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Metamemory in multiple sclerosis: exploring affective and executive contributors[☆]

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Abstract

Although previous reports have examined metamemory in various neurological groups, no study to date has examined various affective and cognitive contributors to metamemory collectively in a sample of multiple sclerosis (MS) patients. In the present study, 48 MS patients completed the Memory Functioning Questionnaire (MFQ) and were administered measures assessing depression, depressive attitudes, and executive functioning. Correlational analyses indicated that certain aspects of metamemory in MS were associated with both affective and executive variables. Structural equation modeling (SEM) analyses of three a priori models revealed the best fit with one model proposing that greater executive dysfunction and depression were associated with increased self-reported memory complaints, but via the mediating influence of depressive attitudes. Although our results suggest some objective basis for metamemory complaints in MS (i.e., executive dysfunction), they also suggest that these complaints may be exacerbated by the potentially reversible influences of depression and depressive attitudes. Treatment of depression and depressive attitudes in MS may result in MS patients having more accurate perceptions of their actual memory abilities that, in turn, may lead to improvements in their quality of life.

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1. Introduction

Metamemory, broadly defined as self-reported memory functioning and memory skills, has been researched extensively. Most studies have found only moderate correspondence between objective memory performance and metamemory (Kahn, Zarit, Hilbert, & Niederehe, 1975; O'Connor, Pollitt, Roth, Brook, & Reiss, 1990; Zarit, Gallagher, & Kramer, 1981), with correlations generally ranging from .20 to .30 (Hultsch, Hertzog, Dixon, & Davidson, 1988). In an attempt to explain the discrepancy between subjective memory reports and memory test performance, researchers have examined possible contributors to metamemory.

Some research has examined the relationship between metamemory and affective status, with results generally reflecting a relationship between memory complaints and increased depression (Cavanaugh & Murphy, 1986). Other studies have demonstrated that individuals with compromised executive functioning inaccurately rate their memory abilities (Janowsky, Shimamura, & Squire, 1989). However, few studies have investigated collectively various affective and cognitive contributors to metamemory, particularly in patients with multiple sclerosis (MS), a demyelinating disease of the central nervous system characterized by physical, emotional, and cognitive difficulties (Rao, 1986). Considering that depression and executive functioning impairment are relatively common emotional and cognitive sequelae of MS (Arnett et al., 1997; McIntosh-Michaelis et al., 1991; Minden & Schiffer, 1991), it is possible that these factors also impact on patients' subjective reports of memory ability. By demonstrating that memory complaints are associated with different MS-related sequelae (e.g., depression vs. executive functioning impairment), rehabilitation efforts might be directed accordingly (e.g., focus on alleviating depression vs. implementing cognitive rehabilitation). Although two studies previously examined the role of executive functioning on metamemory in MS (Beatty & Monson, 1991; Randolph, Arnett, & Higginson, 2001), and another considered the depression–metamemory connection (Gottschalk, 1995), no study to date has comprehensively considered various contributors to metamemory (e.g., depression, depressive attitudes, executive functioning) in MS patients. The present research was designed to consider contributors to metamemory in MS more comprehensively.

One possible explanation for the weak metamemory–objective memory correspondence may lie in the effects of depression and depressive attitudes. Indeed, various studies have demonstrated that depressed individuals show increased memory complaints even in the absence of impairment on objective memory tests (Cavanaugh & Murphy, 1986; Kahn et al., 1975; Rabbitt & Abson, 1991), and that a negative cognitive set is associated with lower self-appraisals of memory (Lachman, Steinberg, & Trotter, 1987). Depression is a particularly common form of psychopathology in patients diagnosed with MS, with a multiyear prevalence between 42 and 62%, and is generally moderate to severe (Joffe, Lippert, Gray, Sawa, & Horvath, 1987).

In the one previous study examining the relationship between depression and metamemory in MS, Gottschalk (1995) found that MS patients' reported memory problems were correlated with depression but not with tested memory ability. Further, studies from the non-MS literature support the notion that depression is related to metamemory reports. In an early study with non-MS depressed patients, Kahn et al. (1975) found that memory complaints were unrelated to patients' performance on story recall and paired-associates tests, but were associated with depression (Kahn et al., 1975). Similarly, Niederehe and Yoder (1989) found that depressives

reported more memory difficulty than controls across various domains of memory ability. These findings are consistent with Abramson, Seligman, and Teasdale's (1978) discussion of the global nature of depressives' attributions about their behavior. Such global attributions may also be common in MS patients who experience depression and may impact metamemory reports in MS.

In light of the above findings, it is possible that some memory impairment reported by MS patients is associated with their depressed state and not with true cognitive dysfunction; if this is the case, treatment of depression in MS may lead to fewer memory complaints. Indeed, one study with non-MS depressives found that successful treatment of depression was associated with a significant reduction in memory complaints (Popkin, Gallagher, Thompson, & Moore, 1982).

Metamemory in MS may not only be related to depression but also to various depressive attitudes or a globally negative cognitive style that may affect individual differences in memory self-assessment. Given Beck's (1967) assertion that depression is caused by, associated with, and maintained over time by negative views about oneself and one's capabilities, it appears likely that such negative views impact self-appraisal of one's cognitive abilities. Moreover, beliefs about one's own memory may represent a subset of various self-oriented attitudes. One class of self-related depressive attitudes, dysfunctional attitudes (Beck, 1967), are perfectionistic and rigid standards of self-worth and acceptance by others (e.g., "It is difficult to be happy unless one is good looking, intelligent, rich, and creative"; "If I do not do well all the time, people will not respect me"; both are items from Weissman & Beck's (1978) Dysfunctional Attitudes Scale). Dysfunctional attitudes have been found to predict depression (Zuroff, Igeja, & Mongrain, 1990), be concomitantly associated with depression (Miranda & Persons, 1988; Segal & Ingram, 1994), and/or persist after (Hamilton & Abramson, 1983) depressive episodes. In turn, it is possible that dysfunctional attitudes are associated not only with depression, but with self-reported memory difficulty in MS patients.

Few studies have examined depressive attitudes in MS, and none have examined the relationship between depressive attitudes and metamemory. One study with MS patients (Shnek, Foley, LaRocca, Smith, & Halper, 1995) examined MS-related helplessness and found that helplessness was a significant predictor of depression in MS. Although this study did not examine metamemory in MS, these findings indicate that a negative cognitive set (e.g., the presence of learned helplessness) may be associated with MS-related depression; it is possible that this set may more generally affect metamemory appraisals in MS patients.

Executive functions, (e.g., concept formation, planning ability, and working memory) have been found to be impaired in a significant number of MS patients (McIntosh-Michaelis et al., 1991; Rao et al., 1991). Previous studies in MS (Arnett et al., 1994; Foong et al., 1999) and non-MS (Janowsky et al., 1989; Miller et al., 1991; Shimamura, Jernigan, & Squire, 1988) samples have consistently demonstrated a connection between executive dysfunction and frontal lobe damage. Relatedly, frontal damage has been associated with increased memory complaints and inaccurate ratings of memory (Janowsky et al., 1989; Shimamura & Squire, 1986).

In one previous study designed to examine metamemory and executive functioning in MS, Beatty and Monson (1991) examined metamemory questionnaire responses and feeling of

knowing (FOK) judgments in MS patients. The authors found that patients with impairment on neuropsychological tasks of either recognition memory or executive functioning (Wisconsin Card Sort Test; Heaton, 1981) demonstrated less accurate FOK judgments. Further, responses on a metamemory questionnaire were not associated with any cognitive task, including executive functioning.

In an earlier study, we (Randolph et al., 2001) found that metamemory questionnaire reports in MS were associated with performance on the Tower of London (Davis, Bajszar, & Squire, 1994), an executive task of strategy and planning ability. We proposed that our results differed from those of Beatty and Monson (1991) in part due to use of a more comprehensive metamemory measure, particularly with regard to items assessing frequency of perceived memory difficulty. However, this measure did not assess other important aspects of metamemory reports, such as significance of forgetting, assessment of memory function over time, and complaints of forgetting while engaging in common everyday tasks such as reading. One aim of the present study was to examine these issues using a multidimensional metamemory measure (Memory Functioning Questionnaire (MFQ); Gilewski, Zelinski, & Schaie, 1990).

Thus, although the existing research is limited, it suggests that self-reported memory difficulty in MS is associated with deficits in executive functioning. Considering the relatively common occurrence of executive functioning impairment in MS (Arnett, 2001; Rao et al., 1991), and the demonstrated role of executive functioning on different aspects of metamemory in both MS and non-MS samples (Beatty & Monson, 1991; Janowsky et al., 1989; Randolph et al., 2001), it seems likely that some subjective memory complaints in MS patients may stem from compromised executive functioning. Also of note is that no previous study has examined the role of executive functioning on metamemory in MS while also accounting for depression and/or depressive attitudes. Indeed, it is currently unclear whether executive functioning impairment alone, or executive impairment in combination with (or in isolation compared to) depression-related factors, leads to memory complaints in MS.

In sum, the present study was designed to examine the relative contributions of depression, depressive attitudes, and executive dysfunction on MS patients' metamemory reports. To this end, we predicted that metamemory reports in MS would correlate with depression, depressive attitudes, and measures of executive functioning based on previous research. If our correlational predictions were accurate, we then planned to test three a priori structural equation models (Figs. 1–3) that considered interrelationships among metamemory, depression, depressive attitudes, and executive functioning. Although all three a priori models were considered to be plausible configurations of study variables (i.e., based on existing theory and previous research), the two models that examined depressive mediational variables (Figs. 1 and 2) were hypothesized to best account for variable relationships examined in the present study. This prediction was based upon Beck's (1967) and others' (Miranda & Persons, 1988) cognitive theories of depression where depression and depressive attitudes are believed to be causally related. However, due to discrepancies in the depression literature related to directionality of depression → depressive cognition relationships (Eaves & Rush, 1984; Miranda, 1992; Segal & Ingram, 1994), and because these variables had not previously been considered collectively relative to metamemory, it was difficult to determine a priori which of the two

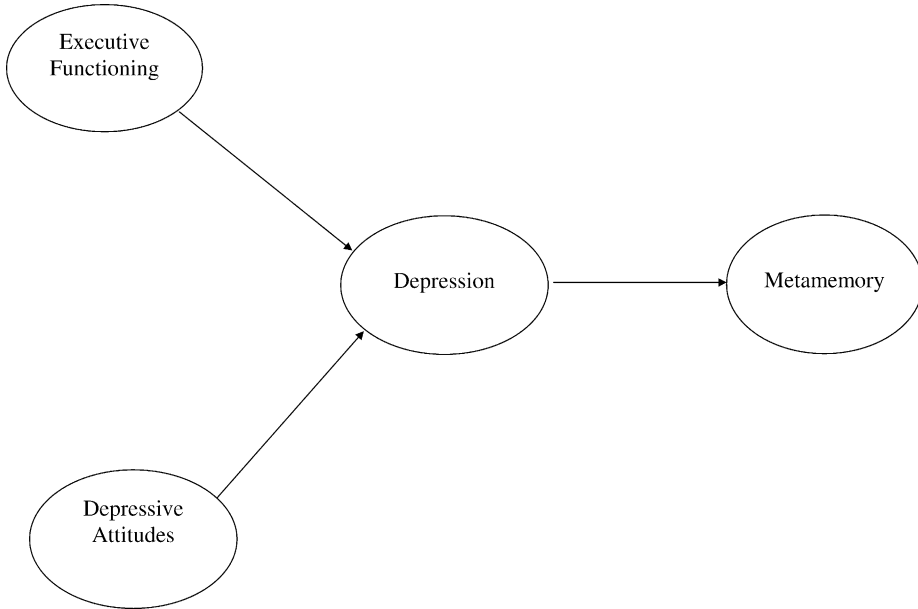


Fig. 1. A priori Depressive Attitudes Mediation Model.

mediational models would provide the best fit to the data. Finally, in the interest of consistency with past metamemory research, we examined the relationship between self-reported memory functioning and tested verbal memory, which we predicted to be significant but modest.

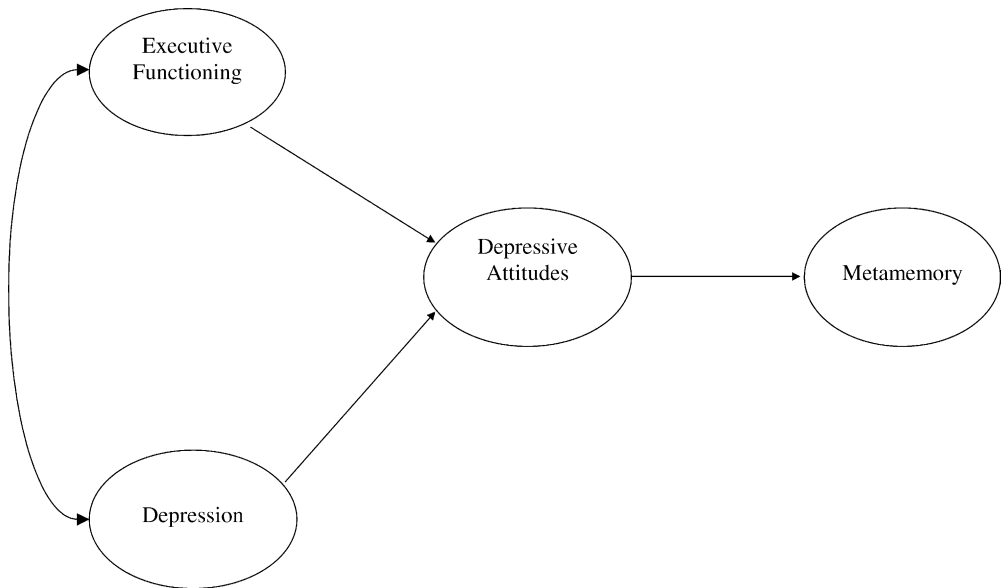


Fig. 2. A priori Depression Mediation Model.

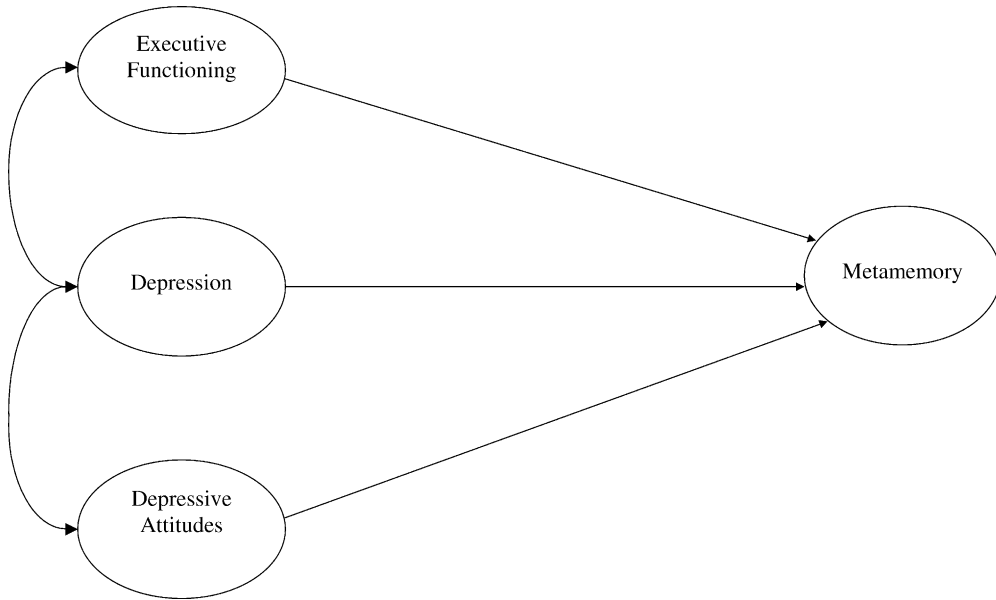


Fig. 3. A priori Non-Mediational Model.

2. Methods

2.1. Participants and procedure

Fifty-four Caucasian patients who met Poser et al. (1983) criteria for definite or probable MS were recruited from outpatient clinics and support groups in the Pullman, WA and Spokane, WA areas to participate in the second phase of a longitudinal study examining cognitive and affective sequelae of MS. Participants were excluded from the present study if they: (a) had a history of drug or alcohol abuse or nervous system disorder other than MS, (b) had severe motor or visual impairment that may have interfered with tests administered to them, (c) developed any neurological condition other than MS since last being tested in the larger longitudinal study (approximately 3 years earlier), or (d) were unable to be evaluated on an outpatient basis. No participant was experiencing an exacerbation of symptoms at the time of testing.

The treatment of participants was in accordance with the ethical standards of the American Psychological Association and the State of Washington. Participants were administered a battery of neuropsychological tests by graduate students extensively trained in interviewing and test administration. Test order administration was counterbalanced to account for possible order effects. In return for their participation in the study, participants were sent a brief neuropsychological report of their cognitive and affective functioning and given oral feedback on this report via telephone.

2.2. Measures

2.2.1. Metamemory measure

2.2.1.1. Memory Functioning Questionnaire. The MFQ (Gilewski et al., 1990) is a self-report, 64-item metamemory measure. Items generally assess memory difficulty and frequency of forgetting information, and are scored on 7-point Likert scales (e.g., “always” to “never” for most items). Factor analytic analyses of the MFQ (e.g., Gilewski et al., 1990) have revealed four correlated factors, two of which were examined in the present study: General Frequency of Forgetting (GFF) and Seriousness of Forgetting (SF).¹ Further, given some earlier studies’ (e.g., Gilewski et al., 1983; Hertzog, Hultsch, & Dixon, 1990) use of the three correlated subscales that comprise the broader GFF scale (Frequency of Memory Problems, Remembering Past Events, and Forgetting While Reading), we also considered these subscales as they related to other study variables. Reliability data are favorable for the MFQ, with internal consistency of factors ranging from .84 to .94 across studies (e.g., Gilewski et al., 1990; Zelinski, Gilewski, & Anthony-Bergstone, 1990). Attesting to its validity as a measure of metamemory, the MFQ has demonstrated concurrent validity with memory performance measures (Zelinski et al., 1990) and convergent validity with another commonly used metamemory measure (Hertzog, Hultsch, & Dixon, 1989). Higher scores reflect more memory complaints.

2.2.2. Depression measures

2.2.2.1. Chicago Multiscale Depression Inventory (CMDI). The CMDI (Nyenhuis et al., 1995) is a 42-item measure of depression developed specifically to assess depression in MS. The CMDI contains three subscales, each assessing different depressive symptoms: mood, evaluative, and vegetative. Based on some researchers’ (Mohr et al., 1997; Nyenhuis et al., 1995, 1998) suggestions that depressed mood is the best index of depression in MS, only the mood scale from the CMDI was used in the present study. Participants rate how well items describe their own experiences (e.g., “sad”; “dreary”) over the past week on a 1–5 scale, from “not at all” to “extremely.” Good reliability and validity data for the CMDI have been reported (Nyenhuis et al., 1995). Items were scored such that higher scores are indicative of more depressed mood.

2.2.2.2. Beck Depression Inventory (BDI). Although some researchers argue that examining subsets of depressive symptoms (e.g., mood symptoms) is more diagnostically accurate when assessing depression in MS (Nyenhuis et al., 1995, 1998), others contend that it is important to assess all depressive symptoms collectively (Aikens et al., 1999; Sullivan et al., 1995), particularly with a historically well-used and well-validated measure. In the interest of comparing a more comprehensive measure of depression with the CMDI Mood scale, we used a revised version of the BDI (Beck, Ward, Mendelsohn, Mock, & Erbaugh, 1961). This version eliminates certain neurovegetative items (tiredness, appetite, and weight change) that were more associated with fatigue than depression in a sample of MS patients (Randolph et al., 2000), but retains all other original BDI items. Items are rated on a 0–3 scale, from neutral

¹ Two other MFQ scales, Mnemonics Usage and Retrospective Functioning, were not considered here because they generally have not been associated with depression or other variables that we examined (cf. McConnell, 1996; Zelinski et al., 1990).

feelings about a statement (e.g., “I don’t feel disappointed in myself,” indicated by a “0”) to depressotypic feelings (e.g., “I hate myself,” indicated by a “3”). The full BDI has been shown to have excellent reliability and validity (Beck, Steer, & Garbin, 1988). Higher BDI scores represent more depression.

2.2.3. Attitudinal measure

2.2.3.1. Dysfunctional Attitude Scale (DAS). The DAS (Form A; Weissman & Beck, 1978) was used to assess participants’ depressive attitudes. The DAS consists of 40 statements representing implicit rules and conditions for self-acceptance, including perfectionistic standards for the self and rigid expectations regarding how others should act. These rules are regarded as dysfunctional because they are rigid and unrealistic, for example, “I cannot be happy unless most people I know admire me,” “If someone disagrees with me, it probably indicates he/she does not like me,” and “If I fail partly, it is as bad as being a complete failure.” Participants respond on a 1–7 scale, from “totally agree” to “totally disagree.” In keeping with its intent to assess stylistic cognitive patterns, the DAS asks participants to report how they think “most of the time.” The DAS has two subscales: Perfectionism (DAS-P) and Interpersonal Expectations (DAS-IE). Higher scores reflect more depressive attitudes. Acceptable psychometric properties for this measure have been reported by various researchers (Hamilton & Abramson, 1983; Weissman, 1979).

2.2.4. Measures of executive functioning

2.2.4.1. Tower of Hanoi (TOH) (computerized). The TOH (Goel & Grafman, 1995) is a computerized task of planning ability and strategy formation. Participants were shown three symmetrically positioned pegs on a computer screen (positioned in the left, center, and right on-screen) and five disks of different sizes. The five disks were arranged in a predetermined “initial state” pattern (increasing in size, from top to bottom) and position (right peg). Using a computer mouse, participants were asked to move the disks in such a way that they ended up in the same pattern but on the left peg (“goal state”). Participants were administered two blocks of trials (Block 1 and Block 2), approximately 30 minutes apart, with four trials per block. They were presented with one demonstration trial before they attempted the Block 1 and Block 2 trials. Participants were asked to achieve the goal state as quickly and in as few moves as possible; however, there was no time limit for the task. TOH scoring indices used in the present study were number of moves per trial for Blocks 1 and 2 (TOH-1 and TOH-2, respectively), with higher scores reflecting more moves.² These scoring indices were considered separately because they may reflect different processes. TOH-1 most likely reflects novel problem-solving, whereas TOH-2 most likely reflects the ability to apply a learned problem-solving set to a new, but related, problem.

2.2.4.2. Letter–number sequencing from the WAIS-III (LN). LN (The Psychological Corporation, 1997) is a test of working memory included in the present study as an index of executive

²Other TOH indices were excluded from analyses in order to allow for a more precise examination of certain core executive skills in our SEM models (e.g., planning, working memory) that minimized potential confounds of other factors (e.g., psychomotor speed).

functioning. Participants are read a string of numbers and letters and are then asked to recall the items by repeating numbers first, in order, followed by letters in alphabetical order. Higher LN scores represent better working memory.

2.2.5. Verbal memory measure

2.2.5.1. *Selective Reminding Test (SRT)*. The SRT (Buschke & Fuld, 1974) is a word-list learning test that was included in the present study to examine the association between memory self-reports and tested verbal memory. For the SRT, participants read a list of 12 words and are then asked to recall these words to the examiner. Over the course of five subsequent trials, participants are told the words that they missed on the previous trial, and are then asked to repeat the list again, including words they might have already said. Total correct for six trials is the index of verbal memory used in the present study, with higher scores indicative of more words recalled.

3. Results

3.1. Analytic strategy

Analyses were three-fold. First, preliminary *t* test and correlational analyses were conducted that served to examine the relationships among demographic/illness and study variables. Second, we examined correlations between metamemory scales and depression, depressive attitudes, and executive functioning. These analyses were important in their own right but also were used to inform structural equation model tests.

Finally, structural equation modeling (SEM) using the EQS computer program (Bentler, 1985) was employed in order to test the relative merit of the hypothesized models. EQS computes a series of regression analyses simultaneously and subsequently generates an estimated covariance matrix for a given model that is compared to the actual covariance matrix of the sample. The degree of agreement between covariance matrices is then compared with various fit indices in order to determine goodness-of-fit of the proposed model.

Using SEM, three structural equation models were tested. For any given set of variables, numerous variable combinations exist; by only testing one model, other equally plausible models that might also account for the data are not considered (Breckler, 1990; MacCallum, Wegener, Uchino, & Farbigar, 1993). For this reason, three plausible theoretical models (Figs. 1–3) were tested in the present study, all based on earlier studies that have documented connections between metamemory and depression, depressive attitudes, and executive functioning.

To examine the fit of each model, three fit indices were used; goodness-of-fit indices were based on the maximum likelihood method. First, the chi-square statistic tests the departure of the specified model's estimated covariance matrix from the actual sample covariance matrix. Given that the chi-square is known to be distorted with small or large sample sizes, some authors have suggested that the chi-square to degrees of freedom ratio is a more appropriate way to use the chi-square statistic to assess model fit (Bollen, 1989). A model is considered acceptable if this ratio is less than 2.0 (Ullman, 1996). The ratio score for the chi-square/degrees of freedom ratio is reported below because of the relatively small sample size used in the current study.

Another fit index, the Incremental Fit Index (IFI), has been found to reflect model fit well regardless of sample size and has less sampling variability than other fit indices (Bentler, 1990; Bollen, 1989). IFI values range from 0 to 1; a value greater than .9 represents good model fit (Bentler, 1995). A third index, the Akaike Information Criterion (AIC) index, was also used. In addition to indicating goodness-of-fit, it assesses model parsimony, and is thought to be most useful in comparing models within a single data set (Loehlin, 1992). Small values relative to other competing models reflect good fitting, parsimonious models (Ullman, 1996). A final note on model fit relates to parameter significance; as might be expected, models with the most statistically significant path coefficients are optimal.

3.2. Preliminary analyses

Three participants failed to complete the MFQ and return it to the experimenter on the day of testing. Two participants were not administered the TOH due to discomfort during the day of testing. One participant arrived at the testing session but refused to participate after completing two tasks; this participant did not complete the TOH, LN, CMDI, BDI, and DAS. Thus, after excluding the above participants using listwise exclusion, the analyses reported below were based on 48 participants with useable data for all variables considered. Demographic and clinical characteristics of these participants are listed in Table 1. Based on BDI scores, 31% of the sample scored in the mildly to moderately depressed range. Also of note is that according to normative data on the SRT (Rao et al., 1991), 8% of patients exhibited memory functioning in the borderline impaired range or below (i.e., standard scores less than 80). Additionally, 4% of patients scored in the borderline impaired range on the LNS (The Psychological Corporation, 1997). Because we developed a non-normed TOH test for use in our study, we were not able to determine how many participants showed impairment relative to controls on this task.

Table 1
Summary of participant characteristics

Variables	
<i>n</i>	48
Age (years)	49.6 (7.8)
Education (years)	15.1 (2.3)
Sex, <i>n</i> (% female)	37 (77)
Estimated IQ	105.2 (6.9)
EDSS	4.6 (1.6)
Symptom duration (years)	16.3 (9.3)
Diagnosis duration (years)	9.9 (6.1)
Clinical course	
Relapsing-remitting, <i>n</i> (%)	28 (58)
Secondary progressive, <i>n</i> (%)	13 (27)
Primary progressive, <i>n</i> (%)	6 (13)
Progressive relapsing, <i>n</i> (%)	1 (2)

Note. Unless otherwise specified, values represent means (standard deviation). Estimated IQ is based on Shipley Institute of Living Scale total scores. EDSS: Expanded Disability Status scale.

Table 2

Correlations between primary Memory Functioning Questionnaire scales and cognitive tests

	TOH-1	TOH-2	LN	SRT
MFQ–GFF	.06	.17	–.16	–.16
MFQ–SF	.05	.08	–.10	.03

Note. MFQ–GFF: Memory Functioning Questionnaire–General Frequency of Forgetting scale; MFQ–SF: Memory Functioning Questionnaire–Significance of Forgetting scale; TOH-1: Tower of Hanoi—Block 1 Moves; TOH-2: Tower of Hanoi—Block 2 Moves; LN: Letter–Number Sequencing task; SRT: Selective Reminding Test. $N = 48$ for all variables.

To examine the possible differences according to MS course type, t tests were also conducted. Given the relatively low number of participants diagnosed with other course types (Table 1), t tests were only conducted between relapsing–remitting and secondary progressive courses. These analyses revealed no MS course differences on any study measure. Additional analyses revealed no associations between participant age, education, and study variables.

3.3. Correlational analyses

Correlational analyses were first conducted between both primary MFQ scales [General Frequency of Forgetting (GFF), Seriousness of Forgetting (SF)] and all indices of depression, depressive attitudes, and cognitive functioning. Both GFF and SF correlated with depression as measured by the BDI ($r = .39$, $P < .01$; $r = .45$, $P < .001$, respectively) but not the CMDI. Thus, participants who reported more memory problems tended to report experiencing more depressive symptoms. Analyses examining the relationships between MFQ scales and depressive attitudes revealed no significant relationships. However, a trend emerged between the GFF scale and the DAS Interpersonal Expectations scale ($r = .26$, $P = .07$), with more memory complaints being associated with more reported depressive attitudes. Neither primary MFQ scale correlated with any index of cognitive functioning (all P s $> .10$) (Table 2).

Significant relationships emerged between all three GFF subscales and current depression (BDI; Table 3). As with earlier findings, although the BDI did correlate with GFF subscales,

Table 3

General Frequency of Forgetting subscale correlations with depression measures and cognitive tests

	CMDI	BDI	TOH-1	TOH-2	LN	SRT
MFQ–FWR	–.01	.32*	.12	.36**	–.35*	–.27
MFQ–RPE	.22	.34*	–.12	.01	.04	.04
MFQ–FMP	.00	.35*	.06	.03	–.04	–.09

Note. MFQ–FWR: Memory Functioning Questionnaire–Forgetting While Reading subscale; MFQ–RPE: Memory Functioning Questionnaire–Remembering Past Events subscale; MFQ–FMP: Memory Functioning Questionnaire–Frequency of Memory Problems; CMDI: Chicago Multiscale Depression Inventory Mood scale; BDI: Beck Depression Inventory; TOH-1: Tower of Hanoi—Block 1 Moves; TOH-2: Tower of Hanoi—Block 2 Moves; LN: Letter–Number Sequencing task; SRT: Selective Reminding Test. $N = 48$ for all variables.

* $P < .05$.

** $P < .01$.

Table 4

Means, standard deviations, and intercorrelations for measures included in SEM analyses

	Mean (S.D.)	1	2	3	4	5
FWR	51.4 (12.9)	–				
TOH-2	102.6 (40.2)	.36**	–			
LN	10.7 (2.1)	–.35*	–.49***	–		
DAS-IE	54.4 (14.9)	.30*	.43**	–.17	–	
BDI	6.6 (4.9)	.32*	.23	–.19	.49**	–

Note. FWR: Memory Functioning Questionnaire–Forgetting While Reading subscale; TOH-2: Tower of Hanoi—Block 2 Moves; LN: Letter–Number Sequencing task; DAS-IE: Dysfunctional Attitudes Scale—Interpersonal Expectations subscale; BDI: Beck Depression Inventory. $N = 48$ for all variables.

* $P < .05$.

** $P < .01$.

*** $P < .001$.

the CMDI did not. One GFF subscale, Forgetting While Reading, was significantly correlated with the DAS Interpersonal Expectations scale ($r = .30$, $P < .05$), with more reported memory lapses while reading being associated with more depressive attitudes. Significant correlations also emerged between Forgetting While Reading and two of four cognitive tests (Table 3), with more reported forgetting while reading being associated with poorer test performance. This scale nearly correlated with tested verbal memory ($P = .06$).

3.4. SEM analyses

For SEM, it is necessary to determine that model variables included in mediational paths are significantly correlated. Statistically, this procedure is imperative when attempting to establish a mediational relationship via SEM or regression analyses (Barron & Kenny, 1986). Because only the Forgetting While Reading metamemory scale correlated with other variables in the proposed mediational paths,³ the three tested models examined the role of depression, depressive attitudes, and executive functioning on reported memory lapses while reading. Intercorrelations of all variables used in tested models are presented in Table 4.

The Depressive Attitudes Mediational Model tested the hypothesis that executive functioning (TOH-2 and LN combined) and depression (BDI) influence metamemory through the mediating variable of depressive attitudes (DAS-IE). SEM analyses revealed a good model fit according to all fit indices, $\chi^2/d.f.$ ratio = 1.74, IFI = .92, AIC = 1.29 (Fig. 4). These findings support the notion that depressive attitudes play a mediational role in the depression/executive functioning-metamemory relationship.

The Depression Mediational Model tested the possibility that executive functioning and depressive attitudes would be associated with metamemory reports through the mediating

³The BDI, rather than the CMDI Mood scale, was included in SEM analyses as a measure of depression because unlike the CMDI, it was associated with critical variables in SEM models. This rationale also applied for the exclusion of the TOH-1. Thus, the tested model is a mixed structural model, meaning that it contains both latent (represented as an oval) and manifest (represented as rectangles) variables. A full latent variable model test was not possible because of the non-significant correlations between some conceptually related study variables.

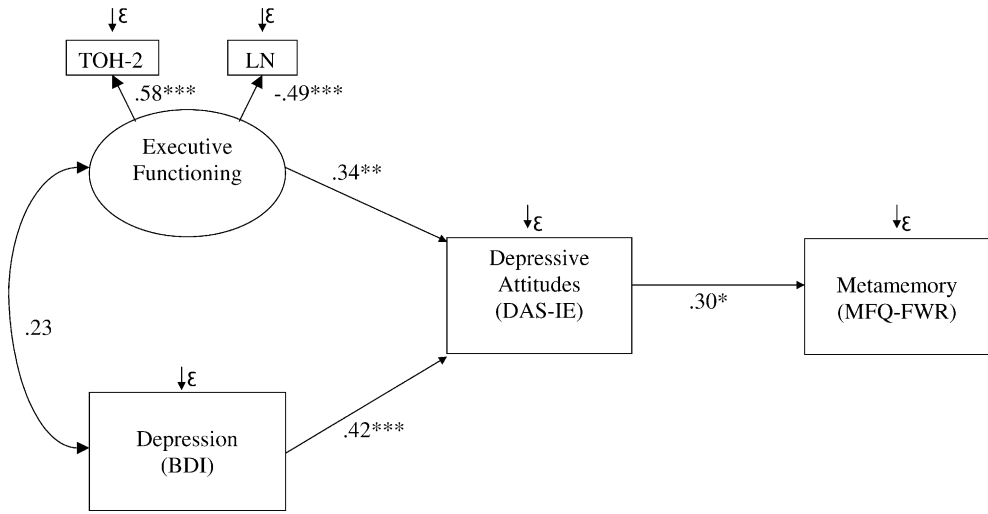


Fig. 4. Tested Depressive Attitudes Mediation Model. *Note.* LN: Letter–Number Sequencing task; TOH-2: TOH—Block 2 Moves; BDI: Beck Depression Inventory; DAS-IE: Dysfunctional Attitudes Scale—Interpersonal Expectations subscale; MFQ–FWR: Memory Functioning Questionnaire–Forgetting While Reading subscale. Standardized path coefficients are indicated on pathways; ε represents unique variance in the observed variables. * $P < .05$; ** $P < .01$; and *** $P < .001$.

variable of depression. A test of this model revealed a relatively poor fit to the data as compared with the previous model, with no fit indices indicating good model fit, $\chi^2/d.f.$ ratio = 2.91, IFI = .73, AIC = 5.44, and one path being non-significant.

The Non-Mediation Model, a third plausible model based on previous research, contained no mediational relationships; depression, depressive attitudes, and executive functioning were all proposed to exert unique effects on metamemory. The test of this model revealed a poor fit to the data, $\chi^2/d.f.$ ratio = 3.09, IFI = .81, AIC = 4.37, with only one model path being significant.

4. Discussion

The present study served to examine the relationships between metamemory and depression, depressive attitudes, and executive functioning in a sample of MS patients. Study analyses revealed four primary findings. First, MS patients’ memory complaints were associated with current depression. Although other studies in the non-MS literature have obtained similar results (e.g., Niederehe & Yoder, 1989), only one previous study (Gottschalk, 1995) had examined and confirmed the metamemory–depression relationship in MS. Second, subjective reports of forgetting while reading were associated with depressive attitudes. This finding supports the assertion that metamemory reports and depressive attitudes are part of a larger class of self-oriented beliefs (cf. Hertzog et al., 1989). Third, patients’ reports of forgetting while reading were associated executive dysfunction. This finding runs contrary to one other study (e.g., Beatty & Monson, 1991) that did not find a metamemory–executive functioning connection

in MS using a self-report measure of metamemory, but is consistent with a more recent study (Randolph et al., 2001). Along with the latter study, these data suggest that patient reports of certain types of memory difficulty may reflect impairment in cognitive domains other than tested memory functioning. Finally, SEM analyses revealed a good fit to the model hypothesizing that depressive attitudes mediate the impact of executive functioning and depression on one aspect of metamemory, forgetting while reading. Thus, certain memory complaints in MS are not only associated with executive dysfunction and depression, but appear to be exacerbated by the presence of depressive beliefs. Although this finding has not previously been reported, it is consistent with existing studies that have selectively examined interrelationships among memory complaints and depression, depressive attitudes, and executive impairment. These findings suggest that assessment of metamemory in MS may be more comprehensive if depressive attitudes are considered along with other potential contributors. They also suggest that treatment of depression and related attitudes in MS may reduce patients' memory complaints as well as improve their quality of life.

One important finding from the present study was the association between various metamemory indices and depression. Depression has been found to be associated with memory complaints in various age (Derouesne, Labomblez, Thibault, & LePoncin, 1999) and patient (Coleman, Sackeim, Prudic, & Devanand, 1996; McConnell, 1996) groups, and has also been found to account for the majority of variance in metamemory ratings, even after accounting for cognitive performance (Rourke, Halman, & Bassel, 1999). In the present study, all metamemory scales correlated with current depression as measured by the BDI. These findings are consistent with various studies in the metamemory literature that have found associations between depression and scales within a single metamemory questionnaire (e.g., McDougall, 1994; Niederehe & Yoder, 1989); however, to our knowledge, this is only the second study to document these relationships in an MS sample (cf. Gottschalk, 1995).

Although metamemory scales correlated with the BDI, no associations emerged between metamemory and depressed mood, as assessed by the CMDI. Some researchers in the MS literature (e.g., Aikens et al., 1999; Sullivan et al., 1995) have found the standard BDI to be a better index of depression in MS than a revised BDI that eliminates items assessing neurovegetative symptoms. Others (Nyenhuis et al., 1998) argue that only depressive mood symptoms should be used when assessing depression in MS due to the inherent overlap between neurovegetative symptoms and physical symptoms of MS. We sought a compromise by using a revised version of the BDI that eliminated some vegetative items previously found to correlate more with MS-related fatigue than depression (Randolph et al., 2000). However, our version of the BDI did include some vegetative symptoms as well as all other non-vegetative BDI items. In turn, our findings here suggest that metamemory in MS is more related to a constellation of depressive symptoms than to a subset of depressive mood symptoms (e.g., as assessed by the CMDI Mood scale). Given that the majority of DSM-IV criteria for depressive diagnoses relate to evaluative and neurovegetative symptoms rather than mood symptoms of depression (American Psychiatric Association, 1994), clinicians and researchers may wish to more regularly consider the diagnostic significance of non-mood symptoms in MS patients. In general, given the present findings, assessment of depression in MS may need to include different types of depressive symptoms, particularly when considering the metamemory–depression relationship.

Metamemory, as assessed by the MFQ Forgetting While Reading scale, was also associated with depressive attitudes. Further, the best fitting structural equation model in the present study was one where depressive attitudes mediated the relationship between executive functioning/depression and metamemory. Taken collectively, these results suggest that certain types of self-critical depressive beliefs may impact self-reports of memory functioning. It also seems likely that certain types of metamemory reports, along with depressive beliefs, are part of a larger set of self-evaluative beliefs. Hertzog et al. (1989) assert that “. . . individuals’ self-reports [of memory abilities] are often based on access to generalized beliefs and self-schemata. . . rather than access to specific, discrete episodes in memory” (p. 688). Similarly, some investigators argue that the typically moderate association between metamemory reports and memory test performance may be more related to neuroticism or the tendency to complain than to other factors, such as affective states (Hultsch et al., 1988; Zelinski et al., 1990). We also found that, in the context of metamemory in MS, the relationship between depression and depressive beliefs in MS was more consistent with Miranda and Persons’s theory of mood-state dependence (Miranda & Persons, 1988; Miranda, Persons, & Byers, 1990) than with Beck’s cognitive theory of depression (Beck, 1967). Thus, depression in MS may activate patients’ dormant or mood-dependent depressive beliefs, which in turn give rise to increased memory complaints. It is important to note that other factors beyond the scope of the present study (e.g., current life events) have been found to moderate the relationship between depression and dysfunctional attitudes (Joiner, Metalsky, Lew, & Klocek, 1999). In general, the association between depressive attitudes, depression, and different aspects of metamemory is one that is just beginning to be explored, particularly in neurological groups such as MS patients. Given these assertions and findings from the present study, one suggestion for future research is to more routinely assess depressive attitudes when examining relationships between metamemory and other variables, particularly with MS patients.

Forgetting While Reading metamemory ratings were correlated with one index of planning in this study, Tower of Hanoi—Block 2 Moves (TOH-2), but not another (TOH—Block 1 Moves; TOH-1). For the Tower task, participants were administered two blocks of trials, with four trials each, that were approximately 30 minutes apart. Follow-up analyses indicated that, as might be expected, participants on average did improve on the second Tower task, although the overall range of responses was similar between TOH-1 and TOH-2. Thus, it is possible that correlates of TOH-1 and TOH-2 may have differed due to “executive learning” and increased task familiarity. For example, the first TOH block may have involved more procedural learning than the second block, due to task novelty during the first trials. If this interpretation is accurate, it seems possible that an executive task with less novelty to the examinee (i.e., TOH-2) may be more related to self-reports of everyday cognitive abilities than a measure that also taps cognitive functioning in other areas (such as procedural learning). A more speculative but interesting possibility is that in everyday life, some planning tasks such as list making may be well rehearsed but become “tests” of planning when applied to new situations. For example, an individual may make a to-do list that resembles one made before, but differs in the tasks the person is attempting to accomplish (e.g., going to the bakery and florist instead of the stationery store). Although the content may differ, the individual still needs to plan the list by taking into account such factors as location of the stores and the time it will take to accomplish tasks at each location. In general, the relationship between cognitive (and, more specifically,

executive) learning and metacognition has been sparsely investigated and deserves attention in future MS and other research.

We found that verbal memory was nearly significantly correlated with MS patients' self-reported memory difficulty. This finding is similar to our earlier study demonstrating a modest relationship ($r = .30$) between story recall memory and memory complaints using a separate sample and different metamemory questionnaire (Randolph et al., 2001). These studies collectively suggest that, similar to non-demented older adults (e.g., Zelinski et al., 1990), MS patients may be able to accurately describe some aspects of their memory deficits on self-report questionnaires. It is important to note, however, that in both studies, self-reported memory difficulties were generally more associated with executive dysfunction than memory dysfunction per se. Thus, it may be the case that MS patients' ratings of memory functioning reflect more general cognitive dysfunction, or specifically, dysfunction in executive domains.

Forgetting While Reading was the only metamemory scale that correlated with cognitive performance as well as affective variables. Other MFQ subscales including Remembering Past Events, Frequency of Memory Problems, and Seriousness of Forgetting did not correlate with any neuropsychological measure. Relatively few studies have examined the items in the Forgetting While Reading subscale independent from the broader General Frequency of Forgetting scale (some exceptions being Gilewski et al., 1983; Hertzog et al., 1989); most studies using the MFQ have focused on the primary MFQ scales (e.g., McConnell, 1996; Zelinski et al., 1990) as indices of metamemory. The present study's findings suggest that the Forgetting While Reading subscale may be a particularly good index of memory self-reports that is more sensitive to cognitive performance, attitudes, and depression in MS than other MFQ scales and subscales. One possibility is that MS patients may be better able to rate their memory for reading material than rate the frequency with which they forget names or appointments. Many MS patients involved in this project commented on recent articles from MS newsletters and/or newspapers that they had read that were relevant to their condition. Thus, it is possible that MS patients are more likely to use reading comprehension and retention as indices of memory ability than other "real-world" tasks due to the importance and salience of reading in their day-to-day lives. Further, judgments of event frequency have been found to have different functional neuroimaging correlates than recognition memory ratings (Haut et al., 2001), suggesting a physiological dissociation between frequency-based reading and other metamemory judgments. In sum, the Forgetting While Reading subscale deserves additional investigation in MS and non-MS samples given its relation to various contributors to metamemory in this study.

Findings from the present study have important implications for rehabilitation and treatment of MS patients. For example, consider the association found between metamemory and depression. In this study and in other research, patients who report more memory problems tend to endorse more self-reported depressive symptoms. Research has also demonstrated that successful treatment of depression in those with self-reported memory difficulty reduces memory complaints (Popkin et al., 1982). The present study's findings also suggest that a specific treatment focused on depressive beliefs may also reduce memory complaints. Indeed, cognitive-behavioral psychotherapy, a treatment modality that serves to modify depressive cognitive styles, has been found to be effective with MS patients (Foley et al., 1987; Mohr, Van Der Wende, Dwyer, & Dick, 2000), although its role on metamemory reports in MS has not yet been examined.

One limitation of the present study is its reliance on correlational data. Associations were found between MFQ scales and various measures of depression and cognitive functioning, and support was gathered for conceptualizing depressive attitudes as a mediating mechanism in the metamemory–depression/executive functioning relationship. One potential criticism of correlational analyses is that as a result of keeping the significance criterion for these analyses at $P < .05$, some variable relationships in the present study might differ in a separate sample and/or might not be as robust as reported. However, it was deemed important to examine variable relationships (particularly mediational relationships) in the context of SEM analyses, and this was only possible by retaining the $P < .05$ criterion. The variable relationships found in the present study were also consistent with a priori predictions and with the metamemory, depression, and cognitive functioning literatures, suggesting that findings were not artifactual.

A related limitation relates to our use of SEM with a clinical sample. Although our sample is larger than other studies in the MS literature (e.g., Beatty, Goodkin, Monson, & Beatty, 1989; D’Esposito et al., 1996), and similar to some reports using SEM (e.g., Crano & Mendoza, 1987; Zautra, Reich, & Guarnaccia, 1990), it is relatively small compared to other non-MS studies in the SEM literature. Guidelines for appropriate sample size in SEM are not firmly established and depend on multiple factors (Tanaka, 1987), although an accepted standard in the literature is approximately 10 participants per path to be estimated (Bentler, 1995). Thus, our tested models meet this minimum standard, particularly given that our fit indices were chosen for their sensitivity in relatively small samples. It is also logistically more difficult to acquire large clinical samples than samples of normal controls or college students, despite the ideal goal of having robust samples for any multivariate statistical procedure. In light of these considerations and the position that model interpretation should be more conservative when small samples are employed (Tanaka, Panter, Winborne, & Huba, 1990), we consider our SEM results preliminary, with the ultimate utility of tested models being dependent on cross-validation in a separate MS sample.

An additional limitation of this study is that other forms of psychopathology were not assessed in relation to metamemory. Anxiety has been found to be associated with various aspects of metamemory in non-MS samples (Jonker, Smits, & Deeg, 1997; McDougall, 1995), and may have impacted MS patients’ self-reports in the present study. Future research may wish to consider multiple symptoms of psychopathology when examining metamemory in MS.

In summary, the present study demonstrates that metamemory reports in MS patients involving forgetting while reading are associated with depression, depressive attitudes, and executive functioning. Multivariate SEM analyses revealed a particularly good fit to a model where depressive attitudes mediated the relationship between executive functioning/depression and forgetting while reading. Another important finding was that several aspects of metamemory were associated with depression as measured by the BDI. These results replicate prior research in MS and extend it by showing that several different aspects of metamemory are associated with depression. Future research will be necessary to explore these issues further, especially concerning techniques for improving metamemory assessment in MS. An overarching goal of this area of research would be to help MS patients, particularly those who experience depression, develop more realistic appraisals of their cognitive strengths and weaknesses that in turn might help them maximize the quality of their lives.

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