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Memory Support System Training in Mild Cognitive Impairment: Predictors of Learning and Adherence

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Abstract

This study aimed to identify predictors of learning and adherence to a previously validated compensatory calendar and note taking system (Memory Support System; MSS) in persons with amnestic mild cognitive impairment (aMCI). Age, education, global cognition, depression, and memory-related self-efficacy were studied as predictors of individuals' ability to learn the use of the MSS during the two-week training and of their adherence to the MSS 6, 12, and 18 months after training. How well an individual was able to learn the use of the MSS was itself examined as a predictor of adherence. Two-hundred-and-fifteen older adults with aMCI and their study partners (e.g. spouse, adult child) received MSS training one hour daily for ten days. Ordinal logistic regression analyses indicated that: 1) global cognition predicted MSS learning at end of training, and 2) MSS learning at end of training predicted MSS adherence at 6, 12, and 18 months post-training. The current study suggests that offering compensatory strategies as early as possible for those with MCI might be of most benefit, and might have implications for long-term adherence.

Keywords

memory compensation training; behavioural intervention; Mild Cognitive Impairment; learning; adherence

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No conflict of interest was reported by the authors.

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Background

An aging population is causing a major burden on the health care system (Brookmeyer, Johnson, Ziegler-Graham, & Arrighi, 2007). There is increased need for interventions that preserve function and cognitive health in older age. To offer the right interventions to the right individuals, predictors of treatment success and treatment adherence need to be better understood. Amnestic Mild Cognitive Impairment (aMCI), often seen as a prodromal period of Alzheimer's dementia (Albert et al., 2011; Petersen et al., 1999; Smith et al., 1996), is a phase during which individuals experience memory impairment that is greater than expected for their age while they experience minimal changes in their daily functioning (Jefferson et al., 2008). To date, pharmacological trials have had little success in reversing or decelerating cognitive decline in persons with MCI (Cummings, Morstorf, & Zhong, 2014). Nonpharmacological interventions provide a promising alternative approach and can delay institutionalization (Olazarán et al., 2010). Specifically, a meta-analysis on behavioural interventions targeting persons with MCI has demonstrated that cognitive interventions, including compensation training, can be helpful for activities of daily living (ADLs) in MCI (Chandler, Parks, Marsiske, Rotblatt, & Smith, 2016).

The Memory Support System (MSS) is a calendar/notebook rehabilitation system developed to help compensate for memory loss (Greenaway, Hanna, Lepore, & Smith, 2008), based on the compensatory rehabilitation method of Solberg and Mateer (1989). A randomized trial demonstrated that memory-related Activities of Daily living (mADLs) were significantly better for persons with aMCI who were provided with 12 one-hour weekly training sessions of the MSS than for persons who were provided with the MSS calendars without training on how to use it (Greenaway, Duncan, & Smith, 2013). While MSS benefits mADLs (Greenaway et al., 2013), not all individuals with MCI may be able to benefit from MSS to the same extent. The aim of the current study is to examine which individuals are best able to benefit from MSS training as it is currently provided. To our knowledge, no studies thus far have examined *predictors of the ability to learn compensational systems* for memory loss in persons with aMCI. However, predictors of impaired declarative learning abilities in aMCI are well documented. Some examples of these predictors include age, education, having lower global cognition, depression (Yatawara, Lim, Chander, Zhou, & Kandiah, 2016), and lower memory-related self-efficacy (Beaudoin & Desrichard, 2011). These predictors of learning may also generalize to persons' with aMCI ability to learn compensatory skills such as MSS. Further, how well someone learns a compensatory skills likely affects ability to adhere to the strategies long-term. Hence, how well an individual masters the use of a compensatory tool at the end of training could logically be a predictor of long term adherence to the tool.

Predictors of long term adherence.

We are aware of no studies examining predicators of long-term adherence to compensatory techniques in MCI. Studies that have investigated predictors of adherence to other behavioural interventions in persons with MCI have found predictors that are similar to predictors of learning including global cognition (Lam 2015), depression, age, and education. We believe self-efficacy, an individual's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives (Bandura, 1994), might also be associated with long-term adherence. Therefore, we hypothesized that global cognition, depression, and memory-related self-efficacy not only predict the ability to learn the use of a compensatory tool, but also predict the subsequent adherence to the compensatory tool. The purpose of this study was to investigate (1) age, level of education, global cognition, depression, and memory-related self-efficacy as predictors of the ability to learn the use of the compensatory MSS training and (2) if MSS learning phase by the end of training (*i.e.,* how well they learned MSS), age, level of education, global cognition, depression, and memory-related self-efficacy predicted adherence to the MSS system training six, 12, and 18 months post training.

Methods

Design

The current study includes secondary analysis of data collected for the "Behavioral Interventions to Prevent or Delay Dementia: Protocol for a Randomized Comparative Effectiveness Study", a 10-day multicomponent intervention program for persons with MCI and their support partners. This trial aimed to compare the effectiveness of the five behavioral interventions; physical exercise, computerized brain fitness, patient and family education, support group, and MSS training (Smith et al., 2017). In this trial, participants were randomized by subtraction instead of addition to ensure that all participants received four out of five interventions. Hence, this trial consisted of five arms. In each of these five arms, four out of five behavioral interventions were given and one of the five behavioral interventions was withheld. The parent study consisted of 272 participants with aMCI. More details of this "subtractive" rather than "additive" trial can be found in our protocol manuscript (Smith et al., 2017). The current study only focused on one out of five interventions, MSS training. As such, 1) only methods and procedures relevant to the current aims and analyses are reported in this manuscript and 2) only participants who received MSS training were included in the analyses of the current manuscript. In other words, the arm of the parent study that was randomized not to receive MSS training was not included in the current sample. This resulted in a sample of 215 persons with aMCI.

The programs took place at Mayo Clinic campuses in Minnesota, Arizona, Florida, and the University of Washington. Each study site ran at least five sessions of 8–20 participants.

Participants

Participant dyads consisted of a person with aMCI and a study partner (e.g. a spouse, adult child, or close friend). The current study sample consisted of 215 participant dyads. Participant and partner dyads were recruited through clinical services at Mayo Clinic and University of Washington. Study criteria included (1) a diagnosis of amnestic MCI (single or multi-domain) based on National Institute on Aging-Alzheimer Association criteria (Albert et al., 2011), (2) a Clinical Dementia Rating (CDR; Morris, 1993) scale score ≤ 0.5, (3) not taking or stable on nootropic medication for at least 3 months, (4) English fluency, and (5) able to attend the full program with a study partner who had at least twice-weekly contact with the person with aMCI and who was cognitively healthy (Mini Mental Status Exam

(Folstein, Folstein, & McHugh, 1975) > 24). Exclusion criteria were (1) participating in another treatment-related clinical trial and (2) presence of significant auditory, visual, or motor impairment impacting ability to participate in the program. Sample demographics are shown in table 1.

Intervention

All couples participated in MSS training for 45–60 minutes daily for two weeks during weekdays (i.e. 10 sessions). The MSS system consists of a written daily and an annual calendar book system for compensatory written reminders for important appointments, tasks, or experiences/thoughts of the day. During MSS training, the person with aMCI is trained to use the system consistently multiple times throughout the day. Using Socratic Interviewing, the use of the calendar is taught in a systematic way. MSS training follows the approach of Solberg and Mateer (1989) as it proceeds in three phases: an Acquisition, Application, and Adaptation phase. Persons with aMCI must master each phase before progressing to the next. Whether or not an individual is ready to progress to the next phase is assessed with a set of Intervention Plan/Questions that increases in difficulty with each subsequent phase(Greenaway et al., 2008). For instance, in the Acquisition phase, participants may be taught where to find the "activities to-be-completed" section in the calendar, while they will be asked more broadly which activities they need to complete tomorrow during the Application phase assessment. These sets of questions are publicly available in the appendix of our previously published manuscript on the Memory Support System (Greenaway et al., 2008). Subjects progress to the next training phase after demonstrating 100% accuracy on the Intervention Plan/Questions on a stage for two consecutive days. During training, the program care-partner is taught to work through the to-be-learned materials with the individual with aMCI twice daily as part of daily homework. Both the persons with aMCI and their study partners were provided the paper MSS materials in an ongoing manner to enable continued use of the system post-training. Program partners are taught how to cue and support the subject in the use of the MSS. Partners do not write in the subject's notebook, and care is taken through discussion with the trainer to ensure the subject is the one responsible for the MSS completion.

Outcome Measures

Center for Epidemiological Studies Depression scale (CES-D)—Depressive Symptoms were assessed by the CES-D (Radloff, 1977), a well-validated, 20-item, self-report measure of depressive symptoms. While it consists of four subscales including negative affect, lack of positive affect, somatic symptoms, and interpersonal difficulties, the total score was used in this analysis.

Memory-related Self-Efficacy—The persons' with aMCI memory-related self-efficacy was assessed using selected items from the Chronic Disease Self-Efficacy Scales (Lorig, 1996). This scale has previously been used in this population and focuses on confidence in medication management, chores, errand ability, and confidence in maintaining hobbies and relationships.

Dementia Ratings Scale-2 (DRS-2)—The DRS-2 was administered at baseline as a measure of general cognitive function (Jurica, 2001). The DRS-2 assesses multiple cognitive domains and helps to distinguish persons with aMCI from both patients with Alzheimer's dementia and healthy controls (Springate, Tremont, Papandonatos, & Ott, 2014). The Mayo Clinic's Older Americans Normative Studies (MOANS) scaled scores that correct for age and education were used in the current analyses (Lucas et al., 1998).

MSS Learning—MSS learning occurs in three training stages: an Acquisition phase, Application phase, and Adaptation phase, as outlined by Sohlberg and Mateer (1989) and described in the Intervention Section above. These three phases were used as a categorical dependent variable in our model (1) to predict MSS learning and as an independent variable in our models (2) to predict MSS adherence.

MSS Adherence—Adherence to the MSS training was assessed by the use of the MSS Adherence assessment (Greenaway et al., 2008) by trained therapists. The original version of this assessment is published (Greenaway et al., 2008) and publicly available. This assessment is based on two separate days that are randomly selected from the week prior to the date of assessment. Random days were selected to offset the possibility of a participant "preparing" the calendar for their visit. Compliance was based upon four criteria for a maximum of 10 points based on how well they use the different sections of the MSS system. As part of this assessment, a subject is considered compliant if they receive a score of seven or greater. In the current ordinal adherence categories, an activity log that partners completed about persons with MCI at each follow-up was also included. Specifically, participants were considered "adherent" if they obtained a raw score of seven out of 10 on the adherence assessment listed above. They were given a "non-adherent" category score if the participant used a calendar system once a week or less, as reported by their program partner informant. Participants that fell between these 2 standards were placed in the "indeterminate" category.

Statistical analysis

Analyses were performed using IBM SPSS Statistics 24 (Armonk, 2007). Ordinal logistic regression analyses were conducted to assess predictors of MSS learning and adherence. For all models we verified that the test of parallel lines was non-significant, meaning that the required proportional odds assumption held for all models. Model 1 assessed predictors of MSS learning phase by the end of the two-week training. Baseline scores of age, education, global cognition, depression, and memory-related self-efficacy were included as predictors in model 1.

Models 2.1, 2.2, and 2.3 assessed predictors of MSS adherence at 6, 12, and 18 months post-training, respectively. Baseline scores of age, education, global cognition, and, most importantly, MSS learning phase, were entered as predictors for these three models. Additionally, depression, and memory-related self-efficacy scores of the respective time point were entered (i.e., depression scores and memory-related self-efficacy scores measured at 12 months post intervention were entered for model 2.2 and depression scores and memory-related self-efficacy scores measured at 18 months post intervention were entered for model 2.3). All predictors were entered simultaneously.

Results

Predictors of MSS learning and adherence

The results of all four ordinal logistic regression models can be found in Table 2. All four models fit significantly better than the null model. Participants' predicted category memberships were saved and compared to the actual category memberships. The classification accuracy for all four models were well in excess of chance, and can be seen in the "percentage better than chance" column in Table 2.

Model 1: The DRS-2 score was a significant predictor of learning ($p < .001$). The conditional odds ratio was 1.242 meaning that persons with a one point higher DRS-2 score had 24.2% higher odds of having achieved a higher MSS Learning Phase. There were no other significant predictors of MSS Learning Phase.

Model 2.1: MSS Learning Phase at end of training was a significant predictor of MSS adherence 6 months post-training. ($p = .001$). Participants in a higher learning phase by end of training had 122.2% higher odds of being more adherent to the MSS system at 6 months. Education was also a significant predictor of MSS adherence 6 months post-training ($p = .023$). Individuals who were more highly educated had 13.6% times higher odds of being more adherent to the MSS system at 6 months.

Model 2.2: MSS Learning Phase at end of training was a significant predictor of MSS adherence 12 months post-training ($p = .004$). Participants in a higher learning phase by end of training had 106.2% higher odds to be more adherent to the MSS system at 12 months. Baseline DRS-2 was also a significant predictor of MSS adherence at 12 months ($p = .028$), such that participants with one point higher DRS-2 MOANS score had 12.4% higher odds of being more adherent to the MSS system. There were no other significant predictors of MSS adherence 12 months post-training.

Model 2.3: MSS Learning Phase at end of training was a significant predictor of MSS adherence 18 months post-training ($p = .008$). Participants in a higher learning phase by end of training had 114.6% higher odds to be more adherent to the MSS system at 18 months. There were no other significant predictors of MSS adherence 18 months post-training.

Discussion

The current study aimed to investigate (1) global cognition, depression, and memory-related self-efficacy as predictors of the ability to learn compensatory MSS training and (2) MSS learning phase by the end of training, global cognition, depression, and memory-related self-efficacy as predictors of adherence to the use of the compensatory memory support system training at 6, 12, and 18 months post training.

Better baseline global cognitive functioning was associated with greater MSS learning phase at the end of training. Further, better learning of the MSS by the end of training was associated with better long-term adherence to MSS at 6, 12, and 18 months post-training, while controlling for global cognition. While this is, to our knowledge, the first study to investigate predictors of the ability to learn a compensatory tool, this finding is in line with findings that lower global cognition is associated with lower declarative learning abilities in aMCI (Yatawara et al., 2016). The finding that better global cognition predicts better learning the use of a compensatory tool suggests that teaching a compensatory tool like the MSS in "early MCI," or the less severe MCI stage, may be most effective. This is consistent with the general emphasis in the field to intervene as early as possible in MCI, or even the pre-MCI stage (Duara et al., 2011). Further, it is intuitive that adherence to a behavioural strategy would be dependent upon how well one learned to use the strategy in the first place. One implication of this may be that some individuals (particularly those with lower baseline cognition) may require more sessions of MSS training to achieve more thorough learning of the tool to give them the best chance of benefitting from the tool in the long run. Both memory-related self-efficacy and depression did not significantly predict learning or adherence to the MSS system.

Limitations and generalizability

Despite attempts to recruit ethnic and racial minority populations, the current population includes predominantly non-Hispanics whites. It is not clear how our findings might generalize to minority populations. Further, the current analyses are part of a multimodal intervention program that includes other behavioural interventions. The participation in other interventions including yoga, computerized exercises, wellness education, and support groups may have affected the adherence in the current population. As such, it is unclear whether the current findings also generalize to MSS training as a single intervention, as opposed to part of a multi-domain intervention.

Future Directions

Future studies should assess whether individuals with lower baseline cognition are able to learn and adhere to the MSS if provided with more sessions. In addition, future studies could examine if there are memory compensation systems that are easier to learn by comparing learning, as well as effectiveness, of different memory compensation systems. Patient preference in the format of the compensation tool should also be considered: more digitally oriented individuals may prefer a digital memory systems such as the Digital Memory Notebook application (Chudoba, Church, Dahmen, Katelyn, & Schmitter-edgecombe, 2019; Raghunath et al., 2019) while other individuals may feel more comfortable using a paper-and-pencil memory compensation system such as the MSS that likely also relies on age. To further improve learning, specific teaching strategies to teach MSS such as errorless learning techniques that are thought to improve learning in MCI, should also investigated in the context of learning compensatory mechanisms for memory impairment. A last important point that should be addressed is the association with activities of daily functioning. While we have recently reported the overall outcomes of the our parent study (Chandler et al., 2019), this analysis did not account for the impact of adherence of each intervention. Each of these compensatory tools may have different features that may benefit daily functioning. In addition, different interventions can have different adherence profiles (Amofa et al., 2019). Greater attention to and reporting of adherence effects in randomized controlled trials of different memory-compensation systems and their associations with daily functioning or instrumental activities of daily living is warranted.

Conclusion

Better baseline global cognitive functioning is associated with greater learning of the MSS at the end of a 10-day training program. Greater MSS learning phase by the end of training in turn was associated with better long-term adherence to MSS at six, 12, and 18 months post-training, while controlling for global cognition. These results reinforce the notion pursuing the earliest possible detection and implementation of interventions to prevent or delay progression to dementia from the MCI stage. Future studies should investigate if the current findings can be extended to minority populations.

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Table 1.

Participant demographics

	Mean	SD	
Age	75.40	7.46	
Education	16.12	2.80	
Gender	60.0% Male		
Race/Ethnicity	3.2% Hispanic and/or Non-Caucasian		
CES-D	11.73	8.41	
DRS-2	6.48	3.08	
mem-SE	74.20	13.98	
MSS Learning (n=172)	14.5% Acquisition	25.0% Application	60.0% Adaptation
MSS Adherence			
6 mo (n=156)	23.7% Non-Adherent	42.3% Indeterminate	34.0% Adherent
12 mo (n=148)	33.8% Non-Adherent	39.2% Indeterminate	27.0% Adherent
18 mo (n=125)	40.0% Non-Adherent	38.4% Indeterminate	21.6% Adherent

Note: *SD*: Standard Deviation; CES-D: Center for Epidemiological Studies Depression Scale; DRS-2: Dementia Rating Scale-2; mem-SE: Memory-related Self-Efficacy, mo: months post-training; MSS: Memory Support System.

Table 2.

Ordinal logistic regression model results of predictors of Memory Support System Training learning phase at and of training and Adherence 6, 12, and 18 months post end of training

Model fitting information (ordinal logistic regression analysis)									
Model	**Model fitting criteria**								
	−2 log likelihood								
	Intercept only	**Final**	**Nagelkerke Pseudo R^2**	**% better than chance**	**χ^2**	**N used in model**	***df***	**Sig**	
1 MSS Learning	320.298	297.026	.150	43.7	23.271	172	5	*p*<.001	
2.1MSS Adherence 6 mo	334.462	312.274	.150	82.8	22.188	156	6	*p*=.001	
2.2 MSS Adherence 12 mo	321.851	291.942	.206	15.0	29.909	148	6	*p*<.001	
2.3 MSS Adherence 18 mo	266.266	245.475	.174	44.6	20.791	125	6	*p*=.002	
	Parameter Estimates	**Estimate**	**SE**	**95% CI**	**Estimate**	**Wald**	***df***	**Sig**	**Odds ratio**
				Lower	**Upper**				
1 MSS Learning	Age	−0.043	0.023	−0.088	0.001	3.647	1	0.056	0.958
	Education	−0.042	0.057	−0.153	0.069	0.548	1	0.459	0.959
	DRS-2	0.217	0.055	0.109	0.325	15.614	1	0.000	1.242
	CES-D	−0.034	0.023	−0.078	0.010	2.266	1	0.132	0.967
	memSE	−0.021	0.014	−0.049	0.007	2.163	1	0.141	0.979
2.1 MSS Adherence 6 mo	Age	−0.025	0.021	−0.067	0.016	1.464	1	0.226	0.975
	Education	0.127	0.056	0.018	0.236	5.199	1	0.023	1.136
	DRS-2	−0.012	0.052	−0.114	0.089	0.057	1	0.811	0.988
	CES-D	−0.006	0.023	−0.051	0.038	0.081	1	0.776	0.994
	memSE	0.012	0.014	−0.016	0.039	0.706	1	0.401	1.012
	MSS Learning	0.798	0.241	0.325	1.271	10.935	1	0.001	2.222
2.2 MSS Adherence 12 mo	Age	−0.032	0.022	−0.076	0.011	2.098	1	0.147	0.968
	Education	0.039	0.057	−0.073	0.150	0.462	1	0.496	1.039
	DRS-2	0.117	0.053	0.013	0.221	4.853	1	0.028	1.124
	CES-D	−0.035	0.023	−0.080	0.010	2.351	1	0.125	0.966
	memSE	0.007	0.014	−0.020	0.033	0.263	1	0.608	1.007
	MSS Learning	0.724	0.253	0.227	1.220	8.170	1	0.004	2.062

2.3 MSS Adherence 18 mo	Age	−0.016	0.024	−0.063	0.032	0.406	1	0.524	0.985
	Education	0.034	0.062	−0.088	0.155	0.291	1	0.590	1.034
	DRS-2	0.117	0.062	−0.004	0.238	3.595	1	0.058	1.124
	CES-D	−0.045	0.028	−0.100	0.009	2.662	1	0.103	0.956
	memSE	−0.006	0.015	−0.035	0.023	0.155	1	0.694	0.994
	MSS Learning	0.764	0.289	0.196	1.331	6.963	1	0.008	2.146