Euphoria in Multiple Sclerosis, Myasthenia Gravis, and Neuropsychiatric Systemic Lupus Erythematosus

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List of Abbreviations

AChRs	Acetylcholine Receptors
AI	Awareness Interview
ANOVA	Analysis of Variance
BDI-FS	Beck Depression Inventory – Fast Screen
BVMT-R	Brief Visual Memory Test-Retrieval
CNS	Central Nervous System
COWAT	Controlled Oral Word Association Test
CW	Cottrell and Wilson
CWIT	Colour Word Interference Task
D-KEFS ST	Delis-Kaplan Executive Function System Sorting Test
HC	Healthy Controls
ISS	Internal State Scale
KMO	Kaiser-Meyer-Olkin
LOT-R	Life Orientation Test – Revised
MG	Myasthenia Gravis
MRI	Magnetic Resonance Imaging
MS	Multiple Sclerosis
NMJ	Neuromuscular Junction
NPI	Neuropsychiatric Inventory
NP-SLE	Neuropsychiatric Systemic Lupus Erythematosus
OPS	Optimism and Pessimism Scale
PANAS	Positive and Negative Affect Scale
PCRS	Patient Competency Rating Scale
RAVLT	Rey Auditory Verbal Learning Test
ROCF	Rey-Osterrieth Complex Figure
SES	Socioeconomic Status
SPSS	Statistical Package for the Social Sciences

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Research Report

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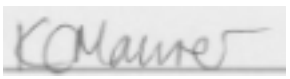
SIGNATURE: 

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Abstract

Multiple sclerosis (MS), neuropsychiatric systemic lupus erythematosus (NP-SLE), and myasthenia gravis (MG) are chronic inflammatory autoimmune diseases, the former two of which affect the central nervous system and include cognitive dysfunction, and the latter of which affects the peripheral nervous system and does not include cognitive dysfunction. The current study was concerned with understanding the reasons for euphoria in MS. Therefore, MG and NP-SLE patients were used as control groups to determine whether euphoria occurs due to the autoimmune nature of the disease, cognitive impairment, or simply is something specific to MS. Euphoria is defined as having three sub-types, namely euphoria sclerotica (positive mood), eutonia sclerotica (physical well-being/unawareness of physical deficits), and spes sclerotica (optimism) (Cottrell & Wilson, 1926). This was the classical measure in this study. Modern measures for euphoria sclerotica (*ISS*, *PANAS*, *NPI*), eutonia sclerotica (*NPI*, physical- and cognitive ability awareness), and spes sclerotica (*OPS*, *LOT-R*) were also included. 10 MS, 10 NP-SLE, and 10 MG patients were examined and compared to 10 healthy controls. The groups were matched on demographics through stratification. Statistical analyses revealed significant between-group differences for classical eutonia sclerotica, modern euphoria sclerotica on the *ISS*, and modern spes sclerotica on the *LOT-R*. In terms of cognitive impairment, some groups differed significantly on visual memory and verbal recognition. Spearman's correlations indicated that some of the cognitive variables correlated significantly and positively but also negatively with the classical and modern euphoria sub-types. Even though the findings were mixed, some of the hypotheses were supported, such as that euphoria sclerotica was present in MS and NP-SLE patients, cognitive impairment was found in NP-SLE patients, and that cognitive impairment in NP-SLE patients was related to the three sub-types of euphoria. This revealed that euphoria in MS might be due to the autoimmune nature of the disease.

Keywords: Multiple sclerosis; Myasthenia gravis; Neuropsychiatry; Systemic lupus erythematosus; Autoimmune disease; Cognitive impairment; Euphoria sclerotica; Eutonia sclerotica; Spes sclerotica

Introduction

Autoimmune diseases such as multiple sclerosis (MS), myasthenia gravis (MG), and systemic lupus erythematosus (SLE) have deteriorating effects on the nervous system (Cantor, 2010; Cottrell & Wilson, 1926; Diaz-Olavarrieta, Cummings, Velazquez, & de la Cadena, 1999; Finger, 1998; Nived, Sturfelt, Liang, & de Pablo, 2003; Skeel, Johnstone, Yangco, Walker, & Komatireddy, 2000). MS affects the central nervous system (CNS), MG the peripheral nervous system, and SLE the central, peripheral, and autonomic nervous system. Since the 1800s, research into MS has reported symptoms of mood as part of the disease (Benedict et al., 2005; Benedict, Shucard, Zivadinov, & Shucard, 2008; Cottrell & Wilson, 1926; Finger, 1998; Fishman, Benedict, Bakshi, Priore, & Weinstock-Guttman, 2004; Scott, Chieffe, & Burgut, 1999; Surridge, 1969). This study investigated the euphoria found in MS patients and the possible contribution of the autoimmune nature of the disease to this symptom. To investigate this, a group with MG, a group with neuropsychiatric (NP) SLE, and a group with healthy controls (HC) were recruited and used as control groups.

Multiple sclerosis, myasthenia gravis, and systemic lupus erythematosus

In autoimmune disease, one's own immune system attacks the self-tissues, mistaking them for foreign, intruding pathogens (Benedict et al., 2008). Therefore, instead of offering protection, the immune cells injure and can destroy multiple organ systems (Benedict et al., 2008).

MS is an inflammatory disease of the CNS, which is characterized by degeneration of myelin, hard plaque formation, and white and grey matter atrophy, and which can cause damage to the cerebral hemispheres, cerebellum, optic nerves, brainstem, and the spinal cord (Benedict et al., 2008; Cantor, 2010; Cottrell & Wilson, 1926; Diaz-Olavarrieta et al., 1999; Figved et al., 2005; Finger, 1998). It is predominantly known as a subcortical or white matter disease, as the demyelination affects the axons (Benedict et al., 2008). Damage to the white matter disrupts action potential propagation, which can result in a variety of cognitive, mood, and physical symptoms (Benedict et al., 2008; Cottrell & Wilson, 1926; Finger, 1998). However, recently, cortical and deep grey matter atrophy has also been found to be involved in these symptoms (Benedict et al., 2008). In MS, cognitive symptoms can include difficulties with memory, attention, and general slowed processing speed. Symptoms of mood can include euphoria and depression (Benedict et al., 2005; Cottrell & Wilson, 1926; Figved et al., 2005; Fishman et al., 2004; Horrobin, & Bennett, 1999; Scott et al., 1999; Surridge, 1969). A

variety of physical deficits can also occur, including visual problems, sensory-motor impairment, and fatigue (Cantor, 2010).

Fatigue is also central to MG (Cantor, 2010). MG is an acquired autoimmune disorder of the neuromuscular junction (NMJ), which is situated where the peripheral nerves meet the muscles (Cantor, 2010; Dönmez et al., 2004; Gilhus, 2012; Wolfe, Meriggioli, Ciafaloni, & Ruff, 2012). The basic abnormality observed in MG is a decrease in acetylcholine receptors (AChRs) at the NMJ, which results from an autoantibody attack (Dönmez et al., 2004). MG leads to a failure of neuromuscular transmission, as the peripheral nerve is hindered in travelling to the muscle terminal, i.e. there is a breakdown in communication between the neural input and muscle contraction (Wolfe et al., 2012). Sensory-motor deficits are therefore something MS and MG have in common. The physical problems that patients with MG may experience are mainly due to muscle weakness and can include limb weakness, ptosis, dysarthria, dysphagia, diplopia, respiratory problems, and difficulties with chewing (Burns, 2012). Negative mood states such as depression are common in MG, and little has been documented regarding positive mood such as euphoria (Cantor, 2010; Cavalcante, Bernasconi, & Mantegazza, 2012). Compared to MS, the deficits seen in MG do not involve cognitive impairment.

SLE, however, can involve cognitive impairment (Benedict et al., 2008). SLE is a chronic multisystem disease, which affects many different tissues and organs and therefore means that there are various different types of SLE (Benedict et al., 2008; Skeel et al., 2000). Like MS, cerebral pathology in SLE is related to white and grey matter changes and can involve areas of demyelination (Covey, Shucard, Shucard, Stegen, & Benedict, 2012). Unlike MS, SLE does not always impact the CNS; it is a neurological syndrome of the central, peripheral, and autonomic nervous system (Nived et al., 2003). SLE is best known for its involvement in cerebrovascular disease (Benedict et al., 2008). Neuropathology in SLE can therefore arise from ischaemic or haemorrhagic injury due to vasculopathy (Benedict et al., 2008; Covey et al., 2012). It may also be due to an autoantibody attack on neural cells. Cognitive symptoms can include decreased attention, poor judgement, deficits in working memory, information processing speed, and visuospatial abilities, recognition, and immediate memory (Covey et al., 2012; Skeel et al., 2000). Physical symptoms may include low fever, skin rash, arthritis, and nephropathy in progressed cases (Benedict et al., 2008; Skeel et al., 2000). Patients with SLE have also been known to experience psychiatric symptoms, including psychosis, dementia, and mood changes (Benedict et al., 2008; Covey et al., 2012; Skeel et al., 2000).

Euphoria in MS. While depression is a major feature of MS, and even though MS patients experience physical deterioration, some seem strangely cheerful and unconcerned about or unaware of their condition (Cottrell & Wilson, 1926; Finger, 1998; Horrobin, & Bennett, 1999). They may exhibit great happiness and optimism (Cottrell & Wilson, 1926; Finger, 1998; Ramanan, 2005). Denial or unawareness of their deterioration may be a reason for the portrayed optimism about the future (Surridge, 1969). However, they may also be aware of their life threatening condition, yet the jovial mood remains (Finger, 1998). It is described as an inappropriate euphoria that occurs due to brain damage (Horrobin, & Bennett, 1999). Tears, sadness, and even depression may follow these happy states of the mind, resembling bipolar mood disorder (Cottrell & Wilson, 1926; Finger et al., 1998; Horrobin, & Bennett, 1999; Scott et al., 1999). However, such bipolar states seem less common than positive and negative mood alone (Scott et al., 1999). All of the above-mentioned descriptions relate to mood abnormalities such as euphoria, which was first observed in MS circa 1840 (Cottrell & Wilson, 1926; Finger, 1998).

While today, euphoria is predominantly described in terms of an abnormal positive mood that persists over time, there are classical descriptions that allude to a quality of euphoria that requires a more broad and inclusive definition (Benedict et al., 2008). Cottrell and Wilson (CW) (1926) defined euphoria in terms of three sub-types: euphoria sclerotica, which referred to positive mood and affective wellbeing, eutonia sclerotica, which referred to a state of physical well being and an unawareness of deficit, and spes sclerotica, which referred to optimism towards the future and ultimate recovery.

Rationale and contributions of the current study

At the current time, there is consensus that euphoria in MS is a result of neurological deterioration of both white and grey matter and that it is mainly a manifestation of advanced MS and severe cognitive impairment (Benedict et al., 2005; Cottrell & Wilson, 1926; Figved et al., 2005; Finger, 1998; Horrobin, & Bennett, 1999). For example, Benedict, Carone, and Bakshi (2004) found in their MRI study that euphoria in MS significantly correlated with atrophy, which was further evidenced by significant correlations with tests of executive functioning, such as for disinhibition, abstract thinking, and information processing speed. However, definitive evidence as to the cause of euphoria has yet to be demonstrated. Immunological abnormalities have been implicated in mood disorders such as depression, euphoria, and bipolar mood disorder (Horrobin, & Bennett, 1999). For example, elevated levels of cytokine production, which have been implicated in the progression of MS, have

also been shown to be involved in depression (Horrobin, & Bennett, 1999). Further, a disorder in the regulation of phospholipid-based signal transduction can affect the neurons and immune system of MS patients resulting in fluctuating mood and therefore resembling bipolar mood disorder and euphoria (Horrobin, & Bennett, 1999). Further, NP-SLE includes euphoria in its list of possible mood symptoms (Benedict et al., 2008; Nived et al., 2003). It was therefore interesting to investigate the possible contributions of the autoimmune nature of the disease to euphoria in the three patient groups. With this in mind, euphoria could be due to a general immunological process of the disease and thus seen in all three patient groups; it could be attributed to cerebral immunological effects and thus evident only in patients with MS and NP-SLE, as MG does not involve the CNS or cognitive impairment, but NP-SLE involves both grey and white matter and results in cognitive impairment (Benedict et al., 2008; Covey et al., 2012); or there could be something specific to MS that accounts for the positive mood identified and therefore could only be observable in the MS group.

To the researcher's knowledge, euphoria in MS has not been investigated from this perspective before. This study might therefore contribute to the existing literature, as it yields information about whether euphoria is autoimmune specific or specific to certain brain involvement or specific to MS only.

Research aims and hypotheses

This study followed four aims and four respective hypotheses:

Aim 1: To determine the frequency of the three sub-types of euphoria in the three autoimmune disease groups and to compare this with the HC group.

Hypothesis 1: Compared with HC participants, the three euphoria sub-types will not be demonstrated highly among MG patients, but similarly high or higher among MS and NP-SLE patients. NP-SLE patients do not have to demonstrate all three euphoria sub-types. MS will demonstrate all three euphoria sub-types.

Aim 2: To comment on the cognitive impairment in the three autoimmune disease groups and to compare them with the HC group.

Hypothesis 2: Compared with the HC group, cognitive impairment will be present in the MS and NP-SLE groups, but not in the MG group.

Aim 3: To determine whether cognitive impairment is correlated positively with the three sub-types of euphoria in the MS and NP-SLE groups.

Hypothesis 3: The three sub-types of euphoria (in terms of positive mood, optimism, and unawareness of deficit) will correlate positively with cognitive impairment (in terms of executive dysfunction) in MS and NP-SLE patients.

Method

Research Design

This study formed part of a larger study and made use of a quasi-experimental between-subjects and a matched-groups design, using cross-sectional and quantitative data and a stratifying technique to match participants. The stratifying technique included capping age, educational status, and income according to the MG and NP-SLE data, so that the MS and HC groups could be as closely matched as possible. Once the MS and HC participants had been selected, 10 participants were chosen randomly for both groups by drawing pieces of paper from a bag. A cross-sectional design was chosen, as it was more time-efficient. Participants were recruited from different age groups and compared to one another, instead of following the same participants throughout a longer period as would be done in longitudinal research (Wilson & Maclean, 2011). Euphoria (inclusive of its three sub-types), and cognitive impairment were measured and correlated using four different between-subject groups. For the latter, cognitive impairment was set as the predictor and mood as the outcome.

Participants

There were four groups in total, namely, the MS, MG, NP-SLE, and the HC group. The data for the MS and HC groups had been collected prior to commencement of this study and was comprised of 100 participants each. The MG (n = 10) and NP-SLE (n = 10) groups were equal in size, but smaller. The study initially set out to have a minimum of 40 participants in each group, however, only 9.09% of the available MG sample (n = 110), and 83.33% of the available NP-SLE sample (n = 12) participated (see Limitation section for more detail).

The participants varied in race (5 White and 35 Coloured), gender (31 female and 9 male), age (25 to 70), socioeconomic status (SES; average combined household income per month ranging between R1’201 and R153’601), highest level of education (grade 7 to a degree), and preferred language (Afrikaans or English). Direct one-to-one matching of participants was not practical due to the great variation in these socio-demographic details for the small sample sizes of the MG and NP-SLE groups. However, due to the large sample sizes of the MS and HC groups it was possible to choose the smallest sample size (n = 10) as the baseline and therewith compare 10 MS and 10 HC, who most closely matched the socio-demographic

information of the MG and NP-SLE individuals. For this a stratifying technique was used. There were no more than 10 MS and 10 HC who would have matched to the other groups, hence no more than 10 could be used from both samples.

The MS, MG, and NP-SLE participants were selected via purposive sampling from the Groote Schuur and Tygerberg Hospitals, and private neurologists. This non-probability sampling technique was used to recruit groups with predetermined criteria, namely their disease (Wilson & Maclean, 2011). Probability sampling was not necessary, as these patients did not have to represent the general population. Further, convenience and snowball sampling were used to recruit participants for the HC group. These non-probability sampling techniques were more efficient, which was necessary for the current study due to time and cost constraints (Wilson & Maclean, 2011).

Exclusion Criteria. Healthy participants were only included if they had no prior or current diagnosis of any infectious, immunological, or neurological disease (e.g. meningitis), brain injury (e.g. stroke, epilepsy, brain tumour), psychiatric disorder (e.g. depression, schizophrenia), developmental delay (e.g. learning disability), or any other debilitating characteristic such as alcohol and/or drug abuse that could affect their neuropsychological functioning (*see Appendix B*). Where possible some of these criteria were also used for the MS, MG, and NP-SLE groups. However, due to the difficulty in obtaining MG and NP-SLE patients for the current study, the patients who met exclusion criteria were noted rather than excluded (see Limitation section for more detail).

Procedure and Setting

The Human Research Ethics Committee of the University of Cape Town (Faculty of Health Sciences) reviewed this and its larger project for the protection of human participants in this research and ethical approval was obtained (*see Appendix E*). The patients' details were obtained from the different sources mentioned above. They were contacted via telephone calls and invited for participation in the study. Once verbal consent had been attained, a meeting time and place was discussed. Patients were met at their own house or at the hospitals. Those patients who came to the hospitals were reimbursed for their transportation fees. Once at the interview, participants received an ethical consent form (*see Appendix F*), which informed them of the purpose of the study and that participation was voluntary. Participants were informed that if they chose to participate they were still allowed to withdraw from the study at any given point and that this would not have any negative consequences for them. They were informed that their answers and identity are kept

confidential and protected. Their names, contact details, and other identifying data were not included, but rather a coding system where each patient received two letters and two numbers. Participants received all contact details of the researchers concerned in this study and were encouraged to ask any questions they found necessary.

During the assessments the patients were asked to complete various tests and questionnaires. A person familiar to them was also asked to answer some questions about the patient. All the assessment techniques and procedures were explained to the participants in detail. The assessments were once off testing sessions, each having lasted approximately two hours. During this time refreshments were offered and breaks granted.

After the interview, the participants were debriefed and given a supervised neuropsychological report (*see Appendix I)* on the outcomes of their assessments and a pamphlet (*see Appendix H*) regarding the common cognitive and mood or behavioural symptoms associated with their respective illness and ways of coping with these.

Upon completion of the testing sessions, three raters were required to determine an average score for the participants' performances on the tasks that measured visual learning and memory, planning ability, visuo-spatial construction, and Cottrell and Wilson's (1926) three sub-types of euphoria.

Data Collection and Measurement Instruments

The data collected was quantitative data. The following measures were used:

Socio-demographic information. Information such as each participant's age, gender, race, SES, and education was recorded on this questionnaire (*see Appendix A*). This was necessary to describe the sample and so that participants could be matched, using a stratifying technique.

Medical information specific to myasthenia gravis and neuropsychiatric systemic lupus erythematosus. These questionnaires informed the researcher about criteria such as the symptom onset and diagnosis (*see Appendix B and C*), which were utilised for the write-up of the neuropsychological reports.

Participant self-report measures. The following were neuropsychological measures pertaining to mood and affect (depression and euphoria sclerotica), awareness of any potential deficits (eutonia sclerotica), and optimism and outlook (spes sclerotica) (*see Appendix G*).

- ***Beck Depression Inventory Fast Screen (BDI-FS)*** (Beck, Steer, & Brown, 2000), a measure of depression.

- ***Cottrell and Wilson Questionnaire*** (Cottrell & Wilson, 1926), a classical measure of the three euphoria sub-types.
- ***Positive and Negative Affect Scale (PANAS)*** (Watson, Clark, & Tellegen, 1988), a modern measure of euphoria sclerotica.
- ***Internal State Scale (ISS)*** (Bauer et al., 1991), a modern measure of euphoria sclerotica.
- ***Neuropsychiatric Inventory (NPI)*** (Cummings, 1997), a modern measure of euphoria sclerotica (but defined as abnormal positive mood) and a modern measure of eutonia sclerotica (unawareness of mood and behavioural symptoms).
- ***Physical Ability Scale*** (self-constructed), a modern measure of eutonia sclerotica (unawareness of physical deficits).
- ***Awareness Interview (AI)*** (Anderson & Tranel, 1989), a modern measure of eutonia sclerotica (unawareness of cognitive deficits).
- ***Optimism and Pessimism Scale (OPS)*** (Dember, Martin, Hummer, Howe, & Melton, 1989), a modern measure of spes sclerotica.
- ***Life Orientation Test – Revised (LOT-R)*** (Scheier, Carver, & Bridges, 1994), a modern measure of spes sclerotica.

Cognitive measures. The following were neuropsychological measures pertaining to memory, executive functioning, and visuospatial abilities. For tests that needed to be timed, a stopwatch was used.

- ***0 and 2 Stage n-back Task*** (Kirchner, 1958; Owen, McMillan, Laird, & Bullmore, 2005), which measured attention, working memory, and speed of information processing.
- ***Controlled Oral Word Association Test (COWAT)*** (Benton & Hamsher, 1976), which measured word generativity.
- ***Rey Auditory Verbal Learning Test (RAVLT)*** (Lezak, Howieson, Bigler, & Tranel, 2012; Rey, 1941), which measured verbal learning (immediate memory), memory (delayed memory), and recognition.
- ***Brief Visuospatial Memory Test-Retrieval (BVMT-R)*** (Benedict, 1997), which measured visuospatial construction and visual learning (immediate memory), memory (delayed memory), and recognition.
- ***Rey-Osterrieth Complex Figure (ROCF)*** (Lezak et al., 2012), which measured planning and visuospatial construction.

- ***Delis-Kaplan Executive Function System Sorting Test (D-KEFS ST)*** (Delis, Kaplan, & Kramer, 2001), which measured abstract thinking.
- ***D-KEFS Colour Word Interference Task (D-KEFS CWIT)*** (Delis et al., 2001), which measured inhibition and set-shifting abilities.

Typically, detailed descriptions of these measures would appear here, however, word constraint allowed for their relocation to the appendix. Please refer to *Appendix D* for the measures' full descriptions and justifications of inclusion.

Data Analysis

To analyse the data the SPSS statistical software package (SPSS Inc., 2012) was used. Descriptive statistics were used to represent the socio-demographic details and to describe the cognitive and mood variables of the four groups. A Chi-Square test of independence was used to determine whether significant differences existed between the groups for gender and race. A one-way ANOVA was used to compare the groups' age, educational status, and income. Inspection of boxplots of the data distribution indicated that in general the data within the four groups was not normally distributed and that there were a few outliers for some of the variables in some of the groups. As one cannot determine with a sample size of $n = 10$ per group, whether results would be normally distributed or not, it was deemed appropriate to run a one-way ANOVA, as this measure is robust to violations of normality (Field, 2009). For each one-way ANOVA test, a Kruskal-Wallis test was also conducted. As results from the Kruskal-Wallis tests indicated no difference, the one-way ANOVA results were reported, as these are more powerful and present effect sizes (Field, 2009). Where Levene's test of homogeneity of variance was not significant ANOVA results were reported, otherwise a Welch correction was performed and reported.

Aim 1: Descriptive statistics were used to describe the frequency of the three sub-types of euphoria, in terms of classical and modern measures, within the groups. A Chi-Square test of independence was used for categorical variables and a one-way ANOVA for continuous variables to identify if the groups were significantly different on the euphoria sub-types or not. The patient groups were compared with the HC group to determine if any of the patient groups were significantly happier, more unaware, or optimistic than the healthy population.

Aim 2: In order to examine group differences on the cognitive measures, the four groups were compared using descriptive statistics and a one-way ANOVA.

Aim 3: A factor analysis was conducted, which indicated that certain cognitive variables and certain modern euphoria sub-types variables could be grouped together to form composites. Therefore, the variables in question were rescaled so that all data points lay on the same scale. The scales could then be added up to form four cognitive composite variables representing *Memory*, *Inhibition/Set-shifting*, *Information Processing Skills*, and *Cognitive Flexibility*, and three euphoria composite variables representing *Modern Euphoria Sclerotica*, *Modern Eutonia Sclerotica*, and *Modern Spes Sclerotica*. The cognitive composite variables and the remaining individual cognitive variables were correlated with the three classical euphoria sub-types and with the three modern euphoria sub-types composites and individual remaining variables to determine if the three sub-types of classical and modern euphoria are correlated with cognitive impairment. A Spearman's correlation was used to perform the correlations, as the data was not normally distributed.

Results

Chi-square tests of independence and an ANOVA were run to determine if there were any significant between-group differences for the socio-demographic variables after having matched participant groups as closely as possible through stratification.

Table 1

Chi-square Test of Independence for Gender Across Participant Groups

	Participant Groups				
Gender	MS	MG	NP-SLE	HC	**Total**
Female	8 (20.00%)	6 (15.00%)	9 (22.50%)	8 (20.00%)	**31 (77.50%)**
Male	2 (5.00%)	4 (10.00%)	1 (2.50%)	2 (5.00%)	**9 (22.50%)**
Total	**10 (25.00%)**	**10 (25.00%)**	**10 (25.00%)**	**10 (25.00%)**	**40 (100%)**

Note. Values in parentheses represent % of total frequencies. Cramer's V = .26.

Table 1.1

Chi-square Test of Independence for Race Across Participant Groups

	Participant Groups				
Race	MS	MG	NP-SLE	HC	**Total**
White	1 (2.50%)	2 (5.00%)	0 (0.00%)	2 (5.00%)	**5 (12.50%)**
Coloured	9 (22.50%)	8 (20.00%)	10 (25.00%)	8 (20.00%)	**35 (87.50%)**
Total	**10 (25.00%)**	**10 (25.00%)**	**10 (25.00%)**	**10 (25.00%)**	**40 (100%)**

Note. Values in parentheses represent % of total frequencies. Cramer's V = .25.

Table 2

Age, Education, and Income Across Participant Groups

Socio-demographic Variables	Participant Groups			
	MS	MG	NP-SLE	HC
Age	43.10 (8.53)	42.10 (16.53)	45.60 (9.54)	41.80 (8.51)
Education	12.40 (2.17)	10.80 (2.39)	10.60 (2.67)	13.20 (1.69)
Income	12.00 (6.50)	22.92 (46.35)	11.04 (11.49)	14.04 (7.07)

Note. Income is represented as the average monthly income per household and is represented in thousands. Education is represented in years, where 7 – 12 years represent Grade 7 - 12, 13 = Certificate from college, 14 = Diploma, 15 = Degree.

For all analyses the significance level was chosen at $\alpha = .05$. *Table 1*, *1.1*, and *2* above show the socio-demographic details across the four different participant groups. The majority of participants were female (31; 77.50%) (*see Table 1*) and Coloured (35; 87.50%) (*see Table 1.1*). A Chi-square test of independence indicated that there were no significant differences between the number of female and male participants, χ^2 (3, N = 40) = 2.72, p = .436, or the number of White and Coloured participants in the four groups, χ^2 (3, N = 40) = 2.51, p = .473.

Table 2 shows that age was similar across the groups. The NP-SLE group (M = 45.60, SD = 9.54) had a slightly higher and the HC group (M = 41.80, SD = 8.51) a slightly lower age average than the other groups. However, the MG group (M = 42.10, SD = 16.53) had more variation than the other groups as is indicative by its standard deviation. The HC group showed higher education (M = 13.20, SD = 1.69) and the NP-SLE group lower education (M

= 10.60, *SD* = 2.67) than the other groups. Income was highest in the MG group (*M* = 22.92, *SD* = 46.35), however, this may well be due to the fact that one participant in the MG group had a much higher income than the other participants (see Limitation section for more detail). The NP-SLE group had the lowest income (*M* = 11.04, *SD* = 11.49).

A between-groups one-way ANOVA was conducted to examine if any between-group differences existed for age, education, and income. *Table 3* below indicates that between-group differences for income were not statistically significant, $F(3, 36) = .50$, $p = .687$, $\eta^2 = .04$. However, ANOVA results for education were statistically significant, $F(3, 36) = 3.10$, $p = .039$, $\eta^2 = .21$ (*see Table 3*). Tukey's HSD *post-hoc* test indicated, however, that none of the between-group differences were statistically significant ($p > .05$).

Welch correction indicated that the between-group differences for age were not statistically significant, $F(3, 19.66) = .30$, $p = .828$, $\eta^2 = .02$.

Table 3

Summary of ANOVA Results for Age, Education, and Income

Effect	*df*	MS_{error}	*F*	*p*	η^2
Age[b]	3, 19.66	127.33	.30	.828	.02
Education[a]	3, 36	5.11	3.10	.039	.21
Income[a]	3, 36	593227630	.50	.687	.04

[a]Levene's test of homogeneity of variance was not statistically significant ($p > .05$) therefore ANOVA results were reported.

[b]Levene's test of homogeneity of variance was statistically significant ($p < .05$) therefore Welch correction was used and reported.

Hypothesis 1

This hypothesis focussed on determining the frequencies of the three euphoria sub-types in the four participant groups.

Cottrell and Wilson's (1926) three sub-types of euphoria were rated by three raters, and were found to have good to high inter-rater reliability: 1) for euphoria sclerotica, $\alpha = .82$ ($p < .001$), 2) for eutonia sclerotica, $\alpha = .96$ ($p < .001$), and 3) for spes sclerotica, $\alpha = .96$ ($p < .001$).

In the following, results for the three sub-types of euphoria, in terms of classical and modern measures, are presented with euphoria sclerotica, eutonia sclerotica, and spes sclerotica being presented in that order.

Table 4

Chi-square Test of Independence for Classical Euphoria Sclerotica

Euphoria Sclerotica	Participant Groups				**Total**
	MS	MG	NP-SLE	HC	
Present	6 (15.00%)	6 (15.00%)	5 (12.50%)	10 (100%)	**27 (67.50%)**
Absent	4 (10.00%)	4 (10.00%)	5 (12.50%)	0 (0.00%)	**13 (32.50%)**
Total	**10 (25.00%)**	**10 (25.00%)**	**10 (25.00%)**	**10 (25.00%)**	**40 (100%)**

Note. Values in parentheses represent % of total frequencies. Cramer's V = .41.

Table 4.1

Chi-square Test of Independence for Modern NPI Euphoria Sclerotica

NPI Euphoria Sclerotica	Participant Groups				**Total**
	MS	MG	NP-SLE	HC	
Present	5 (12.50%)	4 (10.00%)	3 (7.50%)	0 (0.00%)	**12 (30.00%)**
Absent	5 (12.50%)	6 (15.00%)	7 (17.50%)	10 (100%)	**28 (70.00%)**
Total	**10 (25.00%)**	**10 (25.00%)**	**10 (25.00%)**	**10 (25.00%)**	**40 (100%)**

Note. Values in parentheses represent % of total frequencies. Cramer's V = .41.

Table 4 indicates that classical euphoria sclerotica was most frequent in the HC group (10; 100%) and least frequent in the NP-SLE group (5; 12.50%). *Table 4.1* indicates that the MS group presented with the highest frequency of euphoria sclerotica for modern *NPI* euphoria sclerotica (5; 12.50%) and the HC group exhibited no euphoria sclerotica on this measure (0; 0.00%). A Chi-square test of independence has shown that between-group differences were not significant for classical euphoria sclerotica, χ^2 (3, N = 40) = 6.72, p = .081, or for modern *NPI* euphoria sclerotica, χ^2 (3, N = 40) = 6.67, p = .083.

Table 5 below indicates that from the remaining modern euphoria sclerotica variables, the HC group scored highest on the *PANAS* (M = 38.80, SD = 4.69) and the *ISS* (M = 12.40, SD = 2.32), while the MS group scored lowest on both, the *PANAS* (M = 32.10, SD = 8.67) and the

ISS (*M* = 7.90, *SD* = 2.73). In terms of depression, the HC group scored lowest on the *BDI* (*M* = 1.90, *SD* = 2.88) and the MS group scored highest (*M* = 6.40, *SD* = 4.84).

Table 5

Descriptive Statistics for Mood Variables Across Participant Groups

	Participant Groups			
Mood Variables	MS	MG	NP-SLE	HC
BDI	6.40 (4.84)	4.40 (2.50)	4.00 (4.19)	1.90 (2.88)
Euphoria *PANAS* POS	32.10 (8.67)	37.50 (3.31)	36.50 (4.53)	38.80 (4.69)
Euphoria *ISS*	7.90 (2.73)	11.50 (2.32)	10.40 (1.71)	12.40 (2.32)
Eutonia Physical Ability Awareness	-1.10 (3.14)	-2.30 (3.83)	-.80 (1.55)	.00 (1.70)
Eutonia Cognitive Ability Awareness	2.00 (1.83)	.50 (1.43)	.60 (.97)	.30 (1.64)
NPI Eutonia Awareness	12.20 (24.53)	1.50 (16.72)	7.50 (6.82)	6.00 (16.35)
Spes *OPS*	51.00 (4.35)	55.10 (3.90)	54.70 (4.42)	53.70 (2.50)
Spes *LOT-R*	7.50 (1.78)	9.90 (1.10)	9.70 (1.16)	9.00 (1.05)

Note. POS = positive; only the positive scale was considered for the *PANAS*. Negative values for all the eutonia awareness variables indicate unawareness of physical, or behavioural, or cognitive deficits.

A between-groups one-way ANOVA was conducted to examine if any between-group differences existed for modern euphoria sclerotica and depression. The ANOVA results (*see Table 6 below*) for the *ISS* showed to be statistically significant, $F(3, 36) = 7.17$, $p = .001$, $\eta^2 = .37$. The Tukey's HSD *post-hoc* test indicated that the HC group ($M = 12.40$) and the MG group ($M = 11.50$) scored significantly higher on the *ISS* than the MS group ($M = 7.90$; $p < .01$). The remaining between-group differences were not significant ($p > .05$). The ANOVA results (*see Table 6 below*) for the *BDI* indicated that between-group differences were not statistically significant, $F(3, 36) = 2.45$, $p = .079$, $\eta^2 = .17$.

Welch correction (*see Table 6 below*) indicated that between-group differences for the *PANAS* were not statistically significant, $F(3, 19.33) = 1.54$, $p = .236$, $\eta^2 = .18$.

Table 6

Summary of ANOVA Results for Mood Variables

Effect	*df*	MS_{error}	*F*	*p*	η^2
BDI[a]	3, 36	13.88	2.45	.079	.17
Euphoria *ISS*[a]	3, 36	5.28	7.17	.001	.37
Euphoria *PANAS* POS[b]	3, 19.33	32.15	1.54	.236	.18
Eutonia Cognitive Ability[a] Awareness	3, 36	2.25	2.68	.061	.18
Eutonia Physical Ability Awareness[b]	3, 19.11	7.46	1.13	.363	.09
NPI Eutonia Awareness[b]	3, 17.79	298.85	.50	.686	.05
Spes *OPS*[a]	3, 36	14.98	2.28	.096	.16
Spes *LOT-R*[a]	3, 36	1.71	6.92	.001	.37

[a]Levene's test of homogeneity of variance was not statistically significant ($p > .05$) therefore ANOVA results were reported.

[b]Levene's test of homogeneity of variance was statistically significant ($p < .05$) therefore Welch correction was used and reported.

Table 7

Chi-square Test of Independence for Classical Eutonia Sclerotica

Eutonia Sclerotica	Participant Groups				**Total**
	MS	MG	NP-SLE	HC	
Present	3 (7.50%)	4 (10.00%)	0 (0.00%)	7 (17.50%)	**14 (35.00%)**
Absent	7 (17.50%)	6 (15.00%)	10 (100%)	3 (7.50%)	**26 (65.00%)**
Total	**10 (25.00%)**	**10 (25.00%)**	**10 (25.00%)**	**10 (25.00%)**	**40 (100%)**

Note. Values in parentheses represent % of total frequencies.

Table 7 indicates that classical eutonia sclerotica was most frequent in the HC group (7; 17.50%), and least frequent in the MS group (3; 7.50%). The NP-SLE group showed no presence of classical eutonia sclerotica (0; 0.00%). A Chi-square test of independence has

shown that there was a significant difference between the four participant groups for classical eutonia sclerotica, χ^2 (3, N = 40) = 10.99, p = .012, and that the effect size was relatively strong, Cramer's V = .52.

Table 5 above indicates that for the modern measures of eutonia sclerotica the MG group showed most unawareness of physical disability (M = -2.30, SD = 3.83). For eutonia cognitive ability awareness and *NPI* eutonia awareness (behavioural deficits) the groups all scored positive, indicating no patient/informant discrepancies and therefore no unawareness of cognitive disability or behavioural deficits. A between-groups one-way ANOVA was conducted to examine if any between-group differences existed for modern eutonia sclerotica. The ANOVA result (*see Table 6 above*) indicated that between-group differences for eutonia cognitive ability awareness were not statistically significant, F(3, 36) = 2.68, p = .061, η^2 = .18.

The Welch results (*see Table 6 above*) indicated that between-group differences were not statistically significant for eutonia physical ability awareness, F(3, 19.11) = 1.13, p = .363, η^2 = .09, or for the *NPI* eutonia awareness, F(3, 17.79) = .50, p = .686, η^2 = .05.

Table 7.1

Chi-square Test of Independence for Classical Spes Sclerotica

Spes Sclerotica	Participant Groups				
	MS	MG	NP-SLE	HC	**Total**
Present	5 (12.50%)	8 (20.00%)	8 (20.00%)	8 (20.00%)	**29 (72.50%)**
Absent	5 (12.50%)	2 (5.00%)	2 (5.00%)	2 (5.00%)	**11 (27.50%)**
Total	**10 (25.00%)**	**10 (25.00%)**	**10 (25.00%)**	**10 (25.00%)**	**40 (100%)**

Note. Values in parentheses represent % of total frequencies. Cramer's V = .29.

Table 7.1 indicates that classical spes sclerotica was least frequent in the MS group (5; 12.50%). The MG, NP-SLE, and HC groups were all most optimistic on classical spes sclerotica (8; 20.00%). A Chi-square test of independence has shown that between-group differences for classical spes sclerotica were not significant, χ^2 (3, N = 40) = 3.39, p = .336.

Table 5 above shows that according to the modern spes sclerotica measures, the MS group was again the least optimistic: the *OPS* (M = 51.00, SD = 4.35) and the *LOT-R* (M = 7.50, SD = 1.78). The MG group showed highest optimism for the *OPS* (M = 55.10, SD = 3.90) and

LOT-R (M = 7.50, SD = 1.78). A between-groups one-way ANOVA was conducted to examine if any between-group differences existed for modern spes sclerotica. The ANOVA results (*see Table 6 above*) indicated that between-group differences for the *OPS* were not statistically significant, $F(3, 36) = 2.28$, $p = .096$, $\eta^2 = .16$, but were statistically significant for the *LOT-R*, $F(3, 36) = 6.92$, $p = .001$, $\eta^2 = .37$. The Tukey's HSD *post-hoc* test for the *LOT-R* indicated that the MG group ($M = 9.90$) and the NP-SLE group ($M = 9.70$) were significantly more optimistic than the MS group (M = 7.50; $p < .01$). The remaining between-group differences were not significant ($p > .05$).

Hypothesis 2

This hypothesis focussed on the cognitive performance in the four participant groups. Tasks that measured visual learning and memory (the *BVMT-R* tasks), planning ability, and visuo-spatial construction were rated by three raters, and were found to have high inter-rater reliability: 1) for *BVMT-R* visual learning, $\alpha = .99$ ($p < .001$), 2) for *BVMT-R* visual memory, $\alpha = .97$ ($p < .001$), 3) for planning, $\alpha = .94$ ($p < .001$), and 4) for visuo-spatial construction, $\alpha = .96$ ($p < .001$).

Table 8 below indicates that the three patient groups performed worse than the HC group on all the cognitive tasks, except for the *CWIT* disinhibition task, where the NP-SLE group performed the best (M = 11.10, SD = 2.18), the *CWIT* set-shifting task, where the NP-SLE group ($M = 9.60$, $SD = 3.57$) performed the same as the HC group ($M = 9.60$, $SD = 1.51$), and the planning task, where the MS group, although barely, performed the best ($M = 4.80$, SD = .82). Out of the three patient groups the MS group performed the best on seven cognitive tasks (working memory, verbal learning and recognition, visual learning and memory, abstract thinking, planning, and visuo-spatial construction), the MG group on three cognitive tasks (attention, information processing speed, and visual recognition), and the NP-SLE group also on three cognitive tasks (word generativity, disinhibition, and set-shifting) (*see Table 8*).

Table 8

Descriptive Statistics for Cognitive Variables Across Participant Groups

	Participant Groups			
Cognitive Variables	MS	MG	NP-SLE	HC
0-back Attention Score	19.40 (2.27)	19.60 (1.26)	18.10 (4.63)	20.70 (.48)
2-back Working Memory Score	22.50 (4.09)	19.17 (8.70)	19.75 (4.83)	24.71 (2.56)
n-back Information Processing Speed	.73 (.28)	.63 (.18)	.78 (.43)	.56 (.22)
RAVLT Verbal Learning	9.38 (1.97)	8.22 (2.45)	8.30 (1.92)	9.92 (1.39)
RAVLT Verbal Memory	8.40 (3.06)	8.40 (3.03)	8.10 (3.54)	10.90 (2.33)
RAVLT Verbal Recognition	28.00 (2.00)	27.30 (2.63)	27.90 (1.52)	29.50 (.71)
BVMT-R Visual Learning	6.77 (2.24)	5.84 (2.62)	5.48 (2.45)	8.39 (2.69)
BVMT-R Visual Memory	7.57 (3.31)	7.13 (2.52)	6.73 (2.76)	10.50 (2.52)
BVMT-R Visual Recognition	11.00 (1.33)	11.40 (1.07)	10.90 (1.20)	11.90 (0.32)
COWAT Word Generativity	27.80 (9.74)	27.60 (9.69)	30.10 (14.26)	34.30 (11.76)
Abstract Thinking Ability	7.30 (3.40)	6.60 (2.55)	5.70 (2.95)	8.80 (3.01)
Planning Ability	4.80 (.82)	4.60 (1.14)	3.80 (1.41)	4.73 (1.09)
Visuo-spatial Construction Ability	29.79 (4.37)	29.10 (3.26)	27.58 (9.64)	31.06 (2.67)
CWIT Disinhibition Ability	9.70 (3.89)	10.60 (2.63)	11.10 (2.18)	10.20 (3.26)
CWIT Set-shifting Ability	8.10 (3.96)	9.40 (3.56)	9.60 (3.57)	9.60 (1.51)

Note. Information processing speed is represented in seconds. A low score on the *n*-back information processing speed task indicates fast reaction.

Table 9

Summary of ANOVA Results for Cognitive Variables

Effect	*df*	MS_{error}	*F*	*p*	η^2
0-back Attention Score[b]	3, 16.62	7.11	3.64	.035	.12
2-back Working Memory Score[a]	3, 23	28.92	1.56	.226	.17
n-back Information Processing Speed[a]	3, 36	86534.13	1.09	.365	.08
RAVLT Verbal Learning[a]	3, 36	3.89	1.79	.167	.13
RAVLT Verbal Memory[a]	3, 36	9.13	1.87	.152	.14
RAVLT Verbal Recognition[b]	3, 17.75	3.43	5.24	.009	.18
BVMT-R Visual Learning[a]	3, 36	6.29	2.69	.061	.18
BVMT-R Visual Memory[a]	3, 36	7.81	3.75	.019	.24
BVMT-R Visual Recognition[b]	3, 16.72	1.12	3.55	.037	.13
COWAT Word Generativity[a]	3, 36	132.53	.73	.540	.06
Abstract Thinking Ability[a]	3, 36	8.95	1.91	.145	.14
Planning Ability[a]	3, 36	1.28	1.67	.190	.12
Visuo-spatial Construction Ability[a]	3, 36	32.44	.65	.591	.05
CWIT Disinhibition Ability[a]	3, 36	9.36	.38	.770	.03
CWIT Set-shifting Ability[a]	3, 36	10.84	.48	.697	.04

[a]Levene's test of homogeneity of variance was not statistically significant ($p > .05$) therefore ANOVA results were reported.

[b]Levene's test of homogeneity of variance was statistically significant ($p < .05$) therefore Welch correction was used and reported.

A between-groups one-way ANOVA was conducted to examine if any between-group differences existed in cognitive impairment. ANOVA results (*see Table 9 above*) showed to be statistically significant for *BVMT-R* visual memory, $F(3, 36) = 3.75$, $p = .019$, but not for the other cognitive variables ($p > .05$). The Tukey's HSD *post-hoc* test indicated that the HC group ($M = 10.50$) performed significantly better on *BVMT-R* visual memory than the NP-

SLE group (M = 6.73; p = .023). The remaining between-group differences were not significant ($p > .05$).

Welch results (*see Table 9 above*) showed to be significant for 0-back attention, $F(3, 16.62) = 3.64$, $p = .035$, *RAVLT* verbal recognition, $F(3, 17.75) = 5.24$, $p = .009$, and *BVMT-R* visual recognition, $F(3, 16.72) = 3.55$, $p = .037$. The Games-Howell *post-hoc* test indicated that the HC group performed better on all three tasks than the patient groups. From this the only significant difference was on *RAVLT* verbal recognition between the HC (M = 29.50) and the NP-SLE group (M = 27.90; p = .044). The remaining between-group differences were not significant ($p > .05$).

Hypothesis 3

It was hypothesised that the three sub-types of euphoria would correlate positively with cognitive impairment in MS and NP-SLE patients. It was assumed that patients would show unawareness of physical, cognitive, and behavioural deficits. As this was not the case for cognitive and behavioural deficits, correlations between cognitive impairment and these eutonia sclerotica measures would be expected to be negative. Since the results for the previous hypothesis indicated that the MS group did not show any cognitive impairment (i.e. showed cognitive functioning), a correlation between cognitive impairment and euphoria was not an option. However, correlations for the MS group conducted here, examined the relationship between cognitive functioning and the euphoria sub-types.

To correlate cognitive impairment/functioning with the three euphoria sub-types, composite variables were created where possible. For this a principal factor analysis was conducted for each group of variables that represented a domain. This was necessary to examine whether variables could be rescaled to lie on the same scale and added up to form the composites. Where the analysis indicated that more than one factor should be extracted, an orthogonal rotation via the varimax normalised rotation method was used. The sampling adequacy for each of the analyses was acceptable according to the Kaiser-Meyer-Olkin (KMO) measure, with all individual KMO values having been greater than or equal to the acceptable level of .50, with the lowest value having been .50 and the highest .79 (*see Table 10 below*). Bartlett's test of sphericity indicated for all final items that the correlations between the items were sufficiently large for principal factor analysis ($p < .05$) (*see Table 10 below*).

Table 10

Summary of KMO and Bartlett's Test of Sphericity Results for Factor Analyses

Composite	KMO	*df*	χ^2	*p*
Memory	.79	15	155.18	.000
Inhibition/Set-shifting	.50	1	20.83	.000
Information Processing Skills	.62	3	22.59	.000
Cognitive Flexibility[a]	.50	1	6.54	.011
Modern Euphoria[a]	.50	1	24.58	.000
Modern Eutonia[a]	.50	1	7.33	.007
Modern Spes	.50	3	15.84	.000

[a]Final composites.

The factor analysis indicated that four composite variables could be created for the cognitive variables, namely *Memory*, χ^2 (15, N = 40) = 155.18, p < .001, which included all *RAVLT* and *BVMT-R* variables (*see Table 11*), *Inhibition/Set-shifting*, χ^2 (1, N = 40) = 20.83, p < .001, which included *CWIT* disinhibition and set-shifting (*see Table 12*), *Information Processing Skills*, χ^2 (3, N = 40) = 22.59, p < .001, which included 0-back attention, *n*-back speed of information processing, and *COWAT* word generativity (*see Table 13*), and *Cognitive Flexibility*, χ^2 (1, N = 40) = 6.54, p = .011, which included planning and abstract thinking (*see Table 14 and 14.2*). For *Cognitive Flexibility* a scree plot suggested that there were two distinct factors (*see Figure 4*). Therefore, two factors were requested for extraction, which indicated that 2-back working memory did not load highly onto *Cognitive Flexibility* (*see Table 14*), but rather was its own factor. For *Information Processing Skills* a scree plot suggested that two factors could be extracted (*see Figure 3*), however, the Eigenvalue for the second factor lay well below 1. Therefore, the suggestion of the scree plot was not pursued. Visuo-spatial construction was not included in the factor analysis, as it was meant to be its own domain.

Further, composites for the modern euphoria sub-types were *Modern Euphoria Sclerotica*, χ^2 (1, N = 40) = 24.58, p < .001, which included the *PANAS* and *ISS* (*see Table 15 and 15.2*), *Modern Eutonia Sclerotica*, χ^2 (1, N = 40) = 7.33, p = .007, which included *NPI* eutonia awareness and cognitive awareness (*see Table 16 and 16.2*), and *Modern Spes Sclerotica*, χ^2

(3, N = 40) = 15.84, p < .001, which included *OPS* and *LOT-R* (*see Table 17*). For *Modern Euphoria Sclerotica* and *Modern Eutonia Sclerotica* the same principle applied as with *Cognitive Flexibility*, where scree plots suggested that there were two distinct factors (*see Figure 6 and 8*). For each of the final factors Eigenvalues were over Kaiser's criterion of 1 (see respective tables for % of total variance explained).

Spearman's Correlations. Spearman's correlations were conducted, as the data was not normally distributed for all variables across the participant groups. All cognitive composites and individual cognitive variables were correlated with all three classical euphoria sub-types and all three modern euphoria sub-types composites and individual variables.

As it was hypothesised that cognitive impairment would positively correlate with the euphoria sub-types, but negatively with *Modern Eutonia Sclerotica*, all correlations for NP-SLE group were run as one-tailed tests. For the MS group correlations were run as two-tailed tests, because the direction of the correlation was uncertain. Inspection of the correlation matrix (*see Table 18 and 19*) revealed some statistically significant correlations between the cognitive and euphoria sub-types variables.

Correlations within the NP-SLE group (*see Table 18*) have indicated that *Information Processing Skills* significantly positively correlated with *Modern Spes Sclerotica*, r = .75, p = .006. *Cognitive Flexibility* significantly positively correlated with both, classical euphoria sclerotica, r = .88, p < .001, and *Modern Eutonia Sclerotica*, r = .82, p = .002. Visuo-spatial construction significantly positively correlated with both, classical euphoria sclerotica, r = .60, p = .035, and *Modern Eutonia Sclerotica*, r = .71, p = .011. *Memory* significantly positively correlated with both, *Modern Eutonia Sclerotica*, r = .89, p < .001, and *Modern Spes Sclerotica*, r = .62, p = .028.

Correlations within the MS group (*see Table 19*) have indicated that *Inhibition/Set-shifting* significantly positively correlated with eutonia physical ability awareness, r = .68, p = .030.

Table 18

Spearman's Correlations for NP-SLE Group Between Cognitive Impairment and the Three Classical and Modern Euphoria Sub-types

Measure	Classical Euphoria Sclerotica	Classical Eutonia Sclerotica	Classical Spes Sclerotica	*NPI* Euphoria Sclerotica	*Modern Euphoria Sclerotica*	Etuonia Physical Ability[a]	*Modern Eutonia Sclerotica*	Modern Spes Sclerotica
Information Processing Skills	.10	.[b]	.44	-.27	-.18	-.08	.32	.75** (.006)
2-back Working Memory	.06	.[b]	-.41	-.47	-.30	.31	.09	-.18
Cognitive Flexibility	.88** (.000)	.[b]	.18	-.38	.36	.06	.82** (.002)	.26
Visuo-spatial Construction	.60* (.035)	.[b]	.35	-.38	.45	-.02	.71* (.011)	.15
Inhibition/Set-shifting	.28	.[b]	.18	-.54	-.14	-.20	-.26	.27
Memory	.45	.[b]	.26	-.49	.31	.23	.89** (.000)	.62* (.028)

Note. $n = 8$ for working memory, $n = 10$ for all other variables. Classical euphoria sclerotica, eutonia sclerotica, and spes sclerotica refer to the CW measures of the three euphoria sub-types. All significant *p*-values are in parenthesis.

[a]This variable represents the eutonia physical ability unawareness variable.

[b]Cannot be computed because at least one of the variables is constant.

*$p < .05$. **$p < .01$.

Table 19

Spearman's Correlations for MS Group Between Cognitive Impairment and the Three Classical and Modern Euphoria Sub-types

Measure	Classical Euphoria Sclerotica	Classical Eutonia Sclerotica	Classical Spes Sclerotica	*NPI* Euphoria Sclerotica	*Modern Euphoria Sclerotica*	Etuonia Physical Ability[a]	*Modern Eutonia Sclerotica*	Modern Spes Sclerotica
Information Processing Skills	.21	-.27	-.04	.04	.33	.16	-.20	.00
2-back Working Memory	-.54	.54	-.53	.00	-.27	.09	.09	-.71
Cognitive Flexibility	.36	-.12	.07	-.21	.54	.28	-.25	.11
Visuo-spatial Construction	.32	.00	.14	-.25	.49	.39	-.22	.17
Inhibition/Set-shifting	.28	.19	-.04	-.45	.46	.68* (.030)	-.41	-.04
Memory	.28	.34	.24	-.17	.60	.50	-.60	.29

Note. $n = 6$ for working memory, $n = 10$ for all other variables. Classical euphoria sclerotica, eutonia sclerotica, and spes sclerotica refer to the CW measures of the three euphoria sub-types. All significant p-values are in parenthesis.

[a]This variable represents the eutonia physical ability unawareness variable.

*$p < .05$.

Discussion

The current study has found mixed results, which partially have supported the hypotheses and partially not. The findings of this study do therefore partially agree and partially deviate from the findings of other studies. It is important to keep in mind that any deviations from past research may well be due to the small sample size (n = 10 per group) that was available for this study. It, however, makes it therefore that much more interesting that there have been significant results. Even though the chosen significance level of α = .05 leaves room for a possible Type 1 error, most of the significant results were well below .05 and even below .01, which reduces the chances of a Type 1 error having occurred.

Results have indicated that after stratification, the sample was not significantly different in terms of gender, race, age, income, and education, which was the desired outcome, so that participant groups were comparable with each other. As results were mixed, each individual hypothesis was discussed in detail in the following.

Hypothesis 1

Even though the between-group differences were only significant for classical eutonia sclerotica (p = .012), the *ISS* (p = .001), and the *LOT-R* (p = .001), it is, nevertheless, important to discuss mean differences to determine whether the hypothesis should be retained or rejected, as it is possible that a Type 2 error occurs if only the significant results are taken into consideration, especially with a small sample size.

It was hypothesised that compared with HC participants, the three euphoria sub-types would not be demonstrated highly among MG patients, but would be demonstrated similarly high or higher among MS patients, who would demonstrate all three euphoria sub-types. It was also hypothesised that the NP-SLE patients would demonstrate some, but not all three euphoria sub-types.

It was expected that the HC group would score highest or highly on all euphoria sub-types measures, except for *NPI* euphoria sclerotica, as it is known as a measure of abnormal positive mood (Benedict et al., 2013; Cummings, 1997). This was expected because the healthy individuals should have positive mood, physical well being, and optimism or a positive outlook on life due to a general assumption of life satisfaction and them not having met any of the exclusion criteria. Results have supported these expectations, as the HC group scored highest on the classical CW measures, modern eutonia sclerotica measures, and highly on the modern spes sclerotica measures. As expected, the HC group scored lowest on *NPI*

euphoria sclerotica. In fact, the HC participants reported no euphoria sclerotica at all on this measure, which indicated an absence of abnormal positive mood.

The MS group was expected to be unaware of their symptoms and remain optimistic, as past research reported that physical deficits can occur in MS, such as visual problems, sensory-motor impairment, and fatigue (Cantor, 2010), while the MS patients remain unaware of them and optimistic about their life (Finger, 1998; Surridge, 1969). Therefore, the MS group was expected to score high on classical eutonia sclerotica (physical well-being) indicating unawareness of deficits and low on modern eutonia sclerotica measures (unawareness of physical, cognitive, and behavioural deficits), and high on all spes sclerotica measures, indicating optimism. Some of the findings supported these expectations. While the MS patients scored low on classical eutonia sclerotica, indicating awareness of negative bodily sensations (unexpected), they scored negatively on modern eutonia sclerotica for physical ability (expected). According to Sherman et al. (2008) a negative value indicates unawareness of the physical deficits, which comes from patient/informant discrepancies on the questionnaire, which are often used in unawareness research and the protocol is to assume underestimation equates to unawareness (Sherman et al., 2008). For awareness of cognitive functioning/impairment and behavioural symptoms all participant groups showed awareness.

These results might seem confusing, however, what this could be suggestive of is that while the MS patients may have reported negative bodily sensations, they may not necessarily have been aware of these sensations as physical deficits, and therefore underestimated them. Further, the MS patients were the least optimistic on all measures of spes sclerotica out of all the participant groups. While this finding was not as high as expected, it nevertheless showed that optimism was present.

The MS group was expected to score high on euphoria sclerotica, as past research has shown that euphoria sclerotica is a common mood symptom in MS (Benedict et al., 2005; Cottrell & Wilson, 1926; Figved et al., 2005; Horrobin, & Bennett, 1999). The MS group scored low on the *PANAS* and *ISS* measures, moderately high on classical euphoria sclerotica, and highest on *NPI* euphoria sclerotica. As aforementioned, *NPI* euphoria sclerotica measures abnormal positive mood, which is commonly observed in MS patients (Benedict et al., 2008; Cottrell & Wilson, 1926; Ramanan, 2005). Therefore, while the MS patients did not demonstrate high positive mood on all of the measures, results implied that they did have an abnormal positive mood. Interestingly, the MS group also scored highest on the *BDI*. Even though this study did not investigate elevated levels of cytokine production, research does suggest that it has been implicated in depression and the progression of MS (Horrobin, &

Bennett, 1999), which therefore could be a reason for the depression exhibited in the MS group. While the regulation of phospholipid-based signal transduction was not investigated in this study, research reports that it can affect the neurons and immune system of MS patients resulting in disordered mood, such as euphoria (Horrobin, & Bennett, 1999), which could therefore be a reason for the euphoria exhibited in the MS group.

NP-SLE patients were expected to score highly on the euphoria measures, as euphoria is in the list of possible mood symptoms for NP-SLE (Benedict et al., 2008; Nived et al., 2003). The NP-SLE patients scored highly on the *PANAS* and *ISS* measures and moderately high on classical euphoria sclerotica, but low on *NPI* euphoria sclerotica. Nevertheless, this showed that the NP-SLE group demonstrated euphoria sclerotica.

Past research indicates that physical symptoms can be part of NP-SLE and include for example arthritis and nephropathy (Benedict et al., 2008; Skeel et al., 2000). It was assumed that the NP-SLE patients would be unaware of physical deficits, as results have shown cognitive impairment for the NP-SLE group, which was assumed to be paired with unawareness of deficits. While the NP-SLE patients reported negative bodily sensations on classical eutonia sclerotica (unexpected), the eutonia physical ability measure indicated patient/informant discrepancies, which meant that there was underestimation of deficits (expected). The same as with the MS group applied here – the NP-SLE group may have been aware of negative bodily sensations, but not necessarily have been aware of these sensations as physical deficits, and therefore underestimated them.

The NP-SLE patients were expected to score highly on spes sclerotica. Indeed, they did, including that they were significantly more optimistic than the MS group on the *LOT-R* ($p < .01$). Interesting observations were that the NP-SLE patients all seemed very religious. This could have been a reason for their optimistic outlook. With this, all the expectations for the NP-SLE group were supported.

It was expected that the MG group would score lower than any of the other groups on euphoria sclerotica and spes sclerotica and higher on depression, as MG patients are reported exhibiting negative mood such as depression and pessimism (Cantor, 2010; Cavalcante et al., 2012). The MG group exhibited euphoria sclerotica on all the euphoria sclerotica measures, and even scored higher on the *PANAS* and *ISS* than the MS group. The MG (and HC) groups were significantly more positive than the MS group on the *ISS* ($p < .01$). The MG group scored relatively low on the *BDI*, therefore not exhibiting depression. Therefore, the expectations were not supported and this finding deviated from past research, such as

mentioned above. Perhaps this study, despite the small sample size, showed that MG patients could be quite euphoric.

MG patients were expected to be aware of their physical deficits and therefore exhibit low or no optimism, as they should not have any cognitive impairment, as MG is a peripheral autoimmune disease (Cantor, 2010; Dönmez et al., 2004; Gilhus, 2012; Wolfe et al., 2012). The MG patients, however, showed high unawareness of physical deficits. Observations often included that patients were in denial of their loss of abilities and had delusional ideas for the future, which showed that perhaps they have difficulties accepting reality. MG patients showed some optimism on the modern spes sclerotica measures, from which optimism on the *LOT-R* was significantly higher than that of the MS group ($p < .01$). While it was expected that the MG group was not optimistic, considering the denial of deficits that was observed, the optimism reported in these patients seems justified.

It is therefore conclusive that the expectations for this hypothesis were partially supported, as the MS and NP-SLE group demonstrated all sub-types of euphoria. However, the expectations surrounding the MG group for this hypothesis were not supported, as the MG group demonstrated all three euphoria sub-types.

Therefore, as euphoria was present in all three patient groups, it could be assumed that euphoria is a result of the autoimmune nature of the disease for MS, but also for NP-SLE and MG.

Hypothesis 2

It was hypothesised that compared with the HC group cognitive impairment would be present in the MS and NP-SLE groups, but not in the MG group. Results were significant for four tasks, namely visual memory, visual recognition, attention, and verbal recognition. The remaining cognitive tasks did not yield significant between-group differences, nevertheless, observations during examination have shown that some patients from the three patient groups appeared to struggle with the majority of the cognitive tasks. This observation is important, as the results might not be significant with the small sample size that was available for this study and therefore the hypothesis could be falsely rejected, resulting in a Type 2 error. It is possible that with a larger sample size more results would have been significant, as there is a great body of research that supports cognitive impairment, specifically in NP-SLE and MS. NP-SLE has cognitive symptoms, such as decreased attention, deficits in working memory, information processing speed, and visuospatial abilities, recognition, and immediate memory (Covey et al., 2012; Skeel et al., 2000). Descriptive results have shown that the above-

mentioned cognitive impairments have been largely supported, as this group has shown the poorest cognitive performance for attention, information processing speed, visuo-spatial abilities, visual recognition, and immediate visual memory (called visual learning here), but also for many more. Post-hoc tests also indicated evidence for cognitive impairment, as the differences between the HC and NP-SLE groups on visual memory and verbal recognition were significant ($p < .05$).

MS is characterized by atrophy, which can cause damage to the cerebral hemispheres, cerebellum, optic nerves, brainstem, and the spinal cord (Benedict et al., 2008; Cantor, 2010; Cottrell & Wilson, 1926; Figved et al., 2005) and therefore result in a variety of cognitive symptoms, such as difficulties with memory, attention, and processing speed (Benedict et al., 2008; Cottrell & Wilson, 1926). Even though descriptive statistics showed that the MS group had one of the slowest reactions for attention and information processing speed, the MS group performed the best out of the three patient groups on the majority of the cognitive tasks, including immediate memory (verbal and visual learning).

On attention and information processing speed the MG group performed the best out of the patient groups. Also, while the MS group may have performed better on immediate memory (verbal and visual learning), the MG (and NP-SLE) group had much more accurate delayed memory, when comparing immediate to delayed memory. The MG group was expected to have good performance on the cognitive tasks, as cognitive impairment is not reported as one of the accompanying symptoms of this disease (Cantor, 2010; Dönmez et al., 2004; Gilhus, 2012; Wolfe et al., 2012). The MG group performed similar to the other patient groups, when taking the descriptive statistics into account. There was only one task on which the MG group performed much worse than the other groups. This was the 2-back working memory task. Nevertheless, there were no significant differences between the MG and HC group, indicating that cognitive impairment was not present in the MG group. Further, 2-back working memory was completed on a computer, which some MG patients were not comfortable with due to computer illiteracy. This may have been a reason for their poorer performance on this task. Further, any average performance in the MG group could have been due to a variety of common physical deficits that occur due to muscle weakness, such as diplopia, dysarthria, sensory-motor impairment, and fatigue (Burns, 2012; Cantor, 2010).

The hypothesis has been supported in that the MG group did not show any cognitive impairment. The hypothesis has been further supported, as the NP-SLE group showed cognitive impairment (taking into consideration the significant results and descriptive

statistics). However, the MS group did not indicate much impairment compared to the HC group, which therefore meant that the hypothesis was partially not supported.

Therefore, as cognitive impairment was not present in MS, it could be assumed that euphoria is not a result of cognitive impairment in MS, but perhaps in NP-SLE.

Hypothesis 3

With the assumption that euphoria sclerotica and spes sclerotica were present in the patient groups, and that unawareness was depicted for the eutonia sclerotica measures, it was hypothesised that the three sub-types of euphoria would correlate positively with cognitive impairment in MS and NP-SLE patients. As all the participants scored positively for cognitive and behavioural deficits (*Modern Eutonia Sclerotica*), correlations with these eutonia sclerotica variables would be expected to be negative. Since the results for the previous hypothesis indicated that the MS group did not show any cognitive impairment (i.e. showed cognitive functioning), and therefore that this correlation was not an option, one part of this hypothesis was not supported. Nevertheless, correlations for MS between cognitive functioning and the euphoria sub-types were conducted, as it was interesting to observe the behaviour of these correlations. Aspects of cognitive functioning correlated significantly positively with the modern eutonia sclerotica measure for physical ability. This could indicate that regardless of cognitive functioning, the MS patients were unaware of their physical deficits (as reported in hypothesis 1). This result could mean that the patients were in denial of any physical deficits, as past research does report that MS patients can experience physical deterioration and remain in a state of denial of their deterioration (Cottrell & Wilson, 1926; Finger, 1998; Horrobin, & Bennett, 1999; Surridge, 1969).

Hypothesis 2 indicated that the NP-SLE group had cognitive impairment, and findings for hypothesis 3 showed some significant and positive correlations within the NP-SLE group for the euphoria sub-types. Therefore, considering the specific significant correlations, this meant that the higher cognitive impairment was, the higher positive mood and optimism were. It also meant that the higher cognitive impairment was the more aware the NP-SLE patients were of their cognitive and behavioural abilities or deficits. As this correlation was not expected to be positive, the NP-SLE part of the hypothesis could only be supported for the euphoria sub-types of euphoria sclerotica and spes sclerotica. Perhaps with a larger sample size results would have been more explicit.

The hypothesis has been partially supported in that the NP-SLE group showed positive correlations between cognitive impairment and euphoria sclerotica and spes sclerotica.

However, the MS group showed no cognitive impairment in the previous hypothesis and therefore this part of the hypothesis was not supported.

This finding is therefore suggestive of euphoria sub-types being a result of cognitive impairment in NP-SLE patients, but not in MS patients. Therefore, according to the findings of this study, it cannot be argued that euphoria in MS is due to cognitive impairment, even though past research has found that inappropriate euphoria occurs due to brain damage and is correlated to executive dysfunction (Benedict et al., 2004; Horrobin, & Bennett, 1999). Perhaps with a larger sample such findings would have appeared.

Limitations

There were various limitations for this study, starting with the few participants who were available. The study initially set out to have a minimum of 40 participants in each group, however, only 9.09% of the available MG sample (n = 110), and 83.33% of the available NP-SLE sample (n = 12) participated. The reason for the small number of NP-SLE patients who were available was that they are rare (as doctors have emphasised). Reasons that the NP-SLE and MG sample were small for this study were due to 1) invalid or missing details, as some of the patient folders did not have any contact details or the contact details were no longer valid and alternate numbers that doctors provided were invalid as well, 2) transportation issues on the patient's side, such as that patients did not have any transportation methods to travel to the hospitals or were unwilling to take public transport even though reimbursement was offered, 3) transportation issues on the researcher's side, such as that the researcher did not own a car and therefore could not meet all patients at their private homes (if they agreed to this), if they lived too far away for a friend to lend a car or come along, 4) language barriers, as patients who could only speak isiXhosa, Afrikaans or any other African language but not English could not be included in the study, as translators could not be hired due to cost constraints for this study, and friends and family were not mother-tongue in any of these languages, and 5) a general disinterest in taking part, as some were unwilling to participate.

Further reasons for the small MG sample were due to 1) distance issues, such as that participants had relocated to different parts of the country, away from Cape Town, 2) not showing up for the arranged meeting at the hospitals, even though the participants were phoned at least one day before or on the same day of the testing session to remind them, and even though they confirmed their attendance, 3) a lack of feedback from doctors, as the majority did not answer any phone calls or E-Mails requesting to work with their patients and

providing ethical approval, and 4) doctors not allowing to use their patients despite ethical approval.

Due to the difficulty in obtaining MG and NP-SLE patients for the current study, the patients who met exclusion criteria, such as having had a corticosteroid treatment, and outliers could not be excluded. As outliers and other complications such as the above-mentioned treatment could have affected the performance and/or mood, this could have affected the results of this study. However, only two patients reported having had a corticosteroid treatment, who in fact did not exhibit high positive mood. Due to the small sample size, one-on-one matching was not possible, therefore any differences in performance due to age, race, gender, education, or income could not be controlled for effectively. However, observations during the testing sessions showed no difference between the patients' approach and/or answering style.

Other possible limitations included 1) that the tests were all developed in first world countries and may have been culturally inappropriate, however, the researcher attempted to control for this by having a reference HC group, and 2) the testing session style. For some of the tasks a computer was used. Not all participants were familiar with this technology, and therefore might have performed below their standards. Depending on the patient, the testing session took two to three hours than the intended one and a half hours, therefore fatigue and loss of concentration could have set in and could have resulted in poor performance. However, the researcher made attempts in avoiding such situations by providing refreshments and breaks. Further, the questionnaires and tests were ordered in a way to try to control for fatigue, keeping them interested and the mind challenged throughout. Certain motivators were also utilised, such as offering reimbursement for travelling costs, a pamphlet regarding the common cognitive and mood or behavioural symptoms associated with their respective illness and ways of coping with these (*see Appendix H*), and a supervised neuropsychological report on the outcomes of their assessments (*see Appendix I*).

Conclusion

The current study was concerned with understanding the reasons for euphoria in MS. Therefore, MG and NP-SLE patients were used as control groups to determine whether euphoria occurs due to the autoimmune nature of the disease and would therefore be present in all three patient groups, or due to cognitive impairment and would therefore only be observable in the MS and NP-SLE groups, or due to something specific to MS, and would therefore not be present in any of the other two patient groups.

Hypothesis 1 indicated that all three patient groups demonstrated all sub-types of euphoria. Past research has reported that euphoria can occur in MS and in NP-SLE (Benedict et al., 2005; Benedict et al., 2008; Cottrell & Wilson, 1926; Nived et al., 2003). However, attention has never been drawn towards patients with MG exhibiting euphoria. With this finding, the current study may have contributed to the literature for mood in MG. Due to the finding for hypothesis 1, it could be assumed that euphoria is a result of the autoimmune nature of the disease for MS, but also for NP-SLE and MG.

Hypothesis 2 indicated that whilst cognitive impairment was present in the NP-SLE group it was not present in the MS group. The argument was that euphoria in MS could be due to cognitive impairment. Even though this is well supported by past research (Benedict et al., 2004; Horrobin, & Bennett, 1999), for this study this argument was refuted.

Hypothesis 3 was therefore no longer valid for the MS group, but still showed meaningful correlations with euphoria sclerotica and spes sclerotica for the NP-SLE group. Whilst the results were mixed and all of the hypotheses were only partially supported, the findings of this study may have still contributed to the existing literature, as it can be said that euphoria is due to the autoimmune nature of the diseases. It would be interesting for future research to investigate if findings remain the same when larger sample sizes are used. Further, it would be interesting to observe, whether or not autoimmune disease groups other than the ones chosen for this study also exhibit euphoria, so that the finding of this study could either be opposed or further supported.

References

Akshoomoff, N. A., & Stiles, J. (1995). Developmental trends in visuospatial analysis and planning: I. Copying a complex figure. *Neuropsychology*, *9*(3), 364-377.

Andersson, G. (1996). The benefits of optimism: A meta-analytic review of the Life Orientation Test. *Personality and Individual Differences*, *21*(5), 719-725.

Anderson, S. W., & Tranel, D. (1989). Awareness of disease states following cerebral infarction, dementia, and head trauma: Standardized assessment. *The Clinical Neuropsychologist, 3,* 327-339.

Bauer, M., Crits-Christoph, P., Ball, W., Dewees, E., McAllister, T., Alahi, P., ... Whydrow, P. (1991). Independent assessment of manic and depressive symptoms by self-rating scale. Characteristics and implications for the study of mania. *Archives of General Psychiatry, 48,* 807-812.

Beck, A. T., Steer, R. A., & Brown, G. K. (2000). *Manual for the Beck Depression Inventory-Fast Screen for Medical Patients*. San Antonio, TX: Psychological Corporation.

Benedict, R. (1997). *Brief Visuospatial Memory Test – Revised: Professional Manual.* Odessa, Florida: Psychological Assessment Resources.

Benedict, R., Carone, D., & Bakshi, R. (2004). Correlating brain atrophy with cognitive dysfunction, mood disturbances, and personality disorder in multiple sclerosis. *Journal of Neuroimaging*, *14*, 36-45.

Benedict, R., Fishman, I., McClellan, M., Bakshi, R., & Weinstock-Guttman, B. (2003). Validity of the Beck Depression Inventory-Fast Screen in multiple sclerosis. *Multiple Sclerosis*, *9*(4), 393-396.

Benedict, R., Schretlen, D., Groninger, L., Dobraski, M., & Shpritz, B. (1996). Revision of the Brief Visuospatial Memory Test: Studies of normal performance, reliability, and validity. *Psychological Assessment*, *8*(2), 145-153.

Benedict, R., Schwartz, C., Duberstein, P., Healy, B., Hoogs, M., Bergsland, N., ... Zivadinov, R. (2013). Influence of personality on the relationship between gray matter volume and neuropsychiatric symptoms in multiple sclerosis. *Psychosomatic Medicine*, *75*(3), 253-261.

Benedict, R., Shucard, J., Zivadinov, R., & Shucard, D. (2008). Neuropsychological impairment in systemic lupus erythematosus: A comparison with multiple sclerosis. *Neuropsychology Review*, *18*(2), 149-166.

Benedict, R., Wahlig, E., Bakshi, R., Fishman, I., Munschauer, F., Zivadinov, R., & Weinstock-Guttman, B. (2005). Predicting quality of life in multiple sclerosis: Accounting for physical disability, fatigue, cognition, mood disorder, personality, and behaviour change. *Journal of the Neurological Sciences*, *231*(1/2), 29-34.

Benton, A. L., & Hamsher, K. (1976). *Multilingual aphasia examination* (2nd ed.). Iowa City, IA: AJA Associates.

Blumenau, J., & Broom, Y. (2011). Performance of South African adolescents on two versions of the Rey Auditory Verbal Learning Test. *South African Journal of Psychology*, *41*(2), 228-238.

Burke, K. L., Joyner, A., Czech, D. R., & Wilson, M. J. (2000). An investigation of concurrent validity between two optimism/pessimism questionnaires: The Life Orientation Test-Revised and the Optimism/Pessimism Scale. *Current Psychology*, *19*(2), 129.

Burns, T. M. (2012). The MG composite: An outcome measure for myasthenia gravis for use in clinical trials and everyday practice. *Annals of the New York Academy of Sciences, 1274,* 99-106.

Cantor, F. (2010). Central and peripheral fatigue: Exemplified by multiple sclerosis and myasthenia gravis. *PM & R: The Journal of Injury, Function, and Rehabilitation*, *2*(5), 399-405.

Cavalcante, P., Bernasconi, P., & Mantegazza, R. (2012). Autoimmune mechanisms in myasthenia gravis. *Current Opinion in Neurology*, *25*(5), 621-629.

Cottrell, S. & Wilson, S. (1926). Original papers: The affective symptomatology of disseminated sclerosis: A study of 100 cases. *The Journal of Neurology and Psychopathology*, *7*(25), 1-30.

Covey, T. J., Shucard, J. L., Shucard, D. W., Stegen, S., & Benedict, R. B. (2012). Comparison of neuropsychological impairment and vocational outcomes in systemic lupus erythematosus and multiple sclerosis patients. *Journal of the International Neuropsychological Society*, *18*(3), 530-540.

Cummings, J. L. (1997). The Neuropsychiatric Inventory: Assessing psychopathology in dementia patients. *Neurology, 48,* S10S-S16.

Delis, D. C., Kaplan, E., & Kramer, J. H. (2001). *Delis-Kaplan Executive Function System (D-KEFS): Examiner's Manual.* San Antonio, TX: Psychological Corporation.

Delis, D. C., Kramer, J. H., Kaplan, E., & Holdnack, J. (2004). Reliability and validity of the Delis-Kaplan Executive Function System: An update. *Journal of the International Neuropsychological Society*, *10*(2), 301-303. doi:10.1017/S1355617704102191

Dember, W. N., Martin, S. H., Hummer, M. K., Howe, S. R., & Melton, R. S. (1989). The measurement of optimism and pessimism. *Current Psychology: Research & Reviews, 8*, 102-119.

Diaz-Olavarrieta, C., Cummings, J., Velazquez, J., & de la Cadena, C. G. (1999). Neuropsychiatric manifestations of multiple sclerosis. *The Journal of Neuropsychiatry and Clinical Neurosciences*, *11*(1), 51-57.

Dönmez, B., Ozakbas, S., Oktem, M., Gedizlioglu, M., Coker, I., Genc, A., & Idiman, E. (2004). HLA genotypes in Turkish patients with myasthenia gravis: Comparison with multiple sclerosis patients on the basis of clinical subtypes and demographic features. *Human Immunology*, *65*(7), 752-757.

Field, A. (2009). *Discovering statistics using SPSS* (3rd ed.). Thousand Oaks, CA US: Sage.

Figved, N. N., Klevan, G. G., Myhr, K. M., Glad, S. S., Nyland, H. H., Larsen, J. P., ... Aarsland, D. D. (2005). Neuropsychiatric symptoms in patients with multiple sclerosis. *Acta Psychiatrica Scandinavica*, *112*(6), 463-468.

Finger, S. (1998). A happy state of mind: A history of mild elation, denial of disability, optimism, and laughing in multiple sclerosis. *Archives of Neurology*, *55*(2), 241-250.

Fishman, I., Benedict, R., Bakshi, R., Priore, R., & Weinstock-Guttman, B. (2004). Construct validity and frequency of euphoria sclerotica in multiple sclerosis. *The Journal of Neuropsychiatry and Clinical Neurosciences*, *16*(3), 350-356.

Fournier, M., de Ridder, D., & Bensing, J. (1999). Optimism and adaptation to multiple sclerosis: What does optimism mean? *Journal of Behavioral Medicine, 22,* 303-326.

Gilhus, N. (2012). Myasthenia and the neuromuscular junction. *Current Opinion in Neurology*, *25*(5), 523-529.

Goldberg, E., & Bougakov, D. (2005). Neuropsychological assessment of frontal lobe dysfunction. *Psychiatric Clinics of North America*, *28*(3), 567-580.

Healy, A. K., Kneebone, I. I., Carroll, M., & Anderson, S. J. (2008). A preliminary investigation of the reliability and validity of the Brief Assessment Schedule Depression Cards and the Beck Depression Inventory-Fast Screen to screen for depression in older stroke survivors. *International Journal of Geriatric Psychiatry, 23*, 531-536.

Heled, E., Hoofien, D., Margalit, D., Natovich, R., & Agranov, E. (2012). The Delis–Kaplan Executive Function System Sorting Test as an evaluative tool for executive functions after severe traumatic brain injury: A comparative study. *Journal of Clinical and Experimental Neuropsychology*, *34*(2), 151-159.

Horrobin, D., & Bennett, C. (1999). Depression and bipolar disorder: Relationships to impaired fatty acid and phospholipid metabolism and to diabetes, cardiovascular disease, immunological abnormalities, cancer, ageing and osteoporosis. Possible candidate genes. *Prostaglandins, Leukotrienes, and Essential Fatty Acids*, *60*(4), 217-234.

Jaeggi, S. M., Buschkuehl, M., Perrig, W. J., & Meier, B. (2010). The concurrent validity of the n-back task as a working memory measure. *Memory*, *18*(4), 394-412.

Kirchner, W. K. (1958). Age differences in short-term retention of rapidly changing information. *Journal of Experimental Psychology, 55*(4), 352-358.

Kolakowsky-Hayner, S., Wright, J., & Bellon, K. (2012). A brief overview of the Patient Competency Rating Scale: Updates and additions to the COMBI. *The Journal of Head Trauma Rehabilitation*, *27*(1), 83-85.

Lezak, M., Howieson, D. B., Bigler, E. D., & Tranel, D. (2012). *Neuropsychological assessment* (5th ed.). New York, NY: Oxford University Press.

Loonstra, A., Tarlow, A., & Sellers, A. (2001). COWAT metanorms across age, education, and gender. *Applied Neuropsychology*, *8*(3), 161-166.

Nived, O. O., Sturfelt, G. G., Liang, M. H., & de Pablo, P. P. (2003). The ACR nomenclature for CNS lupus revisited. *Lupus*, *12*(12), 872-876.

Owen, A. M., McMillan, K. M., Laird, A. R., & Bullmore, E. (2005). N-back working memory paradigm: A meta-analysis of normative functional neuroimaging studies. *Human Brain Mapping, 25*, 46–59.

Prigatano, G. P. (1996). Neuropsychological rehabilitation after brain injury: Scientific and professional issues. *Journal of Clinical Psychology in Medical Settings*, *3*(1), 1-10. doi:10.1007/BF01989285

Ramanan, S. V. (2005). The giggly girl. *BMJ: British Medical Journal (International Edition)*, *330*(7503), 1313.

Rey, A. (1941). L'examen psychologique dans les cas d'encephalopathie traumatique. *Archives de Psychologie, 28*, 21.

Ruff, R. M., Light, R. H., & Parker, S. B. (1996). Benton Controlled Oral Word Association Test: Reliability and updated norms. *Archives of Clinical Neuropsychology, 11*(4), 329-338.

Scheier, M. F., Carver, C. S., & Bridges, M. W. (1994). Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): A re-evaluation of the Life Orientation Test. *Journal of Personality and Social Psychology, 67*, 1063–1078.

Scheinthal, S. M., Steer, R. A., Giffin, L., & Beck, A. T. (2001). Evaluating geriatric medical outpatients with the Beck Depression Inventory – Fast Screen for medical patients. *Aging & Mental Health, 5*(2), 143-148.

Scott, T. F., Chieffe, C., & Burgut, T. (1999). Affective disorders in patients with multiple sclerosis: Patholophysiology and approaches to management. *CNS Drugs*, *12*(6), 431-436.

Sherer, M., Hart, T., & Nick, T. G. (2003). Measurement of impaired self-awareness after traumatic brain injury: A comparison of the Patient Competency Rating Scale and the Awareness Questionnaire. *Brain Injury*, *17*(1), 25-37.

Sherman, T. E., Rapport, L. J., & Ryan, K. A. (2008). Awareness of deficit in multiple sclerosis. *Journal of Clinical and Experimental Neuropsychology, 33,* 301-311.

Skeel, R. L., Johnstone, B., Yangco, D. R., Walker, S. E., & Komatireddy, G. R. (2000). Neuropsychological deficit profiles in systemic lupus erythematosus. *Applied Neuropsychology*, *7*(2), 96-101.

SPSS Inc. (2012). SPSS Statistics (Version 21.0) [Computer software]. Chicago, IL: SPSS Inc.

Strauss, E., Sherman, E. M. S., & Spreen, O. (2006). *A compendium of neuropsychological tests: Administration, norms and commentary* (3rd ed.). USA: Oxford University Press.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology, 18*, 643-662.

Sumerall, S., Timmons, P., James, A., Ewing, M., & Oehlert, M. (1997). Expanded norms for the Controlled Oral Word Association Test. *Journal of Clinical Psychology*, *53*(5), 517-521.

Surridge, D. (1969). An investigation into some psychiatric aspects of multiple sclerosis. *The British Journal of Psychiatry: The Journal of Mental Science*, *115*(524), 749-764.

Tombaugh, T. N., Kozak, J., & Rees, L. (1999). Normative data stratified by age and education for two measures of verbal fluency: FAS and animal naming. *Archives of Clinical Neuropsychology*, *14*(2), 167-177. doi:10.1016/S0887-6177(97)00095-4

Ware, J. E., & Sherbourne, C. D. (1992). The MOS 36-item short-form health survey (SF-36). *Medical Care, 30,* 473-483.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*(6), 1063-1070.

Wilson, S., & Maclean, R. (2011). Research methods and data analysis for Psychology. London: McGraw-Hill.

Wolfe, G., Meriggioli, M., Ciafaloni, E., & Ruff, R. (2012). Introduction for myasthenia gravis and related disorders. *Annals of the New York Academy of Sciences*, *1275,* vii-viii.

Appendix D

Description of Data Collection and Measurement Instruments in Detail

Participant self-report measures. The following were neuropsychological measures pertaining to mood and affect (depression, euphoria sclerotica), awareness of any potential deficits (eutonia sclerotica), and optimism and outlook (spes sclerotica). See *Appendix G* for an overview of the tests and questionnaires.

Beck Depression Inventory Fast Screen (BDI-FS). The *BDI-FS* (Beck et al., 2000) has established validity and reliability with an internal consistency that ranges between different studies between α = .75 and .88, is used to evaluate depression, and consists of 7 items (Benedict, Fishman, McClellan, Bakshi, & Weinstock-Guttman, 2003; Healy, Kneebone, Carroll, & Anderson, 2008; Scheinthal, Steer, Giffin, & Beck, 2001). This measure was relevant to the study to capture the level of depression seen in patients. The *BDI-FS* scores were compared to the euphoria sclerotica reported in individuals to determine if a positive or negative mood prevails.

Cottrell and Wilson Questionnaire. This questionnaire was taken from the paper *The affective symptomatology of disseminated sclerosis: A study of 100 cases* by Cottrell and Wilson (1926) and explored the three sub-types of euphoria. It was relevant, as the aforementioned literature suggested that such aspects are common in MS. With this, scores from MG and NP-SLE patients were compared to those of MS patients and possible conclusions were drawn as to whether such aspects were due to the autoimmune nature of the diseases, due to brain involvement in autoimmune diseases, or due to MS only.

Positive and Negative Affect Scale (PANAS). The *PANAS* (Watson et al., 1988) is a 20-item scale that is highly internally consistent with α = .84-.90 and that measured positive (levels of energy, enthusiasm, alertness) and negative (anger, contempt, fear, distress, guilt, nervousness) affect (Watson et al., 1988). Participants rated their affect on a 5-point Likert scale (1 [not at all] to 5 [extremely]). It was important for the same reasons mentioned above.

Internal State Scale (ISS). The *ISS* (Bauer et al., 1991) has four subscales, one of which was used as a measure of hypomania, which is similar to euphoria sclerotica. This scale was used because there are very few self-report measures of euphoria sclerotica available. The scale has well-established validity and reliability with α = .81-.92 (Bauer et al., 1991). The scale was slightly altered for reasons of consistency with the other measures used in this study and for reasons of simplicity, as the original would have required participants to rate

statements from 0 to 100. The current scale allowed participants to rate statements on the same Likert scale that the *PANAS* used.

Neuropsychiatric Inventory (NPI). The *NPI* (Cummings, 1997) has well-established validity and reliability with α = .75 and measures euphoria sclerotica in terms of a persistent and unusually positive mood (Benedict et al., 2013). It therefore was important for the same reasons mentioned for the *Cottrell and Wilson Questionnaire* (Cottrell & Wilson, 1926). The participants' informant also completed this questionnaire and patient/informant discrepancies were used as a measure of eutonia sclerotica, in terms of unawareness of mood and behavioural symptoms. It consists of twelve symptom domains (apathy/indifference, depression/dysphoria, euphoria/elation, agitation/aggression, disinhibition, night-time behaviour, hallucinations, delusions, anxiety, irritability/lability, eating disorder, aberrant motor behaviour) each yielding a severity (0 [mild] to 3 [severe]) and frequency score (0 [none] to 4 [daily]) (Benedict et al., 2013).

Physical Ability Scale. As a simple scale for physical ability could not be located, a scale was created using the physical components of the *Patient Competency Rating Scale (PCRS;* Prigatano, 1996), which is a 30-item scale with well-established test-retest reliability ranging between .85 and .97 and an internal consistency of α = .91-.93 (Kolakowsky-Hayner, Wright, & Bellon, 2012; Sherer, Hart, & Nick, 2003), and the physical components of the *Medical outcomes study 36-Item short-form health survey* (Ware & Sherbourne, 1992). Both the patient and an individual who was aware of the patient's disabilities rated the patient's ability on a 3-point Likert scale (1 [cannot perform] to 3 [performs with ease]) on a variety of tasks including emotional, behavioural, physical, and cognitive functioning (Kolakowsky-Hayner et al., 2012; Sherer et al., 2003). It was included, as patient/informant discrepancies on the physical ability items were used to determine unawareness of physical disability (eutonia sclerotica).

Awareness Interview (AI). The *AI* (Anderson & Tranel, 1989) is a questionnaire that consists of eight domains, namely thinking, memory, orientation, language, visual perception, motor impairment, hospitalisation, and ability to return to work, from which the latter three were excluded for the current study, as they were irrelevant to assess cognitive functioning. The interview asked participants and an informant to describe the participants' cognitive abilities such as memory impairment (Sherman, Rapport, & Ryan, 2008). The *AI* was included because it is an appropriate measure of unawareness of cognitive impairment (measured via patient/informant discrepancies) with a high inter-rater reliability of .92

(Anderson & Tranel, 1989) and because it is commonly used among unawareness of deficit research (Sherman et al., 2008).

Optimism and Pessimism Scale (OPS). The *OPS* (Dember et al., 1989) consists of 36 items that measured participants' positive and negative outlook on life, and 20 items that were filler items (Burke, Joyner, Czech, & Wilson, 2000). Participants rated the items on a 4-point Likert scale (1 [strongly disagree] to 4 [strongly agree]). It was included as it elicited optimism or spes sclerotica and as it is a reliable measure with alpha coefficients of .84 for optimism and .86 for pessimism (Burke et al., 2000; Dember et al., 1989).

Life Orientation Test – Revised (LOT-R). The *LOT-R* (Scheier et al., 1994), used as a measure of spes sclerotica, contains 8 items that measure dispositional optimism (a generalised belief that good things will happen) and 4 filler items (Andersson, 1996). Answers were assessed on a 4-point Likert scale, so to be in line with the *OPS*, so that a forced choice was enforced and answers could only either be optimistic or pessimistic. The *LOT-R* was included as it is frequently used among optimism research and is a relevant measure of spes sclerotica with an internal reliability of $\alpha = .78$ (Burke et al., 2000; Fournier, de Ridder, & Bensing, 1999).

Cognitive measures. The following were neuropsychological measures pertaining to memory, executive functioning, and visuospatial abilities. For tests that needed to be timed, a stopwatch was used.

0 and 2 Stage n-back Task. The 0-back task, a type of *n*-back Task (Kirchner, 1958; Owen et al., 2005), measured attention and required participants to identify a visually presented target letter by pressing a computer key (Jaeggi, Buschkuehl, Perrig, & Meier, 2010). The 2-back task, another type of the *n*-back Task, assessed working memory and required participants to compare each letter with the letter presented two letters previously and to ascertain if they were a match by pressing a computer key (Jaeggi et al., 2010). A number of studies present different reliability coefficients for this test, ranging from insufficient to as high as .80, where the latter occurs when higher levels of the task (2-back) are used (Jaeggi et al., 2010). Despite the mixed measures of reliability, the test was chosen, as it is one of the primary measures within working memory research, and it includes a measure of reaction time, which denotes speed of information processing (Jaeggi et al., 2010).

Controlled Oral Word Association Test (COWAT). The *COWAT* (Benton & Hamsher, 1976) measured verbal generativity in that patients were given three letters (one at a time) and were asked to generate a list of words that begin with the specified letter (Sumerall, Timmons, James, Ewing, & Oehlert, 1997). All words other than proper names and the same words with

different endings (e.g. pot, pots, potter) were allowed. It was included, as it is a recognised test of executive dysfunction with high reliability and validity with an alpha coefficient of .83 (Ruff, Light, & Parker, 1996; Loonstra, Tarlow, & Sellers, 2001; Sumerall et al., 1997; Tombaugh, Kozak, & Rees, 1999).

Rey Auditory Verbal Learning Test (RAVLT). The *RAVLT* (Lezak et al., 2012; Rey, 1941) is an assessment of learning and memory with high internal reliability of α = .90 (Strauss, Sherman, & Spreen, 2006). A list of 15 words was presented on 5 occasions. The *RAVLT* is used to test participants' memory retrieval – immediate (recalling the list in any order after having heard it) and delayed (after 20 minutes) – and recognition memory (identifying the words from a list) (Blumenau & Broom, 2011). This test was included, as executive memory deficits are demonstrated through learning and by comparing the free recall and recognition scores.

Brief Visuospatial Memory Test-Retrieval (BVMT-R). The *BVMT-R* (Benedict, 1997) is a multi-form test with high interform reliability and construct and criterion-related validity, that assessed visuospatial memory on five different occasions, namely on three learning trials (reliability coefficients range from .96 to .97), a 25-minute delayed trial (α = .97), and a delayed recognition task (Benedict, Schretlen, Groninger, Dobraski, & Shpritz, 1996). It was selected, as it was directly comparable with the *RAVLT* and had similar means of assessing executive memory dysfunction.

Rey-Osterrieth Complex Figure (ROCF). The *ROCF* (Lezak et al., 2012) is a hierarchically organized structure comprised of multiple elements such as rectangles, single lines, and circles. The copy trial, which was utilised in this study, measured planning ability and constructional abilities. Participants were required to copy this figure and were assessed on the way in which they approached the task (e.g. accuracy, fragmentation, confabulation) (Akshoomoff & Stiles, 1995). This test was important because poor planning and constructional strategies could indicate executive dysfunction. Inter-rater reliabilities in this study were high, α = .94.

Delis-Kaplan Executive Function System Sorting Test (D-KEFS ST). The *D-KEFS ST* (Delis et al., 2001) consists of two sets of six stimulus cards, each having a different shape and a word in its centre (Heled, Hoofien, Margalit, Natovich, & Agranov, 2012). The cards must be sorted into two groups of three cards each, each group having common features (Goldberg & Bougakov, 2005). There are eight possible arrangement options (Heled et al., 2012). The test measured abstract thinking and was included due to its well-accepted

reputation as a test of executive functioning with high internal consistency and reliability of α = .80 (Delis, Kramer, Kaplan, & Holdnack, 2004; Goldberg & Bougakov, 2005; Heled et al., 2012).

D-KEFS Colour Word Interference Task (D-KEFS CWIT). The *D-KEFS CWIT* (Delis et al., 2001) is a modification of the *Stroop test* (Stroop, 1935), which measured inhibition and set shifting in four different conditions (Goldberg & Bougakov, 2005). Firstly, participants had to name correctly the different colours of blocks, secondly read correctly colour words printed in black ink, thirdly name correctly the ink of the colour word and not read the word itself (measured inhibition), and fourthly colour words in different ink were presented, where participants had to read correctly the ink instead of the word, unless the word had a box drawn around it in which case the word had to be read (measured set shifting) (Goldberg & Bougakov, 2005). This measure is a well-known measure of executive dysfunction with high reliability of α = .80 (Delis et al., 2004) and was thus chosen for inclusion in this study.

Even though the reliability of the majority of the measures was found, there were a few tasks, such as the Cottrell and Wilson questionnaire, the *AI*, the *n*-back test, the *ROCF*, and the *D-KEFS* tests that did not yield much information. Despite this, these measures were considered important and were therefore included.