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Research Article

Coping is a moderator of relationships between cognitive fatigue and cognitive variability in multiple sclerosis

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Abstract

Objective: Mean levels of cognitive functioning typically do not show an association with self-reported cognitive fatigue in persons with multiple sclerosis (PwMS), but some studies indicate that *cognitive variability* has an association with cognitive fatigue. Additionally, coping has been shown to be a powerful moderator of some outcomes in multiple sclerosis (MS). To date, however, coping has not been considered as a possible moderator of the relationship between cognitive fatigue and cognitive *variability* in MS. The current study examined this relationship. **Method:** We examined 52 PwMS. All participants were administered the Fatigue Impact Scale, the Coping Orientation to Problems Experienced Questionnaire, and cognitive tests. Indices of variability for memory and attention/executive functioning tests were used as outcome variables. Avoidant coping, active coping, and composite coping indices were used as moderators. **Results:** The interaction analyses for the avoidant coping and composite coping indices were significant and accounted for 8 and 11% of the attention/executive functioning variability outcome, respectively. The interactions revealed that at low levels of cognitive fatigue, attention/executive functioning variability was comparable between the low and high avoidant and composite coping groups. However, at high levels of cognitive fatigue, PwMS using lower levels of avoidant coping (less maladaptive coping) showed less variable attention/executive functioning scores compared with those using higher levels of avoidant coping. We found a similar pattern for the composite coping groups. **Conclusion:** At high levels of cognitive fatigue, PwMS using adaptive coping showed less attention/executive functioning variability. These findings should be considered in the context of treatment implications.

Keywords: Fatigue; fatiguability; attention; executive functioning; memory variability; attention/executive functioning variability

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Introduction

Kluger et al. (2013) have defined a concept often referred to as "fatiguability" that is manifested as variability or decline in cognitive performance over time, either within a task or across a battery of tasks. Fatiguability, measured in this way, typically reflects the domain of cognitive fatigue in multiple sclerosis (MS). Cognitive fatigue reflects a "mental exhaustion" that may make it more challenging to think clearly or quickly process information. However, in MS, there has been equivocal evidence of a relationship between cognitive fatigue and *objective* cognitive performance (Bruce et al., 2010). Relatedly, Wang and colleagues (2014) have suggested that intraindividual variability (IIV) in cognitive performance over time can represent an index of fatiguability. Cognitive variability is commonly seen across a number of neurological and psychiatric conditions including Alzheimer's disease (Burton et al., 2006), sports-related concussion (Merritt et al., 2019; Rabinowitz & Arnett, 2013), MS (Wojtowicz et al., 2012), HIV (Vance et al., 2021), and schizophrenia (Cole et al., 2011), among others. Cognitive variability reflects the extent to which an individual's performance varies either across a test battery or within a particular test (such as reaction time variability in a choice reaction time test – see Bruce et al., 2010). IIV has commonly been operationalized using both a maximum discrepancy score (MDS – subtracting the lowest score from the highest score for each participant) and an index of the intraindividual standard deviation (ISD). The latter involves taking the standard deviation of all the standardized scores across the test battery (Merritt et al., 2019; Rabinowitz & Arnett, 2013).

Fatigue is common in persons with multiple sclerosis (PwMS) and often reported as their most debilitating symptom (Marchesi et al., 2020). It is also associated with reduced quality of life, impacting work and other daily activities (Gullo et al., 2020). Although fatigue may exist across multiple domains (i.e., cognitive, physical, psychosocial), cognitive fatigue is most central to the present study given its potential relationship with cognitive performance. This said, although PwMS often report that fatigue negatively impacts their cognitive functioning, few studies have shown that cognitive fatigue is associated with mean cognitive performance in PwMS

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(cf, Thomas et al., 2023). In contrast, some studies have shown that cognitive fatigue in PwMS is associated with fatiguability and IIV (Aldughmi et al., 2017; Bruce et al., 2010; Holtzer et al., 2013; Riegler et al., 2021; Wojtowicz et al., 2012). This suggests that variability across or within tasks (i.e., fatiguability) may capture the impact of cognitive fatigue better than examining associations between self-reported cognitive fatigue and mean cognitive performance.

In addition to examining cognitive variability in relation to cognitive fatigue in PwMS being a fruitful avenue to better understand the impact of cognitive fatigue on performance-based cognitive functioning, exploring possible moderators of this relationship could be beneficial. For example, coping has consistently been found to be a powerful moderator of important outcomes in MS, especially depression. Coping is a mental or behavioral response following a stressor and is typically studied within the context of coping styles. Avoidant coping involves doing things to avoid dealing with stress and has generally been shown to be maladaptive and associated with negative outcomes (e.g., depression). In contrast, active coping involves doing things to actively address the source of stress, has most typically been shown to be adaptive, and is associated with providing a buffer against such negative outcomes (Carver et al., 1989).

Arnett et al. (2002) found that coping moderated the relationship between cognitive impairment and depression in MS. Specifically, they found that cognitively impaired PwMS were depressed only when they also employed maladaptive (i.e., avoidant) coping strategies. Similarly, when cognitively impaired PwMS relied more on adaptive (i.e., active) coping strategies, they were unlikely to be depressed. These relationships were also replicated longitudinally (Rabinowitz & Arnett, 2009). Bradson et al. (2022) examined pain and depression in MS, also considering coping as a moderator. They found that high levels of pain in PwMS were only associated with depressive symptoms when they tended to rely on avoidant rather than active coping in response to stress.

In a study using a longitudinal design, Ukueberuwa and Arnett (2014) conceptualized fatigue as a type of stressor. They examined coping (Time 1) as a possible moderator of the relationship between overall fatigue (as measured by the Fatigue Impact Scale – FIS at Time 1) and an overall executive functioning composite (Time 2). This study showed a significant interaction between the FIS and the avoidant coping index. The nature of this interaction was such that at low levels of fatigue, the low and high avoidant coping groups had comparable executive functioning. However, at high levels of fatigue, the high avoidant coping group showed substantially worse executive functioning compared with the low avoidant coping (i.e., using more adaptive coping) group.

Given that fatigue might be conceptualized as a stressor that PwMS have to cope with, it may be that coping moderates the relationship between cognitive fatigue and cognitive variability in MS. Examining coping in this context is appealing, because it is something that can be modified by therapy (Mohr & Goodkin, 1999; Siegert & Abernethy, 2005) and may potentially mitigate the impact of fatigue on cognitive variability in PwMS, thus making their cognitive functioning more consistent and effective in their daily lives.

In summary, available evidence suggests that although mean levels of cognitive functioning are typically not associated with self-reported cognitive fatigue in MS, some studies indicate that *cognitive variability* is associated with subjective cognitive fatigue. Additionally, coping has been shown to be a powerful moderator of depression outcomes in MS when cognitive dysfunction or pain is present. To date, however, coping has not been considered as a possible moderator of the relationship between subjective cognitive fatigue and cognitive variability in MS. The current study was designed to examine this relationship. Given the novelty of the current study, previous literature regarding variability within domains of attention/executive functioning and memory is not available; however, considering previous research on fatigue, coping, and neuropsychological performance within the domain of mean levels of executive functioning (Ukueberuwa & Arnett, 2014), we hypothesize the following:

Primary hypothesis: Coping will moderate the relationship between self-reported cognitive fatigue and cognitive variability in MS.

Hypothesis 1a: PwMS who report high levels of cognitive fatigue and use low levels of adaptive coping (i.e., low active coping, high avoidant coping, and low composite coping) will show the greatest memory variability.

Hypothesis 1b: PwMS who report high levels of cognitive fatigue and use low levels of adaptive coping (i.e., low active coping, high avoidant coping, and low composite coping) will show the greatest attention/executive functioning variability.

Materials and methods

Participants

MS group

The study included 53 PwMS. Inclusionary criteria were (a) no history of substance use disorder or nervous system disorder other than MS; (b) no sensory impairments that might interfere significantly with cognitive testing; (c) no developmental history of a learning disability or ADHD; (d) no medical condition other than MS that could substantially affect cognition or motor function; (e) no relapse or corticosteroid use within four weeks of assessment; and (f) absence of severe physical and neurological impairment that would significantly impede testing. One of the 53 participants (a male with secondary progressive MS) was excluded from the analyses due to having an extreme outlier score on the processing speed variability index (>5 SD above the mean). As a result, 52 total participants were included in the final analyses.

MS diagnoses were confirmed by board-certified neurologists who also assessed disease course based on Lublin's criteria (2014). Thompson et al.'s (2018) revised McDonald criteria were applied to MS diagnoses. A breakdown by course type included relapsing-remitting ($n = 38$), secondary progressive ($n = 11$), and primary progressive ($n = 3$). Duration of illness from symptom onset and from diagnosis, as well as neurological disability using the Expanded Disability Status Scale (EDSS; Kurtzke, 1983), was also rated. No patient was experiencing a clinical exacerbation at the time of the evaluation. All participants were paid $100 for their participation.

All participants were non-Hispanic White. Participants signed an informed consent form prior to starting the study, according to institutional guidelines, and were treated in accordance with the ethical standards of the American Psychological Association and the Helsinki Declaration. The study was approved by the Institutional Review Board at our institution. All procedures were performed in compliance with relevant laws and institutional guidelines. See Table 1 for participant characteristics.

Participants completed a battery of neuropsychological tests and questionnaires that assessed cognitive, emotional, and physical functioning. Demographic information (including age and education) was obtained via a semi-structured psychosocial

Table 1. Demographic and illness-related information

	Persons with MS mean (SD)
N	52
% Female	69% (36/52)
Age (years)	52.35 (11.60)
Education (years)	14.83 (1.99)
Disease duration (years)	15.87 (8.38)
EDSS	4.32 (1.66)
Course type	
Relapsing-remitting	*N* = 38 (73%)
Secondary progressive	*N* = 11 (21%)
Primary progressive	*N* = 3 (6%)

Note: EDSS = Expanded Disability Status Scale, MS = multiple sclerosis.

interview conducted prior to the cognitive assessment. Cognitive tasks were completed on one day; the fatigue and coping measures were completed by participants as part of a questionnaire packet provided in the week prior to the neuropsychological testing meeting.

Measures

Neurological disability

The EDSS is a measure of MS disease progression and neurological impairment (Kurtzke, 1983) and a common metric of disability used across many MS studies. Participants were asked to rate their functional abilities in a number of different physical domains, and then EDSS ratings were determined by a clinical neuropsychologist experienced in MS (P.A.). Scores on the EDSS range from 0 (no neurological impairment) to 10 (death from MS). Self-report instruments of neurological disability, such as the measure we used, have been shown to have high levels of validity. For example, Solari et al. (1993) found high ($r = .84$) intraclass correlations between a patient self-administered version of the EDSS and neurologists' independent ratings.

Neuropsychological tests

Attention/executive functioning. Attention/executive functioning indices included from the neuropsychological test battery were Digit Span – Forward, Digit Span – Backward (Wechsler, 1997), Oral Symbol Digit Modalities Test (SDMT; Strober et al., 2020), Controlled Oral Word Association Test (COWAT) Total, Animal Naming Total, and Paced Auditory Serial Addition Task (PASAT) – 3 s Trial Total Correct (Rao, 1990).

Memory. Memory indices from the neuropsychological test battery included the Brief Visuospatial Memory Test-Revised Total Immediate and Delayed Recall (Benedict, 1997); the California Verbal Learning Test-II (CVLT-II) Immediate Recall Trials 1-5, CVLT-II Short Delay Recall, and CVLT-II Long Delay Recall (Delis et al., 2000); and the Affective Word List (AWL) Immediate Recall Trials 1–3, and AWL Delayed Recall (Meyer & Arnett, 2014).

Scores from each test index were transformed to z-scores with a mean of 0 and standard deviation of 1 using the sample mean and standard deviation of the current sample. Scores were created such that higher scores always indicated better performance.

Intraindividual cognitive variability indices. Once scores were standardized to z-scores, the cognitive variability indices were created. We derived four intraindividual cognitive variability (IIV) indices (e.g., two for memory and two for attention/executive functioning). Previous work has used the variability metric of maximum discrepancy score (MDS). The MDS involved subtracting the lowest score from the highest score for each participant (Rabinowitz & Arnett, 2013). For the other metric of variability, we used the ISD. This involves taking the standard deviation of all the standardized scores across the test battery (Merritt et al., 2019). Based on precedent from this prior work (Riegler et al., 2021), we calculated these two measures of IIV for our study.

Using the MDS/ISD framework, we created four indices of variability: memory MDS, memory ISD, attention/executive functioning MDS, and attention/executive functioning ISD. The correlation between the variability indices for each composite was very high, such that Memory ISD was significantly correlated with Memory MDS, $r(52) = 0.98$, $p < .001$, and attention/executive functioning ISD was significantly correlated with attention/executive functioning MDS, $r(52) = .94$, $p < .001$. Therefore, we combined the two variability indices to create one overarching measure of IIV for each of the domains of tests (i.e., one for memory and the other for attention/executive functioning). We then created a mean standard score (mean = 100, $SD = 15$ standard score metric) for each of the IIV indices – one comprising a memory variability composite and the other an attention/executive functioning variability composite – which were then used as the primary outcome variables in the hypothesis testing regression analyses.

Fatigue and coping

Fatigue. The FIS is a 40-item self-report measure of fatigue that measures the impact of different types of fatigue including cognitive (e.g., "I have been less alert"), physical (e.g., "My muscles have felt weak"), and psychosocial components (e.g., "I have been limited in my ability to do things away from home"; Fisk et al., 1994). Examinees rate items on a 5-point Likert scale of how much of a problem fatigue has caused them in the past month 0 (no problem) to 4 (extreme problem). Because of our interest in cognitive fatigue, and the relevance to our outcome variable of cognitive variability, only the cognitive fatigue scale was used for this study.

Coping. To measure coping, we administered the Coping Orientation to Problems Experienced (COPE) Questionnaire (Carver et al., 1989). This 52-item self-report questionnaire is designed to measure a variety of coping styles used in response to stressful events. The COPE consists of 13 distinct scales each comprised of four-item clusters. A common way of combining the scales suggested by the original authors of the COPE and in our prior work has involved dividing the scales into two broad indices of 12 items each. The active coping index is comprised of the subscales of active coping, planning, and suppression of competing activities subscales. The avoidance coping index is comprised of subscales for mental disengagement, behavioral disengagement, and denial.

Consistent with our prior work (Bradson et al., 2022; Rabinowitz & Arnett, 2009), the active and avoidant coping indices were not significantly correlated with one another in the present study, $r(52) = -13$, $p = .33$. This shows clearly that high scores on one index will not necessarily be associated with low scores on the other index. As a result, and also consistent with this prior work, we created a coping composite that represented the relative contributions of both active and avoidant coping in one index. Specifically, we created this composite coping index by taking the difference between the z-scores of a participant's active coping index and avoidant coping index (Rabinowitz & Arnett, 2009; Ukueberuwa & Arnett, 2014). Positive composite coping index scores reflect the use of more adaptive (i.e., more active, less avoidant) coping skills; conversely, negative scores indicate the use of less adaptive coping strategies.

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Table 2. Primary data analysis variables

	Persons with MS mean (SD)
N	52
FIS – cognitive scale	14.46 (9.38)
Active coping index	32.19 (7.54)
Avoidant coping index	20.73 (4.73)
Composite coping index (z-scores)	−0.87 (1.88)
Attention/executive variability index (standard scores)	98.48 (9.88)
Memory variability index (standard scores)	100.40 (14.84)

Note: FIS = Fatigue Impact Scale, MS = multiple sclerosis.

Table 3. Hypothesis testing analyses. Interaction of cognitive fatigue and active coping on memory variability

	R^2	Δr^2	Δ F	p-level
Step 1: FIS – cognitive scale	.00	.00	.00	.95
Step 2: Active coping index	.00	.00	.00	.99
Step 3: Interaction term	.02	.02	.77	.34

Note: FIS = Fatigue Impact Scale, dependent variable = memory variability index.

Key outcome variables: cognitive variability indices

The two cognitive variability indices were created using the above memory and attention/executive functioning variables. Of note, higher scores on these indices indicated *better* scores, that is, *lower* variability, and lower values reflected worse scores, that is, *higher* variability.

Statistical analyses

The Statistical Package for Social Sciences (SPSS) version 25 was used for all data analyses.

Preliminary analyses

First, we examined correlations between the demographic and illness variables with the two key cognitive variability indices. None of the demographic and illness variables were significantly ($p < .05$) correlated with either of the cognitive variability outcome variables, so they were not included as covariates in the key hypothesis testing analyses.

Hypothesis testing analyses

Linear regression analyses were conducted for all hypothesis testing analyses. In each case, the FIS – cognitive scale was entered in Step 1, the relevant COPE index in Step 2, and the interaction term of these variables in Step 3. The dependent variable in each of these analyses was either the memory variability index or the attention/executive functioning variability index. Simple effects tests were used to clarify the pattern of any significant interactions. The effect of cognitive fatigue on memory or attention/executive functioning variability was tested at high and low (1 SD above and below the mean) levels of perceived active coping, avoidant coping, and the composite coping index.

Results

See Table 2 for descriptive statistics for primary data analysis variables.

Table 4. Interaction of cognitive fatigue and active coping on attention/executive functioning variability

	R^2	Δr^2	Δ F	p-level
Step 1: FIS – cognitive scale	.00	.00	.03	.86
Step 2: Active coping index	.00	.00	.01	.94
Step 3: Interaction term	.06	.06	2.81	.10

Note: FIS = Fatigue Impact Scale, dependent variable = attention/executive functioning variability index.

Table 5. Interaction of cognitive fatigue and avoidant coping on memory variability

	R^2	Δr^2	Δ F	p-level
Step 1: FIS – cognitive scale	.00	.00	.00	.95
Step 2: Avoidant coping index	.01	.01	.62	.44
Step 3: Interaction term	.05	.04	1.95	.17

Note: FIS = Fatigue Impact Scale, dependent variable = memory variability index.

Table 6. Interaction of cognitive fatigue and avoidant coping on attention/executive functioning variability

	R^2	Δr^2	Δ F	p-level
Step 1: FIS – cognitive scale	.00	.00	.03	.86
Step 2: Avoidant coping index	.02	.02	1.09	.30
Step 3: Interaction term	.10	.08	4.39	.04

Note: FIS = Fatigue Impact Scale, dependent variable = attention/executive functioning variability index.

Active coping analyses

Hypothesis 1: Active coping will moderate the relationship between self-reported cognitive fatigue and cognitive variability in MS. As shown in Tables 3 and 4, the interaction term was not significant for either the analysis with the memory variability index or the one with the attention/executive functioning variability index as the dependent variable. With that said, the interaction term for the attention/executive functioning variability index accounted for 6% of the variance ($p = .10$).

Avoidant coping analyses

Hypothesis 2: Avoidant coping will moderate the relationship between self-reported cognitive fatigue and cognitive variability in MS. In these analyses, the interaction term was significant for the model with the attention/executive functioning variability index as the dependent variable, accounting for 8% of the variance ($F(1,48) = 4.39$, $p < .05$; Table 5); however, in the analysis with the memory variability index as the dependent variable, the interaction was not statistically significant (Table 6). To examine the nature of the significant interaction for attention/executive functioning variability, the first and fourth quartiles of the FIS – cognitive distribution were used to create low and high cognitive fatigue groups, respectively. Regarding the COPE indices, one SD below and above the mean of the mean-centered avoidant coping distribution was used to create low and high levels of avoidant coping, respectively. As shown in Figure 1, the interaction reveals that at low levels of cognitive fatigue, attention/executive functioning variability is comparable between coping groups. However, at high levels of cognitive fatigue those using lower levels

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Table 7. Interaction of cognitive fatigue and composite coping on memory variability

	R^2	Δ r^2	Δ F	p-level
Step 1: FIS – cognitive scale	.00	.00	.00	.95
Step 2: Composite coping index	.01	.01	.25	.62
Step 3: Interaction term	.05	.05	2.31	.14

Note: FIS = Fatigue Impact Scale, dependent variable = memory variability index.

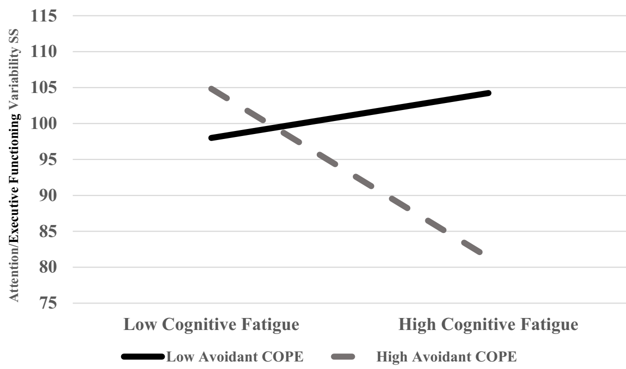

Figure 1. Simple effects tests for the interaction of cognitive fatigue and avoidant coping on attention/ executive functioning variability. *Note.* SS = standard score – higher values reflect *lower* variability.

(i.e., less maladaptive coping) show considerably better (i.e., less variable and more consistent) attention/executive functioning variability score, compared with PwMS using higher levels of avoidant coping.

Composite coping analyses

Hypothesis 3: Composite coping will moderate the relationship between self-reported cognitive fatigue and cognitive variability in MS. In this case, the interaction term was not significant for the model with the memory variability index as the dependent variable (Table 7); however, in the analysis with the attention/executive functioning variability index as the dependent variable, the interaction was significant, accounting for 13% of the variance ($F(1,48) = 6.25$, $p < .02$; Table 8). To illustrate the nature of this effect, first and fourth quartiles of the FIS – cognitive distribution were again used to create low and high cognitive fatigue groups, respectively. Regarding the COPE indices, one SD below and above the mean of the mean-centered composite coping distribution was used to create low and high levels of composite coping, respectively. As shown in Figure 2, the interaction reveals that at low levels of cognitive fatigue, attention/executive functioning variability is generally comparable between coping groups. However, at high levels of cognitive fatigue those using higher levels (i.e., more adaptive coping) show considerably better (i.e., less variable and more consistent) attention/executive functioning variability scores, compared with PwMS using lower levels of composite coping.

Discussion

The current study was designed to examined whether coping moderated the relationship between cognitive fatigue and cognitive variability in MS, with memory and attention/executive functioning variability considered separately. The results of our investigation

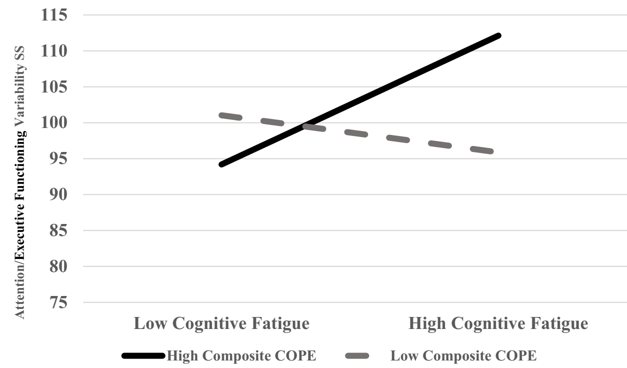

Figure 2. Simple effects tests for the interaction of cognitive fatigue and composing coping on attention/executive functioning variability. *Note.* SS = standard score – higher values reflect *lower* variability.

provided partial support for our hypotheses. When examining memory variability as the key outcome, none of the interaction analyses testing the moderator hypothesis were significant. In contrast, two of the three interactions were statistically significant when considering attention/executive functioning variability as the outcome. In particular, analyses for avoidant coping and the composite coping index interacting with the cognitive fatigue variable were significant, accounting for 8 and 11% of the attention/executive functioning variability outcome, respectively.

Regarding the nature of these effects, as Figures 1 and 2 illustrate, at low levels of cognitive fatigue, attention/executive functioning variability is comparable between the low and high avoidant and composite coping groups. However, at high levels of cognitive fatigue those using lower levels (i.e., less maladaptive coping) show considerably better (i.e., less variable and more consistent) attention/executive functioning variability scores, compared with PwMS using higher levels of avoidant coping. We found a similar pattern for the composite coping groups, whereby at high levels of cognitive fatigue, PwMS using higher levels of composite coping (i.e., more adaptive coping) show considerably better (i.e., less variable and more consistent) attention/executive functioning variability scores compared with those using lower levels (i.e., more maladaptive) of composite coping.

The results of the present study extend the findings from Ukueberuwa and Arnett (2014), showing that avoidant coping is also a key moderator of the relationship between cognitive fatigue and an important cognitive outcome, in this case, attention/executive functioning variability. It is also worth noting that attention/executive functioning deficits are central to the cognitive profile in MS. Thus, finding a variable (i.e., coping) that might moderate the impact of a common MS symptom like fatigue on variability in this cognitive domain seems important. Our study adds more specificity in focusing particularly on cognitive fatigue rather than overall fatigue and examining cognitive variability, rather than traditional mean cognitive performance. We also specifically examined memory and attention/executive functioning in the present study instead of just the executive functioning domain examined in Ukueberuwa and Arnett (2014).

One interesting comparative point between our study and Ukueberuwa and Arnett (2014) is that in the latter study, the interaction between fatigue and avoidant coping was only significant when examined longitudinally but not cross-sectionally. It is possible that the impact of fatigue and reliance on maladaptive (i.e., avoidant) coping on mean cognitive functioning is not immediately evident but becomes more apparent over time.

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In contrast, the impact of cognitive fatigue combined with avoidant coping may have more immediate effects on attention/executive functioning variability.

Other factors, not considered in our study, could potentially moderate the relationship between fatigue and attention/executive functioning variability in MS. In particular, motivational factors such as apathy (Raimo et al., 2022) and cognitive reserve (Stein et al., 2023) may play a role and warrant further research in MS.

Fatigue is extremely common in PwMS, often reported as their most debilitating symptom (Marchesi et al., 2020), and typically associated with reduced quality of life, impacting domains of work and other daily activities (Gullo et al., 2020). Our study shows that in PwMS who rely more on maladaptive coping strategies in response to stress, cognitive fatigue may result in less consistent attention/concentration and processing speed performance. Given that the latter cognitive functions are important and can impact things like performing job tasks, driving, and other important daily activities (Arnett & Smith, 2022), finding ways to make such cognitive functions more consistent could be beneficial to PwMS. The results of our study suggest a possible point of intervention to improve such skills – coping.

Coping is something that has been shown to be amenable to cognitive-behavioral treatments in PwMS and thus appears to be a modifiable behavior. Stress management therapy for MS (SMT-MS; Mohr, 2010) and stress inoculation training (Foley et al., 1987) are both designed to help PwMS learn better coping skills to improve their response to stress. Our study suggests the possibility that helping PwMS who experience high levels of fatigue use more adaptive coping strategies in response to stress could lead to more consistent deployment of attention/executive functioning resources. The Avoidant COPE scale that we used consists of subscales involving behavioral disengagement, mental disengagement, and denial. These coping strategies, in the context of high levels of cognitive fatigue, were associated with greater attention/executive functioning variability in our study. Helping PwMS increase their behavioral and mental engagement and reduce their reliance on denial as a strategy in response to stress could result in making such cognitive functions more consistent, and thus result in more adaptive daily functioning. The Active COPE scale that we used is comprised of subscales for active coping, planning, and suppression of competing activities. Given that this Active COPE scale (along with the Avoidant COPE scale) makes up the Composite COPE scale we used, assisting those with MS in using more of these active coping strategies in response to stress could also make their attention/executive functioning more consistent.

Limitations

Although our data are provocative and could suggest avenues for treatment, the causal statements we make when considering interpretive issues are necessarily speculative given the correlational nature of our data. Future work could test some of these speculations using treatment designs that attempt to increase the use of active and reduce the use of avoidant coping strategies in MS.

Another limitation of our study is that all of the participants were White. Thus, we cannot generalize our data to groups of people from other racial/ethnic backgrounds. It will be important for future work to evaluate these issues in a more diverse sample.

Finally, it is important to keep in mind that coping style is only a perception at one moment in time and, therefore, may not be an accurate reflection of the coping strategies individuals employ in real life over a long period of time. Additionally, coping strategies may also change depending on whether an individual is presently experiencing symptoms of depression and/or anxiety. Future work may wish to more systematically evaluate the coping strategies individuals employ in their daily lives and to examine ways in which oft-utilized strategies may change with targeted interventions. Future work may also wish to include depression and anxiety within a more complex model examining cognitive performance, coping styles, and psychological/fatigue factors.

Table 8. Interaction of cognitive fatigue and composite coping on attention/executive functioning variability

	R^2	Δr^2	ΔF	p-level
Step 1: FIS – cognitive scale	.00	.00	.03	.86
Step 2: Composite coping index	.01	.01	.52	.47
Step 3: Interaction term	.13	.11	6.25	< .02

Note: FIS = Fatigue Impact Scale, dependent variable = attention/executive functioning variability index.

Conclusions

Fatigue is common in PwMS and is associated with negative impacts on quality of life and daily functioning. Our study showed that cognitive fatigue predicted attention/executive functioning variability in PwMS who relied on the maladaptive coping strategy of avoidant coping. Given that coping can be modified through available treatments, helping PwMS use better coping in response to stress might help them deploy their attention/executive functioning resources more consistently, with possible benefits in their daily functioning. Given that avoidant coping is comprised of mental disengagement, behavioral disengagement, and denial, helping PwMS become more mentally and behaviorally engaged and rely less on denial in response to stress could provide targets for treatment. Future work will be needed to test out some of these causal possibilities.

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Competing interests. Peter Arnett, Ph.D. has served on the EMD Serono – Speakers' Bureau and served as a consultant for Biogen and Roche Pharmaceuticals. He has received research funding from the National Multiple Sclerosis Society, National Institute of Mental Health, and National Institutes of Health. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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