Original article

Mind wandering in people with Multiple Sclerosis: A psychometric study

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ABSTRACT

Background: Although mind wandering (MW) is associated with various psychological aspects frequently affected in people with Multiple Sclerosis (PwMS), there is lack of validated tools to assess MW in this clinical population.
Objective: This psychometric study aimed to assess structural and construct validity and reliability of a brief Italian version of Mind Wandering (MW) Scale that measures two different dimensions of MW, i.e., spontaneous (MW-S) and deliberate (MW-D).
Methods: Structural validity of the MW Scale was assessed by explorative factor analysis (EFA). To investigate construct validity, mood (Hospital Anxiety Depression Scale) and personality (10-items Big Five Inventory Test) were correlated with MW constructs. Reliability was assessed by Cronbach's α for internal consistency and intraclass correlation coefficients.
Results: EFA confirmed two distinct constructs of MW, i.e., MW-S and MW-D, also in PwMS. This tool appropriately fits the graded response model, supporting validity (about 79% of hypotheses for convergent and discriminant constructs confirmed) and internal consistency (MW-S: Cronbach's α = 0.84; MW-D: Cronbach's α = 0.88).
Conclusion: MW Scale could be a useful tool to measure MW also in PwMS. As MW seems to be connected to clinical manifestations of MS, a detailed assessment of MW should be encouraged in clinical practice.

1. Introduction

Multiple sclerosis (MS) is a chronic disease of the central nervous system characterized by heterogeneous symptoms and signs, and a variable impact on physical, psychological and social functioning. Personality changes, that may include social inadequacy, disinhibition, apathy, emotional lability, self-rumination and impulsivity, have been reported in many PwMS (Maggio et al., 2020; Stathopoulou et al., 2010; Benedict et al., 2001). Personality characteristics affect individuals' capacity for adaptation and management of stressful situations and, combined with mood disorders and cognitive deficits, may have a negative impact to the course of the illness (Stathopoulou et al., 2010). For these reasons, several studies have used personality traits to obtain information on patients' individual responses to the difficult experiences related to the disease (Raimo et al., 2019).

According to the Five-Factor Model taxonomy (Stathopoulou et al., 2010), evidence indicates that PwMS showed lower levels of

conscientiousness (i.e., extent to which a person is task-oriented, achievement-striving and organized), extraversion (i.e., dependence on external stimulation for arousal and tendency to be outgoing and sensation seeking), openness (i.e., tendency to be intellectually curious, creative and imaginative) and agreeableness (i.e., proclivity for social cooperation, honesty, and altruism), as well as higher levels of neuroticism (i.e., stress reactivity or emotional responsiveness to challenge, and proclivity for negative mood states) than healthy controls (Benedict et al., 2001). Furthermore, these personality traits are often associated with mood and psychological well-being in MS population (Benedict et al., 2001; Podda et al., 2020).

Personality is also related to mind wandering (MW), an ubiquitous and pervasive phenomenon with high intra-individual stability in which thematic content is mostly driven, directly or indirectly, by the individual's goal or current life concerns (Seli et al., 2016). Nearly half of daily-life thoughts could be classified as MW and such phenomenon occurs frequently and may impact various activities (Killingsworth and

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Gilbert, 2010).

MW could be defined as *spontaneous* when task-unrelated thoughts capture attention, triggering an uncontrolled shift from the task, and *deliberate* when attention is intentionally shifted from the focal task toward internal thoughts (Vannucci and Chiorri, 2018). Several studies have shown that tendencies to spontaneous and deliberate MW, although positively correlated, are differentially associated with a number of psychological traits. Specifically, evidence has been reported that spontaneous MW may reflect difficulties in controlled processing: spontaneous but not deliberate MW was found to be associated with attention-deficit/hyperactivity disorder (ADHD) symptomatology, with higher reports of obsessive-compulsive disorder (OCD) symptoms and with self-reported fidgeting and self-reported propensity to act without awareness (Vannucci and Chiorri, 2018).

Two theories have tried to explain MW considering the executive control and the resource allocation theory (Randall et al., 2014). The first states that MW represents a failure of executive control since goal maintenance and ongoing activities may be disrupted by task-unrelated thoughts or environmental stimuli. In a variety of tasks (e.g. sustained attention, visual search or reading) higher rates of MW are often associated with greater detriments to performance (e.g. slower reaction times, greater errors, poorer memory retention) (Seli et al., 2016; Randall et al., 2014; Figueiredo et al., 2020). The second theory explains that off-task thoughts are attributed to failures in self-regulation processes, which are analogous to the control component in executive control theories because they are theoretically responsible for directing and maintaining attentional control. According to this theory, MW occurs when self-regulatory processes are not engaged, suggesting that MW would be more likely in later stages of performance for tasks that can be automated, when tasks are so easy that they can be performed without much attentional effort, or when they are so difficult they are beyond the reach of the person executing them (Randall et al., 2014).

Although the relationship between MW and mood is often unclear and complex, some studies highlight a link between this phenomenon and anxiety and depression (Figueiredo et al., 2020; Konjedi and Maleeh, 2017). Individuals presenting high anxiety levels experience more off-task thoughts and have greater difficulty to maintain goal-directed behaviors and, consequently, to manage their minds (Figueiredo et al., 2020). Furthermore, the negative content of MW, known as rumination that is referred to as persistent and recurring thoughts associated with a common issue, can increase the likelihood and the intensity of depression and excessive rumination predisposes to the increased risk of depression (Konjedi and Maleeh, 2017). Indeed, many people believe that when they become sick, they have to try to focus on their inner strengths because they think that such a concentration will give them the insight to find a solution to their problem (Nobakht, 2019).

Attempts to investigate and evaluate MW in MS are very scarce (Broscheid et al., 2020). This dearth of knowledge is an important omission and understanding the consequences of this ubiquitous thought process is needed, especially in a clinical population in which psychological aspects as personality traits and mood are often affected by the disease. PwMS have to deal with a lot of issues after the diagnosis. Symptoms may be ambiguous, with a variety of clinical manifestations, leading people to mind wander about their source and possible evolution, and thus affect work and social roles (Podda et al., 2020). In most cases, this may upset their identities and self-confidence, generate psychological problems and thus lead to the continuation of involvement in rumination (Nobakht, 2019). Given the relevance of the self in the experience of MW and its link with some personality traits and mood, validated tools able to evaluate MW in PwMS are somewhat required. For these reasons, the aim of this study was to assess structural validity and construct validity of a brief questionnaire to measure MW in PwMS.

2. Materials and methods

2.1. Participants

Subjects were enrolled among those followed as outpatients or at-home by the Italian MS Society (AISM) Rehabilitation Services of Genoa, Padua and Vicenza, without any inclusion/exclusion criteria unless MS diagnosis according to McDonald's criteria (Thompson et al., 2018) and with an age above 18 years. For each participant, demographic (i.e., gender, age, years of education) and clinical (i.e., disease duration, disease course and disability level as measured by the Expanded Disability Status Scale, EDSS (Kurtzke, 1983) information were acquired. Written informed consent was obtained from all subjects prior to study entry. The study was approved by the Regional Ethics Committee of Azienda Ospedaliera "San Martino", Genoa, Italy. Data were collected from December 2020 to March 2021.

2.2. Outcomes

MW was tested using the 8-items Italian version of the Mind Wandering Scale (Carriere et al., 2013; Chiorri and Vannucci, 2019), which consists in a 7-point Likert scale that catches the spontaneous (MW-S) and deliberate (MW-D) modalities of MW. The MW-S items include: 1) "I find my thoughts wandering spontaneously", 2) "When I mind-wander my thoughts tend to be pulled from topic to topic", 3) "It feels like I don't have control over when my mind wanders" and 4) "I mind-wander even when I'm supposed to be doing something else", ranging from "rarely" (1) to "a lot" (7) for items 1, 2, and 4, and ranging from "almost never" (1) to "almost always" (7) for item 3. The MW-D items are 1) "I allow my thoughts to wander on purpose", 2) "I enjoy mind-wandering", 3) "I find mind-wandering is a good way to cope with boredom" and 4) "I allow myself to get absorbed in pleasant fantasy", ranging from "rarely" (1) to "a lot" (7) for items 1, 2, and 4, and ranging from "not at all true" (1) to "very true" (7) for item 3 (see Appendix). Higher scores reflect a greater tendency to mind wander spontaneously or deliberately.

Personality dimensions were assessed using the 10-items Big Five Inventory Test (10 BFI) (Guido et al., 2015), which comprises 10 items taken from the BFI-44 (John and Srivastava, 1999), with two for each big five domains (one reverse-scored): extraversion (items 6, 36); agreeableness (items 2, 22); conscientiousness (items 3, 23); neuroticism (items 9, 39); openness (items 20, 41). Items are rated on a 5-point Likert scale ranging from 1 (completely disagree) to 5 (completely agree).

Mood disorders were tested using the Hospital Anxiety and Depression Scale (HADS) (Honarmand and Feinstein, 2009), which consists of two subscales, measuring anxiety (HADS-A) and depression (HADS-D), scored separately. Its usefulness has been validated as a marker of major depression and generalized anxiety disorder in the MS population. Items are rated on a 4-point Likert scale, with higher scores indicating greater anxiety and depression. Below 7 is normal, 8–10 is borderline abnormal and over 11 is abnormal. A score ≥ 8 reflected the presence of anxiety and depression.

2.3. Statistical analysis

2.3.1. Data quality and items distribution

Percentage of missing values per item and score distribution was analyzed. The presence of floor and ceiling effects was explored by examining the frequency of the highest and lowest possible scores in both MW subscales. Floor and ceiling effects were considered present if more than 15% of participants achieved either the lowest or highest scores in both MW subscales. The sample size has been estimated based on the recommendation to enroll a number ranging from 5 to 20 respondents per item (Rattray and Jones, 2007); here, to run a solid factor analysis and considering 15% of possible incomplete information/data loss, we aimed to include at least 15 respondents for each items for a

total of at least 140 participants. This sample size was deemed to be adequate for exploratory factor analysis (EFA), but it did not afford sufficient statistical power to carry out a confirmatory factor analysis (CFA). EFA was performed for the assessment of MW Scale.

2.3.2. Structural validity

Factors were extracted by principal component factor analysis with a varimax orthogonal rotation method. Bartlett's test of Sphericity (BTS) and a Kaiser-Meyer-Olkin (KMO) test must be conducted to confirm the suitability of data. BTS with $p < 0.05$ and a KMO value of 0.60 were considered suitable when running the EFA (Cerny and Kaiser, 1977; Kaiser, 1974). The Kaiser's criterion for factors with an eigenvalue ≥ 1 was used as a criterion for component extraction. Factor loadings greater than 0.40 were considered significant. Items that loaded in a same way on more than one factor and that had loadings < 0.40 were deleted; also, items with cross loading greater than 0.40 were dropped (Nunnally and Bernstein, 1994), as they would determine high instability and poor contribution in terms of construct to the instrument. Model fit was tested with the ratio between chi-square and degree of freedom (χ^2/d.f.) (good if ≤ 3) and the root mean square error of approximation (RMSEA) (good if ≤ 0.08) (Hu and Bentler, 1999).

2.3.3. Construct validity

Construct validity was assessed by the degree to which the scores were consistent with predefined hypotheses regarding the correlation between the MW constructs (spontaneous and deliberate) and the other measures. Specifically, on the basis of the existing findings about MW, we formulated fourteen hypotheses (see Table 1): correlations were expected between spontaneous and deliberate MW and the personality traits related to focus on inner world (conscientiousness, neuroticism and openness) (hypotheses 1–6); no correlations were expected between spontaneous and deliberate MW and the personality traits related to outer states (extroversion and agreeableness) (hypotheses 7–10); correlations were expected between spontaneous and deliberate MW and anxiety and depression (hypotheses 11–14). Spearman's correlations coefficients (ρ) were considered low for $\rho < 0.30$, moderate for ρ: 0.30–.59 and high for $\rho \geq 0.60$ (Cohen, 1988).

2.3.4. Reliability

Reliability was assessed with internal consistency and item reliability. The internal consistency was estimated by Cronbach's alpha coefficient and average inter-item correlation. The statistically acceptable Cronbach's alpha coefficient should be > 0.7 (Streiner et al., 2015), and average inter-item correlations should be comprised between 0.30 and 0.70 (Nunnally and Bernstein, 1994). Items reliability was assessed by test-retest correlations, determined by calculating intraclass correlation coefficients (ICC) and 95% interval confidence (IC) on subscales scores which are expected to remain stable. To do this, 40 participants were required to complete the MW Scale, one months apart. ICC was calculated by two-way random effects model, absolute agreement and an ICC value of 0.70 was recommended as a minimum standard for reliability (de Vet et al., 2006).

3. Results

3.1. Participants

170 PwMS were enrolled and included in the statistical analyses. Table 2 presents the demographic and clinical characteristics of the participants.

3.2. Data quality and distribution

None of the items had missing values, by indicating good acceptability. PwMS used the full range in each item. Individual item mean scores ranged from 2.78 to 3.80. No ceiling effect was found in both MW

Table 1

Specific hypotheses and correlation coefficients of the MW subscales with other measurement instruments.

Hypothesis	Confirmed yes/no	Correlations coefficients (ρ)
(1) A correlation was not expected between the **MW-S** and Conscientiousness (10 BFI) because inner experience happens without a deliberate own control.	yes	0.12
(2) A correlation was expected between the **MW-D** and Conscientiousness (10 BFI), because this suggests a deliberate and voluntary inner experience.	yes	0.16*
(3) A correlation was expected between the **MW-S** and Neuroticism (10 BFI), due to individuals' tendency to have intense inner activity through worries and concerns.	yes	0.26**
(4) A correlation was expected between the **MW-D** and Neuroticism (10 BFI), due to individuals' tendency to have intense inner activity through worries and concerns.	yes	0.20*
(5) A correlation was expected between the **MW-S** and Openness (10 BFI), because individuals show a tendency to curiosity and explore new ideas.	yes	0.22*
(6) A correlation was expected between the **MW-D** and Openness (10 BFI), because a tendency to curiosity and explore new ideas.	yes	0.17*
(7) A correlation was not expected between the **MW-S** and Extroversion (10 BFI), because the focus is directed externally (external stimulation seeking).	yes	0.03
(8) A correlation was not expected between the **MW-D** and Extroversion (10 BFI), because the focus is directed externally (external stimulation seeking).	yes	0.09
(9) A correlation was not expected between the **MW-S** and Agreeableness (10 BFI), because the focus is directed externally (tendency to be selfless).	no	0.20*
(10) A correlation was not expected between the **MW-D** and Agreeableness (10 BFI), because the focus is directed externally (tendency to be selfless).	no	0.27**
(11) A correlation was expected between the **MW-S** and anxiety (HADS-A), because anxiety implies attentional lapses and weaker concentration among tasks.	yes	0.27*
(12) A correlation was expected between the **MW-D** and anxiety (HADS-A), because anxiety implies attentional lapses and weaker concentration among tasks.	no	−0.01
(13) A correlation was expected between the **MW-S** and depression (HADS-D), because the ruminations on errors can increase negative mood.	yes	0.22*
(14) A correlation was expected between the **MW-D** and depression (HADS-D), because ruminations on errors can increase negative mood.	yes	−0.10

* $p < 0.05$.
** $p < 0.001$.

subscales (0.6% scored 28 for MW-S; 0.6% scored 28 for MW-D); a slight floor effect was present for MW-S subscale (13.5% scored 4) whereas no floor effects was found for MW-D (9.4% scored 4). Fig. 1 shows the percentages of the answers provided by the participants in each item.

Distribution of participants' responses to each item is represented in gray scale. Participants were asked to select the answer that most accurately reflects their everyday MW activity. The MW items are scored using a 7-point Likert-type scale ranging from "rarely", "not at all true" or "almost never" (1) to "a lot", "very true" or "almost always" (7).

Table 2

Demographic and clinical characteristics of 170 PwMS.

	$N = 170$
Age in years, mean (SD)	56.5 (11.4)
Gender, n (%)	
Female	100 (58.8%)
Male	70 (41.2%)
Level of education, n (%)	
Primary school	50 (29.4%)
High school	88 (51.8%)
University	32 (18.8%)
Disease duration in years, mean (SD)	21.3 (10.4)
EDSS score, mean (SD)	5.2 (1.7)
MS type, n (%)	
RR	79 (46.5%)
SP	63 (37.0%)
PP	28 (16.5%)

Note. SD: Standard Deviations; EDSS: Expanded Disability Status Scale; RR: Relapsing-Remitting; SP: Secondary Progressive; PP: Primary Progressive.

3.3. Structural validity

As expected, EFA showed that MW measured the two constructs (i.e. spontaneous and deliberate) also in PwMS. BTS with $p < 0.001$ and KMO of 0.855 confirmed the suitability of the data. Two factors had eigenvalues greater than Kaiser's criterion of 1. After varimax rotation, the extracted factor explained up to 70.7% of the total variance. The model fit indices showed an acceptable fit for the two-dimensional scale: χ^2/d. f. = 2.1 and RMSEA= 0.079. Table 3 shows the results of the EFA after varimax orthogonal rotation.

3.4. Construct validity

Conscientiousness correlated only with MW-D ($\rho = 0.16$), neuroticism with both MW-S ($\rho = 0.26$) and MW-D ($\rho = 0.20$), openness with both MW-S ($\rho = 0.22$) and MW-D ($\rho = 0.17$). Extroversion was not correlated with the tendency to show MW-S ($\rho = 0.03$) and MW-D ($\rho = 0.09$). Surprisingly, agreeableness trait was found associated with both MW-S ($\rho = 0.20$) and MW-D ($\rho = 0.27$). Results revealed correlations between anxiety and depression and MW-S ($\rho = 0.27$; $\rho = 0.22$, respectively). No significant correlation was found between anxiety and

depression and MW-D ($\rho = -0.01$; $\rho = -0.10$, respectively). Table 4 presents Spearman's correlation (ρ) between MW subscales and HADS and 10-BFI scores.

3.5. Reliability

Internal consistency as measured by Cronbach's alpha for the two subscales was generally high: 0.84 for MW-S and 0.88 for MW-D. Similarly, average inter-item correlation were 0.56 (MW-S) and 0.64 (MW-D). These values are in line with published satisfactory thresholds for scale reliability (Carriere et al., 2013).

Test-retest reliability, as measured with ICC, was 0.77 (95% IC: 0.57–0.88) for MW-S and 0.68 (95% IC: 0.40–0.83) for MW-D showing good/ moderate temporal stability.

4. Discussion

Given the lack of validated tool to investigate MW in PwMS, such a pervasive phenomenon associated with psychological aspects highly affected in this population, this study aimed to assess structural and construct validity and internal consistency of a brief Italian version of Mind Wandering Scale, which consists of two subscales measuring both spontaneous and deliberate mind wandering (respectively, MW-S and MW-D). Results showed that such tool identified two distinct constructs, as expected, also in a sample of PwMS. Overall, the questionnaire properly fits the graded response model, with first evaluations supporting both validity and reliability of this scale to measure spontaneous and deliberate MW also in MS. EFA showed consistency with previous results that have construed MW as a heterogeneous construct (Seli et al., 2015) and confirmed this also in a neurological population as MS.

As previously mentioned, internal consistency of both MW-S and MW-D was high and acceptable as indicated by the values of Cronbach's alpha, in addition to the temporal stability resulting good and moderate, respectively, as showed by the ICC values.

The analysis also showed satisfying results for construct validity of the MW Scale, as about the 79% of the hypotheses were confirmed. Conscientiousness trait positively correlated with MW-D, but not with MW-S suggesting that the inclination to be organized and achievement-oriented representative of conscientiousness (Bruce and Lynch, 2011)
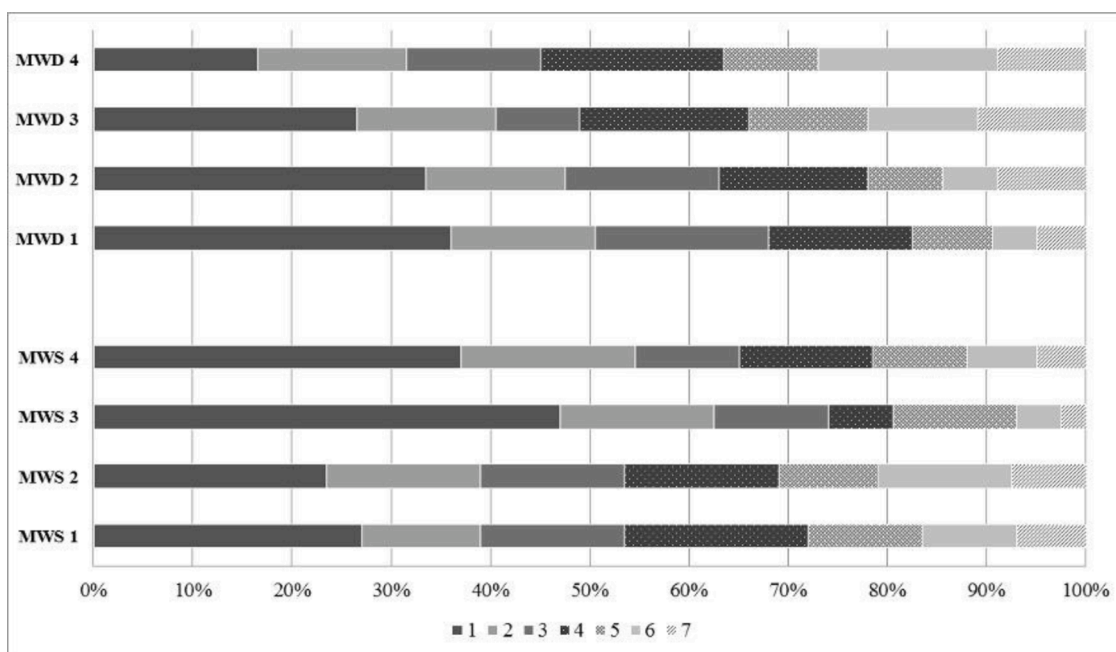

Fig. 1. Distribution of participant's answers to each MW Scale item.

Table 3
Factor loading of the EFA after varimax orthogonal rotation on the 8 items of the MW Scale.

Items	Descriptive		Rotated component matrix	
	Mean (SD)	Inter-item correlation	Factor 1 (MW-S) Cronbach's α: 0.837	Factor 2 (MW-D) Cronbach's α: 0.875
MW-S 1	3.35 (1.90)	0.475	0.711	
MW-S 2	3.45 (1.96)	0.474	0.759	
MW-S 3	2.42 (1.76)	0.495	0.845	
MW-S 4	2.76 (1.84)	0.471	0.801	
MW-D 1	2.74 (1.76)	0.452		0.759
MW-D 2	3.09 (1.99)	0.459		0.845
MW-D 3	3.57 (2.09)	0.472		0.863
MW-D 4	3.88 (1.92)	0.489		0.808

Table 4
Spearman's correlation (ρ) between MW Scale and 10 items BFI and HADS, for personality and mood respectively.

Outcome	MW-S	MW-D
Personality traits		
10 BFI - Conscientiousness	0.12	0.16*
10 BFI - Neuroticism	0.26**	0.20*
10 BFI - Openness	0.22*	0.17*
10 BFI - Extroversion	0.03	0.09
10 BFI - Agreeableness	0.20*	0.27**
Mood		
HADS-A	0.27**	−0.01
HADS-D	0.22*	−0.10

MW-S (spontaneous mind wandering); MW-D (deliberate mind wandering); 10 BFI (10 items Big Five Inventory); HADS-A (Hospital Anxiety and Depression Scale - anxiety subscale); HADS-D (Hospital Anxiety and Depression Scale - depression subscale).

* $p<0.05$.
** $p<0.001$.

was positively linked with a tendency of deliberate focus attention on inner states. Neuroticism and openness to experience were strongly linked with both spontaneous and deliberate MW. Both traits make individuals inclined to an intense internal activity focusing on their inner world, but in different manner. The mind of an individual characterized by a more cautious approach to the world (Soubelet and Salthouse, 2010), as indicated by a neuroticism trait, could be absorbed in task-off thoughts that include worries and resistance to exploring new opportunities. Instead, while openness is related to creativity and desire for new knowledge and ideas, this could explain the positive outcomes of MW phenomenon (Ibaceta and Madrid, 2021). While consistent evidence confirms neuroticism in PwMS (Benedict et al., 2001; Bruce and Lynch, 2011), openness trait was found to be less frequent in MS (Raimo et al., 2019). However, selecting the Likert scale point ≥ 5 that identifies a considerable tendency to mind wander deliberately or spontaneously, we noted that two specific items that were scored more frequently by the majority of participants suggest openness propensity to "cognitively explore" both abstract and sensory information. The 37.65% of PwMS felt pleasure when their own mind wander (item MW-D 4: "*I allow myself to get absorbed in pleasant fantasy*"). This confirms that MW can, at times, be conceived of a beneficial state, as it has been associated with positive outcomes such as increased creativity (Carriere et al., 2013). Also, the percentage of 31.76% may indicate that, although engaged in a spontaneous MW, PwMS could experience and be aware of some degree of control over this frequent switch between thoughts whom contents are miscellaneous (Broscheid et al., 2020) (item MW-S 2: "*When I mind-wander my thoughts tend to be pulled from topic to topic*"). As expected, extraversion, defined as amount of external stimulation required to achieve optimal excitement, was not correlated with MW. And this is in line with several evidence that found PwMS less inclined to seek for

external stimulation required to achieve an optimal state of arousal (Maggio et al., 2020; Raimo et al., 2019. Unexpectedly and contrary to other studies (Strober, 2017; O'Brien et al., 2007), agreeableness was correlated with both MW-S and MW-D. This is surprising since one could expect that individuals desire for social harmony and a tendency to be selfless and empathetic could be less associated with a such inner activity as MW.

Considering mood disorders, our results indicate that PwMS with anxiety and depression show a predominant tendency to show spontaneous, but not deliberate MW. Existing empirical evidence supports the contention that mood disorders lead the mind to wander without individual's control. A pioneering work by (Watts et al., 1988) showed that individuals with depression reported greater frequencies of MW during reading (81% of lapses of concentration) (Watts et al., 1988). In particular, such off-task thoughts tended to occur mainly in the first half of the 10-minute reading period. Furthermore, a similarity between MW and defined anxiety manifestations was demonstrated, suggesting that individuals presenting high anxiety levels experience more off-task thoughts and have greater difficulty to manage their minds (Aldao et al., 2010). Anxious individuals are often unable to stay focused on tasks and display impaired executive control mechanisms, which help to maintain goal-directed behaviors.

When interpreting these results, we should consider some limitations as well as future developments. Since MW phenomenon also contributes to failures in sustained attention, working memory and real-word task with a high cognitive load as driving performance (Seli et al., 2017), further studies should consider information about PwMS' cognitive functioning, one the most affected domain in MS. Furthermore, in our study we entirely considered a self-report measure able to catch the frequency of spontaneous and deliberate MW in everyday life. Future researches should include behavioural tasks in order to extend the investigation of spontaneous and deliberate MW, in terms of duration, form and the content of the mental thoughts generated during MW episodes (e.g., temporal focus, affective state, self-relevance).

Despite these limitations, our study shows that Italian MW Scale is a valid and reliable tool to measure MW also in PwMS, providing additional support for the importance of distinguishing between deliberate and spontaneous MW (Seli et al., 2016). The use of this scale could be suitable to investigate pervasive phenomenon linked to critical areas of deficit in MS. An increased understanding of personality profiles and psychological domains could help clinicians in decision about intervention. Given that rumination and negative stress-induced thoughts in PwMS lead to hopelessness and affect the patients' mental health, finding suitable therapeutic interventions for modifying their problems is of significant importance. Successful treatment of personality disturbance has significant implications, as personality disturbance in MS is associated with poor coping and a reduced overall quality of life. Since the ability to think about what is not happening is a cognitive achievement that comes at an emotional cost (Killingsworth and Gilbert, 2010), learning how to monitor and accept present moment experience, as in mindfulness interventions, could help to enhance attentional control and thus reduce MW and emotion dysregulation (Rahl et al., 2017). Accordingly, consistent evidence indicates that mindfulness based therapy could help PwMS by focusing on the present instead of the future and by increasing self-monitoring and awareness of their own body, which may lead to a significant reduction in psychological symptoms, including anxiety and depression, and improved self-care (Podda et al., 2020)' (Nobakht, 2019).

CRediT authorship contribution statement

Jessica Podda: Conceptualization, Validation, Writing – original draft, Writing – review & editing, Visualization. **Andrea Tacchino:** Conceptualization, Writing – original draft, Writing – review & editing. **Ludovico Pedullà:** Writing – review & editing. **Margherita Monti Bragadin:** Resources. **Mario Alberto Battaglia:** Supervision.

Appendix

Mind Wandering-Spontaneous (MW-S) Scale

Per ognuna delle seguenti affermazioni indica per favore l'alternativa di risposta che riflette nel modo più accurato la tua esperienza quotidiana.

1) Mi accorgo che la mia mente vaga liberamente, indipendentemente dalla mia volontà

Raramente | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Moltissimo

2) Quando la mia mente vaga, i miei pensieri tendono a saltare da un argomento all'altro

Raramente | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Moltissimo

3) Quando la mia mente vaga liberamente, mi sembra di non avere il controllo sui miei pensieri

Quasi mai | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Quasi sempre

4) La mia mente si mette a vagare anche quando dovrei essere concentrato su qualcos'altro

Raramente | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Moltissimo

Mind Wandering-Deliberate (MW-D) Scale

Per ognuna delle seguenti affermazioni indica per favore l'alternativa di risposta che riflette nel modo più accurato la tua esperienza quotidiana.

1) Lascio intenzionalmente che i miei pensieri vaghino per conto loro

Raramente | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Quasi sempre

2) Mi piace quando la mia mente vaga per conto suo

Raramente | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Quasi sempre

3) Trovo che vagare con la mente sia un buon modo per affrontare la noia

Per niente vero | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Molto vero

4) Mi lascio assorbire da fantasie piacevoli

Raramente | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Quasi sempre

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