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Self-reported occupational functioning in persons with relapsing-remitting multiple sclerosis: Does personality matter?

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ABSTRACT

Background: Multiple sclerosis (MS) poses a major threat to sustainable employability. Identifying conditions and factors that promote work participation is of great importance. Our objective was to explore the contribution of personality traits in explaining occupational functioning in MS.

Methods: 241 participants with relapsing-remitting MS (78% female, median age: 42.0 years, median EDSS: 2.0) and 60 healthy controls (70% female, median age: 45.0 years) underwent neuropsychological and neurological examinations and completed questionnaires. Multivariate logistic and linear regression analyses were conducted to examine relations between personality traits and self-reported occupational functioning, while accounting for known correlates.

Results: Personality traits were not associated with self-reported occupational functioning when correcting for known correlates. A higher impact of fatigue (B = -0.05, $p = .005$ and B = -0.04, $p = .009$) and depression (B = -0.22, $p = .008$ and B = -0.21, $p = .01$) were associated with no paid job ($R^2 = 0.13$) and considering to reduce work hours ($R^2 = 0.12$). A higher impact of fatigue (B = -0.05, $p = .008$, $\beta = 0.46$, $p = .001$ and $\beta = -0.36$, $p = .001$) was associated with absenteeism from work ($R^2 = 0.15$), more presenteeism ($R^2 = 0.35$) and lower work ability ($R^2 = 0.25$). A higher impact of fatigue ($\beta = 0.46$, $p = .001$) and anxiety ($\beta = 0.25$, $p = .001$) were associated with more work difficulties ($R^2 = 0.54$).

Conclusion: Personality traits did not explain additional variance in self-reported occupational functioning in persons with relapsing-remitting MS with mild disability. The impact of fatigue was the main and most consistent correlate of occupational functioning, often combined with depression or anxiety. Total explained variance of the

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models was limited, emphasizing the need to additionally examine other (contextual) factors when considering occupational challenges in MS.

1. Introduction

Multiple sclerosis (MS) is an idiopathic inflammatory demyelinating disease of the central nervous system [1]. The onset of symptoms usually occurs in young or middle adulthood, when most people are building a working career. MS has a huge impact on occupational functioning. A Dutch study including persons with MS with all levels of disease severity showed that only 31% of patients below retirement age were employed [2]. Of those who retained employment, 25.5% reported either short-term or long-term sick leave. In addition, workers with MS may deal with negative work events [3] and experience various work difficulties due to physical, psychological, cognitive and external work barriers [4,5]. The large impact of MS on occupational functioning cannot solely be explained by factors such as MS-related disability and cognitive dysfunction [6]. Recent studies argue for consideration of the role of personality in occupational functioning [7,8].

Personality is defined as a characteristic set of internal psychological mechanisms that direct our behaviour. Personality is most often described according to five traits of human behaviour, including neuroticism, extraversion, openness, agreeableness and conscientiousness [9]. Although personality is generally thought to be stable across the life span [10], their associated behavioral effects are potentially modifiable [11]. Personality can change with aging, life experiences, emotional and physical health. Furthermore, behavioral effects associated with certain personality traits can be modified using behavioral coaching [11]. Personality differences have been reported in persons with MS as compared with healthy controls, in that persons with MS exhibit higher levels of neuroticism and lower levels of extraversion [12–14] and conscientiousness [15,16]. These personality traits correspond closely to the distressed personality type (type D), characterized by the tendency to experience negative emotions (negative affectivity), while simultaneously showing the tendency *not* to express these emotions (social inhibition) [17]. Within the MS population, either type D personality or the corresponding personality traits have been linked to various negative health related outcomes, such as worse quality of life [8,18,19], more depression and anxiety [8,18,20], greater experience of fatigue [8,21], maladaptive coping [8,22], worse treatment adherence [8,23] and cognitive dysfunction [14,16,24,25]. The aforementioned correlations between type D personality (or related personality traits) and health may be explained by both behavioral and biological mechanisms. Type D individuals show fewer engagement in health-related behaviours, less often seek medical care, and exhibit more cardiovascular reactions linked to stress [26].

This vulnerability to psychological distress may also reveal itself in the occupational setting. Persons with MS with a type D personality were more often considering to reduce their work hours or leave the work force [8]. Furthermore, more occupational stress amongst persons with MS was associated with higher neuroticism, lower extraversion and lower conscientiousness [27]. Other studies reported higher informant-reported conscientiousness [28], more persistence (a component of conscientiousness) [29] and higher levels of agreeableness [30] in employed as compared to unemployed persons with MS.

In summary, evidence would indicate that personality traits might be relevant with respect to occupational outcomes in MS. The aforementioned studies in MS mainly focused on associations between personality and work status, while more subtle occupational outcomes have received less attention. With this in mind, we conducted an exploratory study investigating the relationship between the Five Factor Model personality traits and several occupational outcomes (i.e. work status, absenteeism, presenteeism, work role functioning, work ability, work difficulties and self-reported consideration to reduce work hours). We expected higher levels of neuroticism and lower levels of extraversion and conscientiousness to be related to worse occupational functioning in persons with MS. Furthermore, we expected that personality would explain additional variance in occupational functioning over known disease-related and demographic correlates, such as MS-related disability, use of immunomodulatory treatment, impact of fatigue, depression, anxiety, information processing speed, age and gender.

2. Material and methods

2.1. Design and participants

For this study, persons with relapsing-remitting MS (RRMS) from 16 MS outpatient clinics in the Netherlands were recruited in the context of the MS@Work study, a three-year study of work participation in persons with RRMS [31]. The criteria for inclusion in the MS@Work study were a diagnosis of RRMS [32], 18 years or older and currently employed or within three years since last employment. Persons with co-morbid psychiatric disorders, co-morbid neurological disorders, substance abuse, neurological impairment that might interfere with cognitive testing (such as vision problems), or unable to speak and/or read Dutch were excluded from participating in our study. Healthy controls ($N = 60$) were recruited through advertisements on social media and the local newspapers. The same inclusion and exclusion criteria were used, except for absence of a chronic disorder.

We included 289 persons with RRMS from the MS@Work study. For the current study, 23 persons were excluded because they did not complete the NEO-Five Factor Personality Inventory. Another 23 persons were excluded because they did not have a neurological examination completed. One participant was excluded because of inconsistencies in the work participation questionnaire. Another participant was excluded because she was a full-time student with only three paid working hours per week. This resulted in a total of 241 persons with RRMS.

The MS@Work study was approved by the Medical Ethical Committee Brabant (NL43098.008.12 /P1307) and the Board of Directors of the participating MS outpatient clinics. All subjects provided written informed consent. The study is performed in agreement with the Declaration of Helsinki [33].

2.2. Procedure

The participants underwent yearly neuropsychological examinations at their outpatient clinics and were asked to fill in online questionnaires for a period of three years. The participants with MS additionally underwent yearly neurological examinations. The online questionnaires assessed demographic and disease characteristics, occupational functioning and personality. The current study concerns the baseline assessment, which took place between March 2014 and January 2017.

2.3. Measures

2.3.1. Demographics

The participants provided information about their age, gender and educational level. Educational level was divided into three levels: low level education (finished low-level secondary school), middle level education (finished secondary school at a medium level) and high level education (finished secondary school at the highest level and/or obtained a college/university degree).

2.3.2. Personality

Personality traits were examined with the NEO-Five Factor Personality Inventory (NEO-FFI) [34]. The NEO-FFI consists of 60 items in total, including 12 items per personality trait: openness to experience, conscientiousness, extraversion, agreeableness and neuroticism. The NEO-FFI is scored on a 5-point Likert-scale. Raw domain scores were used and ranged from 12 to 60, with higher scores indicating higher levels of that personality trait. The questionnaire has been validated in persons with MS [35].

2.3.3. Occupational assessment

Work status was dichotomized as 'not having a paid job' (0) and 'having a paid job' (1). Those having a paid job received income based on employment and/or self-employment, either working full-time (35 or more hours per week), part-time (12–34 h per week) or less than 12 h a week (criteria Dutch Central Bureau of Statistics).

The following measures were examined only in the participants with a paid job:

Absenteeism represents the self-reported number of hours absent due to MS in the past week, based on a single item of the Work Productivity and Activity Impairment Questionnaire [36]. Due to skewed data distribution, the variable was dichotomized into 'absenteeism in the past week due to MS' (0) and 'no self-reported absenteeism in the past week due to MS' (1).

Self-reported consideration to reduce work hours was assessed by asking the participants 'Are you thinking of reducing your work hours due to MS?' which required a 'yes' or 'no' response. The variable was dichotomized into 'considering reducing work hours' (0) and 'not considering reducing work hours' (1).

Presenteeism represents the self-reported negative influence of MS symptoms on work productivity on a scale from 1 to 10, based on a single item of the Work Productivity and Activity Impairment Questionnaire [36]. Higher scores indicate a higher self-reported negative influence of MS symptoms on work productivity.

Work role functioning was examined using the Work Role Functioning Questionnaire 2.0 (WRFQ-2.0) [37]. The WRFQ measures the perceived percentage of time that physical and emotional problems impact certain work demands. The WRFQ was only administered in participants working at least 12 h per week. There are four subscales, i.e. work scheduling & output demands, physical demands, mental & social demands, and flexibility demands. For the current study the total score was used, ranging from 0 to 100 with higher scores indicating better work role functioning.

Work ability was examined using the item 'current work ability compared with the lifetime best' of the Work Ability Index (WAI) [38]. Possible scores range from 0 = 'completely unable to work' to 10 = 'work ability as its best'.

Work difficulties were examined using the shortened version of the Multiple Sclerosis Work Difficulties Questionnaire (MSWDQ) [4], a 23-item questionnaire on work difficulties over the past 4 weeks which are rated on a 5-point scale. There are 3 subscales, i.e. psychological/cognitive barriers, physical barriers and external barriers. For the current study the total score was used, ranging from 0 to 100 with higher scores indicating greater work difficulties.

Self-reported opportunity to remain working was assessed by a subitem of the Capability Set for Work Questionnaire (CSWQ) [39]: 'Taking all things together, I think I have enough opportunities to remain working', which required a response ranging from 1 = 'totally disagree' to 5 = 'totally agree'. Due to the low number of participants that reported not having enough opportunities to remain working (who responded with 'totally disagree' and 'disagree' to the previous question), this variable was only used for descriptive purposes.

2.3.4. Clinical and neuropsychological characteristics

MS-related disability was assessed using the Expanded Disability Status Scale (EDSS) [40]. EDSS scores range from 0 (normal neurological exam) to 10 (death due to MS) and increment with steps of 0.5. The EDSS was administered by the treating neurologist in the outpatient clinic.

Use of immunomodulatory treatment was assessed based on self-reported use of immunomodulatory drugs (i.e. either currently using or not using immunomodulatory treatment). The treating neurologist also noted which treatment was used. In case of discrepancies, the neurologist's report was used. As different types of immunomodulatory drugs were used, it was not feasible to examine the effects of specific immunomodulators.

Depression and anxiety were assessed using the Hospital Anxiety and Depression Scale (HADS) [41]. Possible scores per domain, i.e. anxiety or depression, range from 0 to 21 with higher scores indicative of more symptoms.

The impact of fatigue was assessed using the Modified Fatigue Impact Scale (MFIS) [42]. The MFIS examines the impact of fatigue on daily functioning in physical, cognitive and psychosocial dimensions. Possible total scores range from 0 to 84 with higher scores indicative of a higher impact of fatigue.

Information processing speed was examined using the Symbol Digit Modalities Test (SDMT) [43]. The SDMT is often used as an indicator of cognitive functioning in MS [44]. Possible total scores range from 0 to 110. Higher scores indicate better performance.

2.4. Statistical analyses

We examined differences in demographics, occupational characteristics, personality traits and neuropsychological characteristics between the participants with MS and the healthy controls using parametric or non-parametric tests where appropriate. Multivariate binary logistic regression analyses were then conducted within the participants with MS to examine predictors of work status (i.e. not having a paid job versus having a paid job), absenteeism (i.e. absenteeism in the past week due to MS versus no absenteeism in the past week due to MS) and consideration to reduce work hours (considering reducing work hours versus not considering reducing work hours). Multivariate regression analyses with bootstrapping were used to examine predictors of presenteeism, work role functioning, work ability and work difficulties within the participants with MS. Before conducting the regression analyses, univariate relations were determined between the independent variables and each dependent variable. We used Spearman or Pearson correlation analyses to examine correlations between quantitative independent and dependent variables. In case of categorical independent and/or dependent variables, independent *t*-tests, Mann-Whitney *U* tests or Chi-square tests were used where appropriate. Only independent variables that were associated with the dependent variable at $p \leq .10$ were entered in the regression models. The first block contained the demographic and disease-related factors, i.e. age, gender, level of MS-related disability (EDSS), use of immunomodulatory treatment, depression and anxiety (HADS), fatigue (MFIS) and information processing speed (SDMT). In the second block we added the NEO-FFI personality traits. The level of statistical significance for interpreting the regression models was set at $p \leq .01$. SPSS for Windows (release 24.0) was used for data analysis.

3. Results

3.1. Sample description

Demographic and clinical characteristics, occupational characteristics, personality traits and neuropsychological characteristics of the participants with MS and healthy controls are noted in Tables 1 and 2 respectively. Participants with MS and healthy controls did not differ in gender, age, educational level, work role functioning and agreeableness. Healthy controls did report more working hours, less presenteeism, better work ability and less work difficulties than participants with MS

Table 1
Demographic, clinical, occupational and neuropsychological characteristics of the participants with MS.

	Mean / Median / *N*	SD / IQR / %	Range	*N*
Demographic and clinical characteristics				
Female[a]	188	78.0%	–	241
Age[b]	42.0	14.0	21–63	241
High educational level	102	42.3%	–	241
Medium educational level	97	40.2%	–	241
Low educational level	42	17.4%	–	241
Disease duration (years)[b]	5.0	8.0	0–31	227
MS-related disability (EDSS; 0–10)[b]	2.0	1.5	0–6	241
Using immunomodulatory treatment[a]	187	77.6%	–	241
Occupational characteristics				
Paid job[a]	210	87.1%	–	241
Working hours/ week[b]	26.0	16.0	0–60	210
Self-reported absenteeism in the past week due to MS[a]	34	16.2%	–	210
Presenteeism (1−10)[b]	2.0	3.0	1–10	210
Work role functioning (WRFQ-2.0; 0–100)[b]	84.4	31.7	0–100	147
Work ability (WAI; 0–10)[b]	8.0	2.0	0–10	173
Work difficulties (MSWDQ; 0–100)[b]	19.0	22.0	0–69	241
Self-reported consideration to reduce work hours[b]	28	13.3%	–	210
Self-reported opportunity to remain working (0–5)[b]	4.0	1.0	1–5	153
Personality				
Neuroticism (12–60)[c]	29.1	7.7	13–49	241
Extraversion (12–60)[b]	41.0	10.0	22–58	241
Openness (12–60)[c]	36.2	6.2	22–54	241
Agreeableness (12–60)[b]	45.0	6.0	31–55	241
Conscientiousness (12–60)[c]	46.0	5.6	28–60	241
Neuropsychological characteristics				
Depression (HADS depression; 0–21)[b]	3.0	5.0	0–15	241
Anxiety (HADS anxiety; 0–21)[b]	5.0	4.0	0–21	241
Fatigue (MFIS; 0–84)[c]	36.7	15.8	0–80	241
Information processing speed (SDMT; 0–110)[c]	53.8	8.9	27–75	239

SD: standard deviation; IQR: interquartile range; EDSS: Expanded Disability Status Scale; WRFQ-2.0: Work Role Functioning Questionnaire-2.0; WAI: Work Ability Index; MSWDQ: Multiple Sclerosis Work Difficulties Questionnaire; HADS: Hospital Anxiety and Depression Scale; MFIS: Modified Fatigue Impact Scale; SDMT: Symbol Digit Modalities Test. Sample sizes (N) differ depending on the number of participants that completed the examination or questionnaire.
[a] N(%).
[b] Median (IQR).
[c] Mean (SD).

(all $p \leq .001$). Healthy controls scored lower on neuroticism ($p = .019$), and higher on extraversion ($p \leq .001$), openness ($p \leq .001$) and conscientiousness ($p = .027$), reported less symptoms of depression and anxiety ($p \leq .001$), a lower impact of fatigue ($p \leq .001$) and showed higher information processing speed ($p = .003$).

Of the participants with MS using immunomodulatory treatment, 29.9% used interferons, 22.5% glatiramer acetate, 10.7% teriflunomide, 18.2% dimethylfumarate, 7.0% natalizumab, 11.2% fingolimod and 0.5% alemtuzumab.

3.2. Correlates of work status, absenteeism and consideration to reduce work hours in persons with RRMS

Univariate relations between the independent variables and each dependent variable are presented in Appendix A. All independent variables that were associated with the dependent variable at $p \leq .10$ were entered in the regression models.

The multivariate logistic regression for work status (Table 3) revealed a significant model when adding MS-related disability, depression, anxiety, impact of fatigue and information processing speed (Model $\chi^2(5) = 32.93$, $p \leq .001$; $R^2 = 0.13$). A higher level of depression

Table 2
Demographic, occupational and neuropsychological characteristics of the healthy controls.

	Mean / Median / *N*	SD / IQR / %	Range	*N*
Demographic characteristics				
Female[a]	42	70.0%	–	60
Age[b]	45.0	16.0	20–64	60
High educational level	30	50.0%	–	60
Medium educational level	27	45.0%	–	60
Low educational level	3	5.0%	–	60
Occupational characteristics				
Paid job[a]	58	96.7%	–	60
Working hours/ week[b]	36.0	11.0	12–70	58
Presenteeism (1–10)[b]	1.0	1.0	1–8	58
Work role functioning (WRFQ-2.0; 0–100)[b]	90.6	66.9	0–100	58
Work ability (WAI; 0–10)[b]	8.5	1.0	0–10	58
Work difficulties (MSWDQ; 0–100)[b]	6.5	13.0	0–41	58
Personality				
Neuroticism (12–60)[c]	26.6	7.0	15–47	60
Extraversion (12–60)[b]	45.0	7.0	23–55	60
Openness (12–60)[b]	39.5	8.0	26–54	60
Agreeableness (12–60)[b]	46.5	8.0	28–54	60
Conscientiousness (12–60)[b]	47.0	7.8	39–60	60
Neuropsychological characteristics				
Depression (HADS depression; 0–21)[b]	1.0	2.0	0–10	60
Anxiety (HADS anxiety; 0–21)[b]	4.0	2.0	1–12	60
Fatigue (MFIS; 0–84)[c]	20.3	12.9	0–66	60
Information processing speed (SDMT; 0–110)[b]	58.5	11.0	39–73	60

SD: standard deviation; IQR: interquartile range; EDSS: Expanded Disability Status Scale; WRFQ-2.0: Work Role Functioning Questionnaire-2.0; WAI: Work Ability Index; MSWDQ: Multiple Sclerosis Work Difficulties Questionnaire; HADS: Hospital Anxiety and Depression Scale; MFIS: Modified Fatigue Impact Scale; SDMT: Symbol Digit Modalities Test. Sample sizes (N) differ depending on the number of participants that completed the examination or questionnaire.
[a] N(%).
[b] Median (IQR).
[c] Mean (SD).

Table 3
Results of the multivariate logistic regression analysis for work status (not having a paid job (0) versus having a paid job (1)) ($N = 239$).

	B	SE	95% CI	Odds ratio	*p*
Model 1					
Constant	3.82	1.70			0.03
MS-related disability	−0.16	0.17	0.62–1.19	0.86	0.35
Depression	−0.22	0.08	0.69–0.95	0.81	0.008*
Anxiety	0.15	0.08	0.99–1.35	1.16	0.065
Impact of fatigue	−0.05	0.02	0.92–0.99	0.95	0.005*
Information processing speed	0.01	0.03	0.96–1.06	1.01	0.63
Model 2					
Constant	2.82	3.47			0.42
MS-related disability	−0.14	0.17	0.62–1.22	0.87	0.42
Depression	−0.25	0.10	0.65–0.95	0.78	0.01*
Anxiety	0.15	0.09	0.97–1.40	1.17	0.10
Impact of fatigue	−0.05	0.02	0.92–0.99	0.95	0.008*
Information processing speed	0.01	0.03	0.96–1.07	1.01	0.59
Neuroticism	0.01	0.05	0.92–1.10	1.01	0.89
Extraversion	−0.03	0.05	0.89–1.06	0.97	0.56
Conscientiousness	0.04	0.05	0.95–1.14	1.04	0.40

Model 1: $R^2 = 0.13$ (Cox & Snell), $R^2 = 0.24$ (Nagelkerke). Model $X^2(5)=32.93$, $p \leq .001$.
Model 2: $R^2 = 0.13$ (Cox & Snell), $R^2 = 0.25$ (Nagelkerke). Model $X^2(8)=33.79$, $p \leq .001$. ΔModel 2–1 × $^2(3)=0.86$, $p = .83$. *$p \leq .01$.

(B = -0.22, $p = .008$) and a higher impact of fatigue (B = -0.05, $p = .005$) were associated with not having a paid job. The second model, adding the personality traits neuroticism, extraversion and conscientiousness did not significantly add to the prediction of work status (Block $\chi^2(3) = 0.86$, $p = .83$).

The multivariate logistic regression for absenteeism (Table 4) revealed a significant model when adding age, MS-related disability, depression, anxiety and impact of fatigue (Model $\chi^2(5) = 33.34$, $p \leq .001$; $R^2 = 0.15$). A higher impact of fatigue (B = -0.05, $p = .008$) was associated with a higher chance of absenteeism from work in the past week. The second model, adding the personality trait neuroticism, did not significantly add to the prediction of absenteeism (Block $\chi^2(1) = 0.00$, $p = .99$).

The multivariate logistic regression for considering to reduce work hours (Table 5) revealed a significant model when adding gender, depression, anxiety and impact of fatigue (Model $\chi^2(4) = 27.11$, $p \leq .001$; $R^2 = 0.12$). Higher levels of depression (B = -0.21, $p = .01$) and a higher impact of fatigue (B = -0.04, $p = .009$) were associated with a higher chance of considering to reduce work hours. The second model, adding the personality traits neuroticism and extraversion, did not significantly add to the prediction of considering to reduce work hours (Block $\chi^2(2) = 0.44$, $p = .80$).

Sensitivity analyses using z-scores for personality traits, depression, anxiety, impact of fatigue and information processing speed scores (based on the mean and SD of the control group) revealed similar results in terms of model parameters and significant predictors (results not shown, available upon request).

3.3. Correlates of presenteeism, work role functioning, work ability and work difficulties in persons with RRMS

Univariate relations between the independent variables and each dependent variable are presented in Appendix B. All independent variables that were associated with the dependent variable at $p \leq .10$ were entered in the regression models.

The multivariate linear regression analysis for presenteeism (Table 6) revealed a significant model when adding MS-related disability, depression, anxiety, impact of fatigue and information processing speed ($F(5,202) = 22.00$, $p \leq .001$; $R^2 = 0.35$). A higher impact of fatigue ($\beta = 0.46$, $p = .001$) was associated with more presenteeism. The second model, adding the personality traits neuroticism, extraversion and conscientiousness did not significantly add to the prediction of presenteeism ($\Delta R^2 = 0.01$, $p = .44$).

Table 4
Results of the multivariate logistic regression analysis for absenteeism (self-reported absenteeism in the past week due to MS (0) versus no self-reported absenteeism in the past week due to MS (1)) ($N = 210$).

	B	SE	95% CI	Odds ratio	p
Model 1					
Constant	2.72	1.12			0.02
Age	0.05	0.02	1.00–1.10	1.05	0.05
MS-related disability	−0.18	0.17	0.60–1.18	0.84	0.31
Depression	−0.11	0.08	0.77–1.05	0.90	0.17
Anxiety	−0.04	0.07	0.84–1.10	0.96	0.55
Impact of fatigue	−0.05	0.02	0.92–0.99	0.95	0.008*
Model 2					
Constant	2.73	1.38			0.05
Age	0.05	0.02	1.00–1.10	1.05	0.05
MS-related disability	−0.18	0.17	0.60–1.18	0.84	0.31
Depression	−0.11	0.08	0.77–1.05	0.90	0.19
Anxiety	−0.04	0.08	0.82–1.12	0.96	0.61
Impact of fatigue	−0.05	0.02	0.92–0.99	0.95	0.009*
Neuroticism	−0.001	0.04	0.93–1.08	1.0	0.99

Model 1: $R^2 = 0.15$ (Cox & Snell), $R^2 = 0.25$ (Nagelkerke). Model $X^2(5)=33.34$, $p \leq .001$.
Model 2: $R^2 = 0.15$ (Cox & Snell), $R^2 = 0.25$ (Nagelkerke). Model $X^2(6)=33.34$, $p \leq .001$. ΔModel 2–1 $\times$ $^2(1)=0.00$, $p = .99$. *$p \leq .01$.

Table 5
Results of the multivariate logistic regression analysis for considering to reduce work hours (0) versus not considering to reduce work hours (1) ($N = 210$).

	B	SE	95% CI	Odds ratio	p
Model 1					
Constant	5.19	6.01			0.001*
Gender	−1.37	5.96	−19.6- -0.09	0.25	0.05
Depression	−0.21	0.09	−0.41- -0.05	0.81	0.01*
Anxiety	0.06	0.09	−0.11- 0.26	1.06	0.49
Impact of fatigue	−0.04	0.02	−0.08- -0.01	0.96	0.009*
Model 2					
Constant	4.67	6.51			0.07
Gender	−1.38	5.97	−19.7- -0.10	0.25	0.05
Depression	−0.18	0.12	−0.47-0.03	0.84	0.10
Anxiety	0.07	0.10	−0.09-0.29	1.07	0.43
Impact of fatigue	−0.04	0.02	−0.08- -0.004	0.96	0.01*
Neuroticism	−0.02	0.05	−0.11-0.08	0.98	0.72
Extraversion	0.02	0.06	−0.09-0.12	1.02	0.69

Model 1: $R^2 = 0.12$ (Cox & Snell), $R^2 = 0.22$ (Nagelkerke). Model $X^2(4)=27.11$, $p \leq .001$.
Model 2: $R^2 = 0.12$ (Cox & Snell), $R^2 = 0.23$ (Nagelkerke). Model $X^2(6)=27.55$, $p \leq .001$. ΔModel 2–1 $\times$ $^2(2)=0.44$, $p = .80$. We included 95% bootstrapping confidence intervals (95% CI) based on 1000 samples. *$p \leq .01$.

Table 6
Results of the multivariate linear regression analysis for presenteeism ($N = 208$).

	B	SE	95% CI	Beta	p
Step 1					
Constant	−0.26	1.14			0.82
MS-related disability	0.21	0.13	−0.02-0.46	0.12	0.10
Depression	−0.01	0.06	−0.15-0.13	−0.02	0.82
Anxiety	0.11	0.07	−0.03-0.24	0.16	0.12
Impact of fatigue	0.07	0.01	0.05–0.09	0.46	≤0.001*
Information processing speed	−0.004	0.02	−0.04-0.03	−0.02	0.83
Step 2					
Constant	−3.05	2.44			0.22
MS-related disability	0.24	0.14	−0.02-0.52	0.13	0.09
Depression	−0.003	0.07	−0.13-0.14	−0.004	0.96
Anxiety	0.09	0.07	−0.06-0.20	0.13	0.22
Impact of fatigue	0.07	0.01	0.05–0.10	0.48	≤0.001*
Information processing speed	−0.004	0.02	−0.04-0.03	−0.02	0.83
Neuroticism	0.02	0.03	−0.04-0.08	0.06	0.57
Extraversion	0.003	0.03	−0.05-0.06	0.01	0.91
Conscientiousness	0.05	0.03	−0.02-0.11	0.11	0.17

$R^2 = 0.35$ for Step 1 ($p \leq .001$); $R^2 = 0.36$ for Step 2 ($p \leq .001$); $\Delta R^2 = 0.009$ for step 2 ($p = .44$). We included 95% bias corrected and accelerated confidence intervals (95% CI) and standard errors based on 1000 bootstrapping samples. *$p \leq .01$.

The multivariate linear regression analysis for work role functioning (Table 7) revealed a non-significant model when adding depression, anxiety and impact of fatigue ($F(3,136) = 2.60$, $p = .056$; $R^2 = 0.05$). The second model, adding the personality traits neuroticism, extraversion and agreeableness did not significantly add to the prediction of work role functioning ($\Delta R^2 = 0.04$ for step 2, $p = .13$).

The multivariate linear regression analysis for work ability (Table 8) revealed a significant model when adding MS-related disability, depression, anxiety and impact of fatigue ($F(4,168) = 14.29$, $p \leq .001$; $R^2 = 0.25$). A higher impact of fatigue ($\beta = -0.36$, $p = .001$) was associated with lower work ability. The second model, adding the

Table 7
Results of the multivariate linear regression analysis for work role functioning ($N = 140$).

	B	SE	95% CI	Beta	p
Step 1					
Constant	88.11	7.03			0.001*
Depression	−0.76	1.06	−2.92-1.22	−0.08	0.48
Anxiety	−0.09	0.93	−1.90-1.91	−0.01	0.92
Impact of fatigue	−0.34	0.21	−0.72-0.14	−0.18	0.12
Step 2					
Constant	29.90	41.10			0.48
Depression	0.32	1.15	−2.04-2.69	0.03	0.78
Anxiety	−0.27	1.02	−2.17-1.74	−0.03	0.79
Impact of fatigue	−0.27	0.21	−0.65-0.19	−0.14	0.22
Neuroticism	0.02	0.53	−0.92-1.07	0.006	0.97
Extraversion	1.02	0.47	0.15–1.95	0.22	0.03
Agreeableness	0.24	0.60	−0.83-1.25	0.04	0.71

$R^2 = 0.05$ for Step 1 ($p = .06$); $R^2 = 0.09$ for Step 2 ($p = .04$); $\Delta R^2 = 0.04$ for step 2 ($p = .13$). We included 95% bias corrected and accelerated confidence intervals (95% CI) and standard errors based on 1000 bootstrapping samples. *$p \leq .01$.

Table 8
Results of the multivariate linear regression analysis for work ability ($N = 173$).

	B	SE	95% CI	Beta	p
Step 1					
Constant	9.72	0.48			0.001*
MS-related disability	−0.17	0.12	−0.40-0.07	−0.09	0.17
Depression	−0.02	0.07	−0.16-0.08	−0.02	0.80
Anxiety	−0.10	0.07	−0.23-0.06	−0.17	0.17
Impact of fatigue	−0.05	0.01	−0.08- -0.02	−0.36	0.001*
Step 2					
Constant	6.73	2.22			0.003*
MS-related disability	−0.15	0.12	−0.39-0.11	−0.08	0.23
Depression	0.02	0.08	−0.14-0.14	0.02	0.83
Anxiety	−0.13	0.09	−0.27-0.06	−0.22	0.12
Impact of fatigue	−0.05	0.01	−0.08- -0.02	−0.35	0.001*
Neuroticism	0.02	0.03	−0.04-0.08	0.08	0.51
Extraversion	0.04	0.03	−0.01-0.09	0.12	0.09
Agreeableness	0.01	0.04	−0.05-0.09	0.03	0.76

$R^2 = 0.25$ for Step 1 ($p \leq .001$); $R^2 = 0.27$ for Step 2 ($p \leq .001$); $\Delta R^2 = 0.01$ for step 2 ($p = .48$). We included 95% bias corrected and accelerated confidence intervals (95% CI) and standard errors based on 1000 bootstrapping samples. *$p \leq .01$.

personality traits neuroticism, extraversion and agreeableness did not significantly add to the prediction of work ability ($\Delta R^2 = 0.01$ for step 2, $p = .48$).

The multivariate linear regression analysis for work difficulties (Table 9) revealed a significant model when adding MS-related disability, depression, anxiety, impact of fatigue and information processing speed ($F(5,202) = 47.47$, $p \leq .001$; $R^2 = 0.54$). A higher level of anxiety ($\beta = 0.25$, $p = .001$) and a higher impact of fatigue ($\beta = 0.46$, $p = .001$) were associated with more work difficulties. The second model, adding the personality traits neuroticism, extraversion, agreeableness and conscientiousness did not significantly add to the prediction of work difficulties ($\Delta R^2 = 0.002$ for step 2, $p = .90$).

Sensitivity analyses using z-scores for personality traits, depression, anxiety, impact of fatigue and information processing speed scores (based on the mean and SD of the control group) revealed similar results in terms of model parameters and significant predictors (results not shown, available upon request).

4. Discussion

The current study examined the relationship between the Five Factor Model personality traits and occupational functioning in persons with RRMS. We were interested in examining whether personality explains additional variance in occupational functioning over known disease-related and demographic correlates, i.e. MS-related disability, use of immunomodulatory treatment, impact of fatigue, depression, anxiety, information processing speed, age and gender.

Table 9
Results of the multivariate linear regression analysis for work difficulties ($N = 208$).

	B	SE	95% CI	Beta	p
Step 1					
Constant	−3.47	4.68	−13.43-6.76		0.44
MS-related disability	0.98	0.56	−0.18-2.00	0.09	0.08
Depression	0.55	0.33	−0.07-1.24	0.12	0.11
Anxiety	1.00	0.27	0.40–1.53	0.25	0.001*
Impact of fatigue	0.42	0.05	0.32–0.50	0.46	0.001*
Information processing speed	−0.04	0.07	−0.18-0.10	−0.02	0.59
Step 2					
Constant	6.18	12.50	−17.89-29.25		0.61
MS-related disability	0.94	0.57	−0.30-2.15	0.09	0.09
Depression	0.52	0.33	−0.13-1.28	0.11	0.12
Anxiety	1.05	0.28	0.46–1.56	0.26	0.001*
Impact of fatigue	0.42	0.06	0.32–0.51	0.46	0.001*
Information processing speed	−0.03	0.07	−0.17-0.11	−0.02	0.69
Neuroticism	−0.06	0.14	−0.31-0.25	−0.03	0.65
Extraversion	−0.05	0.14	−0.35-0.23	−0.02	0.76
Agreeableness	−0.13	0.16	−0.45-0.18	−0.04	0.38
Conscientiousness	−0.01	0.15	−0.31-0.33	−0.004	0.95

$R^2 = 0.54$ for Step 1 ($p \leq .001$); $R^2 = 0.54$ for Step 2 ($p \leq .001$); $\Delta R^2 = 0.002$ for step 2 ($p = .90$). We included 95% bias corrected and accelerated confidence intervals (95% CI) and standard errors based on 1000 bootstrapping samples. *$p \leq .01$.

First of all, we discovered that personality traits were not associated with occupational functioning in MS when correcting for MS-related disability, impact of fatigue, depression, anxiety and information processing speed. Secondly, we discovered that the impact of fatigue was the main and most significant correlate of occupational functioning. A higher impact of fatigue was associated with not having a paid job, a higher chance of absenteeism, a higher chance of considering to reduce work hours due to MS, more presenteeism, worse work ability and more work difficulties. Thirdly, more symptoms of depression were associated with worse occupational functioning in terms of not having a paid job and a higher chance of considering to reduce work hours, and more symptoms of anxiety were associated with more work difficulties, but always in combination with a higher impact of fatigue. Finally, it should be noted that in the multivariate models, age, gender, use of immunomodulatory treatment, MS-related disability and information processing speed did *not* contribute significantly in explaining occupational functioning.

4.1. Personality traits in relation to occupational functioning

The current study demonstrates that personality traits were not associated with occupational functioning in persons with MS when correcting for known disease-related correlates. No multivariate relations were found, despite the fact that significant univariate relations were observed between occupational functioning and neuroticism, extraversion, agreeableness and conscientiousness. We will first describe our findings in relation to our hypotheses.

We expected higher levels of neuroticism and lower levels of extraversion and conscientiousness to be related to worse occupational functioning in persons with MS. These hypotheses were falsified in our multivariate models. Previous studies did find associations between lower levels of extraversion and higher occupational stress in MS [27], between more persistence -a component of conscientiousness- and having a paid job [29] and between lower informant-reported

conscientiousness and vocational disability in MS [28]. Additionally, a recent prospective study found that baseline conscientiousness was an important predictor of a deterioration in employment status over three years in persons with MS [45]. Most of these studies also corrected for fatigue, depression and anxiety. An important feature of the current study is that our study group consisted of persons with a relapsing-remitting disease course, short disease duration and low disability. When reported, the level of physical disability and disease duration were indeed higher in the above mentioned studies than in the current study. Previous studies also included persons with progressive MS, while we included only persons with RRMS. So, we think that the specific characteristics of our study group may explain the discrepant findings.

We specifically focused on measures of perceived occupational functioning and found that the impact of fatigue mainly explained occupational functioning together with depression and anxiety. An interesting review article by Schreiber and colleagues [21] concludes that, especially in the early stages of MS, fatigue may be influenced by personality traits, such as more neuroticism and less extraversion. These personality traits are presumed to lead to inadequate disease coping, including emotional reactions such as negative feelings, negative cognitions and anxiety, eventually resulting in fatigue. Therefore it can be imagined that fatigue, depression and anxiety -as constructs related to personality- explained most variance in occupational functioning in our sample of mildly disabled persons with RRMS. It would be very interesting to examine whether personality does have an additional influence on occupational functioning in persons with MS in more advanced disease stages or with progressive MS. Furthermore, additional studies are needed to examine the association between personality traits and (future) occupational functioning using more objective measures of occupational functioning.

4.2. Impact of fatigue, depression and anxiety in relation to occupational functioning

The impact of fatigue contributed significantly in explaining occupational functioning in 6 of the 7 multivariate models. A higher impact of fatigue was associated with a higher chance of not having a paid job, being absent from work in the past week due to MS, considering to reduce work hours, more presenteeism, worse work ability and more work difficulties. Previous studies support our findings in that strong evidence has been found for the relationship between the self-reported (impact of) fatigue and occupational functioning in persons with MS [6,46–48]. Furthermore, studies into the origins of MS-related fatigue have linked fatigue to brain pathology in MS, as well as secondary factors such as disability level, pain, depression, anxiety, personality and cognitive problems [21,49]. All these secondary factors have themselves been linked with occupational functioning in MS [6]. Interestingly, the current study found the impact of fatigue to be an independent correlate of occupational functioning over and above the influence of disease-related factors such as disability level, depression, anxiety and processing speed [21]. We additionally found that more symptoms of depression (in combination with a higher impact of fatigue) were associated with a lower chance of having a paid job and a higher chance of considering to reduce work hours. More symptoms of anxiety were associated with experiencing more work difficulties, also in combination with a higher impact of fatigue. Previous studies in MS reported associations between more symptoms of depression and either unemployment or a higher probability to quit working, but limited evidence has been found so far for associations between symptoms of anxiety and occupational functioning [6].

Our findings are clinically relevant, in that the management of fatigue and mood are of the utmost importance in optimizing occupational functioning in persons with MS.

4.3. Demographic characteristics, MS-related disability, use of immunomodulatory treatment and information processing speed in relation to occupational functioning

It is important to note that age, gender, use of immunomodulatory treatment, MS-related disability and information processing speed did *not* contribute in explaining occupational functioning in the multivariate models, despite finding several univariate relations. Strong evidence has been found previously that gender, age, information processing speed and MS-related disability are determinants of work-related difficulties in MS [6]. The discrepancy in findings may be due to our relatively mildly disabled sample in terms of physical and cognitive disability as mentioned above. Furthermore, it should be noted that we included measures of occupational functioning that are mostly based on self-report, while MS-related disability and information processing speed are behavioral measures. One interpretation could be that self-report measures tend to predict self-report measures, as these might be similarly influenced by mood and memory bias [50], while weak correlations have been observed between self-report and behavioral measures of the same construct [51].

Our results do suggest that, in persons with RRMS, the impact of fatigue and mood contribute more in explaining occupational functioning than age, gender, use of immunomodulatory treatment, MS-related disability and information processing speed.

4.4. Strengths and limitations

Strengths of the current study include the relatively large sample of persons with RRMS, the use of multiple measures of occupational functioning and the inclusion of a large number of influential disease-related factors (MS-related disability, impact of fatigue, depression, anxiety and information processing speed). Limitations include the low percentage of participants not having a paid job (12.9%), which may hamper the comparison of our findings with studies that examined differences between employed and unemployed persons with MS. We excluded persons with a psychiatric disorder from participation, meaning that our sample was relatively 'healthy' in terms of psychopathology. We used self-report measures of occupational functioning, which may be susceptible to interpretation, mood and memory bias. Future studies might therefore strive to include more objective reports of occupational functioning, for example by including records of absenteeism and occupational functioning as reported by the supervisor. These objective measures could then be used in addition to self-report measures, because self-reported occupational functioning in itself is an important determinant of work outcomes, such as absenteeism, retirement and disability leave [52].

We would have liked to examine personality type D, but decided to analyse separate personality traits, as to our knowledge there is no widely accepted method to deduct personality types from the NEO-FFI alone.

Moreover, and perhaps more importantly, it should be noted that the explained variance of the various measures of occupational functioning ranged from 5% to 54%, and that the variables included in the models were not able to fully capture occupational functioning. We therefore suggest to include more contextual measures in future studies, such as the values and mission of the organisation with respect to inclusiveness of the workplace [53], job resources and demands, work modifications and work-home balance [6].

As a final remark, given the cross-sectional nature of the current study, it is difficult to determine whether a higher impact of fatigue, depression and anxiety are the cause or the result of [changes in] occupational functioning. Future prospective research might focus on examining changes in occupational functioning over time, to see whether disease-related and contextual factors are predictive of future occupational outcomes.

5. Conclusions

The current study demonstrates that personality traits were not associated with self-reported occupational functioning in persons with RRMS when correcting for known disease-related correlates. The perceived impact of fatigue appears to be the main and most significant correlate of occupational functioning explaining most variance in occupational functioning. In addition we found that symptoms of depression and anxiety contributed significantly in explaining work status, considering to reduce work hours and MS-related work difficulties, in combination with a higher impact of fatigue.

It should be noted that the explained variance of the multivariate models was limited. This emphasizes the need to look into other than demographic factors, personality and disease-related factors when considering occupational challenges in persons with MS. These may include more contextual measures, such as the values and mission of the organisation with respect to inclusiveness of the workplace, job resources and demands, work modifications, and work-home balance.

Even though the contribution of the impact of fatigue and mood may be limited within the multifactorial puzzle of occupational challenges encountered by persons with MS, they can potentially be treated or dealt with during personalized rehabilitation and coaching. Our findings may in the future implicate the need for timely and hands-on coaching within the workplace in order to minimize the influence of fatigue and symptoms of depression and anxiety. Future studies should preferably include an occupational assessment that considers the impact of fatigue and mood.

Authors statement

KvdH, DvG, EvE, MR, JvdK, EA, EB, KdG, MH and HM declare no conflicts of interest.

P. J. Jongen received honoraria from Bayer Netherlands for consulting activities.

J.J.J. van Eijk received honoraria for lectures and honoraria for advisory boards from Sanofi Genzyme, Roche, Merck Serono, Novartis and Teva.

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Appendix A. Univariate relations between demographic variables, disease-related variables, personality traits and work status, absenteeism and consideration to reduce work hours

	Work status	Absenteeism	Considering to reduce work hours
Age	U = 3132.5, z = −0.338, p = .735	U = 2340.0, z = −2.011, p = .044**	U = 2138.0, z = −1.371, p = .171
MS-related disability	U = 2195.5, z = −2.969, p = .003***	U = 2399.5, z = −1.858, p = .063*	U = 2100.0, z = −1.522, p = .128
Depression	U = 1672.5, z = −4.421, $p \leq$ .001***	U = 1668.0, z = −4.145, $p \leq$ .001***	U = 1379.0, z = −3.966, $p \leq$ .001***
Anxiety	U = 2619.0, z = −1.766, p = .077*	U = 1860.5, z = −3.512, $p \leq$ .001***	U = 1699.0, z = −2.856, P = .004***
Impact of fatigue	t(239) = 4.837, $p \leq$ .001***	t(208) = 5.025, $p \leq$ .001***	t(208) = 4.168, $p \leq$ .001***
Information processing speed	t(239) = −2.146, p = .033**	t(208) = −1.095, p = .275	t(208) = −0.760, p = .448
Neuroticism	t(239) = 2.240, p = .026**	t(208) = 3.207, p = .002***	t(208) = 2.989, p = .003***
Extraversion	U = 2375.5, z = −2.430, p = .015**	U = 2535.5, z = −1.409, p = .159	U = 1754.5, z = −2.655, p = .008**
Openness	t(239) = −0.582, p = .561	t(208) = 1.624, p = .106	t(208) = 0.955, p = .341
Agreeableness	U = 2946.5, z = −0.854, p = .393	U = 2639.5, z = −1.090, P = .276	U = 2329.5, z = −0.732, P = .464
Conscientious-ness	t(239) = −2.546, p = .012**	t(208) = −1.409, p = .160	t(208) = −0.540, p = .590
Gender	X^2(1)=0.704, p = .819	X^2(1)=1.376, p = .368	X^2(1)=4.318, p = .049**
Use of immunomodulatory treatment	X^2(1)=0.627, p = .646	X^2(1)=0.430, p = .652	X^2(1)=0.004, p = 1.000

*$p \leq$ .10, **$p \leq$ .05, ***$p \leq$ .01.

Appendix B. Univariate relations between demographic variables, disease-related variables, personality traits and presenteeism, work role functioning, work ability and work difficulties

	Presenteeism	Work role functioning	Work ability	Work difficulties
Age	$r_s = -0.055$, $p = .427$	$r_s = 0.078$, $p = .363$	$r_s = -0.087$, $p = .253$	$r_s = -0.005$, $p = .939$
MS-related disability	$r_s = 0.229$, $p = .001$***	$r_s = -0.015$, $p = .865$	$r_s = -0.213$, $p = .005$***	$r_s = 0.211$, $p = .002$***
Depression	$r_s = 0.396$, $p \leq .001$***	$r_s = -0.367$, $p \leq .001$***	$r_s = -0.448$, $p \leq .001$***	$r_s = 0.555$, $p \leq .001$***
Anxiety	$r_s = 0.392$, $p \leq .001$***	$r_s = -0.323$, $p \leq .001$***	$r_s = -0.334$, $p \leq .001$***	$r_s = 0.546$, $p \leq .001$***
Impact of fatigue	$r = 0.573$, $p \leq .001$***	$r = -0.220$, $p = .009$***	$r = -0.474$, $p \leq .001$***	$r = 0.671$, $p \leq .001$***
Information processing speed	$r = -0.133$, $p = .055$*	$r = 0.041$, $p = .634$	$r = 0.075$, $p = .327$	$r = -0.156$, $p = .024$*
Neuroticism	$r = 0.331$, $p \leq .001$***	$r = -0.196$, $p = .020$*	$r = -0.278$, $p \leq .001$***	$r = 0.448$, $p \leq .001$***
Extraversion	$r_s = -0.221$, $p = .001$***	$r_s = 0.351$, $p \leq .001$***	$r_s = 0.328$, $p \leq .001$***	$r_s = -0.290$, $p \leq .001$***
Openness	$r = 0.028$, $p = .683$	$r = 0.032$, $p = .706$	$r = -0.037$, $p = .633$	$r = 0.042$, $p = .544$
Agreeableness	$r_s = 0.019$, $p = .786$	$r_s = 0.232$, $p = .006$***	$r_s = 0.138$, $p = .071$*	$r_s = -0.193$, $p = .005$***
Conscientiousness	$r = -0.138$, $p = .045$**	$r = 0.110$, $p = .195$	$r = 0.070$, $p = .362$	$r = -0.293$, $p \leq .001$***
Gender	U = 3272.0, z = −1.566, $p = .117$	U = 1753.5, z = −0.059, $p = .953$	U = 2352.5, z = −0.617, $p = .537$	U = 3577.0, z = −0.691, $p = .490$
Use of immunomodulatory treatment	U = 3423.5, z = −0.985, $p = .325$	U = 1834.5, z = −0.014, $p = .988$	U = 2573.5, z = −0.317, $p = .751$	U = 3391.5, z = −1.045, $p = .296$

*$p \leq .10$, **$p \leq .05$, ***$p \leq .01$.

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