alzheimer's disease: A systematic review of efficacy. *Dementia and Geriatric Cognitive Disorders*, *30*(2), 161–178. doi:10.1159/000316119
Olesen, P. J., Westerberg, H., & Klingberg, T. (2004). Increased prefrontal and parietal activity after training of working memory. *Nature Neuroscience*, *7*(1), 75–79. doi:10.1038/nn1165
Oswald, W. D., Gunzelmann, T., Rupprecht, R., & Hagen, B. (2006). Differential effects of single versus combined cognitive and physical training with older adults: The SimA study in a 5-year perspective. *European Journal of Ageing*, *3*(4), 179–192. doi:10.1007/s10433-006-0035-z
Owen, A. M., Hampshire, A., Grahn, J. A., Stenton, R., Dajani, S., Burns, A. S., & Ballard, C. G. (2010). Putting brain training to the test. *Nature*, *465*(7299), 775–778. doi:10.1038/nature09042
Perneczky, R., Alexopoulos, P., Schmid, G., Sorg, C., Förstl, H., Diehl-Schmid, J., & Kurz, A. (2011). [Cognitive reserve and its relevance for the prevention and diagnosis of dementia]. Der Nervenarzt, 82(3), 325–330, 332–335. doi:10.1007/s00115-010-3165-7
Persson, J., & Reuter-Lorenz, P. A. (2008). Gaining control: Training executive function and far transfer of the ability to resolve interference. *Psychological Science*, *19*(9), 881–888. doi:10.1111/j.1467-9280.2008.02172.x
Pfeffer, R. I., Kurosaki, T. T., Chance, J. M., Filos, S., & Bates, D. (1984). Use of the mental function index in older adults: Reliability, validity, and measurement of change over time. *American Journal of Epidemiology*, *120*(6), 922–935. doi:10.1093/oxfordjournals.aje.a113963
Rebok, G.W. (2008). Cognitive training: Influence on neuropsychological and brain function in later life. *State-of-Science Review*, SR-E22, 1–24.
Rebok, G. W., Carlson, M. C., & Langbaum, J. B. S. (2007). Training and maintaining memory abilities in healthy older adults: Traditional and novel approaches. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *62*(Spec No 1), 53–61. doi:10.1093/geronb/62.special_issue_1.53
Rebok, G. W., Parisi, J. M., Gross, A. L., Spira, A. P., Ko, J., Samus, Q. M., & Holtzman, R. E. (2012) Evidence-based psychological treatments for improving memory function among older adults. In F. Scogin, & A. Shah Eds., *Making evidence-based psychological treatments work with older adults* (pp. 131–165). Washington: American Psychological Association. Retrieved from http://content.apa.org/books/13753-005
Reichman, W. E., Fiocco, A. J., & Rose, N. S. (2010). Exercising the brain to avoid cognitive decline: Examining the evidence. *Aging Health*, *6*(5), 565–584. doi:10.2217/ahe.10.54
Reitan, R. M., & Wolfson, D. (1993). *The Halstead-Reitan Neuropsychological Test Battery: Theory and clinical interpretation* (2^{nd} ed.). Tuscson, AZ: Neuropsychology Press.
Reuter-Lorenz, P. A., & Park, D. C. (2010). Human neuroscience and the aging mind: A new look at old problems. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *65B*(4), 405–415. doi:10.1093/geronb/gbq035
Richmond, L. L., Morrison, A. B., Chein, J. M., & Olson, I. R. (2011). Working memory training and transfer in older adults. *Psychology and Aging*, *26*(4), 813–822. doi:10.1037/a0023631

Downloaded by [Orta Dogu Teknik Universitesi] at 13:35 09 March 2016

Rozzini, L., Costardi, D., Chilovi, B. V., Franzoni, S., Trabucchi, M., & Padovani, A. (2007). Efficacy of cognitive rehabilitation in patients with mild cognitive impairment treated with cholinesterase inhibitors. *International Journal of Geriatric Psychiatry*, *22*(4), 356–360. doi:10.1002/gps.1681

Salthouse, T. A. (2001). Structural models of the relations between age and measures of cognitive functioning. *Intelligence*, *29*(2), 93–115. doi:10.1016/S0160-2896(00)00040-4

Shah, P., & Miyake, A. (1999). Toward unified theories of working memory: Emerging general consensus, unresolved theoretical issues, and future research directions. In A. Miyake & P. Shah (Eds.), *Models of working memory: Mechanisms of active maintenance and executive control* (pp. 442–482). New York: Oxford University Press.

Sheehan, D. V., Lecrubier, Y., Sheehan, K. H., Amorim, P., Janavs, J., Weiller, E., … & Dunbar, G. C. (1998). The Mini-International Neuropsychiatric Interview (MINI): the development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *Journal of clinical psychiatry*.

Simon, S. S., Yokomizo, J. E., & Bottino, C. M. C. (2012). Cognitive intervention in amnestic Mild Cognitive Impairment: A systematic review. *Neuroscience and Biobehavioral Reviews*, *36*(4), 1163–1178. doi:10.1016/j.neubiorev.2012.01.007

Sitzer, D. I., Twamley, E. W., Patterson, T. L., & Jeste, D. V. (2008). Multivariate predictors of social skills performance in middle-aged and older out-patients with schizophrenia spectrum disorders. *Psychological Medicine*, *38*(5), 755–763. doi:10.1017/S0033291707001304

Smith, G. & Bondi, M. (2013). *Mild cognitive impairment and dementia: Definitions, diagnosis, and treatment*. New York, New York: Oxford University Press.

Smith, G. E., Housen, P., Yaffe, K., Ruff, R., Kennison, R. F., Mahncke, H. W., & Zelinski, E. M. (2009). A cognitive training program based on principles of brain plasticity: Results from the Improvement in Memory with Plasticity-based Adaptive Cognitive Training (IMPACT) study. *Journal of the American Geriatrics Society*, *57*(4), 594–603. doi:10.1111/j.1532-5415.2008.02167.x

Stepankova, H., Lukavsky, J., Kopecek, M., Steinova, D., & Ripova, D. (2012). Modification of subjective cognitive outcomes in older persons through memory training: Immediate effect and 6-month follow-up. *GeroPsych: The Journal of Gerontopsychology and Geriatric Psychiatry*, *25*(3), 117–125. doi:10.1024/1662-9647/a000061

Stine-Morrow, E. A. L., Parisi, J. M., Morrow, D. G., & Park, D. C. (2008). The effects of an engaged lifestyle on cognitive vitality: A field experiment. *Psychology and Aging*, *23*(4), 778–786. doi:10.1037/a0014341

Stott, J., & Spector, A. (2011). A review of the effectiveness of memory interventions in mild cognitive impairment (MCI). *International Psychogeriatrics/IPA*, *23*(4), 526–538. doi:10.1017/S1041610210001973

Troyer, A. K., Murphy, K. J., Anderson, N. D., Moscovitch, M., & Craik, F. I. M. (2008). Changing everyday memory behaviour in amnestic mild cognitive impairment: A randomised controlled trial. *Neuropsychological Rehabilitation*, *18*(1), 65–88. doi:10.1080/09602010701409684

Unverzagt, F. W., Kasten, L., Johnson, K. E., Rebok, G. W., Marsiske, M., Koepke, K. M., & Tennstedt, S. L. (2007). Effect of memory impairment on training outcomes in ACTIVE. *Journal of the International Neuropsychological Society: JINS*, *13*(6), 953–960. doi:10.1017/S1355617707071512

Valentijn, S. A. M., Van Hooren, S. A. H., Bosma, H., Touw, D. M., Jolles, J., Van Boxtel, M. P. J., & Ponds, R. W. H. M. (2005). The effect of two types of memory training on subjective and objective memory performance in healthy individuals aged 55 years and older: A randomized controlled trial. *Patient Education and Counseling*, *57*(1), 106–114. doi:10.1016/j.pec.2004.05.002

Downloaded by [Orta Dogu Teknik Universitesi] at 13:35 09 March 2016

Valenzuela, M., & Sachdev, P. (2009). Can cognitive exercise prevent the onset of dementia? Systematic review of randomized clinical trials with longitudinal follow-up. *The American Journal of Geriatric Psychiatry: Official Journal of the American Association for Geriatric Psychiatry*, *17*(3), 179–187. doi:10.1097/JGP.0b013e3181953b57

Verhaeghen, P., Marcoen, A., & Goossens, L. (1992). Improving memory performance in the aged through mnemonic training: A meta-analytic study. *Psychology and Aging*, *7*(2), 242–251. doi:10.1037/0882-7974.7.2.242

Wechsler, D. (1997a) *Wechsler Memory Scale-Third Edition* (WMS-III). San Antonio, TX: The Psychological Corporation.

Wechsler, D. (1997b) Wechsler Memory Scale-Third Edition (WMS-III). San Antonio, TX: The Psychological Corporation.

Westerberg, H., Jacobaeus, H., Hirvikoski, T., Clevberger, P., Ostensson, M.-L., Bartfai, A., & Klingberg, T. (2007). Computerized working memory training after stroke–a pilot study. *Brain Injury: [BI]*, *21*(1), 21–29. doi:10.1080/02699050601148726

Woods, B., Aguirre, E., Spector, A.E., & Orrell, M. (2011). Can cognitive stimulation benefit people with dementia? Cochrane Summaries. doi:10.1002/14651858.CD005562.pub2

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