Recognition of emotion from facial expression in Multiple Sclerosis

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Abstract

(1) Introduction

Multiple Sclerosis (MS) is a chronic, degenerative neurological condition. It is associated with a range of disabling physical, emotional, cognitive, and social sequelae. It has been demonstrated that people with MS are impaired relative to healthy controls at recognising emotion from facial expression and prosody. It has also been demonstrated that other neurological populations are impaired at recognising the emotional states of others. The present study aimed to further explore the relationship between MS and emotion recognition from facial expression and ascertain whether impaired recognition of emotion from facial expression was associated with reports of everyday social functioning.

(2) Method

Thirty people with MS were assessed using the Facial Expression of Emotion: Stimuli and Tests, comprised of the Ekman 60 Faces and the Emotion Hexagon. Their performance was compared to the published normative data of the FEEST collected from neurologically healthy controls (n = 227; n = 125 respectively). Each MS participant was asked to complete a questionnaire about everyday functional behaviour, the Brock Adaptive Functioning Questionnaire. A parallel version was completed for each MS participant by a significant other.

(3) Results

FEEST

The MS group were significantly worse at overall recognition of emotion ($p<.001$; $p<0.05$). Using published cut-off scores, 36.67% of the MS group were classified as impaired on the Ekman 60 Faces; 23.33% on the Emotion Hexagon, significantly greater than the than the 5% expected from the normative data ($p<.001$). There were also significant between-group differences on recognition of individual emotions.

BAFQ

BAFQ informant reports of aggression were significantly correlated with recognition of disgust on both FEEST tests ($p = .001$). Although several other correlations were approaching significance, no other significant correlations (i.e. $p<.01$) were found. Scores on the BAFQ were generally low, suggesting few social behaviour impairments in the current sample.

(4) Discussion

It was confirmed that people with MS have difficulty recognising emotion from facial expression but insufficient evidence was found to show that this was related to reported social behaviour. The implications for further research are discussed, along with a critique of the methodology.

Contents

1 Introduction

The Central Nervous System (CNS) is the centre of all communication within the body. Information from the outside world is processed, stored, and used to initiate instructions for bodily behaviour. Comprising the brain and spine, the CNS is composed of two cell types: neurons (nerve cells) and glial cells (support cells). The neurons are responsible for transporting communications in the form of electrical impulses throughout the CNS. The communication enters at the neuron's dendrites, travels through the cell body, along the length of the axon and terminates at the synapses. At the synapses the message is passed to the dendrites of another neuron and the communication continues to move through the CNS.

The glial cells have several functions including the provision of the fatty material, myelin, which surrounds the neuronal axons. Myelin serves to insulate the axon to help the electrical impulses to travel with speed and accuracy. In this sense it is much like the plastic coating which surrounds electrical cables. Damage to the myelin sheath, as occurs in Multiple Sclerosis (MS), can significantly impair the function of the neurons and as such the efficient operation of the CNS.

1.1 Multiple Sclerosis

MS is a chronic and lifelong neurological disease. The name is derived from the condition's defining characteristic; the multiple areas of scar-like lesions – or scleroses – spread throughout the CNS which develop following demyelination. The location of the

sclerotic plaques within the CNS determines the presenting symptoms which can include motor dysfunction, impaired bowel and bladder function, cognitive changes, visual disorders, and problems with speech. The range and severity of presenting problems is highly idiosyncratic, with considerable variation between individuals diagnosed with the condition. However, Confavreux and Vukusic (2006) argue that the course of MS can be described by two clinical phenomenon: "relapses of acute neurological symptoms, which end with a partial or complete remission, and progression, which refers to the steady and irreversible worsening of symptoms and signs over 6 months." (pg. 606).

1.1.1 MS Sub-types

MS can be broadly divided into four sub-categories according to the experience of relapse and progression.

Benign MS

In benign MS episodes of relapse are infrequent and the level of disability caused is mild. Recovery from a relapse is complete, with no residual symptoms between episodes. Benign MS is often only diagnosed posthumously when post-mortem examination reveals scarring throughout the CNS (NICE Guidelines, 2003).

Relapsing/Remitting MS

Approximately 80% of people who are diagnosed with MS experience episodes of relapse and remission. Typically, in relapsing/remitting MS symptoms subside completely during a period of remission and functioning returns to the pre-morbid

baseline level. However, over time, a remission may not lead to complete recovery and residual symptoms may persist (NICE Guidelines, 2003).

Secondary Progressive MS

Secondary progressive MS initially presents as relapsing/remitting MS, where episodes of relapse are followed by complete remission. However, as time progresses symptom severity gradually increases independent of discrete episodes of relapse. Disability caused by the disease becomes more acute and permanent. (NICE Guidelines, 2003). All secondary progressive patients begin with the relapsing/remitting sub-type but 5-15 years after onset symptoms worsen (Coyle, 2000).

Primary Progressive MS

In primary progressive MS there are no episodes of relapse *per se*. Rather, there is a gradual increase in symptom severity over time. The level of disability may occasionally (and temporarily) plateau, but otherwise there is a persistent worsening of the condition. Approximately 10-15% of people diagnosed with MS have primary progressive MS from onset (NICE Guidelines, 2003).

1.1.2 Prevalence and Incidence

Multiple Sclerosis (MS) is the most common non-traumatic neurological disorder in young adults (Montreuil and Petropoulou, 2003). In the UK prevalence figures vary widely; Compston (1995) reported that prevalence per 100,000 ranges from 99 to 178 according to a cross section of studies conducted within different areas of the UK. This

variance was also reflected by NICE (2003), which stated that in the UK at any one time there are 100-120 people per 100,000 with an MS diagnosis and 3-7 people per 100,000 are newly diagnosed with MS every year.

Prevalence rates within Scotland are generally higher than within the rest of the UK (e.g. Sutherland, 1956; Shepherd and Downie, 1978; Downie, 1984). Rothwell and Charlton (1998) reported prevalence rates per 100,000 of 203 in Lothian and 219 in the Borders region. Incidence rates per 100,000 were 12.2 and 10.1 for Lothian and the Borders respectively.

It is common for people who have MS to require frequent contact from health care providers. Murphy *et al* (1998) calculated the economic consequence of MS within several European countries, including the UK. They reported that the approximate cost (reported in US dollars) for three months of care in the UK ranges from $5,125 to $14,622, (£2,493 to £7,114 at the present exchange rate) depending on the stage of the disease and level of disability. They concluded that "MS represents a major financial burden on the individual, the family, health services and society, and these costs increase with time."

1.1.3 Risk Factors

Prevalence and incidence studies have investigated potential risk factors which may increase an individual's susceptibility to the disease, particularly the role of environmental and genetic risk factors.

World-wide prevalence data show that MS occurs more frequently within certain countries and continents. Several theories have been put forward to explain this finding. Many authors have drawn attention to the host country's latitudinal location (e.g. Miller *et al*, 1990), the latitudinal gradient hypothesis.

Closer examination of specific populations within high-risk countries demonstrated racial variance with regard MS risk. Specifically, it appears that peoples indigenous to high-risk countries have lower rates of prevalence (e.g. Maoris in New Zealand, Skegg *et al*, 1987; North American Indians in Canada, Hader *et al*, 1985). These studies argue that the primary risk factor for MS is therefore genetic and that the observed variance of world-wide prevalence is attributable to the migration of high-risk populations.

Recent prevalence data collected in Scotland endorse the genetic-vulnerability hypothesis. Rothwell and Charlton (1998) note the absence of a latitudinal gradient affecting prevalence within either England and Wales or Scotland. They explain the increased prevalence within Scotland as a consequence of an increased genetic susceptibility within the Scottish population.

1.1.4 Pathophysiology and Neuroanatomy

Pathophysiology

In MS it is widely understood that the process of demyelination responsible for presenting neurological symptoms occurs due to the activity of the immune system.

Typically, there is a barrier which protects the brain from the potentially harmful neurotoxic effects of the blood, the blood-brain barrier (BBB). In MS the BBB is thought to be faulty and certain immune system cells, T-cells are able to enter the CNS. T-cells react to healthy parts of the CNS as though they were viruses. The action of the T-cells triggers further immunological responses, such as inflammation and activation of additional immune system cells. Ultimately, this process results in axonal demyelination and the faulty operation of the neurones.

The remission of the clinical symptoms of MS which typically follow episodes of relapse may well be the result of remyelination. This is the repair of damaged myelin sheaths which enables neurons to perform normally once again. However, the repaired myelin is often incomplete and less effective than the original. Furthermore, repeated damage limits the effectiveness of subsequent neuronal repair. During later stages of MS, damage to the axons becomes permanent, as do associated clinical symptoms.

Neuroanatomy of MS

Although the sclerotic lesions are spread apparently at random throughout the entirety of the CNS, it has been reported that certain regions of the brain are more prone than others. The majority of lesions are to be found within the white matter surrounding the ventricles. The ventricles are cavities within the brain which are filled with cerebro-spinal fluid (CSF). Periventricular lesions are typically found in the body and atrium of the lateral ventricles. They have also been observed in the anterior, inferior and posterior

horns of the lateral ventricle, the floor of the fourth ventricle and surrounding the third ventricle (Ormerod *et al*, 1987; Brownell and Hughes, 1962).

The corpus callosum, the bundle of fibres which connects the two cerebral hemispheres, is in close proximity to the lateral ventricles and is another common site for lesions to appear (Simon *et al*, 1986; Gean-Marton *et al*, 1991). It is thought that lesions spread from the neighbouring ventricles to the inner callosum via the ependymal veins.

The fourth ventricle projects posteriorly, down through the brainstem which is adjacent to, and shares reciprocal connections with, the cerebellum. Lesions are often found located within both of these areas, especially in established MS (Brainin *et al*, 1987). It is also common for lesions to be found upon the optic nerve which is part of the visual pathway and connects the retina to the lateral geniculate body (e.g. Ebers, 1986).

1.1.5 Diagnosis

The diagnosis of MS can be complex and protracted. This is partly because there is no single test for the disease, but also because the symptoms could potentially be explained by a variety of other neurological conditions. Noseworthy *et al*, (2000) list a range of metabolic disorders, autoimmune diseases, infections, and vascular disorders which have symptoms in common with MS.

Given these complications, NICE (2003) recommend that a diagnosis of MS should only be given once there is clear evidence of lesions occupying different areas of the CNS and

occurring on different occasions; in other words, lesions distributed through space and time. Consequently they recommend that, following a first episode of unexplained neurological problems, MS should be considered but no diagnosis given at that stage. However, following the second presentation of these problems, additional investigations should be conducted by a Consultant Neurologist.

NICE (2003) recommend that a diagnosis should be made based on the outcome of a combination of tests rather than on one alone. Neurologists therefore make use of various investigative tools to help inform their decision making. Magnetic Resonance Imaging (MRI) scans identify old and active lesions in the CNS, and show any damage sustained by the BBB. Evoked potential studies test the speed of neuronal transmission between, for example, the eye and the visual cortex. Scarring of the neural pathway slows the speed of communication between neurones and such latencies would be highlighted by the investigation. A lumbar puncture can be performed in order to extract a sample of cerebro-spinal fluid (CSF). The sample is investigated for elevated white-blood cell count and presence of oligoclonal bands which would provide evidence that cells of the auto-immune system had crossed the BBB (Coyle, 2000).

1.2 Presenting Problems in Multiple Sclerosis

People who have MS can present with a wide variety of symptoms which can change and develop as the disease progresses. This is a consequence of the widespread location of the sclerotic plaques throughout the CNS. As reported, individual patterns of

neurological symptoms can be highly idiosyncratic. These symptoms can be broadly categorised as physical or psychological.

1.2.1 Physical Symptoms

Physical symptoms are closely associated with lesion activity within the brain stem and cerebellum (Rudick, 1992). They are often the most noticeable consequence of MS because of the tangible affect on mobility, vision, and limb strength and their consequent impact on the persons' ability to perform everyday tasks. Perhaps because of this, it is the presence of unexplained physical changes which initially motivates many individuals to seek referral for neurological investigation in first or second episode MS. Physical impairment is commonly measured in MS using the expanded disability status scale (EDSS, Kurtzke, 1983). This is a brief and repeatable rating system focusing largely upon deficits within various domains of physical symptomatology; a high score on the EDSS is related to increased physical impairment.

The range of physical impairments caused by MS is potentially vast; however, three of the most common symptoms are listed below:

Motor symptoms

Motor symptoms are an almost universal consequence of MS with between 80 and 90% of people reporting persistent or remitting difficulties with ambulation, spasticity, altered sensation, or limb weakness, amongst others (Lezak, 2004).

Optic neuritis

As reported above, lesions are commonly found occupying the optic nerve. Optic neuritis presents when the efficiency of transmission of the optic nerve becomes compromised, either by demyelination or neuronal inflammation or degeneration, which can than cause a range of symptoms including partial or total loss of vision, blurred vision, double vision, and impaired eye movement (e.g. Frohman, Zimmerman and Frohman, 2000). The consequences of optic neuritis are often temporary. MS is not the sole cause of optic neuritis (alternative underlying pathologies include viral-bacterial infections, autoimmune disorders, and vasculitis) but it is its most common cause (Lechtenberg, 1988).

Fatigue

Many individuals diagnosed with MS report extreme fatigue which causes profound disability. In a study examining fatigue in MS, more than half of the sample surveyed reported that fatigue was amongst their most disabling symptoms (Fisk *et al*, 1994). People who have MS can perceive fatigue as affecting cognitive, occupational and social activity (Schwartz, Coulthard-Morris and Zeng, 1996).

1.2.2 Psychological Consequences

1.2.2.1 Affective Disorders

Affective disorders are a common presenting complaint in MS. Indeed, Diaz-Olavarrieta *et al* (1999) reported that neuropsychiatric symptoms were present in 95% of their MS

sample, compared with just 16% of their control group. These findings are particularly striking given that they excluded patients with a pre-morbid history of major psychiatric illness and those experiencing an acute relapse. Furthermore, there are reports to suggest that affective disorders can be the primary clinical manifestations of MS (Skegg, 1993; Asghar-Ali *et al*, 2004).

Depression

Depression has received considerable attention from researchers investigating mood disorder and MS. It is widely reported to be a common feature of the disease and is understood by some to be amongst its defining symptoms (Mohr and Cox, 2001). The lifetime prevalence rate of Major Depressive Disorder (MDD) in MS is high, with reports between 25.7% (Patten *et al*, 2003) and 50% (e.g. Sadovnick *et al*, 1991). Minden *et al* (1987) report that in their sample of MS patients (n = 50), 14% reported one episode of MDD prior to onset of MS symptoms whereas after onset the prevalence had increased to 54%.

One problem with diagnosing depression co-morbid with MS is that many of the behavioural and physical symptoms associated with depression are also common physical symptoms of MS itself, e.g. fatigue, disturbed sleep and impaired concentration. The diagnosis of depression in MS requires detailed assessment to ensure that it does not go untreated. Also, if depression is perceived to be a natural reaction to living with an acute, degenerative and life-long neurological disorder then access to psychiatric and psychotherapeutic treatment may not be considered appropriate or even necessary

(Feinstein, 2002). Sollom and Kneebone (2007) observed that although prevalence of major depression was high within their sample (n = 495), few sought treatment.

Diagnostic issues, clinical assumptions, and individual beliefs regarding the provision of treatment may in part explain the high prevalence of suicidal ideation within the MS population. Feinstein (2002) reported that approximately one third of people with MS have suicidal thoughts over their lifetime. This is significantly higher than the prevalence rates reported for the general population (between 2.3% and 14.6% in western societies, Casey *et al*, 2006). Perhaps unsurprisingly therefore there are higher rates of completed suicide within the MS population; Sadovnick *et al* (1991), investigating mortality and MS, reported that of a sample of 3,126, suicide accounted for 15% of all deaths, over seven times greater than the general, age matched population.

Anxiety

Compared with depression, anxiety in MS has received relatively little attention from researchers. Information about prevalence is therefore more limited and considered to contain methodological flaws (Mohr and Cox, 2001). However, Feinstein *et al* (1999), reported that 25% of their sample (n = 152) had clinically significant anxiety, either in isolation or co-morbid with depression. Galeazzi *et al* (2005) reported a lifetime prevalence of 36% for anxiety. To put these figures in context, in the general population, there is a lifetime prevalence of 3-8% for diagnosed Generalised Anxiety Disorder (DSM IV, 1994).

The profound affect that mood disorders can have on an MS population was also highlighted by Feinstein *et al* (1999). They reported that increased anxiety co-morbid with depression was associated with greater risk of suicidal ideation, somatic complaints and social dysfunction. Furthermore, in a disease where medication is often via self-administered injection, specific phobic disorders such as fear of needles can have a significant impact on treatment adherence (Mohr, Boudewyn *et al*, 2001; Mohr, Cox and Merluzzi, 2005).

As with depression, anxiety in MS can often be considered to be a natural consequence of the diagnosis and its inherent uncertainty. Hence clinically significant anxiety can proceed untreated which increases the risk of suicidal ideation and self-harm (Korostil and Feinstein, 2007).

Euphoria and Pathological Laughing and Crying (PLC)

Euphoria refers to a persistent state of optimism in spite of apparently contradictory circumstances. It has been associated with MS since the time of the earliest investigations into the disease. However, it is now considered to affect no more than 10% of those who have long-standing MS with significant neurological impairment (Kesselring and Klement, 2001).

Pathological laughing and crying (PLC) is a condition similar to euphoria where an individual's affective expression is dissociated from the underlying emotion and not necessarily appropriate to the social context. Mood states can also appear to fluctuate

rapidly and the affect on the individual and those close to them can be very debilitating. Prevalence of PLC within the MS population is approximately 10% (Feinstein *et al*, 1997). As with euphoria, it is assumed to be a symptom characteristic of late-stage MS and is associated with greater physical and cognitive disability (Mohr and Cox, 2001).

Psychotic Symptoms

Symptoms akin to psychosis are thought to affect 2-3% of the MS population (Patten *et al*, 2005). Feinstein *et al* (1992) reported that episodes of psychosis in the MS population tend to occur in people who are older than would be typical of schizophrenia and who are experiencing the late stage of the disease. Furthermore, the presentation of psychotic symptoms has been associated with lesions located around the temporal horns (Ron and Logsdail, 1989).

Aetiology of Affective Disorders in MS

Identifying the specific causes underlying the development, onset and maintenance of affective disorders in MS is complex. It is most likely that "psychotic and emotional symptoms are due to an interaction of biological, psychological and social factors" (Brassington and Marsh, 1998).

A number of researchers propose that in MS affective disorders, like those amongst the general population, are essentially psychosocial. They arise as a reaction to an adverse life event and are mediated by pre-morbid as well as existing variables. Indeed, MS can be characterised by the recurrent onset of psychological stressors – physical functioning,

social role and social support can all be compromised by the disease (e.g. Pakenham, 1999; Halper, 2007).

In support of the causal role played by psychosocial factors in the development of affective disorders, Shnek *et al* (1995) reported no relationship between depression and either disease activity or magnitude of disability as measured by the EDSS. Rather, depression was associated with measures of learned helplessness, cognitive distortions and reported self-efficacy. Moller *et al* (1994) found similar results, reporting that depression was not related to demographic variables (age and gender), illness duration nor level of physical disability. Furthermore, Feinstein (2002) reported that factors increasing the risk of suicidal ideation in people with MS were "similar to those in the general population, namely the presence and severity of major depression, alcohol abuse, and social isolation".

Other researchers provide evidence to suggest that the affective disorders in MS are the consequence of an underlying organic cause, the pathological demyelination process and subsequent neurological damage. George *et al* (1994) report a positive correlation between clinical depression and lesion load within the cortical white matter of the left hemisphere. As reported above, Ron and Logsdail (1989) found that MS patients who had psychotic symptoms had greater lesion load around both temporal horns than non-psychotic MS controls. Feinstein *et al* (1992) also noted increased lesion prevalence around the temporal horns in a sample of ten MS patients with psychosis relative to ten MS patients without psychosis. Mahler (1992) proposed that euphoria may emerge as a

consequence of extensive cortical scarring disturbing communication between the frontal cortex and the limbic and diencephalic regions. Also, as reported above, euphoria and PLC typically only present in MS patients who have significant neurological impairment (Kesselring and Klement, 2001; Mohr and Cox, 2001).

1.2.2.2 Cognitive Symptoms

Over recent years, cognitive changes due to MS have received widespread attention from researchers. It is now widely understood that cognitive deficits are common amongst the MS population and that these deficits emerge as a consequence of the disease process. Rao, Leo, Bernardin *et al* (1991) reported a 40% prevalence of cognitive impairment within a community-based sample.

The variability of lesion location within the CNS means that patterns of cognitive change are highly idiosyncratic. For instance, an individual who has significant scarring of the spinal cord may be profoundly physically disabled and yet free from cognitive impairment. Consequently many researchers highlight the risk of assuming that people with MS are a homogenous population with regards to cognitive functioning and cognitive impairment.

A number of studies have charted the natural history of cognitive change within an MS population. Kujala, Portin, and Ruutiainen (1997) completed baseline assessment on an MS cohort (n = 42) and identified them as either cognitively preserved (n = 20) or mildly impaired (n = 22) on a range of neuropsychological tests. At follow-up three years later,

the intact group were still equivalent to healthy controls (n = 34) on cognitive assessment, whereas the impaired group had deteriorated further since baseline assessment. The authors therefore concluded that baseline cognitive impairment is a good predictor of future cognitive functioning.

Amato *et al* (1995, 2001) completed a baseline cognitive assessment with 50 MS participants and repeated it at four and ten year follow-up. They found that, relative to 70 healthy control participants, cognitive deficits were detected in the MS group, even amongst those who had only recently been diagnosed. The investigators reported stability of cognitive ability; cognitive performance did not significantly change at four-year follow-up even amongst those who initially presented with mild impairment. Duration, course and level of impairment were poorly correlated with clinical outcome. However, at ten-year follow-up, cognitive impairment was more marked and fewer members of the cohort remained cognitively intact. At this stage, correlates of cognitive change were more pronounced and included physical disability, disease course, and increasing age. Those with a progressive form of the disease typically perform worse on cognitive assessments (Feinstein, Kartsounis *et al*, 1992). However, Feinstein, Ron and Thompson (1993) reported that people with identical disease course and MRI results can still demonstrate considerable variability on test performance.

The onset of relapse can interfere with cognitive performance. Foong *et al* (1998) measured cognitive ability during acute relapse and then again six weeks later. They noted that impairment was more marked during relapse although the effects were not

necessarily permanent; there was some recovery of function at six week follow-up although this was not always complete.

Key areas of cognitive change

The outcome of studies utilising neuropsychological assessment measures to identify specific cognitive markers are discussed below.

Memory

Memory impairment is common in MS although its presentation varies. Beatty *et al* (1996) found a wide range of memory performance in their MS sample (n = 99). A quarter had no memory problems evident on testing; just over half presented with mild to moderate memory impairments; and just over one fifth of the sample presented with a "severe amnesia-type" impairment. Many investigators have sought to determine the specific characteristics of memory impairment in MS. There is considerable evidence to support the argument that memory failure in MS is the consequence of an inability to spontaneously retrieve information from long term memory (LTM) (e.g. Rao *et al*, 1993; Armstrong *et al*, 1996). These studies demonstrated that immediate recall, recognition and rates of forgetting were intact, thereby implying a retrieval deficit. An alternative explanation was offered by DeLuca *et al* (1994) who argued that it was not retrieval but impaired initial learning causing memory difficulties. To control for this they allowed MS participants more trials to learn new information and found that following this retrieval and recognition abilities were equivalent to controls.

Thornton and Raz (1997) conducted a quantitative review of memory impairment in MS, concluding that there is "significant impairment across all memory domains" (pg 357). They report that the disparity and contradiction within the literature appears to reflect the heterogeneity of the MS population and differing assessment methods.

Attention & Concentration

Like memory, attention and concentration are generally considered to be multi-faceted concepts (e.g. Yantis, 1998). De Sonneville *et al* (2002) assessed performance of people with MS on tasks of focused, divided and sustained attention. They found that people with MS were more impaired across all tasks than healthy controls. They also found variance between the performances of different MS sub-types: secondary progressive patients had the most extensive deficits, followed by primary progressive patients, followed by relapsing remitting patients.

Rao, Leo, Bernardin *et al* (1991) found similar results. On a battery of different tests of attention, patients with MS routinely scored worse than controls. The difference was significant on four of the five tests administered. Beatty *et al* (1996) reasoned that impaired auditory attention could realistically underlie the observed dysfunction of memory in MS, particularly in relation to impaired encoding or registration of to-be-remembered information.

Information Processing

It has been reported that MS typically causes a general slowing of information processing speed (Kujala *et al*, 1994; Kail, 1998). De Sonneville *et al* (2002) developed these findings to report that slowed information processing speed was further compounded by increased task complexity (requiring greater cognitive effort) and the presence of distracters.

It has been proposed that the differences in information processing observed between MS patients and controls could be an artefact of physical disability (Jennekens-Schinkel *et al*, 1988a,b). However differences remain in performance between MS samples and controls even when the physical requirements of a task are controlled for (Rao *et al*, 1989). This suggests that impaired information processing is a central characteristic of impaired cognitive functioning in MS which can then have a consequential affect on other cognitive skills.

Executive Functioning

The executive functions can be characterised as the higher-level cognitive skills that mediate other intellectual operations. Broadly speaking they include initiation of activity, planning, implementing, and monitoring an activity, and adapting to solve novel problems (e.g. Lezak, 2004). The impaired performance of people with MS on tests of executive function has been well documented (e.g. Foong *et al*, 1997; Arnett *et al*, 1997). Some researchers have proposed that euphoria, one of the affective disorders associated with MS (see section 1.2.2.1), could be a behavioural manifestation of impaired executive functions (Foong *et al*, 1997).

Beatty and Monson (1996) commented that impaired performance of people with MS on the Wisconsin Card Sort Test (WCST) was likely to be due to deficient concept formation rather than perseveration. MS patients also perform worse than controls on tests of verbal reasoning, independent of verbal ability (Beatty and Hames *et al*, 1995).

Foong *et al* (1997) found that planning ability, assessed using a modified version of the Tower of London (Shallice, 1982), was impaired in a cohort of 42 MS patients compared to 40 healthy controls. Closer investigation of their results shows that people with MS were less cognitively efficient. Although the MS group reached the correct goal, the route they took contained more errors, reflecting less effective skills of planning and self-monitoring. Arnett *et al* (1997) administered an equivalent test of planning and reported that the impaired performance of the MS group was a likely consequence of both impaired planning and slowed information processing speed.

Insight

Neurological dysfunction has been associated with impairment of an individual's awareness of their own cognitive, physical, and functional difficulties. As a consequence of this, subjective accounts of neurologically impaired patients can be unreliable (e.g. Simpson and Schmitter-Edgecombe, 2002). Impaired insight has been reported in MS. For example, Goverover *et al* (2005) collected data about neurobehavioural impairment from both MS patients (n = 24) and informants (i.e. people who knew the participant well). They compared the two subjective reports and found that greater cognitive

impairment was related to increased disparity between the two reports. Similarly, Beatty and Monson (1991) found that MS patients who were impaired on assessment of memory function were less likely to report any memory difficulties. Randolph *et al* (2004) compared MS patient's actual performance on memory tests with their subjective reports of memory impairment. They found that self-report accuracy was influenced by cognitive and affective variables in MS patients. Specifically, executive impairment, depression and dysfunctional depressive attitudes were associated with reports of increased memory dysfunction.

Neuroanatomical Correlates of Cognitive Impairment

The high prevalence of cognitive impairment in MS samples is perhaps unsurprising given the outcome of studies that attempt to understand relationships between cognitive functioning and lesion activity and location. Using tools such as Magnetic Resonance Imaging (MRI), researchers have discovered an association between global cognitive impairment and the pattern of lesions within cortical and subcortical brain structures, as described in section 1.3.1. Bermel *et al* (2002) found that whole brain atrophy is greater in MS than controls and atrophy is associated with cognitive performance. Baumhefner *et al* (1990) identified total plaque burden within the cerebrum as an indicator of neuropsychological functioning, whereas Huber *et al* (1992) and Edwards *et al* (2001) noted that severe cognitive impairment accompanied significant atrophy of the corpus callosum. Severe cognitive impairment has also been associated with lesion burden within periventricular white matter and the width of the third ventricle (Pozzilli *et al*, 1991; Benedict *et al*, 2002).

Additional neuroanatomical investigations have sought to identify relationships between particular lesion sites and specific cognitive impairments. For example, impaired functioning of the corpus callosum has been attributed to poor performance on tests of information processing speed, rapid problem solving (Rao, *et al*, 1989), and impaired visuo-spatial ability (Ryan *et al*, 1996). Extensive demyelination of the periventricular white matter has been observed to cause dysfunction of memory (Maurelli *et al*, 1992; Anzola *et al*, 1990), concept formation and non-verbal reasoning (Anzola *et al*, 1990). Poor performance on tests of conceptual reasoning has also been attributed to lesions in the white matter of the frontal lobe (Swirsky-Sachetti, Mitchell *et al*, 1992; Arnett *et al*, 1994). Lesions within the frontal and parietal lobes have been implicated in poorer performance on measures of complex attention, working memory (Sperling *et al*, 2001) and cognitive flexibility (Pujol, 2001).

1.2.2.3 Psychosocial Functioning

The symptoms of MS interfere with everyday functional activity. Social and vocational activities in particular can become significantly compromised. Between 50 and 80% of people with MS are unemployed ten years after the onset of the disease (Rao, Leo, Ellington *et al*, 1991). Consequently, financial stressors may emerge. Furthermore, such stressors are not always limited to the experiences of the individual with MS. Close interpersonal relationships may also be affected and long-established roles required to change; a spouse may need to become a caregiver for example.

These observed psychosocial changes can be attributed to both physical and cognitive consequences of MS. However, a number of researchers have proposed that cognitive change is the most important factor in predicting social and vocational activity.

Rao, Leo, Ellington *et al* (1991) examined psychosocial functioning in two MS groups, those who were cognitively intact (n = 52) and those who were cognitively impaired (n = 48). The two experimental groups were equivalent in terms of other disease characteristics, including physical disability. They found that the cognitively impaired group had greater disturbance of their activities of daily living, required greater assistance from others and were less likely to engage in social activities. Amato *et al* (1995, 2001) reported similar findings and argued that cognitive rather than physical change was the best predictor of impaired social and vocational functioning.

Cognitive impairment in general terms and executive functions in particular, could have a significant role in mediating social functioning. Impairment of executive skills could manifest behaviourally as an inability to effectively monitor one's own behaviour resulting in a failure to appropriately respond to social cues, leading to social indiscretions. Consequently a person with deficits of executive functioning could become estranged from partners, encounter difficulties interacting in the workplace and become alienated from social groups.

1.3 Affect Recognition

From the evidence in the previous section it is clear that MS is associated with deterioration in the quality of social and vocational activities. These detriments are thought to be related primarily to aspects of cognitive impairment, executive functioning in particular. The ability to recognise the affective state of other people is a skill vital to successful social interaction and can become compromised by impaired executive functioning (e.g. Goldberg, 2001). Inability to perceive or interpret the emotional states of others could result in inappropriate social behaviour, affecting interpersonal relationships and vocational activity.

1.3.1 Emotion Theory

Emotions can be defined as affective states that are elicited in response to particular environmental stimuli. Emotions are manifest in many different ways. Verbally, speech content can be a potent indicator of emotion. The aural features of speech such as pitch and intonation (prosody) can also provide information on emotion. Non-verbal information such as gesture, poses and facial expression are also powerful cues to underlying emotional states. Of these verbal and non-verbal expressions of emotion, facial expression is arguably the most accurate barometer of underlying affect. This is thought to be because facial expressions are reflexive and difficult to inhibit in situations where true feelings are disguised (e.g. Ekman and Friesen, 1969; Ekman, Friesen and O'Sullivan, 1988; Ekman, Friesen and Scherer, 1976). Consequently it could be argued that recognition of facial expression is an important tertiary skill in mediating appropriate social behaviour.

Darwin's theory of evolution (as discussed by Ekman, 1992) suggested that behavioural manifestations of emotional states are common to all humans irrespective of societal or cultural influence because of our shared evolutionary heritage. Other theorists (e.g. Klineberg, 1938) proposed that the learned association between behavioural expression and underlying emotion was determined by cultural variables. Ekman (1968) and Ekman and Friesen (1969) proposed that there is universality in the physical shapes made by the muscles of the face when emotions are expressed. However, they also commented that individual cultural differences determine which events may stimulate different emotions.

Ekman and colleagues have conducted extensive research into the universality of facial expressions of emotion. They observed that people from different cultural backgrounds could match the same pictures of facial expression to the same emotion words (Ekman and Friesen, 1969). Furthermore, following criticism that participants in their earlier study may have been influenced by their exposure to mass media, the authors studied a group of people living in remote communities in New Guinea (Ekman and Friesen, 1971). They used stringent exclusion criteria to ensure that only those who had had, at most, minimal contact with Western cultures were included. They found that adults ($n = 189$) and children ($n = 130$) were able to match appropriate facial expressions to stories about emotional events.

Ekman and colleagues identified six basic emotions, selected due to the ability of participants in their cross-cultural studies to reliably discriminate between them. The emotions identified were happiness, sadness, anger, disgust, fear, and surprise. They

propose that these basic, universal emotions each have a distinct facial expression; derivatives of these emotions share common features of the facial expressions. Smiling, for example, is associated with happiness as well as other positive emotions such as relief, amusement, and pride (Ekman, 1992b).

Techniques for measuring the ability to recognise emotion in others have often, though not always, utilised the six basic emotions identified by Ekman. Procedures tend to require that participants match a target item of affective expression with an emotion label. Using this technique it has been possible to investigate the emotion recognition abilities in different neurological and psychiatric populations.

1.3.2 Neuroanatomy of Emotion Recognition

Cerebral lateralisation of emotion processing

Some debate remains regarding the cerebral localisation of emotional processing in humans. This debate appears to concern the potential role played by the left-hemisphere which has long been known to be the location of propositional language and damage to this area can impair comprehension and expression of verbal communication (e.g. Heilman and Gilmore, 1998). This has an impact upon the ability to process and express emotional material presented verbally. Some researchers believe that the left-hemisphere plays a more significant role in the processing of emotion. For example, Lee, Meador, Loring *et al* (2004) support the valence hypothesis which posits that the left-hemisphere

is superior to the right in processing all positive emotion, whereas the right-hemisphere is dominant in processing negative emotion.

Studies of lateralised brain-injury populations provide evidence to show that the localisation of emotional processing is unilateral; the right-hemisphere is dominant for all aspects of emotional processing irrespective of valence (e.g. Borod *et al*, 1998). Included within this is the processing and recognition of non-verbal gestures such as facial expression and people with right-hemisphere damage have been shown to have significant difficulty recognising emotion from facial expression (e.g. DeKosky *et al*, 1980; Cicone *et al* 1980; Bowers *et al*, 1985).

Right-hemisphere temporoparietal regions have been shown to have particular significance to emotional processing (e.g. Bowers and Heilman, 1984). Indeed, Hasselmo *et al* 1989 showed that cell clusters responsible for facial expression recognition are located in the superior temporal sulcus. This has caused some researchers to speculate that this is the location of a non-verbal affect lexicon (Bowers, Bauer, and Heilman, 1993). This theoretical mechanism represents a catalogue of non-verbal communicative signals and their emotional meaning. Hence damage to the right-sided temporoparietal region can inhibit processing of non-verbal information.

The limbic system

The limbic system is a network of interconnected neural pathways concerned with the primitive emotional and behavioural functions designed to preserve the species (Diamond

et al, 1985). Crawford *et al* (1986) also implicated the limbic system in the recognition of emotion from facial expression following their study of emotion recognition in the dementias. It is comprised of many neuroanatomical components including the amygdala, located near the rostral tip of the temporal lobe. The amygdala is thought to be fundamental to the evaluation of emotion from facial expression (e.g. Adolphs *et al*, 2001; Anderson *et al*, 2000), fear and anger in particular (Baird, Gruber, Fein *et al*, 1999).

Bi-lateral amygdala damage has been found to impair recognition of various emotions including sadness, anger, fear, surprise and disgust (Adolphs *et al*, 1999). Impaired functioning of the amygdala has also been implicated in childhood developmental and psychiatric disorders that feature social impairments as defining characteristics (Bauman 1991; Hendren *et al*, 1995). However, Hamann *et al* (1996) posited that facial recognition is not solely dependent on the functioning of the amygdala. They said that the developmental stage at which amygdala damage occurs has an important bearing on the likelihood of subsequent impairment in recognition of facial emotion impairment. Specifically, impairment is more likely if damage to the amygdala occurred during childhood.

Frontal lobes

Whereas the cerebral cortex and limbic system have been implicated in emotional communication and expression, the frontal lobes are known to be fundamental in regulating emotional behaviour (e.g. Heilman, 1998). The frontal lobes have been shown

to play a significant role in mediating behaviours necessary for successful social functioning. Indeed, Wood (2001) reports that neurobehavioural disability, including altered social behaviour and personality changes, are often associated with frontal lobe injury. Mah *et al* (2004) found that socio-behavioural pathology was predictive of impaired judgement of social interactions caused by damage to the frontal cortex. Furthermore, Damasio *et al* (1991) reported that injury to the frontal lobes interferes with the usual tendency that people have to avoid situations and stimuli which induce negative emotional experiences. Frontal lobe damage has also been found to impair performance on tests of social cognition. For example, Rowe *et al* (2001) found that patients with unilateral frontal lobe damage (n = 31) were significantly impaired in their ability to make inferences about the beliefs of others relative to 31 matched, healthy controls. It has also been demonstrated that recognition of sarcasm is impaired in patients who have damage to the prefrontal (n = 25) but not posterior (n = 16) regions (Shamay-Tsoory *et al*, 2005).

1.3.3 Affect Recognition Deficits in Clinical Populations

Neurological Conditions

The notion that cognitive dysfunction such as executive impairment may underpin observed deficits in social functioning has been investigated in several neurological populations. Traumatic brain injury (TBI) has received particular attention. McDonald and Flanagan (2004) asked their sample of patients with severe TBI to watch a series of video-taped vignettes showing social interactions. They were then required to make

inferences about the speaker's emotions, beliefs, sincerity, and attempts to influence the opinions of the person to whom they were talking. Results showed that patients had considerable difficulties, except where the information was explicitly provided.

Green *et al* (2004) used a sample of patients with recently acquired TBI (n = 30). They observed that on a test of non-emotional facial perception the performance of their clinical sample was the same as an age-matched healthy control group (n = 30). However, when required to make judgements about facial emotion, the experimental group performed significantly worse than the controls. This implied that recognising emotional states in others is susceptible to the affects of neurological damage.

Saunders *et al* (2006) recorded physiological responses to pictures that varied in their level of affective valence. In their sample of 13 males with severe TBI the level of physiological reaction to emotionally unpleasant pictures was significantly lower than the healthy controls (n = 24). The TBI group also exhibited lower arousal levels in reaction to the unpleasant pictures. The authors concluded that this pattern of physiological reactivity in the TBI group related to underlying impairment in executive functioning including apathy and a lack of responsiveness to emotional state in others.

Using 26 patients who had undergone unilateral temporal lobectomy (15 left-sided, 11 right-sided), Adolphs *et al* (2001) assessed ability to recognise basic emotion from facial expression and prosody relative to a control group of 50 TBI patients. They found that patients with right-sided temporal lobectomy were significantly worse at recognising

negative emotions, fear in particular, from pictures of faces. No such differences were found between groups on tests of prosody.

Difficulty in recognising emotion has been observed in several populations with acquired neurological diseases. Sprengelmeyer *et al* (1996) observed that people with Huntington's disease had difficulty recognising negative emotions from pictures of facial expression. Most striking was their significant difficulty in recognising disgust, their level of accuracy being no better than chance.

Adolphs *et al* (1998) reported that people with Parkinson's disease (PD) performed entirely normally on assessment of recognition of emotion from facial expression. However, a more recent publication by Suzuki *et al* (2006) contested this finding. Using a refined assessment method, they reported that their PD sample (n = 14) was specifically impaired in their ability to recognise disgust relative to demographically matched healthy controls (n = 39).

Crawford *et al* (1986) reported on emotion recognition abilities in the dementias. They found that people with multi-infarct dementia performed significantly worse than controls on a test of affect recognition. Furthermore, this clinical group also performed significantly worse than patients with Alzheimer's type dementia. Indeed, the Alzheimer's group did not exhibit any impairment of facial emotion recognition. The authors also report a discrepancy of performance on this test between people with

Korsakov's syndrome and those with alcoholic dementia. Whereas the former group were significantly impaired relative to controls, the latter group were not.

Psychiatric Conditions

The outcome of studies investigating the emotion recognition abilities of various psychiatric populations suggests that affective states may be related to emotion recognition.

Mandal and Battacharya (1985) reported that patients with depression made more errors than controls when recognising negative (specifically sad) emotions. It was also noted that the experimental group were more inclined to label emotions that they were unable to recognise as sad. This response bias amongst psychiatric populations has been reported by other investigators. Gur *et al* (1992) noted that patients with depression (n = 14) recognised significantly more sadness in facial expressions than did healthy controls (n = 14). Surguladze *et al* (2004) reported on emotion recognition abilities of people with major depression. They found that major depression interferes with the ability to accurately recognise either sad or happy faces.

This affective response bias has also been noted in patients with mania (Lembke and Ketter, 2002). In this study the manic participants with bipolar I (n = 8) were found to be significantly worse at recognising negative emotions (fear and disgust in particular) than healthy controls (n = 10). Overall, their recognition of emotion skills were more impaired than two other clinical groups, euthymic patients with bipolar I (n = 8), and

patients with bipolar II (n = 8). Harmer *et al* (2002) observed that patients with bi-polar disorder (n = 20) were significantly better at recognising disgust than healthy controls (n = 20), suggesting a heightened sensitivity to this negative emotion. The authors hypothesised that this could relate in some way to the clinical features of bi-polar disorder such as low self-esteem. A response bias was also noted in alcoholics who were more inclined to inaccurately label sad faces as hostile (Frigerio *et al*, 2002). The authors suggested that this may in some way explain some of the anti-social behaviours observed in this population.

Schizophrenia is often associated with impaired social functioning. Feinberg *et al* (1986) found that their sample of schizophrenic patients were more impaired than a sample of depressed patients on assessment of both affect recognition and emotion labelling. Similar results were found by Addington and Addington (1998) who reported that facial affect recognition was more impaired amongst a schizophrenia group (n = 40) than either a bipolar (n = 40) or healthy control group (n = 40). Heimberg *et al* (1992) assessed schizophrenic participants' (n = 20) ability to discriminate between emotional and neutral faces. Generally, they performed worse than healthy controls (n = 20) on this task, being more inclined to infer that neutral faces were emotional. Potentially, delusions and paranoia, symptoms often common within this group, could be characterised as the result of misattributing emotional information to otherwise neutral circumstances.

Many of the authors involved in the investigation of affective recognition skills within psychiatric populations have concluded that deficits in this area may underlie observed

impairments in social functioning. Consequently, the psychiatric symptoms are exacerbated and more likely to persist.

1.3.4 Affect Recognition in MS

The ability of people with MS to recognise emotional states in other people has so far received very little attention. To date, there are only two published articles investigating this area.

Beatty, Goodkin, *et al* (1989) aimed to examine the emotional processing abilities of people with relapsing/remitting MS, chronic MS and Parkinson's disease. They also sought to determine whether depression influenced the emotional processing abilities of these two neurological groups. The relapsing/remitting MS group (RR MS) comprised 42 participants. The chronic progressive MS group (CP MS) comprised 21 people. Chronic was defined as "observed deterioration in neurological status over a minimum of 6 months" (pg 391). The Expanded Disability Scale (EDSS, Kurtzke, 1983) and the Ambulation Index (AI, Hauser *et al*, 1983) were used to measure change over time. In the PD group were 43 participants, each of whom had at least two of five listed disturbances of motor functioning. Participants were excluded if they had a history of major psychiatric illness, drug or alcohol abuse, head injury, or CNS disease other than MS or PD. Each clinical group was matched to a neurologically healthy control group recruited from the community. The two control groups were smaller than both clinical groups: n = 19 for the CP MS group; n = 27 for the PD group. The RR MS control group sample size was not reported.

Beatty, Goodkin, *et al* (1989) found that relative to their respective control groups, the CP MS and PD groups scored significantly higher on assessment of depression (measured by the Beck Depression Inventory, BDI, Beck *et al*, 1961) and lower on assessment of cognitive ability (measured by the Mini-Mental State Examination, MMSE, Folstein, Folstein and McHugh, 1975). Both groups were also significantly worse than controls at discriminating neutral faces on the Benton Facial Recognition Test (BFRT, Benton *et al* 1983). Judgements of facial expression were measured using the materials of Ekman and Friesen (1976). Administration of individual photographs of faces was self-paced reportedly to make the task less effortful. Both groups were again significantly worse relative to their respective control groups on this task. The RR MS group was found to be equivalent to their control group on performance on each assessment apart from the BFRT where a mild impairment was noted.

Significant correlations were found between all groups' performance on the affective judgement task and performance on the BFRT. No such relationship was found between affective judgement task performance and either depression score or cognitive ability. This lead the authors to conclude that the "central mechanisms that allow accurate labelling of affective states remain largely intact in MS and PD, but the accuracy of the operation of these mechanisms is defective" (pg 363). They also postulated that affective judgement is possibly secondary to discrimination of facial stimuli given the relationship between scores on the BFRT and the affective judgement task. Therefore they implicated impaired operation of the optic pathway in explaining the observed results. They did not

report a possible explanation as to why there was a difference between the two MS groups.

Beatty, Goodkin, *et al* (1989) also reported that although no affect of depression was observed it cannot be ruled out as the BDI was perhaps not the most accurate measure of depression for either of these two clinical groups given that many of the items relate to physical impairment.

The authors concluded that functional impairment would not necessarily present as a consequence of impaired recognition of affect from facial expression as other non-verbal and verbal cues can be used to inform judgements. However, they suggested that additional assessment of clinical participants' interaction with others would have been of value in this regard.

More recently, Beatty, Orbelo, *et al* (2003) investigated the ability of people with MS to judge emotional states from verbal information. Their experimental cohort consisted of 47 MS patients of varying cognitive ability; the control group (n = 19) was made up of hospital staff and the friends and family of the participants. The hearing of all participants was assessed. All members of the experimental group also underwent cognitive and mood assessment.

During the first trial, affective prosodic comprehension, participants were asked to judge emotional information from spoken sentences. The sentences varied according to how

particular words were intoned, inferring one of six affective states: happy, sad, angry, surprised, disinterested, and neutral. Participants were required to identify the affective state they most closely associated with each sentence. The difficulty of this task was increased through substitution of the sentence words with either monosyllabic (ba-ba-ba) or asyllabic (aaahhhh) sounds. In this way the participant's judgement was reliant upon identification of intonation alone.

In the second trial, affective prosodic discrimination, the experimental sentences were adapted to reduce the phonetic information whilst retaining the stress and intonation patterns associated with the six affective states. Sentences were then paired up. The sentence pairs were played to the participants who had to judge whether the affective state was the same or different in each sentence.

The control group performed significantly better than the MS group on the monosyllabic and asyllabic conditions of the affective prosodic comprehension trial. They were also significantly better on the prosodic discrimination trial. Therefore Beatty, Orbelo, *et al* (2003) reported that the MS group were less able to identify emotional states from prosodic information than controls. The authors also concluded that the results were independent of cognitive and emotional functioning as the results of the MS group on the prosodic experimental tasks did not correlate with their performance on cognitive or mood assessment. This absence of an association is perhaps surprising given the evidence to suggest that psychiatric conditions can influence affective judgements.

1.4 Summary, Aims and Hypotheses

1.4.1 Summary

Multiple sclerosis is a degenerative neurological disorder. It is not uncommon for people with MS to experience cognitive and emotional changes as a consequence of the neurological changes associated with the disease. Psycho-social functioning, including occupational activity and inter-personal relationships, can also be impaired by MS.

One area of cognitive functioning that has received little research attention is the capacity of people with MS to accurately recognise emotion from facial expression. Such a deficit could reasonably be expected to impair social functioning and in turn the quality of social relationships. Impaired emotion recognition has been observed in various neurological and psychiatric populations. Beatty, Goodkin, *et al* (1989) and Beatty, Orbelo, *et al* (2003) have demonstrated that people with MS are impaired in their ability to recognise emotional states from prosody and facial expression.

1.4.2 Aims

The primary aim of this research paper is to develop the existing literature on the emotion recognition abilities of people who have MS. The principal question under investigation is: do people with Multiple Sclerosis have difficulty recognising emotion from facial expression relative to normative data collected from a sample of neurologically healthy controls?

The principle tool used to objectively measure facial expression recognition ability will be the computerised neuropsychological test, the Facial Expression of Emotion: Stimuli and Tests (FEEST, Young, Perrett, *et al*, 2002). The normative data collected from a sample of healthy adults by the authors of the FEEST can be used in order to compare the performance of the experimental group. There is no literature as yet published which has used the FEEST with an MS population.

One of the secondary aims of the research project is to investigate how a deficit in the recognition of facial expression may manifest functionally, affecting everyday social behaviour. The current study will measure everyday functional performance using the Brock Adaptive Functioning Questionnaire (BAFQ, e.g. Dywan and Segalowitz, 1996).

1.4.3 Hypotheses

The following hypotheses are under investigation:

(1) People with MS will be significantly worse at recognising emotion from facial expression in comparison with normative data.

(2) Impaired recognition of emotion from facial expression will be correlated with impaired functional behaviour.

(3) Reports of MS participant's level of social functioning will vary according to the information source – informants will report a significantly greater number of deficits than the MS participants themselves.

2 Method

2.1 Design

The study was an independent samples design, comparing an experimental group of people who have multiple sclerosis and normative data collected from a healthy adult sample.

2.2 Participants

2.2.1 Experimental Group

A total of 30 participants were recruited to the experimental group. Details of the recruitment procedure can be found in section 2.4.1. Demographic characteristics are described in section 3.2.

2.2.2 Criteria for Participation

The criteria for participation within the study are outlined below:

Inclusion Criteria:

- diagnosis of MS given by a consultant neurologist;
- aged between 20 and 70;
- estimated IQ of 90 or higher based on the NART;
- score of 15 or higher on the Shape Detection Test from the VOSP, used to measure visual acuity and shape detection;
- score of 11 or below on both the anxiety & depression scales of the HADS; and

- fluent in English and not aphasic.

Exclusion Criteria:

- recent MS relapse (i.e. within the previous four weeks);
- medically unfit to participate (determined by the referrer);
- history of neurological dysfunction (e.g. Parkinson's disease, drug/alcohol abuse, brain injury, learning disability, dementia) other than MS;
- presence of current significant psychiatric difficulties; and
- presence of marked visual and/or auditory impairment.

2.2.3 Normative Data

The data collected from the MS group was compared with published normative data from the primary outcome measure, the Facial Expressions of Emotion: Stimuli and Tests (FEEST, Young, Perrett *et al*, 2002). The FEEST comprises two assessments. The first of these, the Ekman 60 Faces, has normative data based on an opportunity sample of 227 healthy participants aged between 20 and 70. The second measure, the Emotion Hexagon, has normative data based on an opportunity sample of 125 healthy participants aged between 20 and 75.

2.2.4 Demographic Information

The demographic information recorded for each MS participant included:

- date of birth;
- gender;

- date of diagnosis and MS sub-type (if known); and
- present MS medication.

The name and contact address of the participant's general practitioner were also recorded so that they may be informed of their patient's participation as advised by the local area ethics committee.

2.2.5 Informant Details

The name and contact details of a significant other were also recorded. This person was nominated by the MS patient as the informant who would complete the parallel form of the Brock Adaptive Functioning Questionnaire (BAFQ) about the MS participant.

2.3 Measures

The present study made use of five clinical measures across the screening and experimental trials. These measures are outlined in more detail below.

2.3.1 Screening Trial

2.3.1.1 The National Adult Reading Test (NART Nelson, 1991)

The NART is a reading test comprising a set of 50 irregular words which the participant is asked to read aloud. The total number of mispronunciations is summed to create a NART error score, ranging from 0-50. NART performance significantly correlates with general intellectual functioning as measured by the Wechsler Adult Intelligence Scales – Revised (WAIS-R, Wechsler, 1981). The total NART error score can be used as a means

of predicting performance on the WAIS-R, thereby providing an estimate of general intellectual ability.

In the present study the NART was used to estimate the intellectual abilities of the MS participants. Completion does not require functional motor operation, an ability often impaired in MS. It is also brief (administration takes approximately five minutes) and non-threatening. Furthermore, the NART was used by authors of the FEEST to help estimate the intellectual abilities of members of their normative sample. Those whose predicted FSIQ was below 90 were excluded from the experimental trials, replicating the exclusion criteria used by the FEEST authors during the collection of their normative data. Therefore inclusion of the NART in the present study afforded parity with the procedure used by the FEEST authors.

The NART is suitable to use with adults 18 – 70. It is supported by good evidence of reliability and validity. Several studies have demonstrated the high levels of inter-rater (0.96-0.98) and test-retest reliability (0.98) (O'Carroll, 1987; Crawford *et al*, 1989a; Schlosser and Ivison, 1989b). It has also been independently verified as a valid measure of general intelligence (Crawford *et al*, 1989a).

2.3.1.2 The Shape Detection Test from the Visual Object and Space Perception Battery (VOSP, Warrington and James, 1991)

Impaired visual functioning is a common physical symptom of MS, as described in section 1.2.1. The FEEST is a visually based assessment and performance on it could be

affected by visual impairment. Therefore, the Shape Detection Test from the VOSP was introduced to control for this.

The VOSP is a battery of tests designed to measure visual perceptual functioning. The Shape Detection Test precedes administration of the other sub-tests. Failure on this preliminary test contraindicates administration of the remaining sub-tests. It is derived from the figure/ground perception test devised by Warrington and Taylor (1973) and is sensitive to impaired visual acuity and shape detection but not other impairments of object perception (Warrington and Taylor, 1973; De Renzi *et al*, 1989).

The screening test requires respondents to indicate whether they can or cannot see a partially degraded X printed upon a speckled black and white background. The test is comprised of 20 such items, preceded by two practice items which are used to illustrate the procedure. The score range is 0-20. The authors recommend that a score of 15 or below constitutes a fail based on their observation that the lowest score recorded by any member of their brain-injured group was 17 (Warrington and James, 1991). The same criteria were applied to the present study and those who scored below 15 were not invited to complete the experimental trials.

2.3.1.3 The Hospital Anxiety and Depression Scale (HADS, Zigmond and Snaith, 1983)

As reported in section 1.3.4 of the introduction, mood disorder can interfere with performance on tasks of affective judgement. In order to control for this, a formal

assessment of mood was included in the screening test. The HADS was selected as it is a commonly used clinical and research tool, and is quick to complete and score. Furthermore, according to Herrmann's (1997) extensive review of the HADS's properties, it is well accepted amongst patients and has good reliability with internal consistencies of 0.80-0.93 and 0.81-0.90 for the anxiety and depression sub-scales respectively.

The HADS is comprised of 14 statements. Seven statements refer to symptoms of anxiety (e.g. "I feel tense and wound up") and seven refer to symptoms of depression (e.g. "I still enjoy the things I used to enjoy"). The respondent decides how much they agree with each statement by selecting one of four responses (e.g. Most of the time; A lot of the time; Time to time, occasionally; Not at all), each of which corresponds with a score of 0-3. Therefore, the total anxiety and depression sub-scale scores range from 0 to 21, and the total score from 0 to 42.

HADS scores can be interpreted through use of clinical cut-offs. The mood disorder is categorised as mild, moderate or severe according to the raw score achieved on either the anxiety or depression scales. The authors of the HADS, suggested that normal functioning is reflected in a raw score of 7 or below; mild impairment is a score of 8-10; moderate impairment is 11-15; and severe impairment is 16 and over (Snaith and Zigmond, 1994).

It has more recently been argued that these criteria overestimate the prevalence of mood disorders within the general population. Crawford *et al* (2001) note that, using Snaith and Zigmond's guidelines for classification, 33% of their healthy adult sample scored outwith the normal range (i.e. a raw score of 8 or higher). This contrasts with a prevalence of 13.9% for anxiety disorders within the general population reported by Meltzer *et al* (1995). Crawford *et al* (2001) therefore recommend that a HADS raw score of 11 or higher is a more valid marker of clinical 'caseness' as this more accurately reflects the prevalence of mood disorder within the general population.

Therefore, participants in the present study who scored 11 or higher on either anxiety or depression scales of the HADS were excluded from the remainder of the study due to the probability that this reflected clinically significant levels of self-reported anxiety and/or depressive symptoms.

2.3.2 Experimental Trials

2.3.2.1 The Facial Expression of Emotion: Stimuli and Tests (FEEST, Young, Perrett *et al*, 2002)

The FEEST contains two tests of facial expression recognition, The Ekman 60 Faces and The Emotion Hexagon. Both tests are derived from the emotion recognition work of Ekman and Friesen (1976) who developed a set of photographs each of which showed a facial expression of emotion. Each expression corresponded with one of the six basic emotions: happiness, sadness, surprise, fear, disgust, and anger. As reported in section 1.3.2, these emotions had been identified as those which people can most reliably

discriminate between throughout developed and developing nations. These materials have been widely used in research into recognition of emotion from facial expression. However, prior to the development of the FEEST, they had not been available as a published test.

The FEEST is a computerised assessment and use of a personal computer is necessary for test administration. Once the assessment has been completed all results are stored as an Excel worksheet, which facilitates data analysis.

The procedure for completion of the Ekman 60 Faces Test and the Emotion Hexagon Test is broadly similar. Participants are shown on a computer screen photographs of faces, presented one at a time. Beneath each photograph are six buttons, each with one of the six basic emotions written upon it: happiness, sadness, surprise, fear, disgust, and anger. The participant decides which emotion the picture best represents. Each photograph is displayed for five seconds only, although participants can take as long as they need to provide an answer. A response must be entered before the next photograph is displayed. The total number of correct responses is recorded. Examples of the materials used in the Ekman 60 Faces and Emotion Hexagon tests can be found in Appendix 4.

Responses can be recorded by clicking the appropriate on-screen button, by pressing user-defined keys on the keyboard or by the experimenter inputting the chosen response on the participant's behalf. In the present study this latter input technique was used

exclusively in order to control for individual differences of motor dysfunction between members of the experimental sample.

The Ekman 60 Faces Test comprises a total of 70 items - one experimental trial of 60 items preceded by ten practice items. The Emotion Hexagon Test comprises a total of 180 items - five experimental trials of 30 items preceded by one practice trial of 30 items. Participants were able to rest for as long as necessary between administration of the two tests and between trials of the Emotion Hexagon. This helped control for potential affects of fatigue and distraction, common problems in an MS sample.

The Ekman 60 Faces Test

The authors of the FEEST selected the photograph sets of ten models, six female and four male, from the original materials developed by Ekman and Friesen (1976). Each set of photographs is comprised of six pictures, each corresponding with a different basic emotion, i.e. each model is shown displaying each of the six emotions. The total score range is 0-60, whereas the score range for each of the six constituent emotions is 0-10.

Normative data for the Ekman 60 Faces Test was derived from assessment of 227 healthy participants aged 20-70 and with IQ scores (estimated using the NART if unknown) of 90 or above. The data comprise mean correct recognition rates, standard deviations and cut-offs identifying the boundary between normal and impaired performance for each of the six basic emotions. Normative data for sub-groups categorised by age, gender, and intelligence, are also reported.

The Ekman 60 Faces Test has been demonstrated to be a reliable measure of emotion recognition from facial expression. The authors report statistically significant split-half reliability data for overall scores, recognition of anger, disgust, fear, sadness and surprise. For recognition of happiness scores were at ceiling and so did not correlate significantly. Reliability data are summarised in table 2.1.

Table 2.1: Split half reliability data for the Ekman 60 Faces Test (Young, Perrett et al, 2002)

	Total Score	Anger	Disgust	Fear	Happiness	Sadness	Surprise
Correlation (*r*)	0.62	0.62	0.66	0.53	0.21	0.60	0.61
Probability (*p*)	<.001	<.001	<.001	<.001	>.1	<.001	<.001

The Ekman 60 Faces Test is a valid measure of emotion recognition from facial expression. The normative data from this test correlate highly with that of Ekman and Friesen (1976) (r=0.81, t=10.35, df 58, p<.001). Furthermore, it has been shown to be sensitive to impairments of facial emotion recognition in patients with amygdala damage (Broks *et al*, 1998); basal ganglia lesions (Calder *et al* 2000b) and OCD (Sprengelmeyer *et al*, 1997). It has also been used to demonstrate impaired ability to recognise emotions within people who present with altered social behaviour following onset of a variant of fronto-temporal dementia (Keane *et al*, 2002).

The Emotion Hexagon Test

The images used in the Ekman 60 Faces Test represent broadly stereotypical expressions of facial emotion. The ecological validity of this is debateable as real-life expressions are rarely so easily defined. Therefore the Emotion Hexagon Test was devised to increase item ambiguity by constructing new images through the blending of two pictures of emotional expression. The decision as to which emotions would be blended was determined through development of the emotion hexagon. The corners of the emotion hexagon were occupied by one of the six basic emotions. Each emotion was adjacent to the two emotions it was most likely to be mistaken for. For example, the emotion *fear* was between both *surprise* and *sadness*. Figure 2.1 illustrates the emotion hexagon.

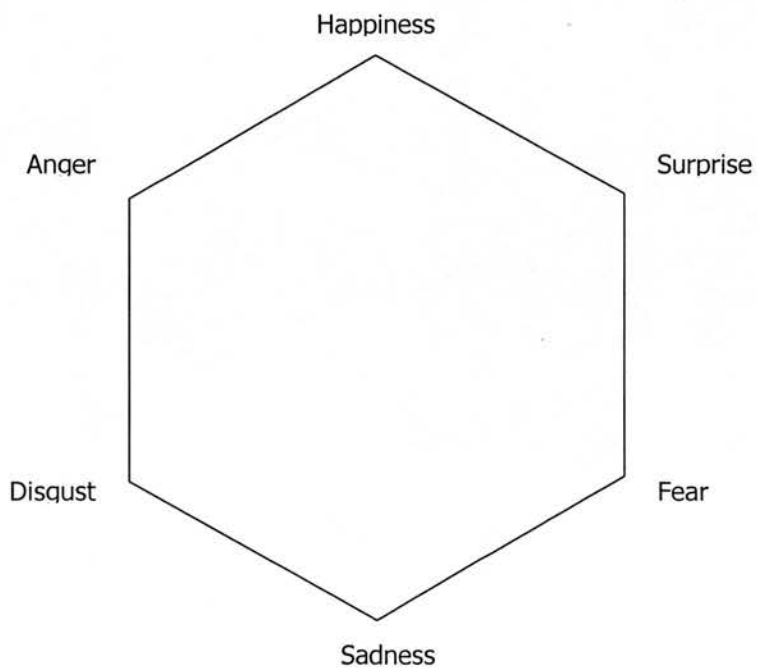

Figure 2.1: The Emotion Hexagon. Each of the six basic emotions is adjacent to the emotions with which it is most likely to be confused (Young, Perrett et al, 2002).

The images of facial expression which illustrated the emotions adjacent on the emotion hexagon were blended together. Therefore there were six emotion pairs: happiness-surprise; surprise-fear; fear-sadness; sadness-disgust; disgust-anger; anger-happiness. An emotional continuum was developed by blending the constituent parts of the pairs together in five different proportions: 90:10; 70:30; 50:50; 30:70; 10:90.

The authors applied this technique to one set of the Ekman and Friesen (1976) photographs to create a new set of 30 images. In the test there are five experimental trials. In each trial participants are shown the 30 images one at a time and asked to report which of the six emotions each picture best represents. Only responses to the items where one emotion is dominant (i.e. constitutes 90% or 70% of the image) are recorded. Responses to the 50:50 blends are not recorded as they are too ambiguous, representing as they do equal amounts of two emotional expressions. The total score range is 0-120 whereas the score range for each of the six constituent emotions is 0-20.

Normative data for the Emotion Hexagon Test were derived from assessment of 120 healthy participants aged 20-75 and with IQ scores (estimated using the NART if unknown) of 90 or above. The data comprise mean correct recognition rates, standard deviations and cut-offs identifying the boundary between normal and impaired performance. Normative data for sub-groups categorised by age, gender, and intelligence, are also reported.

The Emotion Hexagon Test has been found to be a reliable measure of emotion recognition from facial expression as summarised in table 2.2.

Table 2.2: Split half reliability data for the Emotion Hexagon Test (Young, Perrett et al, 2002)

	Total Score	Anger	Disgust	Fear	Happiness	Sadness	Surprise
Correlation (*r*)	0.92	0.68	0.92	0.88	0.18	0.65	0.33
Probability (*p*)	<.001	<.001	<.001	<.001	>.1	<.001	<.001

Young *et al* (2002) compared the data from 67 neurologically healthy control participants who had completed the Emotion Hexagon and Ekman 60 Faces. The two sets of results were found to be significantly correlated. The results of this analysis are provided in table 2.3. Furthermore, the Emotion Hexagon Test has been shown to be more sensitive in identifying impairment in emotion recognition amongst a range of clinical populations than the Ekman 60 Faces Test (Calder *et al*, 2000; Sprengelmeyer *et al*, 1999; Sprengelmeyer *et al*, 1997a).

Table 2.3: Correlations between outcome on the Emotion Hexagon Test and the Ekman 60 Faces Test.

	Total Score	Anger	Disgust	Fear	Happiness	Sadness	Surprise
Correlation (*r*)	0.68	0.51	0.27	0.52	-0.05	0.54	0.42
Probability (*p*)	<.001	<.001	<.05	<.001	>.1	<.001	<.001

2.3.2.2 Brock Adaptive Functioning Questionnaire version 4 (BAFQ Dywan and Segalowitz, 1996)

The BAFQ is a self-report questionnaire developed by Dywan and Segalowitz (1996) to assess behavioural functioning in adults who had sustained traumatic brain injury affecting operation of the frontal lobes. The original version of the questionnaire sought to provide information on functional behaviour within five areas: Planning, Initiation, Attention and Memory, Arousal, and Social Monitoring. A modified version was also developed to increase specificity (Dywan, Roden, and Murphy, 1995). This includes twelve sub-scales: Planning, Initiation, Flexibility, Excess Caution, Attention, Memory, Arousal, Emotionality, Impulse Control, Aggressiveness, Social Monitoring, and Empathy.

Each of the 68 items on the BAFQ is a statement reflecting a functional skill (e.g. *Do you pay attention to whether others are following what you are saying*?) The respondent decides how much each statement reflects their current experience by selecting one of five responses: Hardly ever; Rarely; Sometimes; Often; Almost always. Each of these responses corresponds with a score of 1-5; a high score reflects greater impairment. Clusters of items correspond with different sub-scales. This is summarised in table 2.4. Total scale scores are calculated by summing the ratings for that scale and then dividing by the number of responses given.

Table 2.4: The twelve BAFQ sub-scales and corresponding items.

BAFQ sub-scale (item range)	Representative number of items
Planning (1 – 7)	7
Initiation (8 – 11)	4
Flexibility (12 – 15)	4
Excess Caution (16 – 20)	5
Attention (21 – 27)	7
Memory (28 – 35)	8
Arousal (36 – 40)	5
Emotionality (41 – 44)	4
Impulse Control (45 – 51)	7
Aggressiveness (52 – 56)	5
Social Monitoring (57 – 63)	7
Empathy (64 – 68)	5
TOTAL (1 – 68)	**68**

The BAFQ is comprised of two parallel forms, one to be completed by the participant, the other by someone who knows them well who can act as an informant. Both versions of the questionnaire are identical apart from the substitution of pronouns where necessary. Comparison of scores on participant and informant versions of the BAFQ can be used to provide information regarding the participant's awareness of deficits in everyday functioning. Where participant and informant scores are approximately equivalent this reflects a good level of awareness of deficits. However, if there are significant discrepancies between the two versions then the participant's self-awareness is likely to be compromised.

The BAFQ is not yet commercially available as a published test but has been used in several published studies with neurologically impaired samples, healthy control samples, and informants. The test's author, Jane Dywan has reported that the BAFQ was designed originally as a clinical tool to aid clinical interviews and allow for comparison between past and present functioning following TBI and to provide an index of agreement between the TBI survivor and a significant other (personal correspondence, May 2007). The results are designed to be descriptive and there are as yet no identified cut-off scores to indicate presence of specific pathologies.

Dywan, Roden, and Murphy (1995) provided evidence that the BAFQ can tap areas of functioning controlled by different regions of the frontal system. They administered the BAFQ to 199 healthy school children, aged 15-16. Outcome data underwent factor analysis which identified two groupings. The first comprised Impulse Control, Memory, Aggression, Emotionality, Arousal, Compulsiveness, Attention, and Initiation. The authors speculated that these features related to function of orbitofrontal functioning. The second grouping (Planning, Empathy, Initiation, Social Monitoring, and Flexibility) was speculated to relate to dorsolateral functioning.

Simpson and Schmitter-Edgecombe (2002) used the BAFQ with adult TBI survivors (n = 61) and informants. They reported that there were significant positive correlations between TBI survivor and informant data within the following scales: Planning, Initiation, Flexibility, Compulsiveness, Attention, Memory, Empathy (all p values <0.01), and Arousal ($p<0.05$). The authors noted the absence of significant correlations

between survivor and informant data within the scales of Emotionality, Impulse Control, Aggressiveness, and Social Monitoring. Informants rated these areas as more impaired than the TBI survivors. They speculated that this may be evidence of the TBI survivors reduced insight into existing social behaviours.

Hopkins *et al* (2002) administered the BAFQ to adult TBI participants (n =15), who reported significantly more problems than age-matched, non-injured controls (n = 15) in the areas of Flexibility, Memory, and Arousal ($p<.01$). Informants who completed questionnaires about members of the TBI group reported significantly more problems than the control informants in Planning, Initiation, Flexibility, Compulsiveness, Attention, Memory, Arousal, Social Monitoring, Empathy (all $p<.01$), Emotionality and Impulse Control ($p<.05$ for both). Again, this tendency for people with TBI to report fewer difficulties relative to their informants probably reflects reduced self-awareness amongst some TBI survivors.

A more recent study investigated BAFQ ratings and care-giver stress (Wells *et al*, 2005). The BAFQ was completed by adult TBI survivors (n = 72) and their primary caregivers. Informant ratings were highly predictive of the caregiver's disturbed mood, measured using the Symptoms Checklist (adapted from the Symptoms Distress Checklist, SCL-90, Derogatis, (1983) and negative feelings about providing care, measured using the Caregiver Stress Questionnaire (adapted from the Zarit Burden Interview-Short Form, Bedard *et al*, 2001; and the Questionnaire on Resources and Stress, QRS, Holyroyd,

1985). This finding would appear to suggest that high BAFQ ratings are likely to in turn reflect significant levels of caregiver distress.

In the present study the BAFQ was used to provide a subjective measure of functional behaviour. It was used as an adjunct to the data from the FEEST which represents an objective measure of emotion recognition. The BAFQ was completed by all participants and each participant nominated a significant other to act as informant for completion of the parallel version.

2.4 Procedure

2.4.1 Recruitment

During routine clinical work referrers (including consultant neurologists, MS nurse specialists, speech and language therapists, and psychologists) mentioned the research project to patients who appeared to fit the inclusion criteria provided by the investigator. At this time the referrer also passed on a Participant Information Sheet which provided details of the aims, rationale and procedure of the research project (see Appendix 2). Those who were interested gave verbal consent for their name and contact details to be passed to the lead researcher. The lead researcher then made telephone contact to invite participants to attend the screening appointment.

2.4.2 Screening Trial

The following screening process, which lasted between 30 and 40 minutes, was undertaken with all potential participants and comprised:

- a reminder of the aims and procedure of the research project plus an opportunity to ask questions;
- completion of the consent form by those who chose to participate(see Appendix 2);
- collection of the demographic information listed above was through brief clinical interview;
- administration of the NART, HADS and the VOSP Shape Detection Test (*N.B.* where participants had difficulty with pen control, the lead researcher assisted in completion of the written tests); and
- an offer to take part in the experimental trial given to all participants scoring above the clinical cut-offs on both the NART and VOSP, and below the clinical cut offs on the HADS.

2.4.3 Experimental Trial

The experimental trial was timetabled to take place within seven days of the screening trial where possible. During the experimental trial both tests of the FEEST, the Ekman 60 Faces and the Emotion Hexagon, were administered. This took between 45 and 60 minutes. Data collected from participant's completion of the FEEST were allocated a code to facilitate anonymity. Data were stored on the hard drive of the computer used for administration.

During the experimental trials the following procedure was adhered to:

- instructions were shown to the participant and read aloud by the lead researcher prior to administration of both tests of the FEEST;
- participants then given time to ask questions before the start of the practice trial;
- administration of the FEEST;
- participant provided verbal responses to each FEEST item which the lead researcher then entered into the computer;
- opportunity for the participant to take a break between practice and experimental trials;
- debrief about the project and explanations provided about the materials used once the FEEST administration had been completed;
- distribution of the BAFQ, a version for themselves and a parallel form to be completed by an informant nominated by them during the screening trial;
- BAFQ orientation, instructions given on how to complete it and request made that they complete the BAFQ independently and in their own time; and
- participants asked to return completed forms to the lead researcher in the stamped, addressed envelope provided.

2.5 Ethical Considerations

The main ethical consideration for the present study was potential distress caused by identifying a hitherto unknown cognitive impairment without being able to provide any subsequent support. To protect against such eventualities several precautions were taken. Prior to giving written consent, participants were made aware that:

- no individual feedback of results could be given, although a summary of the study's findings could be sent to their correspondence address if requested;
- there was no direct personal benefit from participation; and
- their General Practitioner would be alerted to their involvement in the study.

Should a mood disorder be detected, individuals were reminded of the services available through their referrer but told that no treatment could be accessed through participation in the study. In general, the overall risk of distress caused by participation was thought to be very low.

Ethical approval for the present study was granted by Lothian Research Ethics Committee (see Appendix 3 for a copy of the Ethics Committee approval letter).

2.6 Data Analysis

The data collected from the FEEST underwent single-sample t-test analysis to establish statistical differences between the experimental sample and normative data. Correlation analysis was completed to establish relationships between FEEST outcome and scores on the twelve sub-scales of the BAFQ. Repeated measures t-tests were completed to determine whether there were significant differences between the self- and informant-reports on the BAFQ.

2.7 Statistical Power

The primary aim of this study was to investigate whether people with MS are impaired at recognising emotion from facial expression. Beatty *et al* (1989) had similar aims and so effect sizes from this study were used in power calculations to determine the sample size required by the current study.

Beatty *et al* (1989) compared a group of patients with progressive MS (n = 21) and healthy controls (n = 19) on a test of facial affect recognition. The means and standard deviations for both group's performance on the test are presented in table 2.5.

Table 2.5: Means and standard deviations of the MS and control groups on a test of facial affect recognition (Beatty et al, 1989).

	Mean	Standard deviation
MS group (n = 21)	75.0	13.4
Controls (n = 19)	90.4	11.2

A significant difference was noted between groups ($F(1,38) = 15.29$, $p < .001$) with a large effect size of d=1.24 (calculated using a pooled standard deviation of 12.42). Therefore to detect an effect of this size, where Power was 0.8, alpha was 0.5 and using a single sample t-test to compare groups, a sample of 26 would be required (Cohen, 1992).

3 Results

3.1 Participants

A total of 54 people with MS gave consent for their name and contact information to be passed to the lead researcher by their referrer. Of these people, four (7.41%) could not be contacted; nine (16.67%) opted out prior to session one; eight (14.81%) participated in session one but were excluded due to HADS scores above cut-off; two (3.70%) opted out between sessions one and two; and one (1.85%) was excluded because she did not have a diagnosis of MS. Therefore the experimental group consisted of 30 people who had MS (henceforth, the MS group).

All 30 members of the MS group completed both tests of the FEEST, the Ekman 60 Faces and the Emotion Hexagon.

3.2 Demographic Characteristics: MS Group

3.2.1 Age; Years since diagnosis; HADS scores; and Predicted FSIQ

The female/male ratio within the MS group was 2:1; 20 females and 10 males. The data describing the MS group's mean age, years since diagnosis, HADS scores, and NART predicted WAIS-R Full Scale IQ (FSIQ) are presented in table 3.1.

Table 3.1: Demographic summary data for the MS group

	Mean	SD	Range (min-max)
Age	45.63	11.64	21 – 70
Years since diagnosis	12.40	9.17	1 – 31
HADS – anxiety	4.80	2.58	0 – 9
HADS – depression	3.33	2.22	0 – 9
NART predicted FSIQ	112.07	10.57	90 – 126

3.2.2 MS Sub-types

Relapsing/remitting MS was the most prevalent disease sub-type within the experimental group (n = 15; 50%). Five participants (16.7%) reported having primary progressive MS and five (16.7) reported having secondary progressive MS. A further three group members reported having a progressive form of MS, but were not able to specify their diagnosis further (n = 3; 10%). Two participants (6.7%) did not know their diagnosis. Figure 3.1 summarises this data. The potential affects of gender, predicted FSIQ, and MS sub-type on FEEST performance are reported in section 3.6.2.

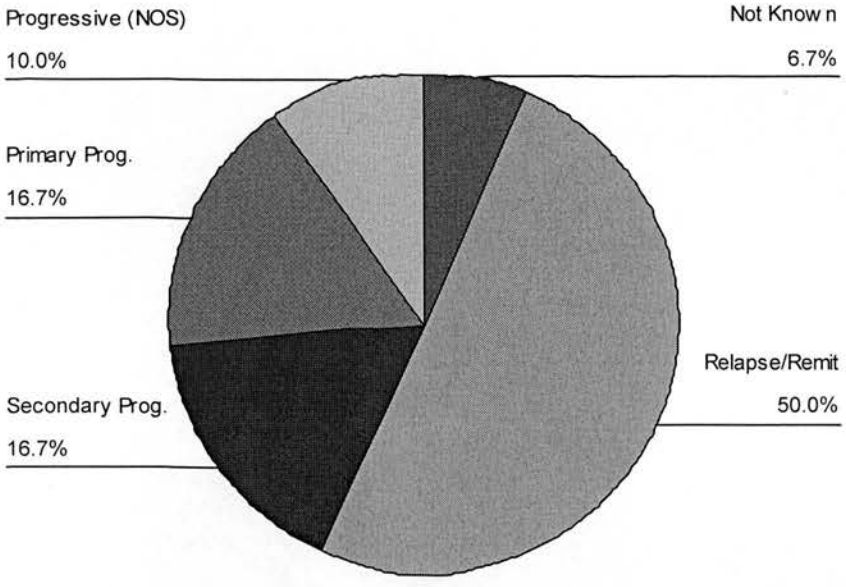

Figure 3.1: Prevalence of MS sub-types within the MS group (NOS – Not Otherwise Specified).

3.3 Demographic Characteristics: Normative Data

The performance of the MS group was compared with normative data from the FEEST (Young, Perrett *et al*, 2002).

3.3.1 Ekman 60 Faces Test

Ekman 60 Faces normative data were collected by the test authors from a sample of 227 healthy participants aged between 20 and 70 and with IQs of 90 and above. This sample comprised 124 females (54.63%) and 103 males (45.37%). The authors completed a three-factor ANOVA to establish how age, intelligence, and gender may affect test

performance. They reported a borderline affect of age (F=2.39, (4, 190) p=.052) but no other significant affects (*p*s >.1).

3.3.2 Emotion Hexagon Test

Emotion Hexagon normative data were collected by the test authors from a sample of 125 healthy participants, aged between 20 and 75, and with IQs of 90 and above. This sample comprised 63 females (50.4%) and 62 males (49.6%). A three-factor ANOVA was again completed to establish how age, intelligence, and gender may affect test performance. No significant affects were found (*p*s>.1).

3.4 Hypothesis (1): People with MS will be significantly worse at recognising emotion from facial expression in comparison with normative data

This study hypothesised that people with MS would perform significantly worse on a test of emotion recognition than would be predicted from normative data collected from a healthy adult sample. Two techniques were employed to determine the validity of this hypothesis:

(1): One-sample independent t-tests were completed to determine whether statistical differences were present between the performance of the MS group and the published normative data collected for the Ekman 60 Faces Test and the Emotion Hexagon Test. Note that the effect sizes (ES) in this chapter have been calculated using a pooled standard deviation (Coe, 2002). The effect sizes can be classified according to Cohen's criteria (as reported in Cohen, 1992) where small = .20; medium = .50, and large = .80.

(2) The FEEST cut-off scores were used to establish the number of MS group members scoring within the impaired range (i.e. $\leq 5^{th}$ percentile).

3.4.1 The FEEST – Between-group comparisons

3.4.1.1 Ekman 60 Faces Test

The Ekman 60 Faces Test comprises a total of 70 items - one experimental trial of 60 items preceded by ten practice items. Each of the six emotions (anger, disgust, fear, happiness, sadness, and surprise) is depicted ten times during the experimental trial. Therefore the maximum score obtainable for each emotion is ten; the maximum total score is 60.

Overall Scores

The mean overall Ekman 60 Faces score for the MS group was 45.03 (SD = 6.42), whereas the normative data mean was 50.64 (SD = 5.04). There was a significant difference between the two groups and a large effect size ($t(29) = 4.784$, $p<.001$; ES = 1.1). This demonstrates that the MS group performed worse than the normative data in recognising facial expressions on the Ekman 60 Faces Test, supporting the experimental hypothesis that the MS group would be significantly worse at recognising emotion from facial expression in comparison with normative data.

Scores for each emotion

Figure 3.2 illustrates the differences between the MS group and the normative data on recognition of individual emotions. Happiness was the emotion most easily recognised by the MS group (M = 9.73, SD = .64) followed by surprise (M = 8.20, SD = 1.54), anger and disgust (both M = 7.07, anger SD = 1.34; disgust SD = 2.55), sadness (M = 7.03, SD = 1.99), and fear (M = 5.93, SD = 2.43). This is a different performance profile to the normative group. Happiness was the most easily recognised (M = 9.87, SD = 0.42), then disgust (M = 8.59, SD = 1.62), surprise (M = 8.55, SD = 1.44), sadness (M = 8.33, SD = 1.66), anger (M = 7.86, SD = 1.90), and fear (M = 7.19, SD = 2.03).

The MS group were significantly impaired compared with the normative data in recognising four of the six emotions: anger ($t(29) = 3.131$, $p = .004$; ES = 0.4); disgust ($t(29) = 3.278$, $p = .003$; ES = 0.8); fear ($t(29) = 2.827$, $p = .008$; ES = 0.6); and sadness ($t(29) = 3.567$, $p = .001$; ES = 0.8). Differences between the groups in recognising happiness and surprise were not statistically significant ($p>.05$). These results suggest that people with MS have more difficulty recognising negative emotions from facial expression.

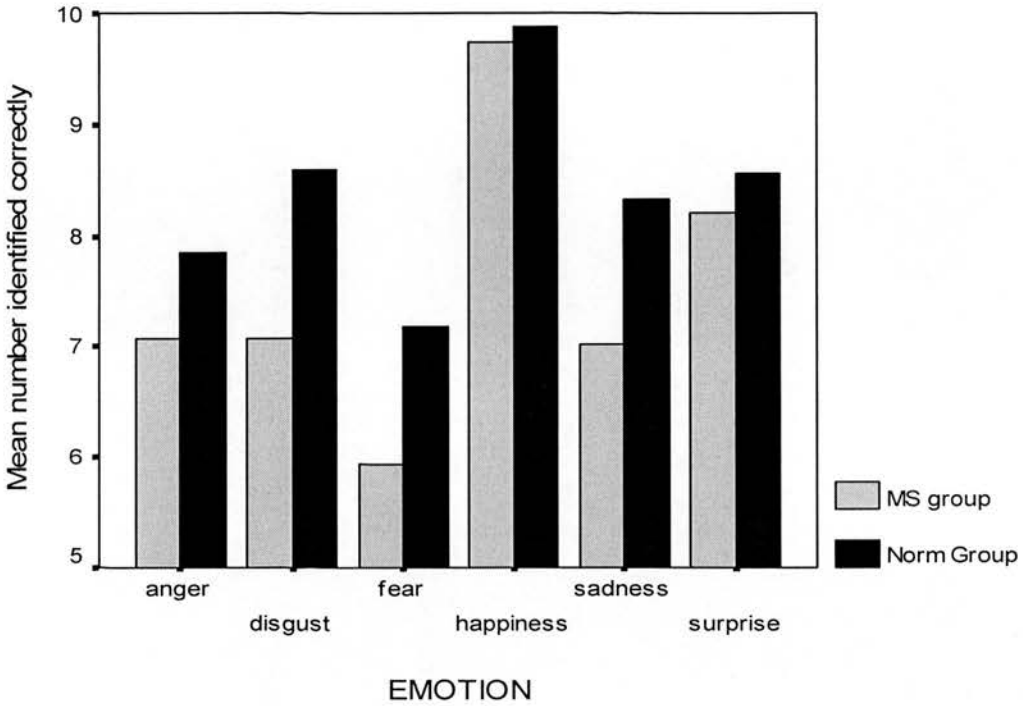

Figure 3.2: MS and normative group mean rates of recognition for the six different emotions in the Ekman 60 Faces Test.

3.4.1.2 Emotion Hexagon Test

The Emotion Hexagon Test comprised a total of 180 items - five experimental trials of 30 items preceded by one practice trial of 30 items. These practice items and 30 other items are not scored, and therefore the maximum total score on the Emotion Hexagon Test is 120. Each of the six emotions (anger, disgust, fear, happiness, sadness, and surprise) is depicted four times in every one of the five experimental trials. Therefore the maximum score obtainable for each emotion is 20.

Overall scores

The mean overall score for the MS group was 102.17 (SD = 14.70), whereas the control group mean was 107.97 (SD = 9.51). There was a significant difference between the two groups with a medium effect size: ($t(29) = 2.163$, p = .039; ES = 0.5). This demonstrates that the MS group was significantly worse than the normative data on overall performance on the Emotion Hexagon Test. It provides further support for the experimental hypothesis that there would be a difference between the MS and control groups on recognition of emotion from facial expression measured by the FEEST.

Scores for each emotion

Figure 3.3 illustrates the differences between the MS group and the normative data on recognition of individual emotions. Happiness was again the emotion most easily recognised by the MS group (M = 19.40, SD = 1.04). This was followed by sadness (M = 18.63, SD = 2.01), surprise (M = 17.13, SD = 2.49), anger (M = 16.57, SD = 4.41), disgust (M = 15.30, SD = 5.94), and fear (M = 15.13, SD = 5.30). This was in contrast to the normative group who found happiness (M = 19.64, SD = .80) to be the most easily recognised, then sadness (M = 18.38, SD = 3.42), disgust (M = 18.01, SD = 3.65), anger (M = 17.84, SD = 2.80), surprise (M = 17.69, SD = 2.16), and fear (M = 16.56, SD = 3.76).

The MS group performed worse than the normative group on recognition of every emotion apart from sadness. However, the discrepancies between the two groups were less marked than on the Ekman 60 Faces Test. There was a significant difference between the performance of the MS group and the control group on recognition of disgust

($t(29) = 2.500$, p=0.018; ES = 0.6). There were no other significant differences between the two groups (p>.1).

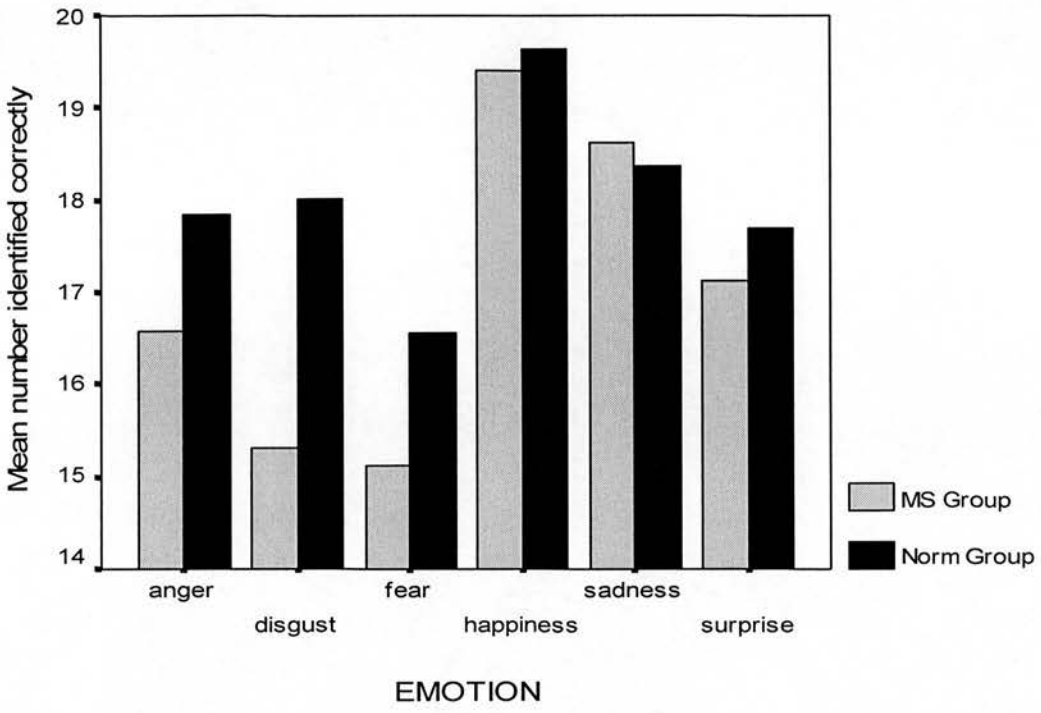

Figure 3.3: MS and normative group mean rates of recognition for the six different emotions in the Emotion Hexagon Test.

3.4.2 The FEEST – Using cut-offs to classify performance

Many psychometric tests and questionnaires used in clinical and research practice provide a cut-off score which indicates the boundary between impaired and non-impaired performance. This is usually set at 1.65 standard deviations below the mean, corresponding to performance at or below the 5th percentile for the population. The FEEST manual provide cut-off scores for Ekman 60 Faces and Emotion Hexagon total

scores as well as individual emotion recognition scores. A score at or below this cut-off can be taken as indicating impaired performance on the test.

Assuming similar variance between groups, if it were the case that MS patients had more difficulty in recognising emotions from facial expression, it might be expected that more than 5% of the MS group would score within the impaired range (i.e. below the 5th percentile). To support the experimental hypothesis that there would be a significant difference between the MS and control groups in their ability to recognise emotion from facial expression, significantly more than 5% of the MS sample should score at or below the cut-off, thereby falling within the impaired range.

Using the cut-off scores for the Ekman 60 Faces and the Emotion Hexagon it was possible to quantify the number of MS group participants scoring within the impaired range for each of the six emotions and overall test performance. Binomial tests were completed to determine whether the percentage falling within the impaired range was significantly higher than the expected 5% of the normative sample.

3.4.2.1 Ekman 60 Faces Test

Table 3.2(a) shows the number and proportion of the MS group participants performing within the impaired range on recognition of individual emotions and overall on the Ekman 60 Faces test. Based on total test scores, significantly more members of the MS group scored within the impaired range than the 5% that would be expected from the normative data ($p<.001$). This was also true for recognition of disgust, fear, sadness,

(*ps*<.001), happiness, surprise (*ps* <.01) and anger (*p*<.05). This suggests that deficits in recognition of emotion from facial expression are more prevalent within MS than neurologically healthy controls. Furthermore, the evidence shows that this impairment affects recognition of all six emotions, rather than just the four negative emotions as reported in section 3.4.1.

Table 3.2(a): Binomial comparison with normative data to show number & proportion of MS group performing within the impaired range (at or below the 5th percentile) for recognition of each emotion and overall on the Ekman 60 Faces Test

	Anger	Disgust	Fear	Happiness	Sadness	Surprise	Total Score
N (%) within impaired range	5 (16.67)	11 (36.67)	8 (26.67)	6 (20.0)	11 (36.67)	6 (20.0)	11 (36.67)
Asympt. Sig. (2-tailed)	.032	<.001	<.001	.006	<.001	.006	<.001

3.4.2.2 Emotion Hexagon Test

Table 3.2(b) shows the number and proportion of the MS group participants performing within the impaired range on recognition of individual emotions and overall on the Emotion Hexagon test. As with the Ekman 60 Faces, test the data collected from the Emotion Hexagon test show that impaired recognition of emotion from facial expressions is more prevalent in the MS group than the healthy normative sample. When using the cut-off scores for comparison there were significantly more members of the MS group scoring within the impaired range on overall test performance (*p*<.01) as well as recognition of anger, disgust (*ps*<.01), fear, happiness, and surprise (*ps* <.05). There was no difference between groups on prevalence of recognition of sadness (*p*>.1).

Table 3.2(b): Binomial comparison with normative data to show number & proportion of MS group performing within the impaired range (at or below 5th percentile) for recognition of each emotion and overall on the Emotion Hexagon Test

	Anger	Disgust	Fear	Happiness	Sadness	Surprise	Total Score
N (%) within impaired range	7 (23.33)	6 (20.0)	5 (16.67)	5 (16.67)	1 (3.33)	5 (16.67)	7 (23.33)
Asympt. Sig. (2-tailed)	.002	.006	.032	.032	1.108	.032	.002

3.5 Hypothesis (2): Impaired recognition of emotion from facial expression will be correlated with impaired functional behaviour

This study also proposed the hypothesis that performance on the tests of emotion recognition would correlate with reports of functional social impairment. Functional social impairment was measured using the BAFQ, which collects information about twelve domains of adaptive functioning. These twelve domains are: Planning, Initiation, Flexibility, Excess Caution, Attention, Memory, Arousal, Emotionality, Impulse Control, Aggressiveness, Social Monitoring, and Empathy. Information is collected from two sources – the MS participant and a significant other (the informant). Therefore FEEST performance can be correlated with both the self- and informant reports.

3.5.1 Everyday Adaptive Functioning

Each of the 30 MS group participants was asked to complete a self-report version of the BAFQ and nominate a significant other to complete the informant version. Completed questionnaires were returned by post. 24 (80%) completed copies of the BAFQ self-

report were returned; 23 (76.7%) completed copies of the BAFQ informant report were returned.

3.5.2 Associations between FEEST performance and BAFQ

To determine whether there were any relationships between adaptive functioning and the ability to recognise emotion from facial expression, correlations were completed between test performance on the FEEST and the self- and informant reports of the BAFQ. In order to reduce the number of BAFQ variables and to maximise the relevance of the analyses, only those scales relating to social behaviour were included. The five selected sub-scales were: Emotionality, Impulsivity, Aggression, Social Monitoring, and Empathy. Furthermore, it was assumed that only impaired emotion recognition would have an affect on functional behaviour. Therefore the selected BAFQ sub-scale scores were only correlated with those FEEST scores which were significantly different from the normative data. As a large number of correlations were completed, only those with $p<.01$ were considered to be statistically significant to reduce the risk of Type I errors.

Emotionality

There were no significant correlations between emotionality and recognition of emotion from facial expression as measured by the FEEST (all $ps > .01$).

Impulsivity

There were no significant correlations between impulsivity and emotion recognition (all $ps > .01$). However, the correlation between self-reports of impulsivity and recognition of

disgust on the Emotion Hexagon (r= -.413, p = .044, two-tailed) was approaching significance. For all remaining correlations p >.05.

Aggression

BAFQ informant reports of aggression were significantly correlated with recognition of disgust on both the Ekman 60 Faces (r= -.618, p = .002, two-tailed), and the Emotion Hexagon (r= -.617, p = .002, two-tailed). There were no other significant correlations (all ps >.01).

Social Monitoring

There were no significant correlations between social monitoring and emotion recognition (all ps >.01). Correlations between informant reports of social monitoring and recognition of disgust on the Ekman 60 Faces (r= -.435, p = .038, two-tailed), and total Emotion Hexagon emotion recognition score (r= -.429, p = .042, two-tailed) were approaching significance. For all remaining correlations p >.05.

Empathy

There were no significant correlations between empathy and emotion recognition (all ps >.01)

In all cases the correlations were negative; thus decreases in recognition of emotion were associated with greater difficulties in adaptive functioning. Correlation matrices illustrating associations between the above sub-scales of the BAFQ (both self- and

informant- reports) and all emotions that were significantly different from the norm can be found in Appendix 5.

The use of multiple regression analyses was considered to investigate how impairment of emotion recognition could predict functional behaviour. However, this was not pursued as the MS group *n* was not of sufficient size. Field (2005) recommends 15 participants for every predictor variable entered into the model. As recognition of four of the six emotions was impaired on the Ekman 60 Faces test, an *n* of 60 would be necessary.

3.6 Hypothesis (3): Reports of MS participant's level of social functioning will vary according to the information source – informants will report a significantly greater number of deficits than the MS participants themselves.

All 68 items on the BAFQ are scored out of five. The scale scores for the twelve domains of adaptive functioning are calculated by summing the scores for each scale and dividing by the number of responses given. A high score represents a high level of impairment. The mean scale scores for the self- and informant reports are presented in Figure 3.4.

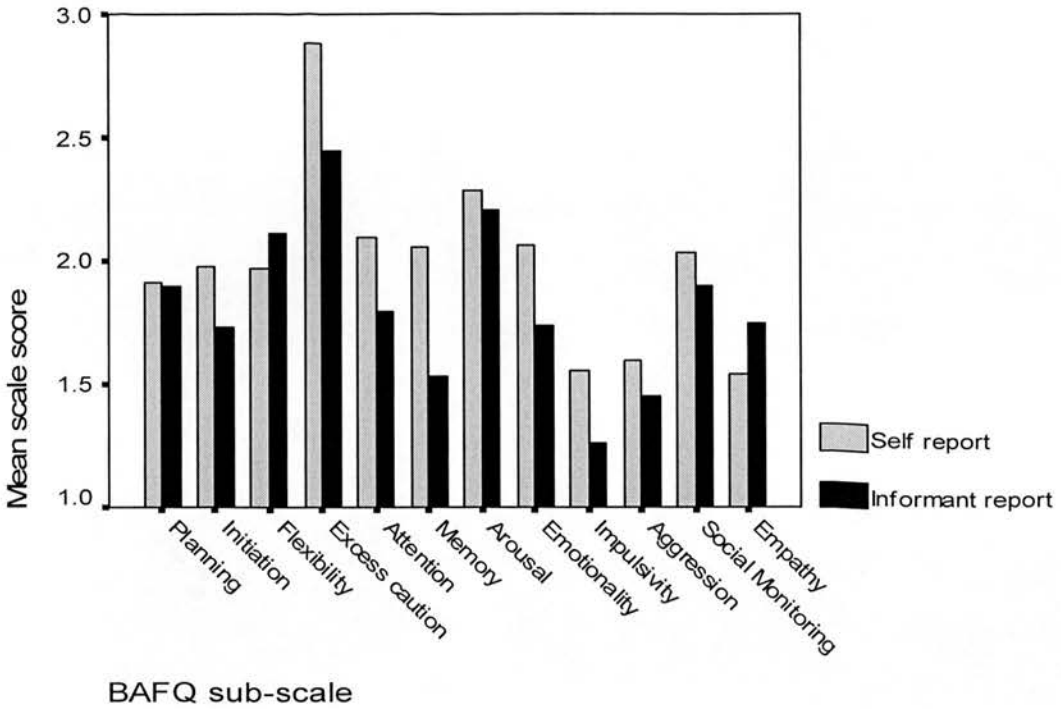

Figure 3.4: Mean self- and informant reports for the twelve sub-scales of the BAFQ

Figure 3.4 shows that both self and informant reports judged excess caution to be the most problematic area, whereas impulsivity was the least. Generally, respondents did not report the presence of many difficulties. However, there was some discrepancy between self- and informant reports on several sub-scales. Statistical analysis was completed to show whether these differences were significant.

Both the MS group participants and the informants were making judgements about the same target (the MS participant), therefore repeated measures t-tests were completed in order to analyse any differences between self- and informant-reports. To compensate for the large number of comparisons completed (and hence the inflated likelihood of Type I errors), alpha levels were set at 0.01, following the example of Hopkins *et al* (2002).

There was a significant difference between self and informant reports of impulsivity ($t(22) = 3.422$, $p = .002$;) and memory ($t(22) = 2.921$, $p = .008$). These findings were opposite to the direction predicted by the hypothesis, with the MS participants reporting greater impairment than the informants. No other significant differences were found between self and informant reports (all *p*s >.01). All *t*-values are summarised in table 3.3.

Table 3.3: Self- and informant-rated BAFQ scale scores – means, standard deviations, and t-values

BAFQ sub-scale	Self Report (N=24) Mean (SD)	Informant Report (N=23) Mean (SD)	*t*-value	*p*-value (two-tailed)
Planning	1.91 (.68)	1.90 (.79)	0.214	.832
Initiation	1.98 (.82)	1.73 (.78)	1.456	.159
Flexibility	1.97 (.69)	2.11 (1.00)	0.488	.630
Excess Caution	2.88 (.72)	2.44 (.88)	2.130	.045
Attention	2.09 (.62)	1.79 (.84)	2.066	.051
Memory	2.05 (.63)	1.54 (.73)	2.921	.008
Arousal	2.28 (.70)	2.21 (.90)	0.563	.579
Emotionality	2.06 (.67)	1.74 (.76)	2.036	.054
Impulsivity	1.56 (.46)	1.26 (.31)	3.422	.002
Aggression	1.59 (.45)	1.45 (.67)	0.633	.533
Social Monitoring	2.03 (.53)	1.90 (.75)	0.878	.390
Empathy	1.54 (.63)	1.75 (.77)	1.269	.218

The presence of two group difference indicates that overall there was a high level of agreement between the self and informant reports of the MS participant's functional behaviour. This suggests that the members of the MS group had good insight into their level of ability and this opinion was shared by their respective informants.

3.7 Supplementary Analyses

3.7.1 Comparing performance on the Ekman 60 Faces and the Emotion Hexagon

The results suggest that there is a discrepancy between the MS group's performance on the two tests of the FEEST. The Ekman 60 Faces produced a greater decrement in performance between MS and normative data than the Emotion Hexagon. Specifically, on the Ekman 60 Faces test the MS group were significantly worse at recognising four of the six emotions (anger, disgust, fear, and sadness) and had a worse overall emotions recognition score. In contrast, performance on the Emotion Hexagon test shows a significant difference between the MS and control groups only on recognition of disgust and overall emotion recognition scores. To explore further these observed differences in performance between the two emotion recognition measures, scores on the measures were converted to percentages. Paired *t*-tests were then completed to ascertain differences between outcomes.

Two-tailed analyses showed that the MS group performed significantly worse on the Ekman 60 Faces Test on recognition of anger ($t(29) = 3.292$, $p = .003$), fear ($t(29) = 4.109$, $p<.001$), sadness ($t(29) = 7.400$, $p<.001$), and total score ($t(29) = 7.843$, $p<.001$) than on the Emotion Hexagon. No other significant differences were found (all $ps > .05$). The results are illustrated in figure 3.5.

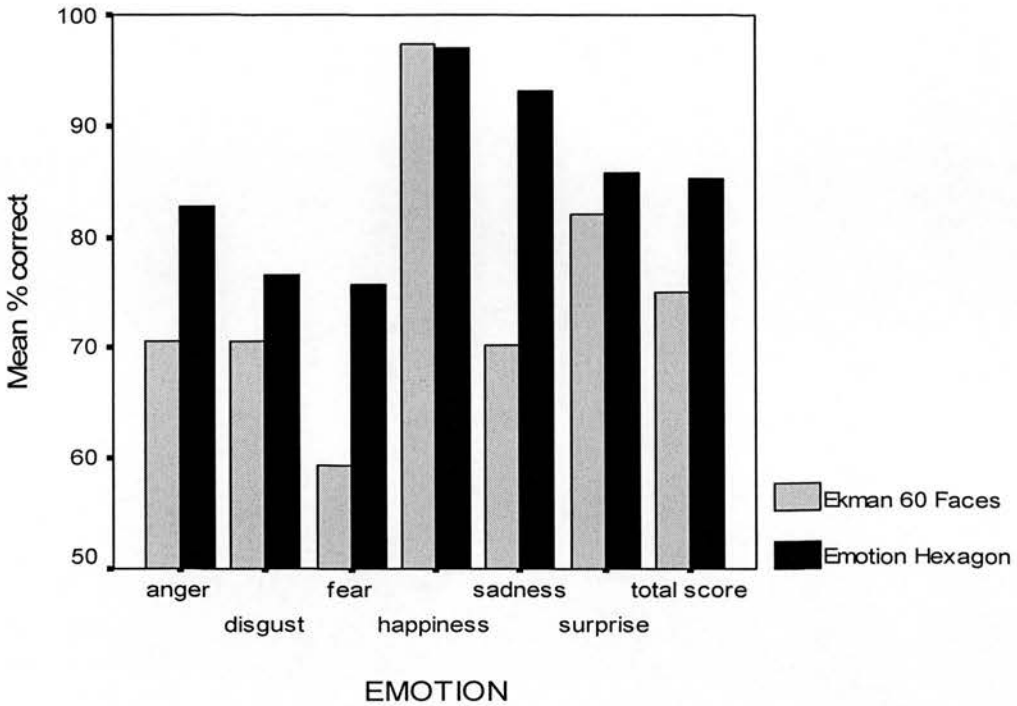

Figure 3.5: MS group mean % correct on the Ekman 60 Faces and Emotion Hexagon Tests

As illustrated by figure 3.6, The Ekman 60 Faces and Emotion Hexagon Tests also varied in the number of MS group participants they classified as impaired. Analysis showed that the Ekman 60 Faces tests classified a significantly greater number of MS participants as impaired on recognition of sadness (χ^2 (1) = 10.42, p = .001). No other significant differences were found (all ps>.05). These findings suggest that the Ekman 60 Faces Test was the more difficult of the two FEEST tests. This contradicts reports that the Emotion Hexagon Test is more sensitive to emotion recognition impairments due to the increased ambiguity of the materials used (Calder *et al*, 2000). This finding also

contradicts the reports of Young *et al* (2002) that the patterns of emotion recognition are comparable between the two tests.

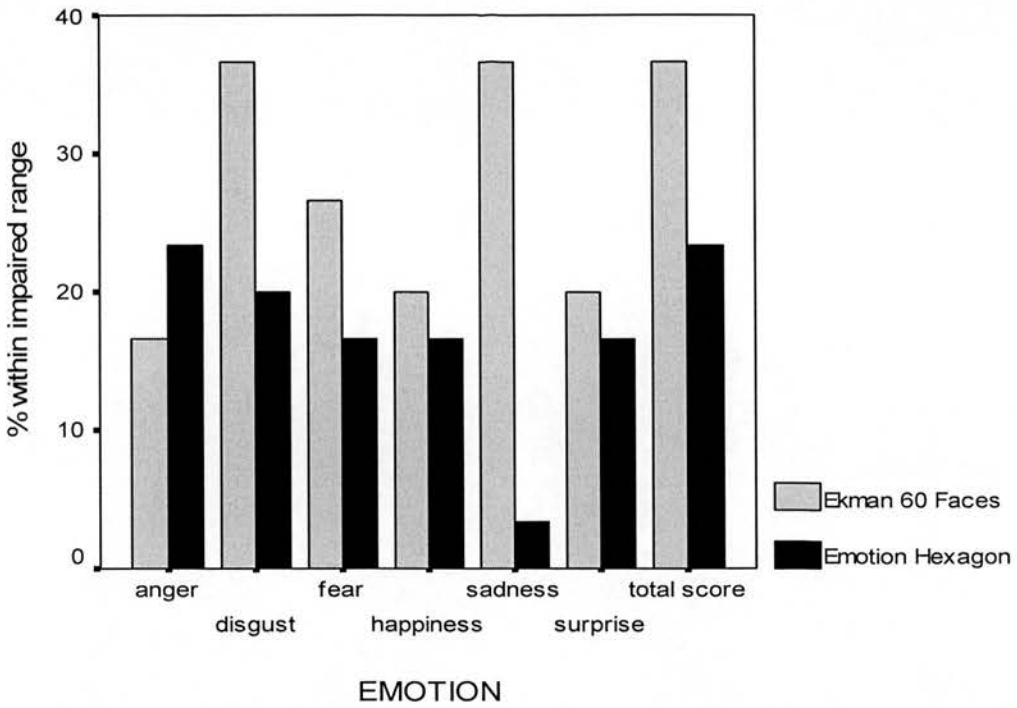

Figure 3.6: Percentage of MS group falling within the impaired range on the Ekman 60 Faces Test and the Emotion Hexagon Test.

3.7.2 Demographic characteristics and FEEST performance

Gender

The possibility of gender affecting performance on both tests of the FEEST was investigated. The MS group was sub-divided by gender (female, n = 20; male, n = 10) and the performance of both sub-groups compared using the Welch *F* test. No significant

differences found between male and female participants on performance on either the Ekman 60 Faces or Emotion Hexagon Tests (all *p*s >.05).

MS sub-type

As reported in section 3.2.2, within the MS group, relapsing/remitting MS was the most prevalent disease sub-type (n = 15; 50%). Thirteen members of the group (43.4%) had a progressive disease type. Therefore the MS group was sub-divided according to disease type (relapsing/remitting or progressive) and their performance on the FEEST tests compared using independent t-tests. The alpha level was again set at 0.01. No significant differences were found between MS sub-types (all *p*s >.05).

Age

The FEEST authors noted a borderline affect of age on performance on the Ekman 60 Faces, but not the Emotion Hexagon. They defined three age categories: 20-40; 41-60; 61-70 (75 for the Emotion Hexagon). A similar comparison was completed here and based on the existing literature it was predicted that increased age would be associated with impaired recognition of emotion. The Young *et al* (2002) age categories were adapted due to the relatively small sample size and reduced from three to two. The categories were 20-45 (n = 15) and 46-70 (n = 15). No significant differences were found between age groups (all *p*s >.05).

Correlation analysis, however, revealed a significant negative relationship between participant age and recognition of anger (r = -.380; p = .038, two-tailed) and happiness (r

= -.379; p = .039, two-tailed) on the Ekman 60 Faces, and fear (r = -.367; p = .046) on the Emotion Hexagon.

3.7.3 Attention, Fatigue, and Practise

Comparison between number of errors made on trials one and five of the Emotion Hexagon was completed to investigate whether performance changed as time progressed. It was hypothesised that a greater number of errors on trial one would provide evidence to suggest that practise had a positive influence on performance. Alternatively, a greater number of errors on trial five would provide evidence to suggest that attention or fatigue had a negative influence on performance. No significant differences were found (p <.05).

4 Discussion

The present study aimed to investigate the ability of people who have multiple sclerosis to recognise emotion from facial expression. The study also aimed to determine how ability to recognise emotion from facial expression affected functional behaviour. There were three primary hypotheses under investigation, each of which shall be discussed in relation to the results. This chapter also includes discussion of the supplementary findings, implications for future research, and a critique of the methodology.

4.1 Hypothesis (1): People with MS will be significantly worse at recognising emotion from facial expression in comparison with normative data.

To test this hypothesis, MS participants were assessed using the Facial Expression of Emotion: Stimuli and Tests (FEEST, Young *et al* 2002), comprised of the Ekman 60 Faces and the Emotion Hexagon. The performance of the MS group was compared with the published normative data, collected from neurologically healthy control participants. Two techniques were used to determine whether there were significant between-group differences. The first involved comparing mean performance scores of the two groups. The second involved use of cut-off scores which helped to classify impairment within the MS group.

4.1.1 Results Summary

Total emotion recognition scores

The results supported the experimental hypothesis; there was a significant difference between the performance of the MS group and the normative data. Overall, the MS group performed significantly worse than would be expected based on normative data on both of the FEEST measures of facial emotion recognition. Furthermore, when using the cut-off scores to identify impairment, 36.67% of the sample fell within the impaired range on the Ekman 60 Faces, and 23.33% on the Emotion Hexagon. This was significantly different to the five per cent predicted to be impaired by the normative data. The results therefore show that recognition of emotion from facial expression is more likely to be impaired amongst individuals with MS and the impairment is of greater prevalence compared to the normative data.

Recognition of individual emotions

Between-group comparisons showed that the MS patients had greater difficulty recognising negative emotions (anger, fear, disgust, and sadness) than positive (happiness and surprise). The magnitude of recognition impairment varied according to the FEEST test used and by method of comparison. The MS group demonstrated greater impairment on the Ekman 60 Faces test.

4.1.2 Comment

Previous studies

The results supported hypothesis (1) and also endorsed the earlier findings of Beatty and Goodkin *et al* (1989) and Beatty and Orbelo *et al* (2003), that recognition of emotion is impaired by multiple sclerosis. The results showed that emotional valence affected

recognition: MS patients had greater difficulty recognising negative emotions (anger, disgust, fear, and sadness). Beatty and Goodkin *et al* (1989) found no such affect of valence in their study of facial emotion recognition. Nevertheless, the potential functional outcome remains the same: difficulty recognising emotion could impair social behaviour.

The present study also concurs with the findings of previous reports which have found affect recognition to be impaired amongst neurological populations including TBI, (McDonald and Flanagan, 2004; Green *et al*, 2004), lobectomy (Adolphs *et al*, 2001), Huntington's disease (Sprengelmeyer *et al*, 1996), Parkinson's disease (Suzuki *et al*, 2006), Korsakov's syndrome and multi-infarct dementia (Crawford *et al* 1986).

Diffuse cerebral pathology and lesion location

It is possible that the observed deficits in emotion recognition reflect damage to cortical and sub-cortical brain structures secondary to the disease process. The results may reflect either: (1) diffuse cerebral pathology; and/or (2) damage to brain areas which are fundamental to the recognition of facial emotion in others.

With regard to point (1), the lesions which characterise MS are typically widespread throughout cortical and sub-cortical structures. These lesions produce a range of symptoms, including cognitive impairments. It has been demonstrated that whole brain atrophy and plaque burden within the cerebrum can lead to global cognitive impairment (Bermel et al, 2002; Baumhefner et al, 1990). Furthermore, the presence of lesions

within cerebral regions which are commonly affected by MS (e.g. the corpus callosum; periventricular white matter and the third ventricle) can result in similar diffuse cognitive impairments (e.g. Huber *et al*, 1992; Edwards *et al*, 2001; Pozzilli *et al*, 1991; Benedict *et al*, 2002). Therefore the outcome of the present study could be due to diffuse cerebral pathology causing diffuse cognitive impairments, including impaired ability to recognise emotion from facial expression.

With regard to point (2), the observed results may be the consequence of lesions inhibiting the operation of specific brain regions which are key to the recognition of emotion. Areas including the temporoparietal lobe of the right-hemisphere, the limbic system (the amygdala in particular) and the frontal lobes have all been implicated in emotion processing. For example, Adolphs *et al* (2001) discovered that emotion recognition was more impaired amongst patients who had undergone right-sided, rather than left-sided, temporal lobectomy. Crawford *et al* (1986) implicated the limbic system in impaired emotion recognition within certain dementia sub-types. Similarly Broks *et al*, (1998) highlighted that damage to a specific component of the limbic system, the amygdala, could impair emotion recognition. Therefore lesions within these areas, or lesions limiting the activation of pathways to these areas, could account for the observed impairment in facial emotion recognition found in the present study.

However, the remit of the present study was to investigate further a potential impairment of MS which had hitherto received little research attention. Therefore the explanations above are hypothetical as neuro-imaging data for the MS group were not gathered and

detailed cognitive assessments were not completed (see section 4.5.1 for further discussion).

4.2 Hypothesis (2): Impaired recognition of emotion from facial expression will be correlated with impaired functional behaviour

The second experimental hypothesis was designed to investigate whether the ability to recognise emotion from facial expression affected everyday functional behaviour. This hypothesis was based on the assumption that the inability to identify emotion from non-verbal cues could lead to misinterpretation of an event's meaning, causing inappropriate behavioural reactions, and potentially leading to difficulties in social interactions.

Everyday behaviour was assessed using the Brock Adaptive Functioning Questionnaire (BAFQ). The BAFQ contains twelve sub-scales related to different aspects of functional behaviour, including several sub-scales related specifically to social behaviour and social functioning (emotionality, impulsivity, aggression, social monitoring, and empathy). BAFQ data for each MS participant were collected from two sources: the participant (who completed the self-report) and a significant other (who completed the informant report).

4.2.1 Results summary

There was insufficient evidence to support hypothesis (2). With the alpha level set at .01, few significant correlations were found between scores of emotion recognition on both

FEEST tests and the self- and informant-reports of the BAFQ. However, some correlations were approaching significance.

With regards to recognition of individual emotions, recognition of disgust was significantly correlated with the BAFQ sub-scale of aggression. Disgust was correlated with impulsivity, social monitoring, and empathy although these correlations fell short of statistical significance. This trend could be interpreted, albeit cautiously, to suggest that impaired recognition of disgust is more closely associated to functional social impairment than the other five emotions. It also resonates with the findings of Sprengelmeyer *et al* (1996), that people with Huntington's disease have particular difficulty recognising disgust from facial expression.

4.2.2 Comment

There are a number of potential explanations as to why the present study found that there were few difficulties of social behaviour amongst the MS sample, in spite of the observed impairment of facial emotion recognition. Firstly, facial expression is a single, albeit significant, non-verbal manifestation of emotion, whilst emotional states are typically communicated by a variety of means, verbal and non-verbal alike. Therefore, the reported absence of impaired social behaviour could be because other techniques of recognising emotion remained relatively intact. Consequently, appropriate social behaviour is not significantly affected.

An alternative explanation relates to the BAFQ itself. It may be that the questions asked were not representative of the problems experienced by the MS group or that the wording of the questions was not specific enough. Therefore it may not have been sufficiently sensitive to detect behavioural problems caused by impaired recognition of facial emotion. Indeed, the BAFQ was originally designed to measure behavioural disturbances manifested following traumatic brain injury affecting executive functions (e.g. Dywan and Segalowitz, 1996) and not as a specific measure of social behaviour *per se*. However, several of the sub-scales do relate specifically to social functioning.

There are currently no normative data yet available for the BAFQ. It is not therefore possible to determine whether the reports of functional change from the MS group are significantly worse than would be expected from a healthy population. It is also difficult to conclude whether the difficulties recorded on the BAFQ are the consequence of a range of problems rather than emotion recognition alone. However, the high level of agreement between the self- and informant-reports suggests that the data gathered were a reliable account of present impairment. Nevertheless, more reliability and validity data are needed for the BAFQ and neurological populations, especially MS.

Finally, the BAFQ was a postal questionnaire and of the 30 copies distributed, only 24 self and 23 informant copies were returned. This had a consequent impact upon data analysis. Also, it could be argued that those participants who did have more significant social behaviour problems chose not to respond to the questionnaire or could not find a suitable informant to complete the parallel form, thereby skewing the overall group data.

4.3 Hypothesis (3): Reports of MS participant's level of social functioning will vary according to the information source – informants will report a significantly greater number of deficits than the MS participants themselves.

Overall there was a good level of agreement between the self- and informant reports. There was a significant difference between self- and informant reports on impulsivity and memory, and contrary to the hypothesis, these findings were due to the MS participants reporting greater difficulty. Indeed this outcome appeared true of many of the BAFQ sub-scales; there was a general trend for MS individuals themselves to report more difficulties than their corresponding informants. Therefore the current data do not support hypothesis (3).

4.3.1 Comment

The current findings were in contrast to the outcome of research investigating insight in MS (e.g. Goverover *et al,* 2005; Beatty and Monson, 1991) and functional behaviour in TBI measured using the BAFQ (Simpson and Schmitter-Edgecombe, 2002). Simpson and Schmitter-Edgemcombe (2002) reported that self- and informant reports did not significantly correlate within the sub-scales of emotionality, impulsivity, aggression, and social monitoring. Informants rated a greater degree of impairment relative to the TBI survivors which the authors interpreted as reduced insight into impairment of social behaviours.

The findings in relation to hypothesis (3) could be an artefact of the range of relationships represented within the informants group. Parents, siblings, spouses, and friends all contributed to the study. Some, e.g. those living with the person who has MS, would arguably be more aware of everyday functional difficulties. Results could have been different had there been strict guidelines as to who could act as informant.

4.4 Supplementary Comment

4.4.1 Performance discrepancy between Ekman 60 Faces and Emotion Hexagon

One unexpected finding of the study was the discrepancy between the MS group's performance on the two FEEST tests. The Ekman 60 Faces test was created using the Ekman and Friesen (1976) materials. The pictures feature expressions which are broadly stereotypical and arguably not typical of natural emotions. The Emotion Hexagon was designed to compensate for this. The materials were developed through the blending of two original emotional expression photographs. This increased the ambiguity of the expression as it contained characteristic features of two separate emotions. Hence, the Emotion Hexagon was understood to be a more challenging task, more sensitive to impaired emotion recognition than the Ekman 60 Faces Test (Calder *et al*, 2000).

The present study did not find evidence to support this. MS group participants performed worse overall on the supposedly easier Ekman 60 Faces and were impaired on recognition of four of the six emotions on the Ekman 60 Faces (anger, disgust, fear, and sadness), compared to one (disgust) on the Emotion Hexagon.

There are several possible reasons to account for this finding. Firstly, it could be the consequence of the order in which the two tests were administered. The Ekman 60 Faces was always administered first and so the reported finding could arguably be the result of practise affects. However, although both tests follow similar principles and procedures, both being tests of facial emotion recognition in which participants to judge photographs of faces, the materials involved are quite different. The Emotion Hexagon uses computer-modified photographs of one of the ten models from the Ekman 60 Faces. The original pictures from which the modified materials are derived are not re-administered in the Emotion Hexagon.

Furthermore, comparisons between the data collected from trials one and five of the Emotion Hexagon suggest that practise did not have a significant affect on the FEEST performance. If repeated exposure to the target materials increased accuracy of emotion recognition, then the number of errors made in trial one should be greater than those made in trial five. As reported in sections 3.6.3, no significant differences were found between the error-frequency of these two trials.

Finally, the between-test discrepancies could be the consequence of increased familiarity with the test procedure, rather than familiarity with test materials. In other words, Ekman 60 Faces performance could have been inhibited by temporary factors such as test anxiety, motivation, or the novelty of testing which dissipated as the session wore on and prior to the administration of the Emotion Hexagon.

4.4.2 Demographic Characteristics

Mood

One of the reasons for the exclusion of potential participants was performance on the HADS mood questionnaire that indicated possible mood disorder. This was introduced into the screening procedure to control for the potential affects of moderate to severe anxiety or depression on test performance. Mood had been demonstrated to be a factor likely to influence emotion recognition (e.g. Mandal and Battacharya, 1985; Surguladze *et al*, 2004) and is common in MS (e.g. Sadovnik, 1991). Therefore the benefit of using a mood screen is that, in all probability, the demonstrated outcomes were independent of mood. However, it is possible that inability to recognise emotion from facial expression might play a causal role in the development of depression. Consequently some people with emotion recognition problems may have been excluded from participating and thus the current results may underestimate the extent of emotion recognition deficits in the MS population.

Predicted intelligence

The mean intelligence of the MS group (as predicted by the NART) was 112, slightly above average. It is likely that this figure is due to the exclusion of people with a predicted IQ below 90. It may also be evidence that high functioning people tend to be more likely to volunteer for research. Both of these factors could have skewed the IQ data set. The mean IQ of the normative sample is not known. However, it is likely that the exclusion of people from the normative sample with IQ below 90 would have also skewed the data set, causing the mean score to be above average.

Gender and age

No significant affects of gender were noted. However it was found that recognition of anger, happiness, (measured by the Ekman 60 Faces) and fear (measured by the Emotion Hexagon) was affected by age. However, the correlations, although significant, were modest and given that no significant correlations between age and emotion recognition were found outwith those reported, it seems doubtful that age significantly affected the results overall.

MS sub-type

The MS group represented a diverse range of MS sub-types, relapsing/remitting proving to be the most prevalent. Certain presenting features are more commonly associated with different disease sub-types. For example, cognitive impairment is more often associated with progressive forms of the disease (e.g. Feinstein, Kartsounis *et al*, 1992; Beatty and Goodkin *et al*, 1989). Beatty and Goodkin *et al* (1989) found relapsing/remitting MS patients to be no different to healthy controls in their performance on tests of emotion recognition. However, the present study found no affect of MS type on FEEST performance. This observation could be accounted for by methodological differences. Whereas the present study displayed each target photograph for a maximum of five seconds, Beatty and Goodkin *et al* (1989) imposed no time limit. This implies that people with MS struggle to process emotional information at speed, rather than fail to recognise emotions *per se*.

4.5 Future Research

The area under investigation has received relatively little attention from researchers to date. Therefore there are a number of ways in which the current findings can be explored further in order to address in greater detail the association between MS and deficits in emotion recognition.

4.5.1 Supplementary Assessment Measures

Cognitive assessment

It would be of value to determine which cognitive functions correlate with recognition of emotion from facial expression. Cognitive assessment tests could be used to identify whether impaired recognition of emotion is an isolated deficit or part of a cluster of other cognitive difficulties. Cognitive assessment results could be used to investigate further the suggestion that impaired recognition of emotion is secondary to global cognitive impairment as a consequence of diffuse cerebral pathology (see section 4.1.2).

Test batteries such as the Wechsler Adult Intelligence Scales-Version III (WAIS-III, Wechsler, 1997a) or the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS, Randolph, 1998) would be able to provide a general measure of global cognitive functioning as well as information about individual cognitive skills. Further, it would be valuable to identify whether impaired executive functioning, often associated with behavioural dysregulation in social situations (see section 1.2.2.2), is related to emotion recognition ability. Test batteries such as the Delis-Kaplan Executive Function

System (D-KEFS, Delis, Kaplan, and Kramer, 2001) could be utilised to measure executive impairment.

Physical assessment

The present study did not take a measure of physical impairment. In future studies it may therefore useful to assess physical disability using, for example, the expanded disability status scale (EDSS, Kurtzke, 1983). It would not necessarily be hypothesised that physical impairment would be correlated with emotion recognition *per se*. However, the EDSS, used in combination with a cognitive assessment could indicate level of disease severity. This might then be used to predict likely performance on a test of emotion recognition.

Mood assessment

There is scope to assess further how mood may affect FEEST performance. It would be interesting to note if participants with scores above cut-offs on the HADS would perform more poorly on emotion recognition measures. Two MS groups could be recruited, one featuring people scoring below cut-off, one above, and comparison made between each group's performance. Alternatively, correlation analyses would show if emotion recognition abilities decreased as mood impairment increased. It would also be interesting to conduct longitudinal studies which could help clarify whether emotional recognition deficits lead to mood disorders or are a consequence of them.

Neuro-imaging data

As mentioned in section 4.1.2, the observed results could be a consequence of general cerebral atrophy or lesions present within key emotion-recognition centres of the brain. Imaging data, such as that provided by MRI or CT scan, would help to clarify the possible organic changes which may underlie impairment of emotion recognition. It seems probable that impaired recognition of facial emotions will be related to the presence of lesions within the cortical and sub-cortical areas responsible for emotion recognition and/or areas of the brain with reciprocal connections to these areas. To test this, two clinical groups could be recruited, one group who have lesions within the emotion-processing areas of the brain, and one without. Each group's performance on the FEEST could be compared to determine which group is most impaired, thereby identifying possible neuroanatomical correlates more directly.

4.5.2 Associations Between the FEEST and Other Measures of Emotion Processing

People with MS may be impaired at recognising emotion from facial expression yet capable of identifying emotion from other sources. Therefore it would be useful to investigate their ability to make emotional judgements based on cues other than facial expression and identify associations with FEEST performance. The Awareness of Social Inference Test (TASIT, McDonald *et al*, 2002), for example, requires participants to make inferences about a person's thoughts and intentions after watching them interact with others on a video vignette. Further, Beatty and Orbelo *et al* (2003) used the Aprosodia Battery to assess recognition of emotion from prosodic cues. If emotion recognition is global, then one might expect impaired performance on the FEEST to accompany impaired performance on the Aprosodia Battery or the TASIT.

It would be valuable to determine whether impaired recognition of emotion, either from facial expression or other sources, is a stand-alone problem or part of a cluster of other impairments of emotion processing. Problems such as emotion regulation and emotional blunting may accompany impaired recognition of emotion.

4.5.3 Assessment of Social Functioning

As mentioned above, the BAFQ may not have been sufficiently sensitive to the social functioning of the current sample. Future research could therefore make use of another measure of social functioning or a modified version of the BAFQ to include additional items concerning social activity, relationships in particular. Number of close friends, frequency of social visits made, and relationship quality could all be informative.

With regard the BAFQ specifically, future research could investigate discrepancies between the reports of informants on the BAFQ, as mentioned in section 4.3.2. It is plausible that informants who live in the same household as the study participant will have a more informed opinion about their functional behaviour relative to a friend or relative who has less frequent contact. If this is demonstrated to be the case then perhaps more stringent guidelines would be needed to inform who constitutes a significant other capable of completing the BAFQ and other such measures.

4.6 Implications for Clinical Practice

The primary motive of this research project was to investigate the social cognitive abilities of people who have MS, specifically their ability to perceive the emotional states of others. This was thought to be valuable given the likely detrimental consequences of impaired recognition of emotion. The reduced ability to recognise emotion in others has the potential to disturb social relationships because it would inhibit the likelihood of making an appropriate behavioural response. This could be misinterpreted as being, for example, unsympathetic and make the relationship less rewarding. Therefore someone who cannot recognise how others are feeling is at greater risk of becoming increasingly socially isolated, which would almost certainly place them at increased risk of mental health problems. Arguably the most important relationship for someone who has MS, particularly as disease severity increases, is with their carer. Deterioration in the quality of this relationship has potentially harmful consequences for both parties.

Therefore, one of the benefits of this project has been to highlight the existence of a difficulty which had hitherto received little research attention and yet has the potential to significantly affect the social relationships of people who have MS. Additional research will be necessary before clinical implications can be more clearly defined. However, on current evidence it seems that assessment of emotion recognition abilities could be introduced into the battery of tests ordinarily used to assess cognitive functioning in MS and consideration of social functioning should be included within psychological assessment. Also, increased awareness of this problem amongst people with MS, their carers, friends, and family could help them to prepare for potential changes in this area.

4.7 Critique – Project Strengths and Limitations

4.7.1. MS Group Recruitment

Recruitment to the MS group was informed by strict inclusion and exclusion criteria. This was to help control for a number of factors which had the potential to confound the outcome. These included age, intellectual functioning, mood, history of neurological dysfunction outwith MS, and visual perception. Care was also taken to exclude potential participants who had difficulties which could have inhibited their ability to complete the primary outcome measure, the FEEST. Therefore potential participants with expressive language or visual impairments were not included within the experimental group.

These stringent inclusion criteria reduced the number of participants eligible for inclusion but helped increase confidence that the results reported were the consequence of key variables of interest in the study rather than other potentially confounding factors. Visual impairment was controlled for using the Shape Detection Test and the NART was included both to provide a general measure of intellectual functioning, and to help attain parity with the FEEST normative data. Arguably inclusion of a cognitive assessment would also have been valuable and indeed was considered as part of the screening procedure. However, addressing the associations between FEEST performance and specific aspects of cognitive functioning was beyond the remit of the current study. Furthermore, use of a cognitive screen to inform inclusion criteria would have possibly facilitated recruitment of an atypical MS sample that was not representative of the MS population.

Recruitment was not limited to one MS sub-type and consequently the observed results could arguably have been caused by the performance of one MS sub-type. However, aside from further limiting the population from which the experimental sample was selected, the validity of focusing attention on a single sub-type is doubtful. Not everyone with MS has a definitive diagnosis and diagnosis can change from one type to another. What is more and as previously reported, there can be considerable variance within sub-type. The decision to be inclusive in recruitment to the experimental group was justified on data analysis when sub-type was not found to affect performance on the FEEST.

4.7.2 Normative Data vs. Control Group

The study's primary aim, to assess whether MS impaired recognition of emotion from facial expression, was investigated through comparison of an MS groups' performance on a test of facial emotion recognition with that of a neurologically healthy sample. The assessment used, the FEEST, has normative data collected from a large sample of neurologically healthy adults. These norms were used in place of a control group and judgements about relative impairments of emotion recognition in MS were made using them.

Recruitment of a demographically-matched clinical group could have helped inform conclusions about the results. A neurological sample could have provided information on the relative magnitude of the deficit in MS, whilst inclusion of a neurologically well but physically disabled group (e.g. spinal injury patients) would have helped to control for

additional factors such as physical functioning. However, the study was concerned exclusively with the affects of MS on emotion recognition and inclusion of extra clinical groups would have reduced the numbers of MS patients that could have been recruited and assessed within the time-frame of the study.

4.7.3 Experimental Measures

The Facial Expression of Emotion; Stimuli and Tests (FEEST)

The FEEST was selected as the outcome measure for the primary research hypothesis for several reasons. It is founded upon the long-established research of Ekman and Friesen (1976), investigating the recognition of emotion from facial expression. Both of its constituent tests have been demonstrated to be valid and reliable measures of facial emotion recognition (e.g. Young, Perrett *et al*, 2002; Calder *et al* 2000b; Keane *et al*, 2002; Sprengelmeyer *et al*, 1999). Administration is straightforward; completion is neither time-consuming nor reliant upon functional motor control.

Although cognitively undemanding, the participant is required to focus and sustain attention for the duration of the test. Completion also requires participants to maintain an adequate level of arousal and wakefulness. MS has been found to affect focused, divided, and sustained attention (e.g. De Sonneville *et al*, 2002; Rao, Leo, Bernardin *et al*, 1991). Fatigue, a common physical symptom of MS (Fisk *et al*, 1994), is believed to compromise cognitive functioning (Schwartz, Coulthard-Morris and Zeng, 1996). The FEEST helps to compensate for the potential confounding affects of fatigue and attention impairment through availability of breaks during completion.

The potential affects of attention and fatigue were also addressed during data analysis. If attention or fatigue had a significant affect on FEEST performance, it was hypothesised that there would be significantly more errors on trial five of the Emotion Hexagon than on trial one. Comparison of these two data sets showed no such differences. It therefore seems unlikely that attention or fatigue played a significant role in the observed results.

There is currently no published research using the FEEST with the MS population and therefore its application here is helping to further the existing literature on emotion recognition in MS. This does however make it difficult to evaluate the results more thoroughly as there is no existing point of reference within the MS population with which to compare the findings. Also the cut-off scores used to classify impairment were arguably overly stringent in classifying impairment in recognising certain individual emotions. For example on the Ekman 60 Faces a respondent was classified as impaired at recognising happiness if they scored below 100% as the normative data uniformly scored at ceiling levels. Therefore, making only one error in recognising a happy face due to a lapse in concentration or other extraneous error could have resulted in 'impaired' performance within that emotion category.

The Brock Adaptive Functioning Questionnaire (BAFQ)

The secondary aim of the present study was to ascertain whether impaired recognition of emotion from facial expression was associated with social behaviour. The BAFQ was selected as the assessment tool because it provides subjective information from two

sources, the MS participant and a significant other. This was advantageous as it helped to compensate for potential inaccuracies caused by insight deficits, positive response bias, and under- or over-estimates of functioning.

However, for reasons discussed in section 4.2.2, above, the BAFQ may have limitations as an outcome measure for the given area of investigation. An adapted version of the BAFQ or a new questionnaire may have been preferable, but such measures would lack the reliability and validity data available for the BAFQ.

4.8 Summary

This research project sought to investigate whether recognition of emotion from facial expression was impaired in multiple sclerosis. This was thought valuable given that impaired comprehension of the emotional states of others could have a damaging affect on social relationships. This could in turn have a detrimental effect on the emotional well-being of people with MS, their ability to maintain close relationships, friendships, and function effectively in occupational or recreational settings.

MS participants were assessed using the two tests of emotion recognition in the FEEST, the Ekman 60 Faces and the Emotion Hexagon. The performance of the MS group was compared to the normative data available for neurologically healthy adults on the FEEST. It was discovered that, relative to the normative data, the MS group were impaired overall at recognising emotions. They were also impaired at recognising individual emotions,

particularly anger, disgust, fear, and sadness. Performance varied between the two tests used, with the Ekman 60 Faces identifying a greater level of impairment.

The remit of the present study was to investigate further a potential impairment of MS which had hitherto received little research attention. As such, neuro-imaging data were not gathered. Therefore it has not been possible to conclude with any certainty whether the observed results have been due to discrete or more diffuse cerebral pathologies.

The research project also aimed to investigate whether impaired recognition of impairment had an affect on social behaviour. This was assessed using the BAFQ, a self-report questionnaire completed by the MS participant and a significant other. Impaired overall recognition of emotion, as measured by the FEEST, was not found to be significantly related to any of the BAFQ sub-scales. Also, it was significant to note that the mean scores on the BAFQ were generally low. This suggests either that the behaviours investigated by the BAFQ were not problematic for the MS group or that the BAFQ was not sufficiently specific or sensitive enough to measure salient social and emotional factors underlying observed functional behaviour. Furthermore, the BAFQ self and informant reports were very similar, indicating good agreement between the two groups. This provided evidence to suggest that the MS sample tested did not have difficulties with insight.

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Appendices

Appendix 1: Brock Adaptive Functioning Questionnaire (BAFQ)

Appendix 2: Participant Information Sheet and Consent Forms

Appendix 3: Lothian Research Ethics Committee Approval Letter

Appendix 4: FEEST materials (a) Ekman 60 Faces Materials

(b) Emotion Hexagon Materials

Appendix 5: Correlation Matrices

Appendix 1

Brock Adaptive Functioning Questionnaire (BAFQ)

- Self-report
- Informant report (female participant)

THE BROCK ADAPTIVE FUNCTIONING QUESTIONNAIRE
(Self-report)

Name: _____ Current Date: _____

The information you provide will help us understand how changes in your abilities may be affecting your day to day function. These changes for some people may be so minor as to be unnoticeable but for some people they may be quite severe. So, some of these questions may seem inappropriate with respect to you but they are in the questionnaire to allow for all levels of severity. **Simply read each question carefully and indicate as best you can how well the question reflects your everyday functioning by checking the appropriate space underneath each question.**

If you cannot answer a question, circle the [?] at the right of the page.

If you feel that you would have answered a question the same prior to your current difficulties, place a check beside ***same*** which means that this aspect of your behaviour has not changed.

If your response is different than it would have been before your current difficulties, place a check beside ***changed*** which means that there has been ***a change in this aspect of behaviour. Change usually refers to some decline in function. However, if the change has been for the better, indicate this with a plus sign (+) beside that question.***

Please note:

If, for any reason, you are unable to complete this questionnaire without assistance, we ask that you get assistance from a person other than the family member completing the other packet of questionnaires. We also ask that the individual assisting you not try to influence your answers in any way.

Place a circle the number that best describes your behaviour. Read your choices carefully each time so you check the right end of the scale. Some behaviours may never be true of you. If you like, you can write "never" where we say "hardly ever" and then check that place.

1. Do you have a hard time making plans for the day on your own?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

2. When going out for the day, do you think about what might be needed later in the day, for example, bringing a jacket in case it gets colder?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

3. When you have several tasks to do, do you organize them in an efficient way?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

4. Would you be able to manage (take the appropriate steps) if an emergency came up and you were home alone?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

5. When making choices, do you consider how these choices may affect you in the future?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

6. When making long term plans, do you think carefully about what you would need to do in order to reach your goals?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

7. When you makes plans, would you say that your plans show good judgement ?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

8. Are you able to get up on time in the morning without actually being prompted by another person?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

9. Do you carry out your household jobs without being reminded by anyone?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

10. Do you have trouble getting started on a project unless someone starts you off?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

11. Even though you know exactly what has to be done to keep a project going, do you have a hard time moving to the next step on your own?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

12. Once you have made plans, do you find it very difficult to change them?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

13. When doing a task, can you easily distinguish between the more important and the less important aspects of the task. (Would you be able to skip the less important steps?)

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

14. When telling someone about an event or a movie, can you easily skip unimportant details pressed for time?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

15. Do you have a hard time switching topics during a conversation?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

16. Do you find yourself going over and over the same things in your mind more than you need to?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

17. Do you feel much more comfortable doing things in the same way each time?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

18. Do you become uncomfortable if your usual routines have to be changed?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

19. Do you check <u>many times</u> to make sure that things are safe (e.g. doors locked, stove off etc.)?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

20. Do you seem more suspicious of other people than you think is necessary?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

21. Do you get distracted easily?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

22. Are you likely to forget that the stove or kettle has been left on?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

23. Do you have a lot trouble keeping track of where things are around the house?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

24. Do you have trouble following spoken directions?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

25. Do you have trouble sticking to the point that you are trying to make when having a discussion?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

26. Are you easily confused in stores and shopping malls?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

27. Are you likely to get lost even in relatively familiar places?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

28. Do you have a hard time learning new skills?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

29. Do you have difficulty remembering events that happened in the last week?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

30. Do you have difficulty remembering to do things that you have planned to do?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

31. Do you have trouble remembering the names of people that you see regularly?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

32. Do you have a hard time recognizing people you have met before?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

33. Do you have trouble recalling things that you used to know quite well?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

34. Do you tell people things that may not be true?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

35. Do you tell people things that could not possibly be true?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

36. Do you have difficulty staying awake or alert?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

37. Does your voice sound flat compared to other people?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

38. Do you find it very difficult to get enthusiastic about things?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

39. Do you find it very hard to maintain interest in what you are doing for a long period of time?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

40. Do you feel very sad or depressed?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

41. Do you get much too excited about things?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

42. Do you have difficulty controlling emotional responses (e.g., crying much too easily)?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

43. Are there times when you laugh or talk too much or too loudly compared to others?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

44. Do you find that your eye contact can be too intense during conversations?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

45. Do you make inappropriate comments or blurt things out that would be better left unsaid?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

46. Do you use alcohol (or other drugs) more than you should?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

47. Do you spend money unnecessarily without giving it much thought?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

48. Do you make sexual remarks which seem inappropriate?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

49. Do you touch people in ways which are sexually inappropriate?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

50. Do you have a lot of trouble controlling the amount you eat?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

51. Do you need external constraints in order to control eating (for example, careful control over what food is left around the house or a lock on the refrigerator)?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

52. Are you quick to take offence to what others say?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

53. When you get frustrated, will you throw things around or damage things?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

54. When you get angry, will you threaten people?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

55. If pushed to the limit, could you strike out at someone?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

56. Would you do what you really want to do, even if it were illegal?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

57. Do you stand a little too close when engaged in a conversation?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

58. Do you miss the point of many jokes or stories that other people seem to enjoy?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

59. Do you pay attention to whether others are following what you are saying?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

60. When you are telling things to other people, do you give them as much background information as is needed so they can follow easily?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

61. If others are looking disinterested in what you are saying, will you try to stop talking or change the topic?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

62. Do you tend to tell the same story over again to the same people?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

63. When a social situation has gone badly, do you try to figure out what went wrong so you can make it go better the next time?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

64. If you had just received a favour or some special consideration, would you show appropriate appreciation?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

65. Would you notice if someone were feeling overtired or worried?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

66. If you noticed that someone close looked overworked or worried, would you do what you could to ease their load?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

67. Do you notice when other people are feeling awkward in a social situation?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

68. When someone is feeling awkward in a social situation, will you do what you can to make the person feel more comfortable?

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same
					[ ] changed

Please indicate, by putting a mark through the following line, how satisfied you are with your life:

Completely Satisfied

Not at all Satisfied

Thank you.

THE BROCK ADAPTIVE FUNCTIONING QUESTIONNAIRE
(Version for Family Member of Person with Injury)

Name of person who has had injury: _____

Name of respondent: _____

We are asking you to fill out this questionnaire to provide another perspective on any difficulties your family member might be having as a result of her accident or injuries. In order to maintain this alternate perspective, it is important that you fill out this questionnaire without consulting with your family member. When you are done, and the questionnaire has been returned, you are perfectly free to discuss your responses if you wish.

The information you provide will help us understand the long-term effects of injury. These effects may be so minor as to be unnoticeable for some people but they may be very severe for others. So, some of these questions may seem inappropriate with respect to the person you are rating, but they are in the questionnaire to allow for all levels of severity.

Simply read each question carefully and indicate as best you can how well the question reflects the everyday functioning of your family member by checking the appropriate space underneath each question.

If you cannot answer a question, circle the [?] at the right of the page.

If you feel that you would have answered a question the same before your family member had her injury, place a check beside ***same*** which means that this aspect of her behaviour is the ***same as before her injury***.

If your response is different than it would have been before the injury, place a check beside ***changed*** which means that there has been ***a change in this aspect of behaviour that you have noticed since her injury.***

All information will be treated with strictest confidentiality. Names will be changed to codes and combined with the data from others. Thus, if these data are published or used for teaching purposes, neither you nor your friend or family member will be identified in any way.

Brock Neuropsychology Lab
Psychology Department
Brock University
St. Catharines, Ontario L2S 3A1

-ace a circle the number that best describes your family member's behaviour. Read your choices carefully each time you check the right end of the scale. Some behaviours may never be true of your family member. If you like, you -n write "never" where we say "hardly ever" and then circle the number.

. **Does she have a hard time making plans for the day on her own?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?] [ ] same
1	2	3	4	5	[ ] changed

. **When going out for the day, does she think about what might be needed later in the day, for example, bringing a jacket in case it gets colder?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

. **When she has several tasks to do, does she organize them in an efficient way?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

. **Would she be able to manage (take the appropriate steps) if an emergency came up and she were home alone?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

. **When making choices, does she consider how these choices may affect her in the future?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

. **When making long term plans, does she think carefully about what she would need to do in order to reach her goals?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

. **When she makes plans, would you say that her plans show good judgement (i.e., are they realistic?)**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

. **Is she able to get up on time in the morning without actually being prompted by another person?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

'. **Does she carry out her household jobs without being reminded by anyone?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

). **Does she have trouble getting started on a project unless someone starts her off?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

1. **Even though she knows exactly what has to be done to keep a project going, does she have a hard time moving to the next step on her own?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

2. **Once she has made plans, does she find it very difficult to change them?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

3. **When doing a task, can she easily distinguish between the more important and the less important aspects of the task (That is, if forced to hurry, would she be able to skip the less important steps?)**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

4. **When telling someone about an event or a movie, can she easily skip unimportant details if pressed for time?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

5. **Does she have a hard time switching topics during a conversation?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

6. **Does she appear to go over and over the same things in her mind more than she need to?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

7. **Does she like to do things in the same way each time?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

8. **Does she become uncomfortable if her usual routines have to be changed?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

9. **Does she check <u>many times</u> to make sure that things are safe (e.g. doors locked, stove off etc.)?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

10. **Does she seem more suspicious of other people than you think is necessary?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

1. **Does she get distracted easily?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

2. **Is she likely to forget that the stove or kettle has been left on?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

3. **Does she have a lot trouble keeping track of where things are around the house?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

4. **Does she have trouble following spoken directions?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

5. **Does she have trouble sticking to the point that she is trying to make when having a discussion?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

6. **Is she easily confused in stores and shopping malls?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

7. **Is she likely to get lost even in relatively familiar places?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

8. **Does she have a hard time learning new skills?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

9. **Does she have difficulty remembering events that happened in the last week?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

0. **Does she have difficulty remembering to do things that she has planned to do?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

1. **Does she have trouble remembering the names of people that she sees regularly?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

2. **Does she have a hard time recognizing people she has met before?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

3. **Does she have trouble recalling things that she used to know quite well?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

4. **Does she tell people things that may not be true?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

5. **Does she tell people things that could not possibly be true?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

5. **Does she have difficulty staying awake or alert?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

7. **Does her voice sound flat compared to other people?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

8. **Does she find it very difficult to get enthusiastic about things?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

9. **Does she find it very hard to maintain interest in what she is doing for a long period of time?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

10. **Does she seem very sad or depressed?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

11. **Does she get much too excited about things?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

12. **Does she have difficulty controlling emotional responses (e.g., crying much too easily)?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

3. **Are there times when she laughs or talks too much or too loudly compared to others?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

4. **Do you find that her eye contact can be too intense during conversations?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

5. **Does she make inappropriate comments or blurt things out that would be better left unsaid?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

6. **Does she use alcohol (or other drugs) more than she should?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

7. **Does she spend money unnecessarily without giving it much thought?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

8. **Does she make sexual remarks which seem inappropriate?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

9. **Does she touch people in ways which are sexually inappropriate?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

0. **Does she have a lot of trouble controlling the amount she eats?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

1. **Does she need external constraints in order to control eating (for example, careful control over what food is left around the house or a lock on the refrigerator)?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

2. **Is she quick to take offence to what others say?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

3. **When she gets frustrated, will she throw things around or damage things?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

4. **When she gets angry, will she threaten people?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

5. **If pushed to the limit, could she strike out at someone?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

6. **Would she do what she really wants to do, even if it were illegal?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

57. **Does she stand a little too close when engaged in a conversation?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

58. **Does she seem to miss the point of many jokes or stories that other people seem to enjoy?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

59. **Does she seem to pay attention to whether others are following what she is saying?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

60. **When she is telling things to other people, does she give them as much background information as is needed so they can follow easily?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

61. **If others are looking disinterested in what she is saying, will she try to stop talking or change the topic?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

62. **Does she tend to tell the same story over again to the same people?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

63. **When a social situation has gone badly, does she try to figure out what went wrong so she can make it go better the next time?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

64. **If she had just received a favour or some special consideration, would she show appropriate appreciation?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

65. **Would she notice if someone was feeling overtired or worried?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

66. **If she noticed that someone close looked overworked or worried, would she do what she could to ease their load?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

67. **Does she seem to notice when other people are feeling awkward in a social situation?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

68. **When someone is feeling awkward in a social situation, will she do what she can to make the person feel more comfortable?**

Hardly Ever	Rarely	Sometimes	Often	Almost always	[?]
1	2	3	4	5	[ ] same [ ] changed

Are there any areas in everyday functioning which have changed since the onset of her difficulties that have not been covered in this questionnaire that you think might be important to mention? You could make note of them here:

_____

_____

_____

Thank you.

Appendix 2

Participant Information Sheet & Consent Forms

Research Participant Information Sheet – Version 2, March 2006

Project Title: *Acquired Deficits in the Recognition of Facial Emotion in People who have Multiple Sclerosis (MS).*

Invitation
You are being invited to take part in a research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

Thank you for reading this.

What is the purpose of the study?
A small number of studies have shown that some people who have MS have difficulty correctly identifying the emotions of others. This could potentially lead to problems in everyday social relationships.

This study aims to investigate this area further and develop the existing findings. It makes use of new tools to assess emotion recognition. These tools have not previously been used with an MS population. The study also gives the participant the chance to report any social problems that they may have. The study will run from spring 2006 until summer 2007.

It is hoped that the findings will contribute to a growing understanding of the difficulties faced in MS. The findings could help to inform future support and treatment initiatives.

Why have I been chosen?
This study is only being carried out in Lothian and someone who is involved in your healthcare (for example Consultant Neurologist, MS Nurse Specialist, Occupational Therapist) has identified you as a potential participant.

Do I have to take part?
It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect the standard of care you receive.

What will happen to me if I take part?
You will be invited to come along to a maximum of two sessions. The first one will involve completing a number of 'paper-and-pen' assessments including questionnaires. You may then be asked to take part in a second appointment scheduled for a later date. During this session you will be asked to complete a computer-based assessment and a questionnaire. You will also be asked to nominate someone who can complete a similar

questionnaire about you. This should be someone who knows you well and could include your partner, family member or a friend. This person does not need to be present for either of the sessions as the questionnaire can be posted to them and be completed at home.

Both assessment sessions should last no more than 60 minutes. The sessions will take place either at the Neuropsychology Department, Astley Ainslie Hospital, Western General Hospital, Liberton Hospital or your home. Where the sessions take place will be up to you.

What do I do once I've made my decision?
The departmental secretary will phone you a week after you have received this form and you can tell her if you want to take part. If you agree to take part then I will phone you to introduce myself and to arrange an initial appointment.

Will my taking part in this study be kept confidential?
All information which is collected about you during the course of the research will be kept strictly confidential. Any information about you will have your name and address removed so that you cannot be recognised from it. Your GP will be contacted and told that you will be taking part in the study. However, details of the outcome of the sessions will be kept confidential.

What will happen to the results of the research study?
The results of the study will be reported in the Lead Researcher's doctoral thesis. The thesis is being written as part of training to become a Clinical Psychologist. Once it is completed a copy will be available from the University of Edinburgh library. People who take part in the study will not be identified in the thesis.

Who has reviewed the study?
The study has been reviewed and approved by the Lothian Research Ethics Committee.

Contact for Further Information
If you have any questions, or if you would like further information, then please feel free to get in touch with me using the contact details on the letterhead.

Many thanks once again for taking the time to read this information sheet.

Ross Warwick
Trainee Clinical Psychologist
Lead Researcher

Centre Number:
Patient Identification Number:

Consent Form for Participant

Title of Project: Acquired deficits in the recognition of facial emotion in people who have Multiple Sclerosis

Name of Researcher: Ross Warwick

		Please initial box
1	I confirm that I have read and understood the information sheet dated (version .) for the study named above and I have had the opportunity to ask questions.	☐
2	I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without my medical or legal rights being affected.	☐
3	I understand that sections of my medical notes may be looked at by responsible individuals from the Department of Neuropsychology. I give permission for these individuals to have access to my records.	☐
4	I understand that this is part of a research project designed to promote psychological knowledge and which may be of no benefit to me personally .	☐
5	I agree to take part in the above study	☐

Name of Participant	Date	Signature
Name of person taking consent (if different from researcher)	Date	Signature
Researcher	Date	Signature

Centre Number:
Patient Identification Number:

Consent Form for Companion

Title of Project: Acquired deficits in the recognition of facial emotion in people who have Multiple Sclerosis

Name of Researcher: Ross Warwick

		Please initial box
1	I confirm that I have read and understood the information sheet dated (version .) for the study named above and I have had the opportunity to ask questions.	☐
2	I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without my medical or legal rights being affected.	☐
3	I understand that this is part of a research project designed to promote psychological knowledge and which may be of no benefit to me personally .	☐
4	I agree to take part in the above study	☐

Name of Participant	Date	Signature
Name of person taking consent (if different from researcher)	Date	Signature
Researcher	Date	Signature

Appendix 3

Lothian Research Ethics Committee Approval Letter

Lothian NHS Board

Deaconess House
148 Pleasance
Edinburgh
EH8 9RS
Telephone 0131 536 9000
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20 March 2006

Mr Ross, K Warwick
Trainee Clinical Psychologist
NHS Lothian
Astley Ainslie Hospital
Department of Clinical Psychology
133 Grange Loan, Edinburgh
EH9 2HL

Dear Mr Warwick

Full title of study: **Acquired deficits in the recognition of facial emotion in people who have Multiple Sclerosis**

REC reference number: **06/S1101/6**

Thank you for your letter of 13 March 2006, responding to the Committee's request for further information on the above research and submitting revised documentation.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised.

Ethical review of research sites

The favourable opinion applies to the research sites listed on the attached form.

Conditions of approval

The favourable opinion is given provided that you comply with the conditions set out in the attached document. You are advised to study the conditions carefully.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	*Version*	*Date*
Application	2	13 March 2006
Investigator CV	CI	03 February 2006
Investigator CV	Supervisor	03 February 2006
Protocol	1	03 October 2005
Covering Letter		03 January 2006
Compensation Arrangements		22 August 2005

Questionnaire		
GP/Consultant Information Sheets	1	
Participant Information Sheet	2	13 March 2006
Participant Information Sheet	1 Significant Other	13 March 2006
Participant Consent Form	2	13 March 2006
Participant Consent Form	1 Significant Other	13 March 2006
Response to Request for Further Information		13 March 2006

Research governance approval

The study should not commence at any NHS site until the local Principal Investigator has obtained final research governance approval from the R&D Department for the relevant NHS care organisation.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees (July 2001) and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

06/S1101/6	**Please quote this number on all correspondence**

With the Committee's best wishes for the success of this project

Yours sincerely

Chair

Email: joyce.clearie@lhb.scot.nhs.uk

Enclosures:

Standard approval conditions [SL-AC1 for CTIMPs, SL-AC2 for other studies]
Site approval form

Copy to:

University of Edinburgh
Department of Clinical and Health Psychology,
School of Health in Social Science, University of Edinburgh,
Medical School, Teviot Place
[R&D Department for NHS care organisation at lead site]

Lothian Local Research Ethics Committee 01

LIST OF SITES WITH A FAVOURABLE ETHICAL OPINION

For all studies requiring site-specific assessment, this form is issued by the main REC to the Chief Investigator and sponsor with the favourable opinion letter and following subsequent notifications from site assessors. For issue 2 onwards, all sites with a favourable opinion are listed, adding the new sites approved.

REC reference number: 06/S1101/6 **Issue number:** 1 **Date of issue:** 20 March 2006

Chief Investigator: Mr Ross, K Warwick

Full title of study: Acquired deficits in the recognition of facial emotion in people who have Multiple Sclerosis

This study was given a favourable ethical opinion by the vice chair on behalf of Lothian Local Research Ethics Committee 01 on 20 March 2006. The favourable opinion is extended to each of the sites listed below. The research may commence at each NHS site when management approval from the relevant NHS care organisation has been confirmed.

Principal Investigator	*Post*	*Research site*	*Site assessor*	*Date of favourable opinion for this site*	*Notes* [1]
Mr Ross K Warwick	Trainee Clinical Psychologist	Lothian Primary Care NHS Trust (Astley Ainslie Hospital/Liberton Hospital)Lothian University Hospital NHS Trust (Western General Hospital)	Lothian Local Research Ethics Committee 01	20/03/2006	

Approved by the Chair on behalf of the REC:

..... (Signature of ~~Chair~~/Administrator)

(delete as applicable)

.... (Name)

(1) *The notes column may be used by the main REC to record the early closure or withdrawal of a site (where notified by the Chief Investigator or sponsor), the suspension of termination of the favourable opinion for an individual site, or any other relevant development. The date should be recorded.*

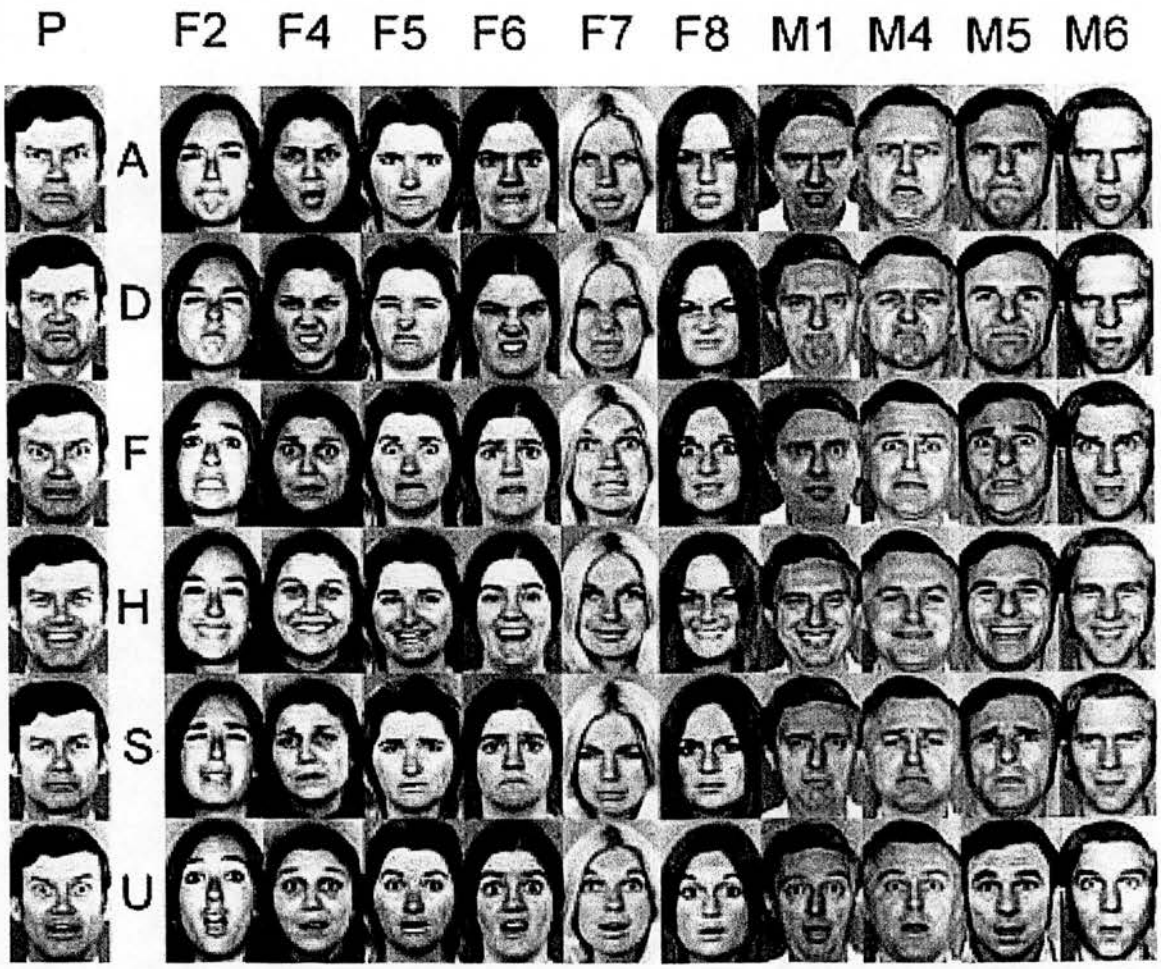
Appendix 4

FEEST materials

4(a): Ekman 60 Faces

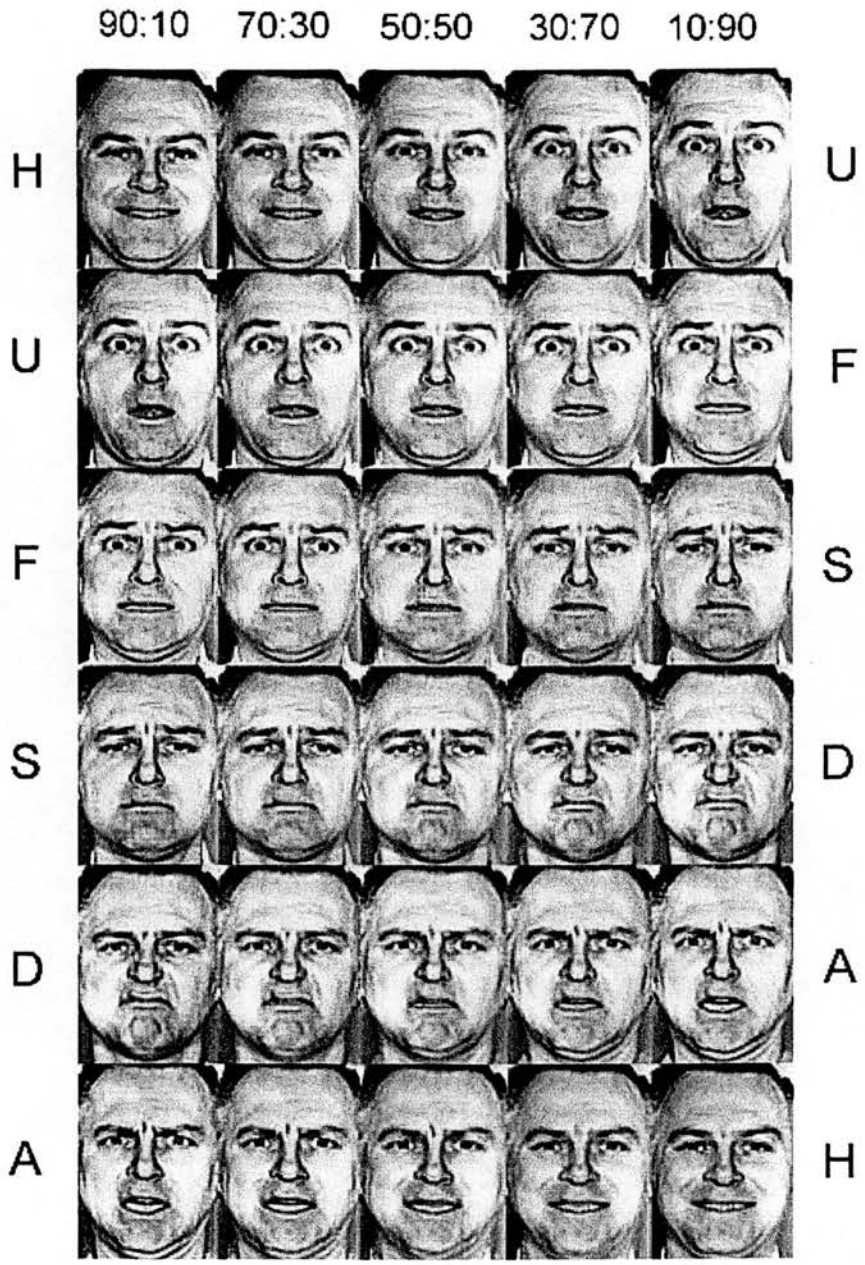
4(b) Emotion Hexagon

4(a) – Ekman 60 Faces Materials (Young *et al*, 2002)



The column labelled 'P' denotes the practice items. All other columns represent the experimental items and are labelled by model identifier. Rows are labelled according to the six emotions: anger (A); disgust (D), fear (F), happiness (H), sadness (S), and surprise (U).

4(b) – Emotion Hexagon Test Materials (Young *et al*, 2002)



Columns are labelled according to the degree by which two emotions are mixed together. The rows are labelled according to which two emotions have been mixed. For instance, the top row illustrates the five degrees by which happiness (H) and sadness (S) have been blended. As with the Ekman 60 Faces test, six emotions were involved: anger (A); disgust (D), fear (F), happiness (H), sadness (S), and surprise (U).

Although all images illustrated were used as materials in the Emotion Hexagon Test, responses to those within column 50:50 were not recorded as they represent equal parts of two separate expressions of facial emotion.

Appendix 5

Correlation Matrices

1. BAFQ self-report and Ekman 60 Faces
2. BAFQ self-report and Emotion Hexagon
3. BAFQ informant-report and Ekman 60 Faces
4. BAFQ informant report and Emotion Hexagon

Correlation Matrix (3): BAFQ informant-report (emotionality, impulsivity, aggression, social monitoring, and empathy) and Ekman 60 Faces (anger, disgust, fear, sadness and total score); N = 23

		BAFQ informant Emotionality	BAFQ informant Impulsivity	BAFQ informant Aggression	BAFQ informant Social Monitoring	BAFQ informant Empathy
60 Faces - Anger	*r*	-.191	.189	.196	.045	.181
	Sig. (2-tailed)	.382	.390	.370	.840	.410
60 Faces - Disgust	*r*	-.320	-.304	-.618	-.435	-.389
	Sig. (2-tailed)	.138	.160	.002**	.038*	.066
60 Faces - Fear	*r*	-.345	-.210	-.069	-.245	-.047
	Sig. (2-tailed)	.108	.336	.756	.260	.830
60 Faces - Sadness	*r*	.075	.151	.199	-.181	.006
	Sig. (2-tailed)	.734	.492	.362	.410	.980
60 Faces - Total Score	*r*	-.304	-.087	-.106	-.370	-.112
	Sig. (2-tailed)	.158	.692	.632	.082	.610

* Correlation is significant at the 0.05 level (1-tailed).
** Correlation is significant at the 0.01 level (1-tailed).

Correlation Matrix (4): BAFQ informant-report (emotionality, impulsivity, aggression, social monitoring, and empathy) and Ekman 60 Faces (anger, disgust, fear, sadness and total score); N = 23

		BAFQ informant - Emotionality	BAFQ informant - Impulsivity	BAFQ informant - Aggression	BAFQ informant - Social Monitoring	BAFQ informant - Empathy
Hexagon - Disgust	*r*	-.215	-.224	-.617	-.331	-.204
	Sig. (2-tailed)	.326	.306	.002**	.124	.352
Hexagon - Total Score	*r*	-.090	-.009	-.194	-.429	-.149
	Sig. (2-tailed)	.684	.968	.376	.042*	.500

** Correlation is significant at the 0.01 level (1-tailed).
* Correlation is significant at the 0.05 level (1-tailed).

Correlation Matrix (1): BAFQ self-report (emotionality, impulsivity, aggression, social monitoring, and empathy) and Ekman 60 Faces (anger, disgust, fear, sadness and total score); N = 24

		BAFQ self-report - Emotionality	BAFQ self-report - Impulsivity	BAFQ self-report - Aggression	BAFQ self-report - Social Monitoring	BAFQ self-report - Empathy
60 Faces - Anger	*r*	-.149	-.018	.083	.217	.231
	Sig. (2-tailed)	.486	.934	.702	.308	.278
60 Faces - Disgust	*r*	-.110	-.401	.188	-.140	-.192
	Sig. (2-tailed)	.610	.052	.380	.514	.370
60 Faces - Fear	*r*	-.375	-.177	-.141	.082	.081
	Sig. (2-tailed)	.072	.408	.512	.702	.706
60 Faces - Sadness	*r*	-.210	-.112	.048	.135	.127
	Sig. (2-tailed)	.324	.602	.824	.530	.556
60 Faces - Total Score	*r*	-.392	-.304	-.016	.043	.072
	Sig. (2-tailed)	.058	.148	.942	.840	.738

* Correlation is significant at the 0.05 level (1-tailed).
** Correlation is significant at the 0.01 level (1-tailed).

Correlation Matrix (2): BAFQ self-report (emotionality, impulsivity, aggression, social monitoring, and empathy) and Emotion Hexagon (disgust and total score); N = 24

		BAFQ self-report - Emotionality	BAFQ self-report - Impulsivity	BAFQ self-report - Aggression	BAFQ self-report - Social Monitoring	BAFQ self-report - Empathy
Hexagon - Disgust	*r*	.049	-.413	.214	-.067	-.120
	Sig. (2-tailed)	.820	.046*	.316	.756	.578
Hexagon - Total Score	*r*	-.274	-.424	.027	-.019	-.091
	Sig. (2-tailed)	.196	.040*	.900	.930	.674

** Correlation is significant at the 0.01 level (1-tailed).
* Correlation is significant at the 0.05 level (1-tailed).