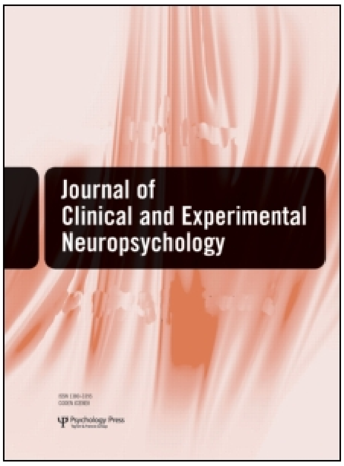

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Awareness of executive functioning deficits in multiple sclerosis: Self versus informant ratings of impairment

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Awareness of executive functioning deficits in multiple sclerosis: Self versus informant ratings of impairment

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This study investigates the accuracy of self and informant ratings of executive dysfunction in a multiple sclerosis (MS) and control sample. Participants completed a neuropsychological battery. Participants and informants completed depression measures and the Dysexecutive Questionnaire (DEX). MS participants rated themselves more impaired than controls, while informants' ratings were not statistically different. MS participants' performance on executive tasks was more highly correlated with self than informant DEX ratings. Discrepancies between informant DEX ratings and executive performance were related to executive functioning for the MS participants only. Overall, results indicate that MS patients were able to accurately rate their executive functioning.

Keywords: Multiple sclerosis; Awareness; Cognition; Caregivers; Questionnaire; Neuropsychology.

INTRODUCTION

The accuracy with which neurological patients can rate their cognitive functioning is an important issue for assessment and rehabilitation. However, many cognitively impaired patients also demonstrate impaired awareness of their deficits. Because of this tendency towards inaccurate self rating, many clinicians and researchers use informant ratings or take the discrepancy between self and informant ratings of cognitive dysfunction as an indication of the patient's level of awareness (Fleming, Strong, & Ashton, 1996). This reliance on informants is based on the assumption that they are more objective and accurate raters of cognitive dysfunction than patients themselves. However, as Fleming et al. (1996) note, significant others of patients with brain injury or disease "themselves may demonstrate varying levels of denial and decreased awareness" (p. 4).

In the multiple sclerosis (MS) literature, research into self-awareness of cognitive deficits has been inconclusive, with a number of studies suggesting that people with MS are generally accurate in their report of their cognitive functioning (Basso et al., 2008; Benedict et al., 2004; Chiaravalloti & DeLuca, 2003; Kujala, Portin, & Ruutiainen, 1996; Matotek, Saling, Gates, & Sedal, 2001; Randolph, Arnett, & Higginson, 2001), and others disputing this (Beatty & Monson, 1991; Christodoulou et al., 2005; Gold et al., 2001; Hoogervorst et al., 2001; Maor, Olmer, & Mozes, 2001; Marrie, Chelune, Miller, & Cohen, 2005; Middleton, Denney, Lynch, & Parmenter, 2006). Researchers have tended to use measures that assess awareness of overall cognitive functioning. However, Allen and Ruff (1990) found that brain-injured patients' accuracy in rating their abilities varied by cognitive domain, suggesting that examining awareness of overall cognitive functioning may mask this variability. For this reason, the present study examines a single cognitive domain—executive functioning, which is often impaired in MS and is related to self-awareness (Bivona et al., 2008). Because executive functioning involves complex behavior, planning, and self-awareness, impairment in these areas may significantly affect quality of life.

It is not clear from the existing literature in MS (Carone, Benedict, Munschauer, Fishman, & Weinstock-Guttman,

Some of the data from this investigation were presented at the 2004 annual conference of the National Academy of Neuropsychology and the 2005 annual conference of the International Neuropsychological Society. This research was conducted, in part, for the first author's doctoral dissertation at Penn State University. The authors have no financial interest or conflicts to disclose. Special thanks to the many neurologists in the Pennsylvania region who contributed their time to verifying multiple sclerosis (MS) diagnoses and ratings of course for the MS participants in the project. We are indebted to the participants and their significant others whose time and effort made this research possible.

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2005; Randolph et al., 2001; Taylor, 1990) whether significant others of MS patients are more accurate in rating patients' cognitive impairment than are patients themselves. Using informant ratings or their discrepancy from patient ratings, as is common practice, would be misleading if patients are accurate in rating their own level of cognitive dysfunction. Additionally, if informants are generally unaware of patients' cognitive impairments, they may have unrealistic expectations of their daily functioning.

In addition to actual cognitive functioning, other factors may influence patients' and informants' ability to make an accurate evaluation. Depression has been found to affect the reporting of general cognitive (Benedict et al., 2004; Carone et al., 2005; Maor et al., 2001; Matotek et al., 2001; Middleton et al., 2006) and memory impairment (Bruce & Arnett, 2004; Randolph, Arnett, & Freske, 2003) in that depressed patients overreport their cognitive dysfunction. Therefore, it is hypothesized that those patients who overestimate the extent of their cognitive difficulties will score higher on measures of depression. Other variables that may affect patient and informant ratings of executive dysfunction include age, sex, level of education, symptom duration, and diagnosis duration (Marrie et al., 2005).

Chiaravalloti and DeLuca (2003) examined self- and informant-rated frontal systems functioning and their correlation to actual test performance in a sample of 26 MS patients and 15 healthy controls using the Frontal Systems Behavior Scale (FrSBe), a questionnaire that assesses apathy, executive dysfunction, and disinhibition (Grace & Malloy, 2001). They found that patient and family ratings on the FrSBe significantly correlated with performance on measures of information processing, working memory, and executive functioning. It is notable, however, that the MS participants in this study scored significantly worse than controls on only 1 of the 13 index scores of the cognitive tests administered. In an investigation of the relationship between FrSBe ratings and cognitive and functional impairment, Basso et al. (2008) found that self ratings on the FrSBe were significantly correlated with performance on executive measures in a sample of 42 MS patients and 13 healthy controls.

The present study examines the accuracy of self and informant ratings of executive dysfunction in MS. Given that executive functioning is critical to awareness, it is hypothesized that the patients who underreport their cognitive impairment will demonstrate more significant executive dysfunction. It is worth considering whether it is reasonable to expect patients or informants to be able to accurately assess their own or another person's level of cognitive functioning. This study also investigates the relationship between self and informant ratings of executive dysfunction relative to objective cognitive measures in neurologically healthy people. The present study expands on previous work (Basso et al., 2008; Chiaravalloti & DeLuca, 2003) by using a significantly larger and more cognitively impaired (Chiaravalloti & DeLuca) sample of MS patients, a well-matched and larger control group, and by examining discrepancies (both under- and overestimating problems) between self ratings and objective cognitive performance and between informant ratings and objective cognitive performance.

METHOD

Participants

The MS participants were recruited from a local MS society, while control participants were referred by MS participants or were recruited through flyers posted in the community. Exclusion criteria included a history of substance abuse, neurological disorder other than MS, uncontrolled hypertension or diabetes, attention deficit/hyperactivity disorder, learning disability, or inability to be evaluated at the testing center due to severe physical, sensory, motor, or neurological impairment. All participants provided informed consent (reviewed and approved by the Institutional Review Board) and were treated in accordance with the ethical standards of the American Psychological Association. Participants were reimbursed $75 for their time and received a written cognitive screening evaluation and verbal feedback. Multiple sclerosis diagnoses were confirmed by a board-certified neurologist who also assessed disease course based on Lublin and Reingold's (1996) criteria. All but 2 patients met McDonald et al. (2001) criteria for MS, with these 2 patients having possible MS—these participants were excluded from the data analysis. No MS participants were experiencing an exacerbation at the time of testing. The MS participants (n = 95) consisted of 17 men (18%) and 78 women (82%). Most participants had a relapsing–remitting course of MS (73, 77%), followed by secondary progressive (17, 18%), primary progressive (4, 4%), and progressive relapsing (1, 1%). The control participants (n = 27) included 5 men (18.5%) and 22 women (81.5%). All MS participants were Caucasian, as were the majority of the controls (26, 96.3%). The informants in the study for both participants with MS and healthy controls were selected by the participants as someone who knew them well. The majority were spouses (65.5%), while others were friends (10.3%), adult children (8.6%), siblings (6.0%), parents (6.0%), or unmarried partners (3.4%). The nature of the relationship to the participant was not indicated by 8 of the informants.

Executive measures

The neuropsychological tests comprising the executive index (described in a later section) were the Visual Elevator, Controlled Oral Word Association Task (COWAT), Animal Naming, Stroop, Shipley Abstraction scale, and a reading span task. The Visual Elevator (VE) is a subtest of the Test of Everyday Attention (Robertson, Ward, Ridgeway, & Nimmo-Smith, 1994) that measures set switching and speeded attention. Participants are presented with a series of pictures of elevators and directional arrows and must state what "floor" they are on as quickly as possible. The raw score for this test is the number of correct "switches" (changes in elevator direction) made per second. The COWAT and Animal Naming are widely used measures of phonemic and category-specific verbal fluency, respectively; both are sensitive to executive-functioning deficits (Lezak, Howieson, & Loring, 2004). The Trenerry version of the Stroop Color–Word test (Trenerry, Crosson, DeBoe, & Leber, 1989) requires consistent inhibition of an overlearned response (Lezak et al., 2004; Malloy, Cohen, & Jenkins, 1998). The Shipley Institute of Living Scale Abstraction subscale provides a measure of conceptual reasoning, a component of executive functioning (Lezak et al., 2004; Zachary, 1986). The reading span task (RS) used in this study is a computer-administered test similar to the task developed by Daneman and Carpenter (1980; Daneman & Merikle, 1996). Participants read aloud from a display of sentences followed by target words (e.g. "The brilliant trial attorney dazzled the jury with his mature knowledge of the case. like") and are asked to remember the target words. As the task progresses, examinees are presented with up to five sentences before they are asked to report the target word, and demands on working memory increase. The total number of target words recalled during the task was the dependent variable for this study.

The Dysexecutive Questionnaire (DEX) is a 20-item self-report measure of executive dysfunction that targets emotional functioning, motivation, behavior, and cognitive functioning (Wilson, Alderman, Burgess, Emslie, & Evans, 1996). Possible scores range from 0 to 60. The DEX is available in self-rated and informant-rated versions. It has been used extensively in research examining awareness of executive functioning deficits in neurological populations, such as traumatic brain injury (Alderman, Dawson, Rutterford, & Reynolds, 2001; Bennett, Ong, & Ponsford, 2005; Odhuba, van den Broek, & Johns, 2005), alcoholism (Heffernan, Ling, & Bartholomew, 2004), and schizophrenia (Evans, Chua, McKenna, & Wilson, 1997). The informant-rated version of the DEX has been shown to correlate highly with neurologic patients' total score on the Behavioral Assessment Of Dysexecutive Syndrome (BADS; Wilson, Evans, Emslie, Alderman, & Burgess, 1998), suggesting that the DEX is sensitive to executive dysfunction. In controls, Chan (2001) reported a trend for participants to rate themselves as experiencing more pathological behavior than their significant others rated them as experiencing.

Disability and depression measures

The Kurtzke Extended Disability Status Scale (EDSS; Kurtzke, 1983), a widely used measure of disease severity in MS, is a rating scale derived from a standard neurological examination. The EDSS provides a rating of disability due to MS, ranging from no disability (0) to death due to MS (10) in half-point increments. For this study, the EDSS was converted into a self-rated questionnaire in consultation with a board-certified neurologist, described in our prior work (Arnett, Higginson, & Randolph, 2001).

The Beck Depression Inventory–II (BDI–II) is a frequently used, 21-item, self-rated depression measure (Beck, Steer, & Brown, 1996). The Chicago Multiscale Depression Inventory (CMDI) is a self-rated depression inventory that was developed for use in medical patient populations (Nyenhuis et al., 1998). The scale's 42 items can be categorized into mood, evaluative, and vegetative subscales or combined to create an overall score. The mood and evaluative scales can be used to estimate depression in medical patients whose depression scores might otherwise be inflated by their somatic symptoms. Participants completed a self-rated version, and informants completed an informant-rated version of the CMDI. The combined mood and evaluative scales were used.

Procedure

Participants and informants were sent the EDSS (patients only), DEX, and CMDI (informants only) by mail approximately one week prior to the testing day and brought the completed questionnaires to the testing session. Prior to any test administration on the day of testing, participants completed a brief psychosocial interview. Following this interview, participants completed the BDI–II, the CMDI, and all cognitive measures. The tests were administered as a part of a larger testing battery in four different, alternating orders to control for fatigue and administration order effects on test performance.

Data analytic strategy

The cognitive test data were initially examined for outliers utilizing a 3-standard-deviation cutoff (Ratcliff, 1993). All outliers were eliminated, resulting in the loss of four scores from the analyses. The DEX and all cognitive test raw scores were converted into z scores utilizing control data means and standard deviations. One-way, between-subjects analysis of variance (ANOVA) tests, multivariate analysis of variance (MANOVA), and t tests were used to evaluate group differences for the DEX ratings, cognitive performance variables, and most demographic and illness variables. Tukey's Honestly Significant Difference (HSD) test was performed post hoc. In cases where Levene's Test of Equality of Error Variances was significant, the Browne–Forsythe statistic, a robust test of equality of means, was used in addition to ANOVA. In cases where initial ANOVAs revealed group differences on a particular variable, this variable was subsequently controlled for in the statistical analyses. Paired-samples t tests were conducted to examine differences between self- and informant-rated DEX scores within each group. Chi square tests for independence were used to examine differences between groups on categorical variables. Pearson correlations were also used to determine the nature of the relationship between self-rated and informant-rated versions of the DEX and to examine the relationship between the DEX ratings and the executive index. Executive index (VE, COWAT, Animal Naming, Stroop, Shipley Abstraction Scale, and RS) scores were formed by obtaining the average z score across the measures (internal consistency = .80).[1]

RESULTS

Demographic, mood, and neuropsychological characteristics of the groups

The MS and control groups were not significantly different in age, years of education, or sex (see Table 1). The groups were also not significantly different on self- and informant-rated CMDI scores, though they were significantly different based on the BDI–II. As expected, one-way ANOVA revealed that the MS group performed significantly worse than controls on the executive index (VE, COWAT, Animal Naming, Stroop, Shipley Abstraction Scale, and RS); $F(1, 120) = 10.45$, $p < .005$, $\eta^2_p = .080$ (see Table 2).

Group differences on the DEX

Cronbach's α revealed adequate interitem reliability for both the self-rated ($\alpha = .86$) and the informant-rated ($\alpha = .90$) DEX.[2] The MS patients (range 0–46) rated themselves significantly higher on the DEX (more executive dysfunction) than did the control participants (range 0–29, see Table 3). However, informant-rated DEX scores for the MS patients (range 0–52) and controls (range 0–43) were not significantly different.

Within the MS group, self-rated DEX scores were significantly higher than informant-rated DEX scores, $t(92) = 2.136$, $p < .05$. However, within the control group, self-rated and informant-rated DEX scores were not significantly different. Self-rated and informant-rated DEX scores were significantly correlated with moderate effects for both the MS ($r = .38$, $p < .001$) and the control groups ($r = .41$, $p < .05$).

TABLE 1
Demographic and mood data

	MS (n = 95)		*Controls (n = 27)*	
	M	*(SD)*	*M*	*(SD)*
Age (years)	47.36	(9.04)	45.63	(12.46)
Education (years)	14.31	(2.02)	15.07	(2.13)
EDSS	4.56	(1.54)	—	
Symptom duration (years)	14.87	(8.71)	—	
Diagnosis duration (years)	10.87	(7.87)	—	
Self-rated CMDI-ME	41.97	(15.59)	36.93	(10.80)
Informant-rated CMDI-ME	47.52	(17.67)	42.31	(14.00)
BDI–II***	11.68	(7.18)	7.11	(6.68)
	n (%)		*n (%)*	
Sex (*n*, % women)	78 (82)		22 (81)	

Note. MS = multiple sclerosis. CMDI-ME = Chicago Multiscale Depression Inventory–Mood and Evaluative Scales. BDI–II = Beck Depression Inventory–II. EDSS = Kurtzke Extended Disability Status Scale. ***$p \leq .005$.

TABLE 2
Neuropsychological data

Neuropsychological test	*MS (n = 95)* *M*	*(SD)*	*Controls (n = 27)* *M*	*(SD)*
VE	4.36	(1.44)	3.65	(0.71)
COWAT	38.77	(12.01)	44.23	(11.70)
Animal Naming	20.12	(5.05)	22.27	(4.19)
Stroop	0.89	(0.21)	1.02	(0.23)
Shipley Abstraction	27.60	(7.35)	28.23	(7.43)
Reading span	34.37	(5.97)	38.65	(5.71)

Note. MS = multiple sclerosis. VE = Visual Elevator time (seconds) per correct switch. COWAT = Controlled Oral Word Association Task total correct. Stroop = Stroop Color–Word correct items per second.

TABLE 3
Group DEX means

DEX	*N*	*M*	*(SD)*	*F*	η^2_p
Self-rated				4.08*	.033
MS	95	0.59	(1.42)		
Controls	27	0.00	(1.00)		
Informant-rated				1.16	.010
MS	93	0.26	(1.12)		
Controls	26	0.00	(1.00)		

Note. DEX = Dysexecutive Questionnaire. MS = multiple sclerosis. Means: z scores. *$p < .05$.

Primary data analysis

In order to assess whether MS patients are accurate in rating their executive dysfunction, correlations were completed for the self-rated DEX scores and executive index scores. These tests were significant and had a medium effect size ($r = -.41$, $p < .001$); the correlation was nonsignificant for the controls ($r = -.21$). In order to examine what factors might contribute to discrepancies between DEX self-ratings and objective performance, discrepancy scores (difference between the self-rated DEX and the executive index) were calculated for all

[1]There were 16 missing cases for the Stroop test and 2 missing cases for the RS. The large number of missing cases for the Stroop was due to the fact that this test was added to the battery after the study initially began. There were no other missing cases for any of the cognitive tests, and no participants were missing more than 2 test index scores. For participants who were missing test data, their index scores reflect the average of the available tests.

[2]No self-rated DEX scores were missing from the data; however, three informant-rated DEX scores (2 in the MS group and 1 in the control group) were missing.

participants. As in Cavallo, Kay, and Ezrachi (1992), cutoffs were established to divide the participants into three groups. Cutoffs were based on quartiles obtained from the control sample to divide each population into accurate raters (25th–75th percentile of discrepancy scores; self ratings on the DEX and objective testing mostly agree), problem overestimators (≤ 25th percentile; self ratings on the DEX indicate more problems than objective testing), and problem underestimators (≥ 75th percentile; self ratings on the DEX indicate fewer problems than objective testing). ANOVA was used to determine whether the discrepancy scores indicate valid differences between the accuracy groups on objective cognitive tests. This method allows for the independent examination of participants who overestimate their problems and those that underestimate them.

In the MS group, there were 26 problem overestimators, 46 accurate raters, and 23 problem underestimators. Levene's Test was significant for age, $F(2, 92) = 4.00$, $p < .05$, symptom duration, $F(2, 92) = 3.43$, $p < .05$, and diagnosis duration, $F(2, 92) = 4.00$, $p < .05$, so the Browne–Forsythe statistic was used in addition to ANOVA for these variables. There were no significant differences for sex, age, symptom duration, or diagnosis duration between the three accuracy groups. However, the three groups were significantly different on years of education, $F(2, 92) = 5.66$, $p < .005$, $\eta^2_p = .11$. Tukey's HSD revealed significant differences between the accurate group ($M = 14.98$, $SD = 2.12$) and the problem overestimator group ($M = 13.50$, $SD = 1.84$, $p < .01$). Analysis of covariance (ANCOVA) with years of education as the covariate comparing the accuracy groups on the executive index was nonsignificant. Though it was predicted that the problem overestimators would demonstrate significantly higher levels of depression than the accurate raters and the problem underestimators, ANOVA did not reveal a significant difference between the three groups. Results for the control group were similar to those found for the MS group and can be seen in Table 4.

In order to assess whether the informants were accurate in rating the MS participants' executive dysfunction, correlations were completed for the informant-rated DEX scores and executive index scores. Informant-rated DEX *z* scores for the MS patients and the executive index scores were significantly correlated, though a small effect size was observed ($r = -.21$, $p < .05$). However, as was true for the controls' self ratings, the correlation between informant-rated DEX *z* scores and the executive index scores was nonsignificant ($r = -.05$). To examine how participants with discrepancies between informant ratings and their actual performance differed from participants whose informants' ratings were accurate, discrepancy scores (difference between the informant-rated DEX and the executive index) were calculated for all participants, and the participants were categorized based on the accuracy of their significant others' ratings, following the same procedure as that described for the self-rated accuracy groups. Using the cutoffs described previously, there were 14 informant problem overestimators, 54 accurate informants, and 25 informant problem underestimators in the MS groups. The three accuracy groups were not significantly different on any demographic or illness variables. However, they were significantly different on executive functioning, $F(2, 90) = 8.53$, $p < .001$, $\eta^2_p = .16$. Tukey's HSD revealed significant differences between the informant problem underestimators ($M = -1.09$, $SD = 0.91$), the informant problem overestimators ($M = -0.14$, $SD = 0.77$, $p \leq .001$), and the informant accurate group ($M = -0.44$, $SD = 0.71$, $p < .005$; see Figure 1). The groups were not significantly different on depression. Similar results were found in the control group (see Table 5 and Figure 1), in that the three groups were significantly different on executive functioning, $F(2, 23) = 4.59$, $p < .05$, $\eta^2_p = .29$.

DISCUSSION

In this community-based sample, MS participants performed significantly worse than control participants on the majority of the cognitive tests. As a group, the MS participants both self-reported and displayed higher levels of executive dysfunction than the control group. Additionally, higher self ratings of executive dysfunction in the MS group correlated with poorer performance on the executive functioning measures, suggesting that using a simple, quick-to-administer screening measure

TABLE 4
Means (*SD*s) by discrepancy group

	Problem overestimator				*Accurate*				*Problem underestimator*			
	MS	*(26)*	*Control*	*(7)*	*MS*	*(46)*	*Control*	*(13)*	*MS*	*(23)*	*Control*	*(7)*
Age	48.15	(6.06)	41.71	(15.09)	46.39	(9.83)	45.69	(12.82)	48.39	(10.29)	49.43	(9.02)
Symp. duration	15.62	(9.55)	—		14.33	(7.20)	—		15.13	(10.64)	—	
Diag. duration	11.46	(8.60)	—		10.39	(6.25)	—		11.17	(9.98)	—	
Education	13.50	(1.84)$_b$	16.43	(2.23)$_a$	14.98	(2.12)$_a$	15.15	(2.04)	13.87	(1.58)	13.57	(1.27)$_b$
Exec. index	–0.38	(0.15)†	0.37	(0.26)†	–0.54	(0.12)†	0.06	(0.18)†	–0.83	(0.16)†	–0.48	(0.26)†
CMDI	0.74	(1.44)	0.51	(1.24)	0.48	(1.54)	–0.02	(0.95)	0.13	(1.22)	–0.47	(0.65)

Note. MS = multiple sclerosis. Means with different subscripts (a,b) are significantly different in the Tukey HSD comparison. Symp. = symptom. Diag. = diagnosis. Exec. = executive. CMDI = Chicago Multiscale Depression Inventory. Age, duration, and education in years.
†Estimated marginal mean values and standard error values reported due to covariate.

TABLE 5
Means (*SDs*) by accuracy group

	Informant problem overestimator				*Informant accurate*				*Informant problem underestimator*			
	MS	*(14)*	*Control*	*(6)*	*MS*	*(54)*	*Control*	*(14)*	*MS*	*(25)*	*Control*	*(6)*
Age	45.57	(8.08)	38.50	(13.47)	46.17	(8.95)	46.64	(11.39)	51.44	(9.01)	50.33	(14.07)
Symp. duration	14.57	(8.75)	—		15.04	(8.57)	—		14.96	(9.51)	—	
Diag. duration	9.07	(5.54)	—		10.61	(7.97)	—		12.44	(8.92)	—	
Education	14.36	(1.91)	15.50	(1.64)	14.24	(2.10)	15.00	(1.88)	14.27	(2.01)	15.17	(3.25)
Exec. index	–0.14	$(0.77)_b$	0.41	$(0.76)_b$	–0.44	$(0.71)_b$	0.07	(0.58)	–1.09	$(0.91)_a$	–0.63	$(0.52)_a$
CMDI	0.44	(1.00)	0.62	(1.24)	0.40	(1.43)	–0.24	(0.59)	0.68	(1.72)	0.07	(1.42)

Note. MS = multiple sclerosis. Means with different subscripts (a,b) are significantly different in the Tukey HSD comparison. Symp. = symptom. Diag. = diagnosis. Exec. = executive. CMDI = Chicago Multiscale Depression Inventory. Age, duration, and education in years.

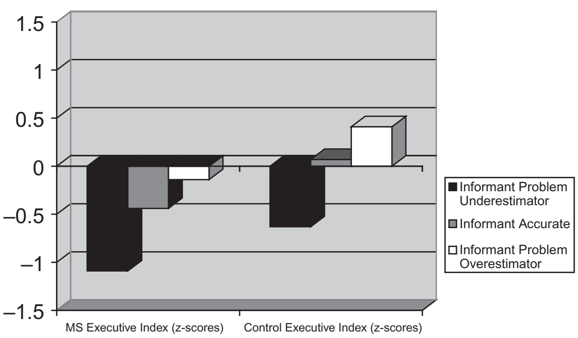

Figure 1. Executive functioning by informant accuracy group.

such as the DEX may assist health professionals in referring patients to neuropsychologists for more comprehensive evaluations. However, for the control participants, DEX self ratings did not significantly correlate with performance on the cognitive tasks, similar to previous research (Chan, 2001). Furthermore, within the control group, participants varied in their ability to accurately rate their executive functioning. This finding suggests that there may be normative variability in metacognitive skill. It may also be that cognitive errors are more personally relevant for MS patients, and this heightened awareness leads to more accurate reporting. However, this finding may also be related to the restricted range of the controls' performance on the cognitive tasks and their responses on the DEX.

It was hypothesized that individuals higher in executive dysfunction would be more likely to underreport on the DEX though this hypothesis was not supported by the results. It may be that for this mildly executively impaired group, awareness was not affected. Alternatively, other factors, such as coping style, personality, or cultural, occupational, familial, and environmental demands may play a larger role in determining awareness of executive-functioning deficits (Ownsworth, Clare, & Morris, 2006). Additionally, it was hypothesized that individuals higher in depression would be more likely to overreport on the DEX. However, when the participants who overestimated their executive dysfunction were examined, they were not significantly more depressed than the accurate or underestimating participants in either group, unlike previous studies that have shown a correlation between depression and self-report of either general cognitive impairment (Benedict et al., 2004; Carone et al., 2005; Maor et al., 2001; Middleton et al., 2006) or memory impairment (Bruce & Arnett, 2004; Randolph et al., 2003). It may be that the specificity of the DEX (i.e., addressing executive dysfunction only) is responsible for this difference. It may also be that the relatively low levels of depression in the MS participants were not sufficient to affect reporting style as found in previous work (Maor et al., 2001; Marrie et al., 2005).

However, in both the MS and control groups, the accuracy groups' level of education differed. In the MS group, the accurate self-rating group had a higher level of education than the problem overestimators, consistent with Randolph et al.'s (2001) findings in metamemory in MS. More broadly, this finding is also consistent with research suggesting that older adults with higher levels of education tend to be more accurate in rating their cognitive functioning (Jonker, Geerlings, & Schmand, 2000; Podewils, McClay, Rebok, & Lyketsos, 2003). However, in the controls, the problem overestimator group had a higher level of education than the accurate and problem underestimating groups. It is possible that individuals with higher levels of education are more likely to rate their executive functioning negatively. The differences between the MS and control accuracy groups could then be explained by considering that ratings indicative of executive impairment are more likely to be accurate in a group of individuals with MS rather than in a group of controls, where such ratings are likely to be problem overestimates.

Although the informant-rated DEX scores of the MS participants were significantly correlated with their actual performance on the executive measures, the effect size was much smaller than that of the self ratings ($r = -.41$ vs. $r = -.21$). In addition, the MS informant-rated DEX scores were not significantly different from the control informant-rated DEX scores. Taken together, these findings indicate that the significant others of the MS participants were not sensitive to the greater executive dysfunction that the MS participants were experiencing relative to the controls. It may be that the types of executive errors that the participants with MS observed and reported on the self-rated DEX are not witnessed by family members. Many executive errors may reflect internal experiences rather than observable behaviors in mildly impaired patients who retain good insight. The participants in this investigation may still have been able to conceal subtle cognitive impairment around family members, but this impairment was detected on cognitive testing. Additionally, when examining the discrepancies between informant ratings and cognitive performance, it was found that the informant problem underestimator group performed significantly worse on the cognitive tests than the accurate and the informant problem overestimator groups. Not only were these participants' significant others inaccurate in rating their level of executive functioning, but these patients were the most impaired participants in the sample. Clearly, if clinicians were to use informant ratings as a gold standard in a community-based population such as our MS participants, they would be greatly underestimating the level of dysfunction experienced.

Regarding the control participants, the only variable found to be significantly different for the three informant accuracy groups was their performance on the executive index. As was true for the MS group, the controls in the informant problem overestimator group performed the best on the cognitive measures while the controls in the informant problem underestimator group performed the worst. This finding indicates that even in neurologically healthy samples, there is variability in the ability of informants to make accurate ratings of executive dysfunction.

As it is noted throughout this investigation, this sample of individuals with MS was only mildly to moderately cognitively impaired. However, this limited impairment is characteristic of community-based samples. It may be that investigation in a more significantly impaired population could address whether the relationship between impairment and awareness is nonlinear. It should also be noted that this examination did not include a measure of planning ability, a component of executive functioning, or some of the more widely used tests of executive functioning, such as the Trail Making Tests and the Wisconsin Card Sorting Test. Therefore, our ability to assess awareness of executive dysfunction is necessarily limited to the elements of executive functioning measured by the tests in our battery. Another limitation is the size of the control sample, in that a larger sample would have afforded more power to the statistical analyses.

CONCLUSIONS

These data indicate that individuals with MS who demonstrate mild to moderate cognitive impairment can provide accurate self ratings of executive dysfunction. Even though their cognitive performance on measures of executive functioning was well below that of the controls, the MS participants' self ratings of executive dysfunction were more highly correlated with objective cognitive testing than that of their significant others. These findings suggest that self-report measures of cognitive dysfunction such as the DEX may be an economical screening measure for subsequent referrals to more comprehensive neuropsychological testing. These data also indicate that it is possible to preserve some level of self-awareness of deficits even with executive functioning impairments that affect daily behavior and performance on objective cognitive tests. Replication of these findings may suggest avenues to pursue in increasing our understanding of the relationship between executive functioning deficits and impaired awareness of these deficits.

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REFERENCES

Alderman, N., Dawson, K., Rutterford, N. A., & Reynolds, P. J. (2001). A comparison of the validity of self-report measures amongst people with acquired brain injury: A preliminary study of the usefulness of EuroQol-5D. *Neuropsychological Rehabilitation, 11*(5), 529–537.

Allen, C. C., & Ruff, R. M. (1990). Self-rating versus neuropsychological performance of moderate versus severe head-injured patients. *Brain Injury, 4*(1), 7–17.

Arnett, P. A., Higginson, C. I., & Randolph, J. J. (2001). Depression in multiple sclerosis: Relationship to planning ability. *Journal of the International Neuropsychological Society, 7*, 665–674.

Basso, M. R., Shields, I. S., Lowery, N., Ghormley, C., Combs, D., Arnett, P. A., et al. (2008). Self-reported executive dysfunction, neuropsychological impairment, and functional outcomes in multiple sclerosis. *Journal of Clinical and Experimental Neuropsychology, 30*(8), 920–930.

Beatty, W. W., & Monson, N. (1991). Metamemory in multiple sclerosis. *Journal of Clinical and Experimental Neuropsychology, 13*(2), 309–327.

Beck, A. T., Steer, R. A., & Brown, G. W. (1996). *Beck Depression Inventory–II manual*. New York: The Psychological Corporation.

Benedict, R. H. B., Cox, D., Thompson, L. L., Foley, F., Weinstock-Guttman, B., & Munschauer, F. (2004). Reliable screening for neuropsychological impairment in multiple sclerosis. *Multiple Sclerosis, 10*(6), 675–678.

Bennett, P. C., Ong, B., & Ponsford, J. (2005). Measuring executive dysfunction in an acute rehabilitation setting: Using the dysexecutive questionnaire (DEX). *Journal of the International Neuropsychological Society, 11*, 376–385.

Bivona, U., Ciurli, P., Barba, C., Onder, G., Azicnuda, E., Silvestro, D., et al. (2008). Executive function and metacognitive self-awareness after severe traumatic brain injury. *Journal of the International Neuropsychological Society, 14*, 862–868.

Bruce, J. M., & Arnett, P. A. (2004). Self-reported everyday memory and depression in patients with multiple sclerosis. *Journal of Clinical and Experimental Neuropsychology, 26*(2), 200–214.

Carone, D. A., Benedict, R. H. B., Munschauer, F. E., Fishman, I., & Weinstock-Guttman, B. (2005). Interpreting patient/informant discrepancies of reported cognitive symptoms in MS. *Journal of the International Neuropsychological Society, 11*, 574–583.

Cavallo, M., Kay, T., & Ezrachi, O. (1992). Problems and changes after traumatic brain injury: Differing perceptions within and between families. *Brain Injury, 6*(4), 327–335.

Chan, R. C. K. (2001). Dysexecutive symptoms among a non-clinical sample: A study with the use of the Dysexecutive Questionnaire. *British Journal of Psychology, 92*, 551–565.

Chiaravalloti, N. D., & DeLuca, J. (2003). Assessing the behavioral consequences of multiple sclerosis: An application of the Frontal Systems Behavior Scale (FrSBe). *Cognitive and Behavioral Neurology, 16*(1), 54–67.

Christodoulou, C., Melville, P., Scherl, W., Morgan, T., MacAllister, W. S., Canfora, D. M., et al. (2005). Perceived cognitive dysfunction and observed neuropsychological performance: Longitudinal relation in persons with multiple sclerosis. *Journal of the International Neuropsychological Society, 11*, 614–619.

Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning and Verbal Behavior, 19*, 450–466.

Daneman, M., & Merikle, P. M. (1996). Working memory and language comprehension: A meta-analysis. *Psychonomic Bulletin & Review, 3*(4), 422–433.

Evans, J. J., Chua, S. E., McKenna, P. J., & Wilson, B. A. (1997). Assessment of the dysexecutive syndrome in schizophrenia. *Psychological Medicine, 27*, 635–646.

Fleming, J. M., Strong, J., & Ashton, R. (1996). Self-awareness of deficits in adults with traumatic brain injury: How best to measure? *Brain Injury, 10*(1), 1–15.

Gold, S. M., Heesen, C., Schulz, H., Guder, U., Monch, A., Gbadamosi, J., et al. (2001). Disease specific quality of life instruments in multiple sclerosis: Validation of the Hamburg Quality of Life Questionnaire in Multiple Sclerosis (HAQUAMS). *Multiple Sclerosis, 7*, 119–130.

Grace, J., & Malloy, P. F. (2001). *Frontal Systems Behavior Scale (FrSBe): Professional manual*. Lutz, FL: Psychological Assessment Resources.

Heffernan, T., Ling, J., & Bartholomew, J. (2004). Self-rated prospective memory and central executive deficits in excessive alcohol users. *Irish Journal of Psychological Medicine, 21*(4), 122–124.

Hoogervorst, E. L. J., van Winsen, L. M. L., Eikelenboom, M. J., Kalkers, N. F., Uitdehaag, B. M. J., & Polman, C. H. (2001). Comparisons of patient self-report, neurologic examination, and functional impairment in MS. *Neurology, 56*(7), 934–937.

Jonker, C., Geerlings, M. I., & Schmand, B. (2000). Are memory complaints predictive for dementia? A review of clinical and population-based studies. *International Journal of Geriatric Psychiatry, 15*, 983–991.

Kujala, P., Portin, R., & Ruutiainen, J. (1996). Memory deficits and early cognitive deterioration in MS. *Acta Neurologica Scandinavica, 93*, 329–335.

Kurtzke, J. F. (1983). Rating neurologic impairment in multiple sclerosis: An expanded disability status scale (EDSS). *Neurology, 33*, 1444–1452.

Lezak, M. D., Howieson, D. B., & Loring, D. W. (2004). *Neuropsychological assessment* (4th ed.). New York: Oxford University Press.

Lublin, F. D., & Reingold, S. C. (1996). Defining the clinical course of multiple sclerosis: Results of an international survey. *Neurology, 46*, 907–911.

Malloy, P. F., Cohen, R. M., & Jenkins, M. A. (1998). Frontal lobe function and dysfunction. In P. J. Snyder & P. D. Nussbaum (Eds.), *Clinical neuropsychology: A pocket handbook for assessment* (pp. 573–590). Washington, DC: American Psychological Association.

Maor, Y., Olmer, L., & Mozes, B. (2001). The relation between objective and subjective impairment in cognitive function among multiple sclerosis patients—the role of depression. *Multiple Sclerosis, 7*, 131–135.

Marrie, R. A., Chelune, G. J., Miller, D. M., & Cohen, J. A. (2005). Subjective cognitive complaints relate to mild impairments of cognition in multiple sclerosis. *Multiple Sclerosis, 11*, 69–75.

Matotek, K., Saling, M. M., Gates, P., & Sedal, L. (2001). Subjective complaints, verbal fluency, and working memory in mild multiple sclerosis. *Applied Neuropsychology, 8*(4), 204–210.

McDonald, W. I., Compston, A., Edan, G., Goodkin, D., Hartung, H.-P., Lublin, F. D., et al. (2001). Recommended diagnostic criteria for multiple sclerosis: Guidelines from the international panel on the diagnosis of multiple sclerosis. *Annals of Neurology, 50*, 121–127.

Middleton, L. S., Denney, D. R., Lynch, S. G., & Parmenter, B. (2006). The relationship between perceived and objective cognitive functioning in multiple sclerosis. *Archives of Clinical Neuropsychology, 21*, 487–494.

Nyenhuis, D. L., Luchetta, T., Yamamoto, C., Terrien, A., Bernardin, L., Rao, S. M., et al. (1998). The development, standardization, and initial validation of the Chicago Multiscale Depression Inventory. *Journal of Personality Assessment, 70*, 386–401.

Odhuba, R. A., van den Broek, M. D., & Johns, L. C. (2005). Ecological validity of measures of executive functioning. *British Journal of Clinical Psychology, 44*, 269–278.

Ownsworth, T., Clare, L., & Morris, R. (2006). An integrated biopsychosocial approach to understanding awareness deficits in Alzheimer's disease and brain injury. *Neuropsychological Rehabilitation, 16*(4), 415–438.

Podewils, L. J., McClay, R. N., Rebok, G. W., & Lyketsos, C. G. (2003). Relationship of self-perceptions of memory and worry to objective measures of memory and cognition in the general population. *Psychosomatics, 44*, 461–470.

Randolph, J. J., Arnett, P. A., & Freske, P. (2003). Metamemory in multiple sclerosis: Exploring affective and executive contributors. *Archives of Clinical Neuropsychology, 619*, 1–21.

Randolph, J. J., Arnett, P. A., & Higginson, C. I. (2001). Metamemory and tested cognitive functioning in multiple sclerosis. *The Clinical Neuropsychologist, 15*(3), 357–368.

Ratcliff, R. (1993). Methods for dealing with reaction time outliers. *Psychological Bulletin, 114*(3), 510–532.

Robertson, I. H., Ward, T., Ridgeway, V., & Nimmo-Smith, I. (1994). *The Test of Everyday Attention*. Bury St. Edmunds, UK: Thames Valley Testing Co.

Taylor, R. (1990). Relationships between cognitive test performance and everyday cognitive difficulties in multiple sclerosis. *British Journal of Clinical Psychology, 29*, 251–253.

Trenerry, M. R., Crosson, B., DeBoe, J., & Leber, W. R. (1989). *The Stroop Neuropsychological Screening Test*. Odessa, FL: Psychological Assessment Resources.

Wilson, B. A., Alderman, N., Burgess, P., Emslie, H., & Evans, J. (1996). *Behavioural assessment of the dysexecutive syndrome*. Bury St. Edmunds, UK: Thames Valley Test Company.

Wilson, B. A., Evans, J. J., Emslie, H., Alderman, N., & Burgess, P. (1998). The development of an ecologically valid test for assessing patients with a dysexecutive syndrome. *Neuropsychological Rehabilitation, 8*(3), 213–228.

Zachary, R. A. (1986). *Shipley Institute of Living Scale: Revised manual*. Los Angeles: Western Psychological Services.