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Short report

Distractibility in multiple sclerosis: The role of depression

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Abstract

The present study assesses the influence of depression and anxiety on the effects of cognitive distracters in people with multiple sclerosis (MS). Participants completed computerized versions of the Symbol Digit Modalities Test (c-SDMT) with ($n = 51$) and without ($n = 51$) auditory distracters. Based on the Hospital Anxiety and Depression Scale (HADS), 29 (28.4%) and 51 (50%) participants were classified as depressed or anxious, respectively. A regression analysis revealed that depression ($p = 0.034$), not anxiety ($p = 0.264$), further impaired performance on the c-SDMT, particularly in the presence of distracters. These results suggest that distracter effects are influenced by depression more than anxiety. Given that distracters are ubiquitous in real-world environments, their use in a cognitive assessment adds to the ecological validity of the results.

Keywords: Multiple sclerosis, depression, cognition, distraction

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Introduction

The general neuropsychological literature devoted to auditory distraction is large, but includes only a handful of multiple sclerosis (MS) studies. This dearth is surprising given that deficits in attention are frequently reported in people with neurological conditions in general and MS in particular.[1] A recent study has, however, highlighted the susceptibility of people with MS to distraction and demonstrated an association with deficits in attention and working memory.[2] While distractibility may reflect a primary cognitive abnormality, it may also be influenced by other factors such as depression and anxiety. Given that both of these emotional states are common in MS and known to add to the cognitive burden,[3,4] we undertook a study exploring their putative connection to distractibility. Our hypothesis was that processing speed, the hallmark cognitive deficit in MS, would be further impaired in the presence of depression and anxiety.

Methods

Study sample

A sample of 102 MS participants meeting the modified McDonald criteria[5] were enrolled. Exclusion criteria included a history of traumatic brain injury, another disease of the central nervous system, psychosis, learning disability, substance abuse and/or previous neuropsychological testing performed within the past year.

Data collection

Demographics and neurological data. Demographic data included age, gender and years of education. Neurological variables included physical disability (Expanded Disability Status Scale (EDSS)), disease course and duration of illness.

Cognitive data. A computerized Symbol Digit Modalities Test (c-SDMT) with and without built-in distracters was administered. All consecutive odd-numbered participants completed the test with distracters and consecutive even-numbered without. The c-SDMT has been previously validated for use in MS.[6] In our modified version, auditory distracters were embedded in the test. Distracters, which included a telephone ringing and a car horn sounding, were intermittently presented at a standard decibel level (100 dB) through an external speaker attached to the computer. A mean time for the c-SDMT was obtained. Impairment was defined as a mean time of 1.5 SD above normative mean data.

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Premorbid intelligence quotient (IQ) was assessed based on vocabulary knowledge on the Wechsler Test of Adult Reading, a valid and reliable measure of premorbid IQ.[7]

Depression and anxiety. Depression and anxiety were assessed using the Hospital Anxiety and Depression Scale (HADS), previously validated for use in people with MS.[8] Based on previous research, a cut-off score of greater than or equal to 8 on the two subscales is indicative of clinically significant depression and anxiety.[8]

Statistical analysis. Comparisons between MS participants with and without depression or anxiety were made using *t*-tests for normally distributed data and Mann-Whitney *U* test for non-normally distributed data. A linear regression analysis was conducted to determine if depression and/or anxiety predicted performance on the c-SDMT. Statistical significance was set at $p < 0.05$.

Informed consent

This study received research ethics board approvals and informed consent was obtained from all participants.

Results

Demographics

Based on HADS cut-off scores, 29 (28.4%) MS participants were classified as having depression and 51 (50%) having anxiety. There were no differences in demographic or disease characteristics between MS participants with and without depression or anxiety (Table 1). Given that different participants completed the distracter and non-distracter c-SDMT, demographic and disease-related comparisons were undertaken between the two groups. No differences were

Table 1. Demographics and neurological data of MS patients by depression and anxiety.

	Depressed Mean (SD)/ frequency (%); $n = 29$	Not depressed Mean (SD)/ frequency (%); $n = 73$	*t*-test/x^2	*p* value
Age (years)	46.17 (8.46)	43.99 (10.56)	$t = -0.994$	$p = 0.322$
Gender (% female)	22 (75.9%)	48 (65.8%)	$x^2 = 0.985$	$p = 0.321$
Years of education	14.34 (1.78)	15.00 (2.35)	$t = 1.356$	$p = 0.178$
Premorbid IQ	104.48 (8.73)	105.93 (8.19)	$t = 0.791$	$p = 0.431$
EDSS	3.03 (2.13)	2.55 (1.98)	$t = -1.709$	$p = 0.283$
Illness duration (years)	12.69 (9.48)	10.36 (7.63)	$t = -1.292$	$p = 0.199$
Disease course				
RRMS	18 (62.1%)	53 (72.6%)	$x^2 = 1.089$	$p = 0.297$
SPMS	8 (27.6%)	14 (19.2%)	$x^2 = 0.589$	$p = 0.443$
PPMS	3 (10.3%)	5 (6.8%)	$x^2 = 0.351$	$p = 0.685$
	Anxious Mean (SD)/ frequency (%); $n = 51$	Not anxious Mean (SD)/ frequency (%); $n = 51$	*t*-test/x^2	*p* value
Age (years)	43.67 (9.91)	45.55 (10.13)	$t = 0.949$	$p = 0.345$
Gender (% female)	35 (68.6%)	35 (68.6%)	$x^2 = 0.000$	$p = 0.999$
Years of education	14.94 (2.28)	14.69 (2.16)	$t = -0.580$	$p = 0.563$
Premorbid IQ	105.88 (8.04)	105.16 (8.66)	$t = -0.438$	$p = 0.662$
EDSS	2.39 (1.99)	2.99 (2.04)	$t = 1.499$	$p = 0.137$
Illness duration (years)	11.53 (7.92)	10.52 (8.57)	$t = -0.615$	$p = 0.540$
Disease course				
RRMS	36 (70.6%)	35 (68.6%)	$x^2 = 0.046$	$p = 0.830$
SPMS	10 (19.6%)	13 (25.5%)	$x^2 = 0.505$	$p = 0.477$
PPMS	5 (9.8%)	3 (5.9%)	$x^2 = 0.543$	$p = 0.715$

EDSS: Expanded Disability Status Scale; RRMS: relapsing–remitting multiple sclerosis; SPMS: secondary progressive multiple sclerosis; PPMS: primary progressive multiple sclerosis; IQ: intelligence quotient.

Table 2. Comparison of cognitive data in MS patients by depression and anxiety.

	Depressed Mean (SD)/ frequency (%); $n=29$	Not depressed Mean (SD)/ frequency (%); $n=73$	Mann-Whitney/x^2	p value
c-SDMT mean time (seconds)				
Distracters	22.69 (14.04)	16.24 (7.84)	$z=-2.676$	$p=0.007$
Non-distracters	16.91 (4.03)	15.54 (6.15)	$z=-2.161$	$p=0.031$
% impaired on c-SDMT				
Distracters	11/15 (73.3%)	13/37 (35.1%)	$x^2=6.266$	$p=0.012$
Non-distracters	7/14 (50%)	11/36 (30.6%)	$x^2=1.654$	$p=0.198$
	Anxious Mean (SD)/ frequency (%); $n=51$	Not anxious Mean (SD)/ frequency (%); $n=51$	Mann-Whitney/x^2	p value
c-SDMT mean time (seconds)				
Distracters	18.20 (10.58)	17.94 (10.12)	$z=-0.451$	$p=0.652$
Non-distracters	15.45 (4.58)	16.21 (6.23)	$z=-0.390$	$p=0.697$
% impaired on c-SDMT				
Distracters	17/32 (53.1%)	7/20 (35%)	$x^2=1.627$	$p=0.202$
Non-distracters	5/19 (26.3%)	13/31 (41.9%)	$x^2=1.247$	$p=0.264$

c-SDMT: computerized Symbol Digit Modalities Test.

found with respect to age ($t=0.402$, $p=0.689$), gender ($x^2=2.001$, $p=0.157$), education ($t=0.682$, $p=0.497$), disease duration ($t=0.591$, $p=0.556$), disease course ($x^2=1.562$, $p=0.458$) and EDSS ($t=0.287$, $p=0.804$). The distracter group was, however, more anxious ($t=2.197$, $p=0.03$).

Cognitive data

MS participants with depression were significantly slower than those without on the distracter ($z=-2.676$, $p=0.007$) and non-distracter ($z=-2.161$, $p=0.031$) versions of the c-SDMT. Significantly more MS participants classified as depressed on the HADS were impaired on the distracter c-SDMT than those who were not ($x^2=6.266$, $p=0.012$). This difference was not present on the non-distracter task ($x^2=1.654$, $p=0.198$). No significant differences were present on the distracter or non-distracter c-SDMT between MS participants with and without anxiety. No significant differences were present on the distracter or non-distracter c-SDMT between MS participants with and without anxiety (Table 2).

To control for the presence of anxiety symptoms in participants deemed depressed on the HADS and depressive symptoms in those deemed anxious on the HADS, both variables were entered into a linear regression as putative predictors of performance on the two versions of the c-SDMT. Depression emerged as a significant predictor of performance on the c-SDMT, more so on the distracter (regression coefficient: 1.01, $p=0.034$) than non-distracter (regression coefficient: 0.475, $p=0.053$) version. The same was not found for anxiety on either the distracter (regression coefficient: -0.525, $p=0.264$) or non-distracter (regression coefficient: -0.378, $p=0.077$) version. There was no additive effect of depression and anxiety in the regression analysis for either the distracter (regression coefficient: 0.244, $p=0.236$) or non-distracter (regression coefficient: -0.052, $p=0.692$) c-SDMT.

Discussion

Our study supports previous research showing that depression adds to the cognitive burden in people with MS. What is novel in our data and partly in keeping with our hypothesis is the finding that the deleterious cognitive effects of depression become more marked in the presence of distracters. Similar effects were not found for anxiety.

People with MS have been shown to be more susceptible to distraction. For example, auditory distracters have been shown to slow cognitive performance on a working memory task in those with relapsing–remitting disease and mild disability.[9] Furthermore, in a recent MS study of inattentional blindness, participants who failed the Stroop test were found to be not only more distractible, but also less efficient in tasks involving working

memory and executive function.[2] Neither of these studies, however, investigated the potential confounding role of depression and anxiety on performance under distracter conditions. Our study therefore adds to the literature in this regard.

Of interest is a recent MS study showing that another test of attention and processing speed, namely the Paced Auditory Serial Addition Test (PASAT), was more susceptible to state anxiety than depression.[4] It remains unclear, however, to what degree this result was influenced by the anxiety-invoking properties of the test itself. What is more certain is the relationship between cognitive impairment and depression in MS. A threshold effect has been demonstrated indicating that cognitive compromise generally occurs only in the context of a more severe disturbance in mood.[3] Greater deficits are thought to arise as a result of depression impeding the executive aspects of working memory.[10] No previous MS study has investigated these cognitive-emotional state associations in the presence of auditory distracters.

In the absence of MS-related data, findings from the general neuropsychological literature can prove informative. Using the Stroop paradigm, greater deficits in selective attention and distracter inhibition have been reported in people who are clinically depressed versus healthy controls (see Epp et al. (2012) for review).[11] Furthermore, severity of depression is associated with larger between-group effects when comparing depressed participants to healthy controls. The emotional Stroop task, which is a modified version of the classic Stroop, measures the speed at which participants name the colour of emotionally significant words. Here the interference is due to the additional processing of words that may have personal emotional significance, which can result in slower response times during colour naming.[11] This suggests that depression not only adds to the cognitive burden by increasing susceptibility to distraction, it also biases attention towards negative stimuli causing further slowing of cognition. These data overlap with those from a study utilizing an auditory distracter task: In the presence of sadness induced by music and autobiographical recall, distraction effects increased twofold.[12] Our study adds to these data, albeit in the context of a neurological illness.

Our study has certain limitations. We did not compare the same participants on both the distracter and non-distracter c-SDMT. However, there were no differences in terms of demographics or disease-related data between the two groups and while the distracter group was more anxious, this did not influence their performance on the distracter c-SDMT. A second limitation was our decision to confine the cognitive assessment to processing speed, working memory and attention. As such we do not know how other aspects of cognition would fare in the presence of auditory distracters.

One of the drawbacks of conventional neuropsychological testing is that it takes place in an artificial environment, namely the enforced quiet of the psychometrician's office. Introducing distracters can change this by simulating real-world situations, thereby potentially conferring ecological validity to test results. By showing an association between depression and the cognitive effects of distracters, our data highlight the added importance of diagnosing depression. Successfully treating depression in people with MS may come with added cognitive benefits. No study has explored this enticing possibility as yet, but our findings suggest it is a question worth pursuing.

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Conflicts of interest

Viral Patel has nothing to declare.

Aaron Zambrana has nothing to declare.

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of multiple sclerosis (Cambridge University Press, 2007); chairs the Medical Advisory Committee for the Multiple Sclerosis Society of Canada; conducts neuropsychiatric evaluation, cognitive testing, and brain imaging in neuropsychiatry in his clinical practice; and receives research support from the Multiple Sclerosis Society of Canada.

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