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Perceived Cognitive Difficulties and Cognitive Test Performance as Predictors of Employment Outcomes in People with Multiple Sclerosis

Cynthia A. Honan,[1] Rhonda F. Brown,[2] AND Jennifer Batchelor[3]

[1]School of Psychology, University of New South Wales, Sydney, Australia
[2]College of Medicine, Biology and Environment, Australian National University, Canberra, Australia
[3]Department of Psychology, Macquarie University, Sydney, Australia

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Abstract

Perceived cognitive difficulties and cognitive impairment are important determinants of employment in people with multiple sclerosis (pwMS). However, it is not clear how they are related to adverse work outcomes and whether the relationship is influenced by depressive symptoms. Thus, this study examined perceived and actual general cognitive and prospective memory function, and cognitive appraisal accuracy, in relation to adverse work outcomes. The possible mediating and/or moderating role of depression was also examined. A cross-sectional community-based sample of 111 participants (33 males, 78 females) completed the Multiple Sclerosis Work Difficulties Questionnaire (MSWDQ), Beck Depression Inventory – Fast Screen (BDI-FS), and questions related to their current or past employment. They then underwent cognitive testing using the Screening Examination for Cognitive Impairment, Auditory Consonant Trigrams test, Zoo Map Test, and Cambridge Prospective Memory Test. Perceived general cognitive and prospective memory difficulties in the workplace and performance on the respective cognitive tests were found to predict unemployment and reduced work hours since MS diagnosis due to MS. Depression was also related to reduced work hours, but it did not explain the relationship between perceived cognitive difficulties and the work outcomes. Nor was it related to cognitive test performance. The results highlight a need to address the perceptions of cognitive difficulties together with cognitive impairment and levels of depression in vocational rehabilitation programs in pwMS. (*JINS*, 2015, *21*, 156–168)

Keywords: Multiple sclerosis, Cognition, Subjective cognition, Self-awareness, Depression, Employment outcomes

INTRODUCTION

Prior research indicates that perceptions of cognitive dysfunction and reduced performance on cognitive tests are related to poorer workplace outcomes in people with multiple sclerosis (pwMS) including unemployment, reduced work hours, negative work events, and/or changed expectations about future employment (Beatty, Blanco, Wilbanks, Paul, & Hames, 1995; Benedict, Rodgers, Emmert, Kininger, & Weinstock-Guttman, 2014; Benedict et al., 2005; Edgley, Sullivan, & Dehoux, 1991; Honan et al., 2012; Honan, Brown, & Hine, 2014; Rao, Leo, Ellington, et al., 1991). Cognitive dysfunction is a common (Khan, McPhail, Brand, Turner-Stokes, & Kilpatrick, 2006; Rao, Leo, Bernardin, & Unverzagt, 1991) and often disabling consequence of MS that can occur at any phase in the illness, even in the early stages (Jønsson et al., 2006; Schulz, Kopp, Kunkel, & Faiss, 2006). While employment, is an important contributor of quality of life (QOL) in pwMS (Aronson, 1997; Benedict et al., 2005; Miller & Dishon, 2006). However, as detailed below, few studies have evaluated the relative contribution of perceived and actual cognitive changes to employment in pwMS or how these changes may be augmented by depressed feelings, which are also common in MS patients (Arnett, Barwick, & Beeney, 2008).

There are also mixed findings in the literature evaluating the relationship between *cognitive test performance* and *perceived cognitive difficulties.* While most prior studies have found little or no relationship between these factors (Beatty & Monson, 1991; Benedict, Munschauer, et al., 2003; Lovera et al., 2006; Maor, Olmer, & Mozes, 2001; Taylor, 1990), when the measures of self-reported cognition correspond

Correspondence and reprint requests to: Cynthia Honan, School of Psychology, University of New South Wales, NSW, 2052. E-mail: c.honan@unsw.edu.au

closely to the specific cognitive domains being tested, significant relationships have been detected (Chiaravalloti & De Luca, 2003; Goverover, Genova, Hali, Chiaravolloti, & DeLuca, 2014; Matotek, Saling, Gates, & Sedal, 2001; Randolph, Arnett, & Freske, 2004; Randolph, Arnett, & Higginson, 2001). In this study, perceived general cognitive problems and prospective memory problems were evaluated separately as measures of perceived cognitive difficulties.

Many previous studies of employment in pwMS have examined only employment status as a work outcome. However, the use of this dichotomous variable has been criticised for lacking the ability to detect more subtle changes in the workplace (Benedict et al., 2014; Benedict & Walton, 2012; Honan et al., 2012). Thus, in this study, reduced work hours and a change in the type of work performed since diagnosis due to MS were examined.

Several studies indicate that perceived cognitive functioning may be more strongly associated with mood or *depression* levels than cognitive test performance (Benedict et al., 2004; Christodoulou et al., 2005; Gold, Schulz, Monch, Schulz, & Heesen, 2003; Lovera et al., 2006; Maor et al., 2001; Middleton, Denney, Lynch, & Parmenter, 2006). Depression is also a strong independent predictor of QOL in pwMS (Janardhan & Bakshi, 2002; Janssens et al., 2003; Lobentanz et al., 2004) and lifetime prevalence estimates of major depression are as high as 50% in this population (Chwastiak et al., 2002; Sadovnik, 1996; Schubert & Foliart, 1993).

In addition, depression has been found to be related to reduced cognitive performance in pwMS. For example, it has been consistently found to be related to tasks involving central executive function or tasks with high attentional capacity demands (e.g., Reading Span test, PASAT, SDMT, Visual Elevator Task, Tower of London) (Arnett, Higginson, & Randolph, 2001; Arnett, Higginson, Voss, Bender, et al., 1999; Arnett, Higginson, Voss, Wright, et al., 1999; Niino et al., 2014), although no relationships have typically been reported between depression and performance on learning and memory tasks (Arnett, Higginson, Voss, Bender, et al., 1999; Arnett, Higginson, Voss, Wright, et al., 1999; Karadayi, Arisoy, Altunrende, Boztas, & Sercan, 2014; Niino et al. 2014; Sundgren, Maurex, Wahlin, Piehl, & Brismar, 2013). Only one study has found that severely depressed pwMS performed worse on a task of verbal learning (Selective Reminding Task) than mildly depressed pwMS (Demaree, Gaudino, & De Luca, 2003).

However, prior research has typically *not* found a relationship between depression and work status in pwMS (Beatty et al., 1995; Benedict et al., 2005), although there are indications that depression may be related to more subtle work problems such as formal reprimands or reduced working hours (Benedict et al., 2014). In addition, the relationship between perceived cognitive difficulties and cognitive impairment may vary as a function of depression severity. Bruce and Arnett (2004) recently found that the relationship between perceived everyday memory and performance on verbal memory and attention/concentration tasks differed depending on depression severity; such that the non-depressed pwMS tended to overestimate, moderately depressed pwMS accurately estimated, and mildly depressed pwMS tended to underestimate their memory ability. However, depression remains untested as a potential mediator between perceived cognitive difficulties, actual cognitive test performance, and work outcomes in pwMS.

To summarize, perceived cognitive difficulties in pwMS does not tend to accord with their cognitive test performance. Nonetheless, perceived cognitive difficulties and cognitive test performance are both related to depression and employment outcomes in pwMS. However, the extent to which perceived cognitive difficulties and cognitive test performance are independently related to work outcomes and the influence of depression remains unclear. Thus, the aim of the current study was to examine the relationships between perceived cognitive difficulties, cognitive test performance, depression severity, and workplace outcomes in pwMS. Perceptions of cognitive difficulties in the workplace, as opposed to perceptions of general cognitive difficulties, were measured in this study. This is because the subjective experience of cognitive difficulties in the workplace setting may differ from that experienced in other settings (e.g., social settings), and may affect work outcomes differently as a result (Honan et al., 2012).

Finally, a measure of *cognitive awareness accuracy* was computed and used as an additional predictor in the analyses in this study. That is, standardized general cognitive and prospective memory test scores were compared to the standardized scores for the participant's perceived abilities in these domains, and the difference score was used as an indicator of the accuracy with which they perceived their functioning in this domain, similar to the approach used by Bruce and Arnett (2004) who evaluated participants who over- or under-estimated their cognitive abilities. An awareness of one's difficulties is an important indicator of rehabilitation readiness and an important catalyst of rehabilitative change (Ownsworth et al., 2013). Awareness of functional impairments has also been demonstrated in individuals with traumatic brain injury (TBI) to be an important determinant of employment outcomes (Sherer et al., 1998).

The following hypotheses were tested: (1) stronger cognitive test performance will be negatively associated with poorer work outcomes; (2) higher perceived cognitive difficulties will be associated with poorer work outcomes (over and above cognitive test performance); (3) cognitive awareness accuracy (difference score between perceived and actual cognition) will be associated with poorer work outcomes; and (4) depression will mediate and/or moderate the relationships between perceived cognitive difficulties, cognitive test performance, cognitive awareness accuracy, and the work outcomes.

METHODS

Participants

Ethics approval for the study was obtained from the ethics committees of the University of New England and MS Australia (ACT, NSW, Vic). The research was carried out in

Table 1. Participant Demographic Characteristics Stratified by Work Status with Comparisons Statistics

Demographic characteristic	In paid employment	Not in paid employment	*F* statistic	Cohen's *d*
Female (*n*)	43	35		
Male (*n*)	19	14		
Age (*M*)	44.34 (10.35)	50.94 (10.53)	10.96**	0.63
Years education (*M*)	13.82 (2.17)	14.37 (2.32)	1.63	0.24
Duration of MS (*M*)	8.50 (7.21)	12.57 (7.52)	8.41**	0.55
MS Type				
RRMS	46	28		
SPMS	10	13		
PPMS	3	5		
Other	3	3		

Note. Standard deviation values are shown in brackets. MS type where possible was confirmed by treating neurologists using McDonald's 2010 criteria (Polman et al., 2005; 2011). Where this was not possible, self-reported MS-type was used.
*$p < .05$.
**$p < .01$.
M = Mean; PPMS = primary-progressive MS; RRMS = relapsing-remitting MS; SPMS = secondary-progressive MS.

accordance with the Helsinki Declaration. One-hundred twenty community-derived pwMS who were currently or previously employed participated in the study. Nine cases were deleted due to excessive missing data on the work-difficulties questionnaire (>50%), leaving a final total of 111 (33 males, 78 females) participants. More than half (56%) were in full- or part-time paid employment ($n = 28$ full-time, 34 part-time). For the remainder, the average time since last paid employment was 4.92 years ($SD = 4.33$).

Participants were recruited *via* invitation letters (sent through the Australian ACT/NSW/Vic MS Society) and advertisements placed in the society's InTouch magazine. Study exclusion criteria included age of less than 18 years, unable to read and speak English or a diagnosis of a psychotic, or bipolar or related disorder, or MS relapse in the past 2 weeks. Additional demographic information stratified by employment status is provided in Table 1.

Procedure

The study questionnaire that asked participants about their MS disease characteristics, employment, and work difficulties was mailed to the participants. Completed questionnaires were collected when cognitive testing and interview to clarify MS diagnosis was undertaken (within 2-weeks of questionnaire being sent to participants).

Cognitive Test Measures

Cognitive tests were selected for the following reasons: (1) they measure cognitive domains commonly affected in pwMS; (2) they possess reasonable psychometric properties and have been validated in MS populations; (3) they measure similar cognitive domains as the cognitive difficulty items on the MSWDQ; and (4) when combined, they form a relatively brief battery of tests. Lengthy administration may be particularly problematic in pwMS due to fatigue (Macallister & Krupp, 2005).

Cambridge Prospective Memory Test

The Cambridge Prospective Memory Test (CAMPROMPT; Wilson et al., 2005) is an ecologically valid 25-min measure of prospective memory that includes three event- and three time-based tasks. Examples include remembering at the end of the test, where objects were hidden at the beginning of the test (i.e., event-based cue), or reminding the examiner not to forget their keys 7 min before test completion (i.e., time-based cue). Various paper and pencil-based distracter tasks are completed during the test. The CAMPROMPT has excellent interrater reliability ($r = .99$), adequate test–retest reliability over 7–10 days (Kendall's Tau-b = .64), and it is moderately correlated with other measures of everyday memory, attention, and executive functioning (Wilson et al., 2005), and can distinguish the performance of those with MS from healthy controls (Foley, Wilson, & Shiel, 2004).

Screening Examination for Cognitive Impairment

The Screening Examination for Cognitive Impairment (SEFCI; Beatty, Paul, et al., 1995) is a 25- to 30-min test battery used to assess cognitive functioning in pwMS that includes: learning and delayed recall of a 10-word list (three learning trials followed by a 10- to 12-min delay); oral version of the Symbol Digit Modalities Test (SDMT; Lezak, Howieson, & Loring, 2004; Smith, 1982); and Vocabulary and Abstraction Scales of the Shipley Institute of Living Scale (SILS; Harnish, Beatty, Nixon, & Parsons, 1994; Zachary, 1994). The Vocabulary Scale was excluded in this study as verbal reasoning is often unaffected in MS. The SEFCI has high sensitivity (86%) and specificity (90%) in distinguishing pwMS with and without cognitive impairment (Beatty, Paul, et al., 1995). It is a routine method of screening for cognitive impairment in pwMS (Brown et al., 2006), and it is comparable to the Neuropsychological Screening Battery for Multiple Sclerosis (NPSBMS) in terms of its ability to

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detect cognitive impairment (Aupperle, Beatty, Shelton, & Gontkovsky, 2002; Solari, Mancuso, Motta, Mendozzi, & Serrati, 2002).

Auditory Consonant Trigrams test

The Auditory Consonant Trigrams test (ACT; Stuss, Stethem, & Pelchat, 1988; Stuss, Stethem, & Poirier, 1987) is a task of working memory that requires a person to maintain information in mind while they attend to alternative stimuli that compete for attentional resources (Fleming, Goldberg, Gold, & Weinberger, 1995). Three letters are recalled following a delay, during which the person is required to count backward by threes (i.e., 100-97-94) for varied periods of time (i.e., 9, 18, and 36 s). Performance on this task is correlated highly (r = .83) with the Paced Auditory Serial Addition Test (PASAT; Ozakbas, Ormeci, Akdede, Alptekin, & Idiman, 2004), which is a longer and more difficult working memory task argued not to be ideal for pwMS (Brooks et al., 2011).

Zoo Map Test

The Zoo Map test (Wilson, Alderman, Burgess, Emslie, & Evans, 1996), from the Behavioural Assessment of the Dysexecutive Syndrome (BADS), is a spatial planning task that requires a demonstration of how a person would visit a series of designated locations, while adhering to several rules. A high-demand planning version of the task is completed followed by a low-demand version that provides step-by-step instructions. Performance on the test is moderately correlated with similar tests of planning ability (e.g., Porteus mazes), it can discriminate between neurological patients (e.g., traumatic brain injury & MS) and controls, and it is predictive of clinicians' ratings of everyday role-functioning in neurological patients (Norris & Tate, 2000).

Self-Report Measures

Work outcomes

Participants provided information on their current *employment status* (paid work *vs*. not in paid work) and whether their *work hours had reduced* since diagnosis due to their MS, and if so, the proportion of this reduction. Response options included: "there has been a small reduction (i.e., around 25%)," "there has been a moderate reduction (i.e., around 50%)," "there has been a large reduction (i.e., around 75%)," and "I no longer work at all (i.e., a 100% reduction)." Participants were asked whether the type of work they performed had changed since diagnosis due to their MS (yes, no, unsure).

Multiple Sclerosis Work Difficulties Questionnaire

The Multiple Sclerosis Work Difficulties Questionnaire (MSWDQ; Honan et al., 2012), a 50-item self-report scale of work difficulties with 12 subscales, assesses how frequently a pwMS has experienced workplace difficulties over the past 4 weeks in their current or most recent job. Respondents are asked to rate the difficulties using 5-point scales, ranging from *never* to *almost always*. In this study, only scores on the "general cognitive difficulties" (six items; e.g., "I had trouble concentrating on a task") and "prospective memory difficulties" (five items; e.g., "I forgot about a deadline I had to meet") subscales were used. The subscales are reported to have high internal consistency, with Cronbach's alphas of .89 to .92, respectively (Honan et al., 2012).

Beck Depression Inventory-Fast Screen

The Beck Depression Inventory-Fast Screen (BDI-FS; Beck, Steer, & Brown, 2000) is derived by summing seven items in the BDI-II (Beck, Steer, & Brown, 1996) including: sadness, loss of pleasure (anhedonia), suicidal ideation, pessimism, past failure, self-dislike, and self-criticalness. Vegetative items, which may overlap with the symptoms of MS, are not included. The scale has been validated for use in pwMS (Benedict, Fishman, McClellan, Bakshi, & Weinstock-Guttman, 2003). Scores of 0–3 indicate nil/minimal depression, 4–6 indicates mild depression, 7–9 indicates moderate depression, and 10–21 indicates severe depression. In this study, moderate and severe categories were combined due to low numbers in these groups.

Data Analysis

A composite *general cognitive* standardized score was calculated by summing z-scores (transformed from the raw scores and based on the mean results of the current sample) on the SDMT, Word List Learning (sum of three learning trials), Word List Delay, ACT, SILS Abstraction Scale, and Zoo Map Test. The internal consistency of the composite measure was high with a Cronbach's α of .82. In addition, two difference scores of *cognitive awareness accuracy* were calculated to examine the degree to which: (1) composite cognitive test scores matched the scores on the "perceived cognitive difficulties" subscale of the MSWDQ; and (2) prospective memory (CAMPROMPT) scores matched the scores on the "prospective memory difficulties" subscale. These difference scores were calculated by subtracting standardized z-scores (transformed from the raw scores) of cognitive test performance (multiplied by −1 to correct for directional effects) from the perceived cognitive difficulty standardized scores. *Positive* values indicated there was an *under*estimation of cognitive abilities (i.e., perceived cognitive difficulties were higher than actual cognitive difficulties), whereas *negative* values indicated an *over*estimation of cognitive ability (i.e., perceived cognitive difficulties were lower than actual cognitive difficulties).

Data was analyzed using IBM SPSS, version 22.0 for Windows. T-tests were used to evaluate differences between pwMS in paid employment and those who were not employed. Stepwise multiple regression and logistic

Table 2. Neuropsychological Test Scores, Self-Report Subscale Scores, and Self-Awareness Scores Stratified by Work Status with *t*-Test Comparisons

Measure	In paid employment (n = 62)	Not in paid employment (n = 49)	*t*-test statistic	Cohen's *d*
SDMT	56.02 (10.55)	47.06 (10.84)	4.39**	0.84
Word List Learning	24.02 (3.14)	22.76 (3.35)	2.04*	0.39
Word List Delayed Recall	7.52 (1.76)	6.63 (2.09)	2.42*	0.46
ACT	48.74 (7.98)	44.67 (8.09)	2.65**	0.51
SILS Abstraction Scale	29.39 (6.14)	27.12 (8.41)	1.64	0.31
Zoo Map	12.76 (3.27)	11.43 (3.49)	2.06*	0.39
CAMPROMPT	29.26 (5.60)	25.59 (7.68)	2.91**	0.55
MSWDQ General Cognitive Difficulties	34.67 (25.69)	46.43 (23.83)	2.47*	0.47
MSWDQ Prospective Memory Difficulties[a]	15.04 (18.29)	26.25 (19.39)	3.12**	0.59
General Cognitive Self-Awareness Score	.08 (1.17)	−.10 (1.30)	0.77	0.15
Prospective Memory Self-Awareness Score	−.04 (1.30)	0.6 (1.43)	0.38	0.47

Note. Standard deviation values are shown in brackets.
[a]Due to violation of normality assumption, the MSWDQ Prospective Memory Difficulties variable was re-run following transformation with no difference in results. Only the original comparison statistic for this variable is reported.
*$p < .05$.
**$p < .01$.
ACT = Auditory Consonant Trigrams test; CAMPROMPT = Cambridge Prospective Memory Test; MSWDQ = Multiple Sclerosis Work Difficulties Questionnaire; SDMT = Symbol Digit Modalities Test; SILS = Shipley Institute of Living Scale.

regression analyses were used to examine the relationship between cognitive test performance, perceived cognitive difficulties, and the work outcomes, controlling for age and gender. *Total years of education* was not significantly related to the composite general cognitive score [F (6,104) = 1.75; p = .120] or the CAMPROMPT [F (1,109) = 0.31; p = .860], and was, therefore, excluded from all analyses.

Except where indicated all assumptions for *t*-tests and regressions analyses were met. Missing self-report data were replaced by values imputed using the expectation maximization algorithm in SPSS's Missing Value Analysis module. Less than 5% of the data was missing in each variable, thus, the results of the analyses are unlikely to be affected by this estimation procedure (Tabachnick & Fidell, 2013).

Moderation effects were examined using standard regression analyses and SPSS syntax developed by O'Connor (1998). As recommended by Cohen, Cohen, West, and Aiken (2003), independent variables were centered about the mean to improve interpretability of the output and multicollinearity diagnostics, but the dichotomous depression group moderator variable was not centered.

Mediation effects were assessed using the guidelines of Shrout and Bolger (2002). For a mediational effect to be present: (1) a significant relationship must be present between the predictor and mediator variables; (2) a significant direct relationship must be present between the mediator and dependent variables, while controlling for the predictor variable; and (3) the indirect path from the predictor variable to the dependent variable *via* the mediator must be significant. In general, when a significant relationship remains between the predictor variable and dependent variable, after controlling for the mediator, "partial" mediation has occurred, whereas a non-significant relationship indicates a "full" mediation effect. Indirect effects were assessed using the Sobel test (Sobel, 1982).

RESULTS

Comparison Analyses and Correlations

Cognitive test scores, perceived cognitive difficulties, and cognitive awareness accuracy for pwMS in/not in paid employment were compared using independent samples *t*-tests (see Table 2). PwMS in paid employment scored higher on all the cognitive tests relative to those who were unemployed, with the exception of the SILS Abstraction scale. There was no difference in cognitive awareness scores of the two MS patient groups. Spearman correlations between cognitive test performance and cognitive difficulties are reported in Table 3. Small-to-moderate negative correlations were found between scores on the SDMT, Word List Learning, Word List Delay and ACT, and the two cognitive self-report subscales, although there were negligible associations between the CAMPROMPT and the cognitive difficulties subscales.

Logistic Regression Analyses Predicting Unemployment Status

Two stepwise logistic regressions were conducted to examine whether cognitive test performance and perceived cognitive difficulties could predict unemployment status, after controlling for age and gender at Step 1. The six general

Table 3. Spearman Correlations Between Neuropsychological Tests and Self-Reported Cognition

	Self-Report MSWDQ Cognition Subscales	
Neuropsychological tests	General cognitive difficulties	Prospective memory difficulties
SDMT	−.30	−.24
Word List Learning	−.22	−.18
Word List Delay	−.19	−.20
ACT	−.24	−.20
SILS Abstraction Scale	−.13	−.06
Zoo Map Test	−.04	−.04
CAMPROMPT	−.03	−.05

ACT = Auditory Consonant Trigrams test; CAMPROMPT = Cambridge Prospective Memory Test; MSWDQ = Multiple Sclerosis Work Difficulties Questionnaire; SDMT = Symbol Digit Modalities Test; SILS = Shipley Institute of Living Scale.

cognitive tests (i.e., SDMT, word list learning & delayed recall, ACT, SILS Abstraction Scale, Zoo Map Test) were entered at Step 2 in the first analysis, and the CAMPROMPT was entered at Step 2 in the second analysis, see Table 4. The six general cognitive tests accounted for 14.0% of the variance in unemployment, but only the SDMT predicted unique variance in unemployment status. In the second logistic regression, the CAMPROMPT accounted for only 4.2% of the variance in employment status.

In each analysis, the two respective perceived cognitive difficulty subscale scores were entered at Step 3. χ^2 difference tests indicated that perceived general cognitive difficulties did not account for additional variance in employment status over and above general cognitive test performance [$\chi^2(1) = 2.78$; $p = .095$]. However, perceived prospective memory difficulties accounted for an additional 12.5% of the variance over and above actual prospective memory performance [$\chi^2(1) = 12.45$; $p < .001$; OR = 1.41].

Stepwise Multiple Regression Analyses Predicting Other Employment Outcomes

Two stepwise multiple regression analyses were conducted to examine the ability of cognitive test performance and respective perceived cognitive difficulties to predict the proportion of work hours reduced since diagnosis. In each analysis, age and gender were entered at Step 1. In the first analysis, the six general cognitive tests were entered at Step 2, and in the second, the CAMPROMPT was entered at Step 2, see Table 5. The six general cognitive tests accounted for 21.6% of the variance in the proportion of work hours reduced, and the SDMT and Word List Delayed recall predicted unique variance in the proportion of work hours reduced. All test scores (with the exception of the Zoo Map test) were negatively correlated with this outcome variable. The CAMPROMPT predicted 7.3% of the variance in the proportion of work hours reduced. At step 3, perceived general cognitive difficulties and prospective memory difficulties accounted for an additional 6.3% [$F\Delta(1,101) = 9.33$; $p = .003$] and 16.2% [$F\Delta(1,106) = 23.42$; $p < .001$] of variance in the proportion of work hours reduced, respectively.

Table 4. Summary of Stepwise Logistic Regression Analyses Investigating the Relationship Between Objective Test Performance Predicting Work Status

Predictors	*B*	*SE*	Wald	Odds ratio
Step 1 (Nagelkerke $R^2 = .12$, $\chi^2 = 10.57$**)				
Age	.06	.02	9.43	1.06**
Gender	.06	.44	.02	1.00
Step 2a (ΔNagelkerke $R^2 = .14$, $\Delta\chi^2 = 13.56$*)				
Age	.04	.02	3.90	1.04*
Gender	−.00	.50	.00	1.00
SDMT	−.07	.03	7.09	.93**
Word List Learning	−.03	.10	.07	.98
Word List Delayed Recall	.03	.17	.02	1.03
ACT	−.03	.03	1.02	.97
SILS Abstraction	.03	.04	.50	1.03
Zoo Map	−.01	.07	.04	.99
Step 2b (ΔNagelkerke $R^2 = .04$, $\Delta\chi^2 = 3.97$*)				
Age	.05	.02	5.97	1.05*
Gender	.05	.45	.01	1.00
CAMPROMPT	−.06	.03	3.81	.94*

Note. Step 2a and 2b are the results from two separate stepwise logistic regression analyses. For this analysis, “in paid employment” was coded as 1 and “not in paid employment” was coded as 2, thus odds ratio values above 1 are representative of the likelihood of being unemployed.
*$p < .05$.
**$p < .01$.
ACT = Auditory Consonant Trigrams test; CAMPROMPT = Cambridge Prospective Memory Test; SDMT = Symbol Digit Modalities Test; SILS = Shipley Institute of Living Scale.

Table 5. Summary of Stepwise Multiple Regression Analyses Investigating the Relationships Between Objective Test Performance and Work Outcomes

	Proportion work hours reduced						Change in work performed					
		95% CI for B						95% CI for B				
	B	LB	UB	β	*r*	*sr*²	B	LB	UB	β	*r*	*sr*²
Step 1 (***R*²**)			**.03**						**.04**			
Age	.03	–.00	.06	.18	.18	.03	.02	–.00	.03	.18	.18	.03
Gender	–.07	–.74	.60	–.02	–.01	.00	.09	–.30	.48	.04	.05	.00
Step 2a† (***R*² Δ**)			**.22****						**.06**			
Age	.00	–.03	.03	.02	.18	.00	.01	–.01	.03	.13	.18	.01
Gender	.18	–.47	.83	.05	–.01	.00	.09	–.33	.51	.04	.05	.00
SDMT	–.04	–.07	–.01	–.25*	–.40**	.04	–.00	–.02	.02	–.02	–.13	.00
Word List Learning	.02	–.10	.15	.05	–.29**	.00	.07	–.01	.15	.23	.02	.02
Word List Delayed	–.27	–.49	–.04	–.32*	–.41**	.04	–.07	–.22	.07	–.15	–.11	.01
ACT	–.04	–.08	.01	–.19	–.31**	.02	–.03	–.06	.00	–.23	–.20*	.03
SILS Abstraction	.02	–.03	.07	.09	–.20**	.00	.01	–.03	.04	.05	–.06	.00
Zoo Map	.06	–.03	.16	.13	–.11	.01	–.01	–.07	.05	–.03	–.13	.00
Step 2b† (***R*² Δ**)			**.07****						**.00**			
Age	.01	–.02	.04	.09	.18	.01	–.05	–1.51	1.42	.18	.18	.03
Gender	–.08	–.73	.57	–.02	–.01	.00	.09	–.30	.48	.04	.05	.00
CAMPROMPT	–.07	–.11	–.02	–.29**	–.31**	.07	–.00	–.03	.02	–.03	–.08	.00

Note: Step 2a and 2b are the results from two separate stepwise regression analyses. Beta values (B) and standardised beta regression coefficients (β) are reported. †*a* and *b* refer to variables included at Step 2 in alternative analyses.
$^*p < .05$.
$^{**}p < .01$.
ACT = Auditory Consonant Trigrams test; CAMPROMPT = Cambridge Prospective Memory Test; LB = lower bound; SDMT = Symbol Digit Modalities Test; SILS = Shipley Institute of Living Scale; *sr* = semi-partial correlation; UB = upper bound.

However, none of the six cognitive test scores [$F\Delta(1,102) = .36$; $p = .231$] or the CAMPROMPT [$F\Delta(1,107) = .81$; $p = .266$] predicted variance in the change in the type of work performed, and neither perceived cognitive difficulties [$F\Delta(1,101) = .10$; $p = .148$] or perceived prospective memory difficulties [$F\Delta(1,106) = .10$; $p = .149$] predicted additional variance in this outcome measure.

Finally, stepwise multiple regression analyses were performed to examine the extent to which cognitive awareness accuracy predicted the work outcomes. After controlling for age and gender (entered at Step 1), neither cognitive awareness accuracy [$F\Delta(1,107) = .32$; $p = .571$] or prospective memory awareness accuracy [$F\Delta(1,107) = 1.95$; $p = .166$] were related to the work hours reduced variable, and neither cognitive awareness accuracy [$F\Delta(1,107) = .95$; $p = .332$] or prospective memory awareness accuracy [$F\Delta(1,107) = .65$; $p = .422$] were related to the change in work performed.

Comparison by Depression Severity Group

A χ^2 analysis indicated that depression severity did not differ according to work status (i.e., employed, unemployed) [$\chi^2(2) = 1.16$; $p = .560$]. One-way analyses of variance (ANOVAs) were then conducted to evaluate differences across depression severity groups in reduced work hours, perceived cognitive difficulties, cognitive test performance, and cognitive awareness accuracy, see Table 6. Mild- and moderate/severe-depression severity groups had reduced their hours to a greater extent than the minimal-depression group (Bonferroni adjusted critical value of .017 was used). The mild- and moderate/severe-depression groups also reported more perceived cognitive difficulties, whereas the moderate/severe-depression group reported more perceived prospective memory difficulties, relative to the minimal-depression group. The moderate/severe-depression group also had better cognitive awareness accuracy than the minimal-depression group. That is, depressed pwMS generally *under*estimated their cognitive abilities, whereas the minimal-depression group somewhat overestimated them. Findings approached significance for prospective memory awareness accuracy ($p = .037$), but there were no group differences in cognitive test performance.

Depression Moderation Analyses

A series of three-way moderation regression analyses were conducted to ascertain whether the relationships between perceived cognitive difficulties, cognitive test performance, cognitive awareness accuracy, and the proportion of work hours reduced (the dependent variable), each varied as a function of depression level. In each analysis, the predictors included the independent variable, group dummy variables, and independent variable by group dummy variable interaction terms. In all cases, the interaction term was not significant, indicating that depression severity did not moderate between high perceived cognitive difficulties, cognitive

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Table 6. Summary of Analysis of Variance with Descriptive Statistics for Depression Severity Groups

	Overall *F*		Depression Severity		
Dependent variable	Statistic	η^2	Nil/Minimal (*n* = 59)	Mild (*n* = 33)	Mod/Sev (*n* = 19)
Work Outcomes					
Hours reduced since diagnosis	6.74**	0.11	1.34 (1.54)[a,b]	2.14 (1.62)[a]	2.40 (1.63)[b]
MSWDQ Subscales					
General Cognitive Difficulties	12.52**	0.27	27.94 (24.69)[a,b]	47.47 (19.29)[a]	59.00 (17.66)[b]
Prospective Memory Difficulties	4.61*	0.09	14.69 (16.80)[b]	23.78 (19.54)	28.01 (22.24)[b]
Neuropsychological Tests					
SDMT	0.71	0.02	52.97 (11.23)	51.32 (13.43)	50.80 (10.15)
Word List Learning	0.34	0.00	23.19 (3.50)	23.68 (3.03)	23.84 (3.10)
Word List Delayed Recall	1.08	0.00	7.05 (2.02)	7.18 (2.14)	7.24 (1.62)
ACT	0.70	0.05	48.50 (7.34)	44.92 (8.74)	45.60 (9.15)
SILS Abstraction	1.44	0.01	28.97 (6.55)	27.32 (7.54)	28.24 (7.28)
Zoo Map Test	0.84	0.02	12.12 (3.22)	11.39 (3.65)	13.16 (3.50)
CAMPROMPT	0.47	0.01	27.62 (6.31)	26.54 (8.10)	28.92 (6.82)
Self-awareness Scores					
General Cognitive	5.70**	0.12	–0.42 (1.16)[b]	0.16 (1.28)	0.79 (1.23)[b]
Prospective Memory	3.04*	0.06	–0.33 (1.25)[#]	0.11 (1.45)	0.63 (1.35)[#]

Note. Post-hoc comparisons were performed using Tukey's Honestly Significant Difference and a Bonferroni-adjusted probability value of .017. Standard deviation values are shown in brackets. In Self-Awareness scores, positive values represented an *under*estimation of cognitive abilities (i.e., perceived cognitive difficulties were lower than actual cognitive difficulties) and negative values represent an *over*estimation of cognitive ability (i.e., perceived cognitive difficulties were higher than actual cognitive difficulties).
[a]Mild Depression group is significantly different from the Nil/Minimal Depression group.
[b]Moderate/Severe Depression group is significantly different from the Nil/Minimal Depression group.
[#]The *p*-value for the comparison between Nil/Minimal and Moderate/Severe Depression groups for Prospective Memory Self-Awareness was .037. η^2 = eta-squared (variance accounted for in DV by IV).
*$p < .05$.
**$p < .01$.
ACT = Auditory Consonant Trigrams test; CAMPROMPT = Cambridge Prospective Memory Test; MSWDQ = Multiple Sclerosis Work Difficulties Questionnaire; SDMT = Symbol Digit Modalities Test; SILS = Shipley Institute of Living Scale.

test performance, or cognitive awareness accuracy, and the proportion of work hours reduced, and it did not moderate the relationship between perceived cognitive difficulties and cognitive test performance.

Depression Mediation Analyses

Finally, a series of mediational analyses were conducted to ascertain whether depression scores mediated the relationship between high perceived cognitive difficulties, cognitive test performance, cognitive awareness accuracy, and the proportion of work hours reduced. Using criteria devised by Shrout and Bolger (2002), depression scores were shown not to mediate any of the above relationships. Depression scores also did not mediate the relationship between perceived cognitive difficulties and actual test performance, see Table 7.

DISCUSSION

This study examined relationships between self-reported cognitive difficulties in the workplace, cognitive test performance, cognitive awareness accuracy, depression severity, and adverse employment outcomes. Consistent with the results of previous studies (Beatty, Blanco et al., 1995; Benedict et al., 2005), the results of this study demonstrated that *actual* cognitive test performance is associated with withdrawal from work. Specifically, general cognitive decrements (measured by tests assessing cognitive domains known to be most affected in pwMS including processing speed, abstract reasoning, working memory, delayed memory, learning, and visual planning) predicted 14% and 22% of the variance in unemployment and reduced work hours since diagnosis due to MS, respectively. Slower cognitive processing speed was a strong predictor of unemployment and reduced work hours, whereas poor delayed-recall memory was the strongest predictor of reduced work hours. However, prospective memory performance predicted little of the variance in the work outcomes (4% and 7%, respectively), although the association was still significant.

In addition, the results indicate that a person's *perceived* cognitive difficulties in the workplace predict the adverse work outcomes, regardless of actual cognitive abilities. That is, perceived cognitive and prospective memory difficulties were related to reduced work hours since diagnosis, after controlling for test performance on the cognitive and prospective memory tasks. Furthermore, perceptions of prospective memory difficulties at work (but not general cognitive difficulties) were related to being unemployed, independent of actual prospective memory performance. Prior studies have indicated that the perception of cognitive abilities is related to work outcomes (Edgley et al., 1991) and

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Table 7. Summary of Mediation Analyses with Beck Depression Inventory-Short Form as Mediator

Independent variable	Work hours reduced since diagnosis	General cognition composite or CAMPROMPT [a]
General Cognition Difficulties (MSWDQ)		
(1) IV and BDI-SF (β)	.483**	.483**
(2) BDI-SF and DV (β)[b]	.016	.041
(3) SOBEL test	.147	.322
Prospective Memory Difficulties (MSWDQ)		
(1) IV and BDI-SF (β)	.333**	.333**
(2) BDI-SF and DV (β)[b]	.087	−.008
(3) SOBEL test	.334	.074
General Cognition Composite		
(1) IV and BDI-SF (β)	−.107	
(2) BDI-SF and DV (β)[b]	.175	
(3) SOBEL test	.940	
CAMPROMPT		
(1) IV and BDI-SF (β)	−.028	
(2) BDI-SF and DV (β)[b]	.202*	
(3) SOBEL test	.281	
General Cognitive Self-Awareness		
(1) IV and BDI-SF (β)	.345**	
(2) BDI-SF and DV (β)[b]	.216*	
(3) SOBEL test	1.842	
Prospective Memory Self-Awareness		
(1) IV and BDI-SF (β)	.248*	
(2) BDI-SF and DV (β)[b]	.189	
(3) SOBEL test	1.560	

[a]The General Cognitive Composite score was used as a DV in the General Cognition Difficulties (MSWDQ) mediation analysis and the CAMPROMPT was used as a DV in the Prospective Memory Difficulties (MSWDQ) mediation analysis.
[b]β controlling for the IV. Sobel test indicates significance of the indirect relationship via the mediator.
*$p < .05$.
**$p < .01$.
β = standardized beta values; BDI-SF = Beck Depression Inventory Short Form (the mediator variable); DV = dependent variable; IV = independent variable.

that objectively measured cognition can contribute to work outcomes more than one's perception of their cognitive difficulties (Benedict et al., 2014). However, this study is the first to demonstrate that perceived cognitive difficulties are related to work outcomes independent of actual cognitive ability.

However, cognitive appraisal accuracy (measured in this study using difference scores between perceived and actual cognition) was not shown to predict the employment outcomes, suggesting that pwMS may make decisions about work irrespective of their insight into their cognitive abilities; for example, they may respond to cognitive effort or cognitive fatigue instead. Few studies have previously examined cognitive appraisal accuracy as a predictor of work outcomes, although one study has previously shown that cognitive awareness accuracy was related to employment in individuals with TBI (Sherer et al., 1998). Nonetheless, it is possible that other methods of calculating cognitive appraisal accuracy such as discrepancy scores between self- and informant-reports (e.g., Goverover et al., 2014) may yield differing results.

Finally, the influence of *depression* (excluding somatic symptoms) was examined on the relationship between cognitive test performance, perceptions of general cognitive and prospective memory difficulties, cognitive appraisal accuracy, and the work outcomes in pwMS. Contrary to the results of other studies (Arnett et al., 2001; Niino et al., 2014; Sundgren et al., 2013), depression was not shown to be related to actual cognitive test performance. However, consistent with prior results (Benedict et al., 2004; Christodoulou et al., 2005; Gold et al., 2003; Lovera et al., 2006; Maor et al., 2001; Middleton et al., 2006), depression severity was shown to be linearly related to perceptions of general cognitive and prospective memory difficulties. That is, pwMS who experienced greater cognitive/memory difficulties in the workplace also reported more severe depression.

However, while depression severity was related to cognitive appraisal accuracy in the general cognitive domain, it did not predict prospective memory appraisals. Nonetheless, consistent with the findings of Bruce and Arnett (2004), non-depressed pwMS tended to underestimate their general cognitive difficulties (i.e., overestimate their cognitive ability), although we failed to show that pwMS with mild depression underestimated their cognitive ability or that pwMS with moderate depression provided more accurate ratings. Rather, pwMS with moderate-to-severe depression tended to overestimate their cognitive difficulties.

The study results revealed that depression severity was related to reductions in work hours but not employment status in pwMS. These results are consistent with both other studies that demonstrate no relationship between depression and employment (Beatty et al., 1995; Benedict et al., 2005), and a more recent study demonstrating a relationship between depression and more subtle negative changes at work (Benedict et al., 2014). Depression did not, however, moderate the relationships between perceived cognitive difficulties, cognitive test performance, and cognitive appraisal accuracy to the work outcomes. That is, the cognitive variables were related to the work outcomes, but the relationships did not generally vary as a function of depression. Depression also did not mediate the relationship between perceived and actual cognition. Taken together, the results suggest that targeting depression in psychological therapy may help to improve work outcomes in pwMS, in particular, in regards to unemployment and reduced work hours due to MS. However, a person's perceived and actual cognition and their insight into their difficulties also need to be targeted.

Study Limitations

Several study limitations should be kept in mind when interpreting the results. First, retrospective reports of perceived cognitive difficulties were provided by some respondents who were not currently employed. Thus, some bias may have occurred in the recall of past work difficulties, especially in the participants with actual memory deficits (for review, see Amato, Zipoli, & Portaccio, 2006). Second, most of the participants in this community-based sample reported none/minimal depression (53%) or only mild depression (30%), with only a small proportion reporting moderate-to-severe depression (17%). While this distribution is somewhat consistent with other MS samples (Chwastiak et al., 2002), only a small number of participants had severe depression, possibly resulting in the failure to detect significant results due to the skewed score distribution. Third, a relatively brief neuropsychological testing protocol was adopted for this study. Whether the use of a more comprehensive neuropsychological test battery would have produced similar findings regarding its relative prediction of work outcomes remains unknown. However, given most prior studies have found little or no relationship between cognitive test performance and self-reports of cognitive function (Beatty & Monson, 1991; Benedict, Munschauer, et al., 2003; Lovera et al., 2006; Maor et al., 2001; Taylor, 1990), we anticipate similar findings. Finally, the cross-sectional nature of this study precludes any causal inferences being drawn, thus, it cannot be asserted that perceived or actual cognitive difficulties or depression have contributed to the adverse work outcomes in pwMS.

CONCLUSION

Perceived cognitive difficulties in the workplace and actual cognitive impairment, but not cognitive awareness accuracy, were shown to be related to adverse work outcomes in pwMS (i.e., unemployment, reduced work hours due to MS). While depression severity was not related to unemployment it was related to more subtle work changes, reducing the proportion of hours worked. Depression did not moderate or mediate the relationship between perceived or actual cognitive difficulties to adverse workplace outcomes. Nonetheless, depression did influence perceptions of cognitive difficulties in the workplace and cognitive awareness accuracy. Taken together, the results highlight the need to address actual cognitive difficulties, perceptions of cognitive difficulties, and levels of depression, in vocational rehabilitation programs. More specifically, cognitive perceptions and depressive symptoms might be explored in the clinical psychology and neuropsychology setting with a view to better preparing MS patients for possible changes in their work in the future.

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