Everyday Memory Measures in Multiple Sclerosis: A Systematic Review

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Everyday memory is one of the most affected cognitive functions in Multiple Sclerosis (MS). Assessing everyday memory problems is crucial for monitoring the impact of memory deficits on individuals' day-to-day lives and evaluating the effectiveness of interventions that aim to improve cognitive functions. The aim of this systematic review was to identify the research literature on everyday memory measures used with people with MS, describe the types of measures used, and summarise their psychometric properties. Empirical studies of cognitive function in MS using standardised everyday memory measures were included. Online databases (MEDLINE, PsycINFO, PsycARTICLES, Embase) and Google Scholar were searched. Forty-four studies met the inclusion criteria. A total of twelve measures were identified, with varied uses and administration methods. The majority of papers did not report any psychometric properties for MS populations. The few papers that did, reported that the measures have good reliability and appear to have good face, concurrent and ecological validity, but these need to be evaluated further. This review presents researchers and clinicians with an overview of the various everyday memory measures used in studies with people with MS, to help them choose the appropriate measure for their evaluations.

Keywords: everyday memory; multiple sclerosis; systematic review; psychometric properties

Introduction

Cognitive deficits affect up to 80% of individuals with Multiple Sclerosis (MS) (Fischer et al., 2014), with attention, memory, information processing, and executive functions being the most affected cognitive functions (Mackenzie, Morant, Bloomfield, MacDonald, & O'Riordan, 2014; McIntosh-Michaelis et al., 1991; Rao, Leo, Bernardin, & Unverzagt, 1991). Cognitive problems adversely affect individuals' activities of daily life, work, domestic, leisure and social activities, and cause distress and mood problems for the individual with MS, their family and carers (Feinstein, 2006; Gilchrist & Creed,

1994; Peyser, Rao, LaRocca, & Kaplan, 1990).

Everyday memory refers to memory functions associated with daily life. Examples include remembering names or faces, directions, shopping lists, locations of objects, future events or appointments. Tests of everyday memory have questionnaire items or activities that relate to, or closely resemble, routine everyday tasks. There is a variety of everyday memory measures available, most of which are subjective patient-reported measures (Chipchase & Lincoln, 2001; Sunderland, Harris & Baddeley, 1983). Some 'objective' measures have also been developed to capture everyday memory (Rendell & Craik, 2000; Smith, Della-Sala, Logie, & Maylor, 2000; Wilson, Cockburn & Baddeley, 1985; Wilson et al., 2005).

The assessment of everyday memory problems is important for monitoring the impact of memory deficits on an individual's daily life throughout disease progression and for evaluating the impact of interventions (e.g., memory rehabilitation) that aim to improve cognitive functions or help people cope with cognitive problems. Several trials of memory rehabilitation, however, have used impairment level measures of outcome, and not functional outcomes that map onto the International Classification of Functioning, Disability and Health's domains of activity limitation and participation restrictions, despite these domains being the focus of rehabilitation (World Health Organization, 2007). In a recent Cochrane review only five out of 15 trials that evaluated the effectiveness of memory rehabilitation in MS used subjective everyday memory measures, and most used list-learning tasks as objective memory assessments (das Nair, Martin, & Lincoln, 2016).

To our knowledge, no systematic review has been conducted on everyday memory measures in MS (or any other clinical groups specifically), and this is the first systematic review examining the use of these measures with people with MS.

Additionally, although the psychometric properties of the everyday memory measures have been adequately demonstrated for the general population or other clinical groups, we have a limited information with regards to their psychometric properties when used with people with MS.

Our aim, therefore, was to systematically review the research literature on everyday memory measures used with people with MS, describe the types of measures used, summarise their psychometric properties in relation to their use with people with MS, and describe how these measures have been used and what they have been used for. We believe this review may help clinicians and researchers choose the appropriate measures for their evaluations with people with MS.

Methods

A systematic search was conducted using the following electronic databases: Ovid MEDLINE (R), PsycINFO, PsycARTICLES and Embase, from their inception until 2nd May 2017. A search strategy was developed for Ovid MEDLINE (R) by two reviewers (A2 and A3) in consultation with a third reviewer (A1) [*Author names removed to maintain the integrity of the review process*]. Key words included: MS, disseminated sclerosis, multiple sclerosis; combined with everyday memory, daily memory, and real life memory. A two-step search process was used. First, an overview of everyday memory measures was compiled from the book *A Compendium of Tests, Scales and Questionnaires* (Tate, 2010). The name of each measure was combined with the above mentioned search terms. The search strategy for the everyday memory measures is available as supplementary material A. Second, where searches identified additional everyday memory measures used with samples of people with MS, these were then systematically searched in MEDLINE (2nd May 2017) and Google Scholar (24th February 2017).

Papers obtained from the systematic search were independently screened by four reviewers (A2, A3, A4 and A6) [*Author names removed to maintain the integrity of the review process*]. Papers were initially screened by their titles and abstracts for eligibility. The fifth reviewer (A1) confirmed eligibility [*Author name removed to maintain the integrity of the review process*]. Eligibility of papers was determined according to the following inclusion criteria: (a) study participants had a diagnosis of any type of MS (relapsing-remitting, primary progressive, etc.); (b) participants were over the age of 16 years; (c) everyday memory of the person with MS was assessed (as outlined in the search strategy keywords) by the researcher/clinician, the individual with MS or their carer; (d) papers reported peer-reviewed empirical studies (excluding dissertations and protocols); (e) papers were available in English. Although measures such as the Perceived Deficits Questionnaire (PDQ; Sullivan, Edgley, & DeHoux, 1990) can be used as a screening tool of cognitive functioning for studies on any topic, for this review we only considered studies using the PDQ where the focus of the study was everyday memory.

A paper was discarded if the abstract clearly did not meet the inclusion criteria or if it was a duplicate of another paper in the search results. Where the abstract provided insufficient detail, full texts were accessed.

Three reviewers (A2, A3 and A6) independently extracted data from the full texts. Any discrepancies were resolved through discussion, with another reviewer (A1) arbitrating where necessary [*Author names removed to maintain the integrity of the review process*]. All relevant data from the papers were entered onto a bespoke data extraction form (Supplementary material B) to enable final decisions regarding inclusion. We extracted the following data using a data extraction table (Supplementary material C): Publication details, study aims and methods, participant demographics,

everyday memory measure used, how the measure was used, psychometric properties, and conclusions.

Results

Characteristics of included studies

The database searches produced a combined total of 1201 hits from which 44 papers were included in this review. These papers included studies from the UK (1, 4, 7-11, 26), Germany (2), Australia (3, 5, 12), USA (6, 13-21, 27, 33- 37, 39, 41, 43), Canada (22, 23, 28, 42, 44), Italy (24), Finland (25, 31, 32), Iran (29), The Netherlands (30), Greece (38) and Spain (40). Sixteen studies used correlational designs (1, 3, 6, 7, 13, 14, 18, 19, 23, 26, 27, 30, 37-39, 41), eleven had comparison group designs (2, 5, 12, 16, 21, 22, 25, 28, 29, 35, 44). Eight studies were randomised controlled trials (4, 9, 11, 17, 32, 40, 43), four were longitudinal (24, 34, 36, 42), two studies were quasi-experimental (15, 33), one study was an extension of another study (31, 32), one study used a retrospective design (8), one study used a survey design (10), and another was a longitudinal case study (20). See figure 1 for PRISMA flow diagrams for Ovid and Google Scholar searches (Moher, Liberati & Tetzlaff, 2009).

Figure 1 here

Characteristics of the samples

In total, 4402 people with MS participated in these studies, and 17 studies also included healthy controls (n = 779) (2, 5, 8, 12, 18, 19, 21, 22, 25, 27-29, 34, 35, 37, 42, 44). Some studies had mixed samples; three studies included informants (n = 368) (30, 35,

37), two studies included people with stroke (n = 107) (4, 8), one included participants with traumatic brain injuries (n = 16) (4), and one included 51 carers of 51 people with MS (1).

Demographics and illness characteristics of the samples

The mean age of the MS participants ranged from 35.9 to 71 years old (SD range 6.4 to 13.78), with the youngest being 17 and oldest 84 years old (8, 44). Gender weightings in the sample were between 46% (21) to 100% women (20). Participants' educational level was variously coded in the studies. Thirty-six papers reported information on education and of these, only 27 papers reported the mean years of education of the participants (3, 4-6, 12-14, 16, 18, 19, 21- 23, 25-27 31, 32, 34-37, 40-44). The mean years of education ranged from 10.21 to 15.7 years for the overall sample (SD range 1.93 to 3.77). The other nine papers reported education in the following ways: 'levels' of formal education (2); the total number of participants within each education level (17, 23, 33, 30,); age at which participants left education (16 years old; 9); percentages of the overall sample (15, 38); and the participants' highest qualification attained (20). Eight papers did not report this demographic characteristic (1, 7, 8, 10, 11, 24, 29, 39).

Only 25 papers reported participants' ethnicity, with 90% to 100% of the sample reported as 'Caucasian' in 10 papers (13, 15-18, 27, 33-35, 39). African-American people represented 3% to 14.3% in seven papers (15, 16-18, 27, 33, 39), American-Indian represented 4% in one paper (27), and Hispanic people represented 1% to 5% of the overall sample in four papers (15, 16, 18, 27). Other ethnic minorities were simply described as 'other' in five papers (15, 16-18, 33) with one paper using the term 'other' with the exception of Asian or Pacific Islander, Native American or Hispanic (39). Some participants had chosen not to provide details of their ethnicity and this was

reported as ‘declined’ in one paper (27). Two papers reported some ethnicity categories but not others (34, 35).

Thirty-four papers specified the types of MS participants had, whereas ten did not report this (1, 4, 5, 8, 10, 17, 29, 33, 38, 44). Three studies had samples of participants with relapsing-remitting MS only (20, 31, 32). Most papers had mixed samples with relapsing-remitting in 25 papers (2, 3, 6, 7, 9, 11, 12, 16, 18, 19, 21, 25-28, 30, 34-37, 39- 43), primary progressive in 22 papers (2, 3, 6, 7, 9, 11, 14, 16, 19, 22, 27, 28, 30, 34-37, 39-43), secondary progressive in 26 papers (3, 6, 9, 11, 13-16, 18, 19, 21-23, 26-28, 30, 34-37, 39-43), progressive-relapsing in three papers (27, 35, 41), clinically isolated syndrome in two papers (28, 30), and benign MS in one paper (11). Type of MS was unknown in four papers (6, 7, 9, 11) and defined as ‘uncertain’ in one paper (27).

Characteristics of everyday measures

There were 12 everyday measures identified in the 44 papers. In this section, we describe the types of measures used, why they were used, how they were administered, and the reported psychometric properties of these measures based on samples of people with MS, as described by the studies using these measures.

Types of everyday measures

The MS Neuropsychological Questionnaire (MSNQ; Benedict et al., 2003) was the most frequently used measure of everyday memory, used in 14 studies (15, 17, 23, 26, 28, 30-35, 37, 40, 42). Six studies also used the MSNQ informant version (15, 23, 30, 31, 37, 42). Eight studies used the Perceived Deficits Questionnaire (17, 31, 32, 36, 38, 39, 41, 44), and 6 studies used the Everyday Memory Questionnaire (EMQ; Sunderland et al., 1983) (1, 4, 8-11). Five studies used the Prospective and Retrospective Memory

Questionnaire (PRMQ; Smith et al., 2000) (16, 18, 20, 22, 29). Four studies used the Memory Functioning Questionnaire (MFQ; Gilewski et al., 1990) (6, 14, 15, 43) and four used the Virtual Week task (Rendell et al., 2000) (5, 12, 20, 21). Three studies used the Rivermead Behavioural Memory Test (RBMT; Wilson et al., 1985) (2, 4, 24), one of which used its Extended version (Wilson et al., 1999) (4). Two studies used the Cognitive Failures Questionnaire (CFQ; Broadbent et al., 1982) (7, 19) and two used the Memory for Intentions Screening Test (MIST; Raskin, Buckeit & Sherrod, 2010) (16, 27). The other tests used were the Cambridge Prospective Memory Test (CAMPROMT; Wilson et al., 2005) (3), the Memory Rating Scale (MRS; Rao, 1984) (13), and the Self-Evaluation of Everyday Memory and Learning Questionnaire (25). The scoring, administration, reliability and validity of the measures are presented in Table 1.

Uses of everyday memory measures

Eleven studies used everyday memory measures to correlate everyday memory with another measure of memory (e.g., another everyday memory measure, or other memory measures) (6, 13, 15, 18, 19, 30, 35, 36, 39, 41, 42), and 12 studies used measures to correlate everyday memory with another variable (e.g., quality of life or mood) (13, 14, 18, 22-24, 27, 37-39, 41, 42). Everyday memory measures were also used as a predictor variable (e.g., for quality of life or carer strain) in five papers (1, 3, 7, 37, 38) and a predicted variable in three papers (19, 27, 34). In 23 studies, everyday memory measures were used to compare the difference in performance between groups (e.g., between people with MS and healthy controls) (2, 4, 5, 9, 11, 12, 16, 17, 19, 21, 22, 25-27, 29, 31, 32, 34-36, 40, 42, 43). Everyday memory measures were also used in seven studies as outcome measures in randomised controlled trials of memory rehabilitation (4, 9, 11, 17, 21, 31, 32). Other uses of everyday memory measures were to classify

people with MS as having impaired or unimpaired memory (10); to determine whether people with MS had over-estimated or underestimated their cognitive ability (35); to screen participants for eligibility into a trial (17, 28, 33); or as part of a battery to describe memory deficits for a case study (20). Eight papers analysed the psychometric properties of an everyday memory measure (8, 15, 23, 30, 34, 35, 37, 44).

Administration of Everyday Memory Measures

Everyday memory measures were mostly administered face-to-face (see Table 1) or this was inferred from 27 papers (2-5, 9, 12, 14-16, 18-24, 26-28, 31, 32, 34, 35, 37, 40, 42, 43). They were also used as postal measures in seven studies (1, 4, 7, 10, 11, 30, 39), or administered over the phone in two studies (17, 33). Only three papers explicitly reported that the measure was self-administered (25, 30, 38) (we made an assumption in the absence of information in the paper that when used as a postal measure, the measure was self-administered). One paper posted the measure in a newsletter (44). Seven papers did not report how the everyday memory measures were administered (6, 8, 13, 17, 29, 36, 41).

Table 1 here

Psychometric properties of Everyday Memory Measures

The following psychometric properties were reported for the reliability and validity of the everyday memory measures as described within the included studies that used these measures with samples of people with MS (see Table 2).

Of the six papers that used the EMQ, only one reported the internal consistency reliability (8). Cronbach's alpha was high (0.89) for the 13-item version of this scale.

Two papers reported on its validity, both reporting ‘good face validity’ (4, 8). One paper assessed this by comparing the original scale with a 13-item revised scale, and also assessed the construct validity by comparing patients with memory problems with healthy participants (8).

Of the 14 papers that used the MSNQ, four reported on the internal consistency, with two only referring to it as ‘reliable’ (23), and having ‘excellent internal consistency’(35), and another two papers reported Cronbach’s alphas ranging from 0.93 to 0.95 (17, 30). Two papers reported on the interrater reliability, with one paper referring to it as ‘moderate’ with an intraclass correlation coefficient of -0.59 (95% 0.49 – 0.69), along with low to moderate weighted kappa values for item scores (0.25 – 0.50) (30). Another paper reported correlation scores between MSNQ-Self report and MSNQ-Informant report scores ($r = .55$, $p < .01$) (37). Two papers reported on the test-retest reliability; Cronbach’s alpha ranged from 0.86 to 0.90 for one of the papers (34), whereas the other paper referred only to the measure having ‘excellent test-retest reliability’ (35).

Validity was reported by five papers. Construct validity was reported in one paper by testing six hypotheses by calculating Spearman correlations between the MSNQ-P (self-report) and MSNQ-Informant report, an observational measure of memory and measures of anxiety and depression (correlations ranged from 0.26 – 0.49) (30). One study assessed construct validity via regression and reported R2 values ranged from 0.28 – 0.40 and reported that two combined measures (the Symbol Digits Modalities Test (SDMT; Smith et al., 1982) and the Beck Depression Inventory Fast Screen (BDIFS; Benedict et al., 2003) accounted for a third of the variance in the MSNQ (34). One study assessed the validity of the MSNQ discrepancy scores in all MS patients who had either under-, over-, or accurately estimated neuropsychological

impairment, and then in a subgroup of cognitively impaired patients (35). This paper reported discrepancy scores ranging from 16 – 30 (M = 21.1, SD = 3.6) in the under-estimator group, -4 – 11 (M = 2.4, SD = 4.2) in the accurate estimator group, and -37 – -11 (M = -20.6, SD = 7.4) in the over-estimator group. For MS patients categorised as 'cognitively impaired', discrepancy scores ranged from 16 – 30 (M = 20.6, SD = 4.3) in the under-estimator group, -3 – 10 (M = 2.5, SD = 4.0) in the accurate estimator group, and -37 - -11(M = -20.4, SD = 7.5) in the over-estimator group (35). The fourth paper reported MSNQ sensitivity as .52 (95% confidence interval [CI] .32 - .72) and specificity as 0.70 (95% CI .51 - .82) when categorising patients in the 'global cognitive impairment categories' (37). With a cut-off score of 24 on the MSNQ, only 62% of the MS patients were correctly categorised as either impaired or not impaired. A cut-off score of 7.5 produced the maximum sensitivity (.90) and specificity (.96) for the MSNQ (37).

Only one of the five studies that used the PRMQ reported the internal consistency, with Cronbach's alpha reported as 0.89, 0.84 and 0.80 (16). Again, validity was not reported. None of the three papers using the RBMT reported the reliability or validity of the measure, with only one paper suggesting that the test had been 'validated by five to ten years follow ups of patients with memory problems' (p. 161) (2). Of the four papers that used the Virtual Week, only one reported the split-half reliability (Cronbach's alpha ranged from 0.71 to 0.85) and none reported on the measure's validity (5). One of the two papers that used the CFQ reported the internal consistency reliability (Cronbach's alpha of 0.95) (7). Neither reported the validity. Only one of the four papers using the MFQ referenced the internal consistency reliability of the measure from other studies (Cronbach's alpha ranged from 0.84 to 0.94) and also stated that the measure 'has demonstrated concurrent validity and convergent validity with another

commonly used metamemory measure' (p. 265, 14) (Gilewski et al., 1990; Hertzog, Hultsch, & Dixon, 1989; Randolph et al., 2004; Zelinski, Gilewski, & Anthony-Bergstone, 1990). The study that used the CAMPROMPT reported inter-rater reliability (r = .99) and 'adequate test-retest reliability over 7-10 days (Kendall's Tau-b = 0.64), and suggested the measure was 'ecologically valid' (3). Of the two papers that used the MIST, one paper referenced 'strong evidence of reliability and construct validity' (p. 890, 27) from other studies (Gupta et al., 2010; Woods et al., 2008), and one paper did not report the reliability or validity (16). Of the eight papers that used the PDQ, only two papers reported on reliability. One of the papers (36) reported internal consistency by referencing Cronbach's alpha ranges 0.77 – 0.97 from other studies (Fischer et al., 1999; Marrie et al., 2003) and also reported test-retest reliability $r = .564$, $p < .001$. The other paper reported internal consistency reliability from its own dataset with Cronbach's alpha ranging from 0.76 to 0.84 (44). Only three papers reported on the validity of the PDQ. The first paper reported the PDQ has 'good…validity in persons with MS' (p. 616, 36). The second paper did not find any correlations with objective cognitive tests and was 'uncertain' as to what the PDQ assesses (39). The third paper reported 'the validity of self-report measures of cognitive problems may best be addressed by examining whether these measures predict disruptions in daily living, not whether they predict neuropsychological test scores'. (p.103, 44). Papers using the MRS-C (13), and the Self-Evaluation of Everyday Memory and Learning Questionnaire (25) did not report on the reliability or validity of the measures.

Table 2 here

Discussion

Everyday memory measures were used with a wide age range of people diagnosed with MS, with the mean number of years of education ranging from 11 to 15.7 years. Most of the participants were women and of White ethnicities, which is representative of the MS population. All MS sub-types were represented in the literature. Of the 12 everyday measures identified in the 44 papers, the majority were questionnaires, with only four being observer-assessed 'objective' tests that required the respondent to follow certain actions. These objective measures were the RBMT, CAMPROMPT, Virtual Week, and MIST.

Everyday memory measures were used for a variety of reasons: to assess how different everyday memory measures compare with each other, how everyday memory relates to other symptoms of MS (such as mood problems), and whether everyday memory can predict an outcome. Everyday memory measures were also used to screen participants for memory problems, and to classify and describe people's memory problems. Some trials of cognitive rehabilitation used everyday memory measures as a primary or secondary outcome to evaluate the impact of the intervention on everyday memory performance.

The variability of the use of these measures also suggests their versatility. Their versatility is also reflected in their administration formats, with the everyday memory questionnaires being administered face-to-face, over the phone, or by post. The questionnaires could also be self-administered. This is important for their use as outcome measures in intervention trials, because most of these trials are observer-blinded and the chances of the outcome assessor becoming unblinded increases if they are in direct contact with participants. Indeed, many trials have imperfect blinding (Fergusson et al., 2004). This gets more difficult with participants with memory

problems who even when told not to reveal their group allocation sometimes forget this instruction and inadvertently unblind the assessor (Lincoln, personal communication, 2017).

The majority of papers did not report or reference information related to reliability. Of the measures that did discuss reliability, one reported test-retest reliability (Kendall's Tau = b-0.64) (Honan et al., 2015) and inter-rater reliability (r =.99), and six discussed internal consistency (Cronbach's alphas ranging from 0.80 to 0.95). The validity of the measures was even less frequently presented. Where validity was discussed most authors presented a verbal description of the face validity, concurrent validity with independence and employment, and 'ecological validity'. Ecological validity refers to the extent to which cognitive tests relate to cognitive problems in daily living or functional limitations, emphasising how these tests predict function in real-life settings (Ginsberg, Kibby & Long, 1996). Higginson et al. (2000) highlight the EMQ and RBMT as examples of ecologically valid tests of memory for use with people with MS; the EMQ, a rating scale assessing the frequency and of real-life memory problems, and the RBMT, a test which assesses analogues of everyday memory situations. Their study, which compared ecologically valid measures (memory questionnaires and tests) with standard neuropsychological tests (e.g., list learning and symbol-digit modalities test), found that the ecologically valid tests were better predictors of functional disability than both memory questionnaires and standard neuropsychological tests commonly used in assessing people with MS. The lack of correlations between some of these tests suggested that the ecologically valid tests measured something different than what was measured by the standard neuropsychological tests.

Everyday memory measures, therefore, have an important role to play in assessing memory functions in people with MS, predicting functional disability,

establishing how everyday memory relates to other symptoms of MS, evaluating change over time, and examining the effectiveness of interventions.

One limitation of our review is that we did not assess the risk of bias or methodological quality of the included papers through a standardised checklist. Our aim was to clearly report all available evidence and synthesise findings, rather than presenting the 'weight' of the evidence. Thus, we cannot determine whether the included studies provide robust or generalisable findings.

Conclusions

This review presents researchers and clinicians with an overview of the various everyday memory measures that have been used in studies with people with MS. Everyday memory measures have been used for a variety of reasons with people with MS of different demographics and different MS subtypes. These measures are often questionnaires or objective tests with prescribed activities. The questionnaires are versatile, can be self-administered and can be used over the telephone or by post. Both the questionnaires and tests have been used as outcome measures in trials of cognitive rehabilitation. The measures have good reliability and appear to have good face, concurrent and ecological validity, but these need to be evaluated further in samples of people with MS.

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Table 1. Scoring, administration, reliability and validity of EM measures.

Table 2. Reliability and validity of EM measures in MS samples.

Figure 1. PRISMA flowchart for searches.

Table 1. Scoring, administration, reliability and validity of EM measures

Questionnaires/ Tests	Number of items/subtests	Scaling and scoring	Administration time	Administration modality	Reliability and validity
CFQ	25 items	Likert scale scored 0 (never) to 4 (very often)	Not reported	Two papers reported using postal administration (7) and face-to-face administration (19)	The factor structure of the CFQ varied between occupational groups (Broadbent et al., 1982).
EMQ	35 items (28 in revised version)	Likert scale scored 0 (never) to 4 (more than once a day). Total score is sum of all items.	Not reported	Five papers reported using postal and inferred postal administration (1, 4, 10, 11) and inferred face-to face (9)	
MFQ	64 items, 7 sections	7 point Likert scale (never to always)	Not reported	Three papers reported face-to-face and inferred face-to-face administration (14, 15, 43)	
MRS-C	31 items	Likert scale scored 1 (much worse than the average person) to 5 (much better than the average person)	Not reported	Not reported	

Questionnaires/ Tests	Number of items/subtests	Scaling and scoring	Administration time	Administration modality	Reliability and validity
MSNQ	15 items	Likert scale scored 0 (never) to 4 (very often)	Not reported	Thirteen papers reported using face-to-face or inferred face-to-face administration (15, 23, 26, 28, 31, 32, 34, 35, 37, 40, 42), self-administration and postal administration (30) and telephone administration (33)	“Cronbach's alpha coefficients were 0.93 and 0.94 for the patient- and informant-report forms, respectively, and both forms of the test were strongly correlated with a more general cognitive complaints questionnaire. The patient MSNQ form correlated significantly with measures of depression but not with objective tests of cognitive function. In contrast, the informant form was correlated with patient cognitive performance but not depression. A cut-off score of 27 on the informant form of the MSNQ optimally separated patients based on a neuropsychological summary score encompassing measures of processing speed and memory. There were two false-negatives and one false-positive, giving the test a sensitivity of 0.83 and a specificity of 0.97” (Benedict et al., 2003)
PDQ	20 items	Likert scale scored 1 (never) to 5 (almost always)	Not reported	Six papers reported using telephone administration (17), inferred face-to-face (31, 32), self-administration (38), postal administration (39) and	Analyses revealed that the 4 subscales were internally consistent: attention/concentration (alpha=0.78), planning/organization (alpha=0.84), retrospective memory (alpha=0.83), prospective memory (alpha=0.76). Principal components analysis with

Questionnaires/ Tests	Number of items/subtests	Scaling and scoring	Administration time	Administration modality	Reliability and validity
				posted in a newsletter (44)	oblique rotation yielded a 4-factor solution that paralleled the subscale structure. Inter-factor correlations averaged 0.45 (p.102) (44).
PRMQ	16 items	Likert scale scored 1 (never) to 5 (very often)	Not reported	Four papers reported using face-to-face and inferred face-to-face administration (18, 22, 16, 20)	Has self and proxy rating versions, normative data from 555 healthy controls aged 17-94 years (Crawford et al., 2003). "We examined the split half reliability of the questionnaire, comparing the two questions within each category from the elderly and young control participants only (*n*= 406). Using the Spearman-Brown formula, the split half reliability was *r*SB=0.84." (p. 315) (Smith et al. 2000)
Self-evaluation of memory and learning	Data Unavailable	Likert scale scored 1 (never) to 5 (often)	Not reported	Self-administered	From personal communications with author (24th August 2016), no psychometric properties were available.
CAMPROMPT	6 tasks	Data unavailable	25 mins	Needs trained administrator; Face-to-face	
MIST	8 tasks	6 subscales ranging 0-8, summed into summary score ranging 0-48	30 mins	Needs trained administrator; face-to-face	

Questionnaires/ Tests	Number of items/subtests	Scaling and scoring	Administration time	Administration modality	Reliability and validity
RBMT	14 tasks	Gives standardised scores and percentile rank with cut-off data for impairment level	30 mins	Needs trained administrator; Face-to-face	
Virtual Week	3 different types of tasks	Scored on tasks correct, incorrect, late or missed.	75-120 mins	Needs trained administrator; Board game or computerised, individual or group	

Note. Abbreviations: CAMPROMPT: Cambridge Prospective Memory Test; CFQ: Cognitive Failures Questionnaire; EM: Everyday memory; EMQ: Everyday Memory Questionnaire; MFQ: Memory Functioning Questionnaire; MIST: Memory for Intentions Screening Test; MRS: Memory Rating Scale; MS: Multiple Sclerosis; MSNQ: MS Neuropsychological Questionnaire (MSNQ-P: patient self-report version; MSNQ-I: Informant version); PDQ: Perceived Deficits Questionnaire; PRMQ: Prospective and Retrospective Memory Questionnaire; RBMT: Rivermead Behavioural Memory Test.

Table 2. Reliability and validity of EM measures in MS samples

EM Measure (no. of papers used in)	Reliability in MS samples	Validity in MS samples	Other Comments
EMQ (6)	Not Reported	The EMQ 'has good face validity, assesses real-life situations…' (p.897) (das Nair et al. 2012)	'…and is used in clinical practice' (p.897) (das Nair et al. 2012)
	'Cronbach's alpha for the scale was high (0.91)' (p.117) (Royle et al. 2008) (controls only) 'Cronbach's alpha for the shortened scale was high (0.89) and all items showed corrected item-total correlations of at least 0.3, indicating strong internal reliability' (p.117-8) (Royle et al. 2008) (both groups)	'…good face validity' (p. 114) (Royle et al. 2008) 'Further evidence of the validity of the revised scaled was confirmed by the strong relationships between the original and revised versions, suggesting that the revised 13-item questionnaire could provide a valid and reliable tool for clinical use…' (p.119) (Royle et al. 2008)	The EMQ 'was initially developed for use with survivors of head injury …further refined…with both non-clinical and clinical samples'. (p. 115) (Royle et al.2008) 'The original questionnaire consisted of 35 items, which has since been altered to 28-item questionnaire to increase the measure's validity and facilitate self-administration'. (p. 115) (Royle et al. 2008)
	Not Reported	Not Reported	'The outcome measures used (including EMQ) may not be appropriate to detect the benefits of providing an intervention' (p.97)(Lincoln et al. 2002)
	Not Reported	Not Reported	'Only a few items from the Everyday Memory Questionnaire completed by the person with MS were associated

EM Measure (no. of papers used in)	Reliability in MS samples	Validity in MS samples	Other Comments
			with carer strain, and there was no apparent difference between those items that were related…and those that were not…' (p. 772) (Chipchase et al. 2001)
	Not Reported	Not Reported	
	Not Reported	Not Reported	The EMQ 'was used as there was no appropriate alternative available with good psychometric properties' (p.559) (Carr et al. 2014)
MSNQ (14)	Not Reported	Not Reported	
	The MSNQ 'appears reliable to detect cognitive impairment (p.410) (Stuifbergen et al. 2012)	Not Reported	'There was a strong correlation between the results obtained on the neuropsychological tests at least for memory functioning, and the score on the MSNQ-informant.' (p.413) (Stuifbergen et al. 2012)
	'The Cronbach's alpha for internal consistency reliability ranged from 0.94 to 0.95' (p.886) (Cutajar et al. 2000)	Not Reported	MSNQ 'scores were significantly correlated with scores on a battery of neuropsychological tests and measures of whole-brain lesion burden and atrophy in prior research' (p.886) (Cutajar et al. 2000) (Benedict et al. 2004; Benedict & Zinadinov, 2006)

EM Measure (no. of papers used in)	Reliability in MS samples	Validity in MS samples	Other Comments
	Not Reported	Not Reported	
	Not Reported	Not Reported	
	Cronbach's alpha for MSNQ-P 0.93 and MSNQ-I 0.94 showed good internal consistency. Interrater reliability between MSNQ-P and MSNQ-I was moderate, with Intraclass Correlation coefficient of 0.59 (95% CI: 0.46-0.69). Weighted kappa values for item scores were low to moderate (0.25-0.50)	Construct validity was confirmed through six hypotheses: 1) Correlation between MSNQ-P and BRBN small positive, 0.26 2) Correlation between MSNQ-I and BRBN moderate and positive, 0.39 3) Correlation between MSNQ-P and anxiety and depression scales (HADS) moderate and positive, 0.49 and 0.47 respectively 4) Correlation between MSNQ-I and anxiety and depression small positive, 0.36 and 0.33 5) Correlations between MSNQ-P and BRBN small positive, 0.26 and correlation between MSNQ-I and BRBN is higher , 0.39 6) Correlation between MSNQ-P and anxiety and depression, 0.47	'Internal consistency was good for both scales. Assessment of construct validity showed that all hypotheses based on previous studies were confirmed (Benedict et al. 2003; Vanotti et al. 2009)'. 'The interrater reliability of the total score and the item scores between the patient and informant versions was moderate'. 'Interrater agreement was poor'. 'The main outcome is that the MSNQ-I is more promising to screen for cognitive impairment in MS patients. The patient version has no added value, so when screening for cognitive impairment in MS the MSNQ version is preferred'. (p. 95) (Sonder et al. 2012)

EM Measure (no. of papers used in)	Reliability in MS samples	Validity in MS samples	Other Comments
		and 0.49 respectively. Correlation between MSNQ-I and anxiety and depression is lower, 0.33 and 0.36 respectively. (p. 94) (Sonder et al. 2012)	
	Not Reported	Not reported	
	Not Reported	Not Reported	
	Not Reported	Not Reported	
	'Test-retest correlations ranged from.0.86 [test 2 to test 3] to 0.90 [test 3 to test 4 for MSNQ.' (p. 943) (Benedict et al. 2008) 'Our results clearly show that SDMT and MSNQ are reliable when administered by nursing staff at monthly intervals.' (p. 944) (Benedict et al. 2008). 'Test-retest coefficients were acceptable to strong for both tests and showed very little variation over the course of the study.' (p. 944) (Benedict et al. 2008)	R^2 final model: Month 2=0.40 (BDIFS and SDMT), Month 3=0.37(BDIFS), Month 4=0.38 (BDIFS), Month 5=0.28 (BDIFS and SDMT), Month 6=0.38 (BDIFS and SDMT) 'The final R^2 values ranged from 0.28 to 0.40, suggesting that SDMT and BDIFS combined account for roughly 1/3 of the variance in MSNQ.' 'The question of validity was also examined in the regression models where we attempted to determine the	'The current findings parallel previous showing good test-retest reliability with these measures using a weekly assessment schedule (Benedict et al. 2004; Benedict, Cox, Thompson et al. 2004)(p.944) (Benedict et al. 2008) (post hoc rationale) 'The high reliability for the SDMT and MSNQ when used on a monthly basis means that these tests can be used to identify patients at high risk for neuropsychological compromise with minimal error, in the clinic setting.' (p. 944) (Benedict et al. 2008)

EM Measure (no. of papers used in)	Reliability in MS samples	Validity in MS samples	Other Comments
		most significant correlate of the MSNQ…..it was understood that correlations between MSNQ and tests of depression were higher than with neuropsychological testing.' (p. 944) (Benedict et al. 2008)	
	'The test has excellent internal consistency and test-retest reliability (Benedict et al. 2003; Benedict et al. 2004)(p. 575) (Carone et al. 2005)	MSNQ Discrepancy scores for all MS patients: Underestimator group: 16-30 (M=21.1, SD=3.6) Accurate estimator group: -4 – 11 (M=2.4, SD= 4.2) Overestimator group: -37 - -11 (M=-20.6, SD=7.4) MSNQ Discrepancy scores for cognitively impaired MS patients: Underestimator group: 16 – 30 (M=20.6, SD=4.3) Accurate estimator group: -3 – 10 (M=2.5, SD=4.0) Overestimator group: -37 - -11 (M=-20.4, SD=7.5)	'While the validity of such informant report questionnaire responses is demonstrated in MS (Benedict et al. 2003), and other conditions (Koss et al. 1993; McGlone et al. 1990) ; Sunderland et al., 1983), it falls short of actual observation and could be subject to report bias on part of the informants'. (p. 581) (Carone et al. 2005)

EM Measure (no. of papers used in)	Reliability in MS samples	Validity in MS samples	Other Comments
		'…our study assessed the validity of the MSNQ discrepancy scores in all MS patients first, and then in a subsample of cognitively impaired patients…we found that discrepancy scores reflecting over-estimation of ability were associated with poor neuropsychological test performance in both analyses'. (p. 580) (Carone et al. 2005)	
	Interrater reliability: Correlation between MSNQ-S and MSNQ-I scores r=.55, p<.01	Sensitivity and Specificity: MSNQ-S demonstrated sensitivity=.52 (95% confidence Interval (CI) .32- -.72) and specificity= .70 (95% CI .51 - .82) when categorising persons in the global cognitive impairment categories, utilising the recommended cut-off score of 24. MSNQ-I demonstrated sensitivity=.66 (95% CI .44 - .84) and specificity=.77 (95% CI .56 - .89) when categorising persons in the global cut-off score	'With a cut-off score of 24 on the MSNQ-S, only 62% of the MS sample was correctly classified as either impaired or not impaired. A cut-off score of 22 on the MSNQ-I resulted in 70% of the MS sample correctly classified as either impaired or not impaired.' (p. 943) (O'Brien et al. 2007) 'Results showed that the MSNQ-I appears to be a useful screening measure

EM Measure (no. of papers used in)	Reliability in MS samples	Validity in MS samples	Other Comments
		utilising the recommended cut-off score of 22. ROC curve analysis: MSNQ-S, area under ROC Curve is .62% (S.E.=.09, p> .05). This value was not significant. In the current study, a score of 7.5 on the MSNQ-S produced maximum sensitivity (.90) and specificity (.96) for this measure. MSNQ-I, area under ROC curve is .74 (S.E=.08, p> .05. This did not provide a strong support for the ability to differentiate between cognitively impaired and non-impaired groups. In this current study, a score of 10 on the MSNQ-I produced the maximum sensitivity (.94) and specificity (.55) for this measure. (p.943-45) (O'Brien et al. 2007)	for cognitive impairment in persons with MS'. (p. 945) (O'Brien et al. 2007)
	Not Reported	Not Reported	
	Not Reported	Not Reported	'Of note is that both self and informant MSNQ findings did discriminate between the MS and healthy control

EM Measure (no. of papers used in)	Reliability in MS samples	Validity in MS samples	Other Comments
			groups at both baseline and follow-up'. (p.150) (Walker et al. 2016)
PRMQ (5)	Not Reported	Not Reported	(post hoc rationale) 'One can also question the reliability of the answers given on the PRMQ. However there are two arguments in favour of the reliability of the data. On the one hand, there is the effect size…on the other hand, there is convergence between some of our results and those obtained by others…' (p. 732-733) (Demers et al. 2011)
	Cronbach's alpha 0.89, 0.84, 0.80 (p. 401)	Not Reported	
	Not Reported	Not Reported	'The PRMQ can be broken down into prospective and retrospective memory factors… given a very high correlation between these factors (r>.80)' (p. 41) (Bruce et al. 2010)
	Not Reported	Not Reported	
	Not Reported	Not Reported	
RBMT (3)	Not Reported	'Furthermore, this test has been validated by five to ten years follow ups	'The RBMT has shown to correlate well to results of traditional memory tests

EM Measure (no. of papers used in)	Reliability in MS samples	Validity in MS samples	Other Comments
		of patients with memory problems, thus showing a close association between test performance and independence and/or employment' (Wilson et al. 1991) (p.161) (Haupts et al. 1994)	such as the Wechsler Memory scale and subjects' self-assessment reports'(Lincoln & Tinson, 1989) (p.161) (Haupts et al. 1994)
	Not Reported	Not Reported	
	Not Reported	Not Reported	'It evaluates the mnemic function understood in its 'ecological' sense'. (p. 189) (Cutajar et al. 2000)
Virtual Week (4)	Split half reliability of tasks for MS group: regular (.85), irregular (.71), time check (7.1) (.79, .75, .73 for controls) (p. 742) (Rendell et al. 2012)	Not Reported	'Virtual Week is a laboratory measure of PM that closely represents the types of PM tasks that actually occur in everyday life' (p. 739) (Rendell et al. 2012)
	Not Reported	Not Reported	'It has been found to be very sensitive to the effects of ageing on prospective memory (Rendell & Craik, 2000) and also discriminates between patients with bipolar disorder and healthy controls' (Rendell et al. 2012) (p. 411) (Rendell et al. 2007)
	Not Reported	Not Reported	

EM Measure (no. of papers used in)	Reliability in MS samples	Validity in MS samples	Other Comments
	Not Reported	Not Reported	'…this board game has been found to be sensitive to PM deficits in other populations, as well…' (p747) (Kardiasmenos et al. 2008)
CFQ (2)	Cronbach's alpha was 0.95. (p. 103) (Phillips et al. 2009)	Not Reported	'There are also indicators from previous studies that the CFQ and ERQ are associated with objective indicators of performance' (see Robertson et al. 1997) (TBI study)). (p. 104) (Phillips et al. 2009)
	Not Reported	Not Reported	
MFQ (4)	Not Reported	Not Reported	'The dependant variable used in these analyses was the Total MFQ score, which has a possible range of 64 (lowest rating of one's memory faculties) to 448 (highest rating).' (p. 558) (Krch et al. 2011)
	'internal consistency of factors ranging from 0.84 to 0.94 across'(Gilewski et al. 1990; Zelinski et al. 1990) (p. 265) (Randolph et al. 2004)	'…has demonstrated concurrent validity with memory performance measures and convergent validity with another commonly used metamemory measure'. (Zelinski et al. 1990; Hertzog et al. 1989) (p. 265) (Randolph et al. 2004)	'Associations were found between MFQ scales and various measures of depression and cognitive functioning…' (p. 275) (Randolph et al. 2004)

EM Measure (no. of papers used in)	Reliability in MS samples	Validity in MS samples	Other Comments
	Not Reported	Not Reported	
	Not Reported	Not Reported	
CAMPROMPT (1)	'Excellent interrater reliability (r= .99), adequate test-retest reliability over 7-10 days (Kendall's Tau-b= .64).' (p. 158) (Honan et al. 2015)	The CAMPROMPT 'is an ecologically valid 25-min measure of prospective memory' (p, 158) (Honan et al. 2015)	The CAMPROMPT 'is moderately correlated with other measures of memory, attention and executive functioning (Wilson et al., 2005), and can also distinguish the performance of those with MS from healthy controls'(Foley et al. 2004) (p. 158) (Honan et al. 2015)
MIST (2)	Not Reported	Not Reported	The MIST 'demonstrates strong psychometric properties and has been shown to accurately reflect prospective memory in a variety of neurologic patient populations'(Woods et al. 2008; Raskin et al. 2009) (p. 401) (Thelen et al. 2014)
	Not reported for the current sample 'The research version of the MIST shows strong evidence of reliability'(Woods et al. 2008) (p. 890) (Miller et al. 2014)	Not reported for the current sample '…and construct validity '(Gupat et al .2010) (p.890) (Miller et al. 2010)	'As such the current study extends the external validity of the initial findings.' (p. 892)

EM Measure (no. of papers used in)	Reliability in MS samples	Validity in MS samples	Other Comments
MRS-C (1)	Not Reported	Not Reported	'Adapted from the Everyday Memory Questionnaire, the MRS-C is composed of 31 items that ask participants to compare their current ability to remember day-to-day information with that of the average person'. (Sunderland et al. 1983) (p. 204) Bruce & Arnett 2004)
PDQ (8)	Not Reported	Not Reported	
	Not Reported	Not Reported	'The reliability and validity of the MSQLI (Fischer et al. 1999) and PDQ have been shown in patients with MS' (Marrie et al. 2003) (p. 103) (Mäntynen et al. 2014)
	Not Reported	Not Reported	
	'The PDQ has good reliability…in persons with MS (Cronbach's alpha for five item PDQ reported between 0.77-0.97' (Fischer et al. 1999; Marrie et al. 2003) (p. 616)(Christodoulou et al. 2005)	'The PDQ has good….validity in persons with MS…'(p.616) (Christodoulou et al. 2005)	

EM Measure (no. of papers used in)	Reliability in MS samples	Validity in MS samples	Other Comments
	Test-retest reliability r=.564, p<.001 (p.616) (Christodoulou et al. 2005)		
	Not Reported	Not Reported	
	Not Reported	'Since the PDQ did not correlate with any of the objective cognitive tests used in this study, what the PDQ actually assesses is uncertain.' (p. 81) (Lovera et al. 2006)	
	Not Reported	Not Reported	'Reports of cognitive concerns on the PDQ were highly correlated with concomitant reports of depression, anxiety, fatigue and self-efficacy, in line with existing literature' (Lovera et al 2006; Kinsinger et al. 2010; Lester et al. 2007). (p. 187) (Strober et al. 2016)
	The 4 subscales were internally consistent: attention/concentration (Cronbach's alpha)=.78, planning/organization (Cronbach's alpha)=.84, retrospective memory (Cronbach's alpha)=.83, prospective memory (Cronbach's alpha)=.76.	'Concerns have been raised about the validity of self-report measures of cognitive functioning' (Herrman et al. 1984) 'For example, the current findings indicate that individuals with MS reported experiencing difficulties in	'The results of the survey also indicated a high prevalence of spontaneous utilisation of strategies to deal with cognitive difficulties. The most commonly reported strategy was a use of an external memory aid.' (p. 103) (Sullivan et al. 1990)

EM Measure (no. of papers used in)	Reliability in MS samples	Validity in MS samples	Other Comments
	Inter-factor correlations averaged=.45	prospective memory, and planning and organization'. 'The validity of self-report measures of cognitive problems may best be addressed by examining whether these measures predict disruptions in daily living, not whether they predict neuropsychological test scores'. (p.103) (Sullivan et al. 1990)	
Self-evaluation of everyday memory and learning (1)	Not Reported	Not Reported	From personal communications with author (24th August 2016) this was a unitary scale that was self-administered. No psychometric properties were available.

Note. Abbreviations: BDI-FS: Beck Depression Inventory-Fast Screen; BRBN: Brief Repeatable Battery of Neuropsychological Tests; CAMPROMPT: Cambridge Prospective Memory Test; CFQ: Cognitive Failures Questionnaire; EM: Everyday memory; EMQ: Everyday Memory Questionnaire; ERQ: Emotion Regulation Questionnaire; HADS: Hospital Anxiety and Depression Scale; MFQ: Memory Functioning Questionnaire; MIST: Memory for Intentions Screening Test; MRS: Memory Rating Scale; MS: Multiple Sclerosis; MSNQ: MS Neuropsychological Questionnaire (MSNQ-P: patient self-report version; MSNQ-I: Informant version); MSQLI: Multiple Sclerosis Quality of Life Inventory; PDQ: Perceived Deficits Questionnaire; PM: Prospective memory; PRMQ: Prospective and Retrospective Memory Questionnaire; RBMT: Rivermead Behavioural Memory Test; ROC: Receiver Operating Characteristic; SDMT: Symbol Digit Modalities Test; TBI: Traumatic Brain Injury.

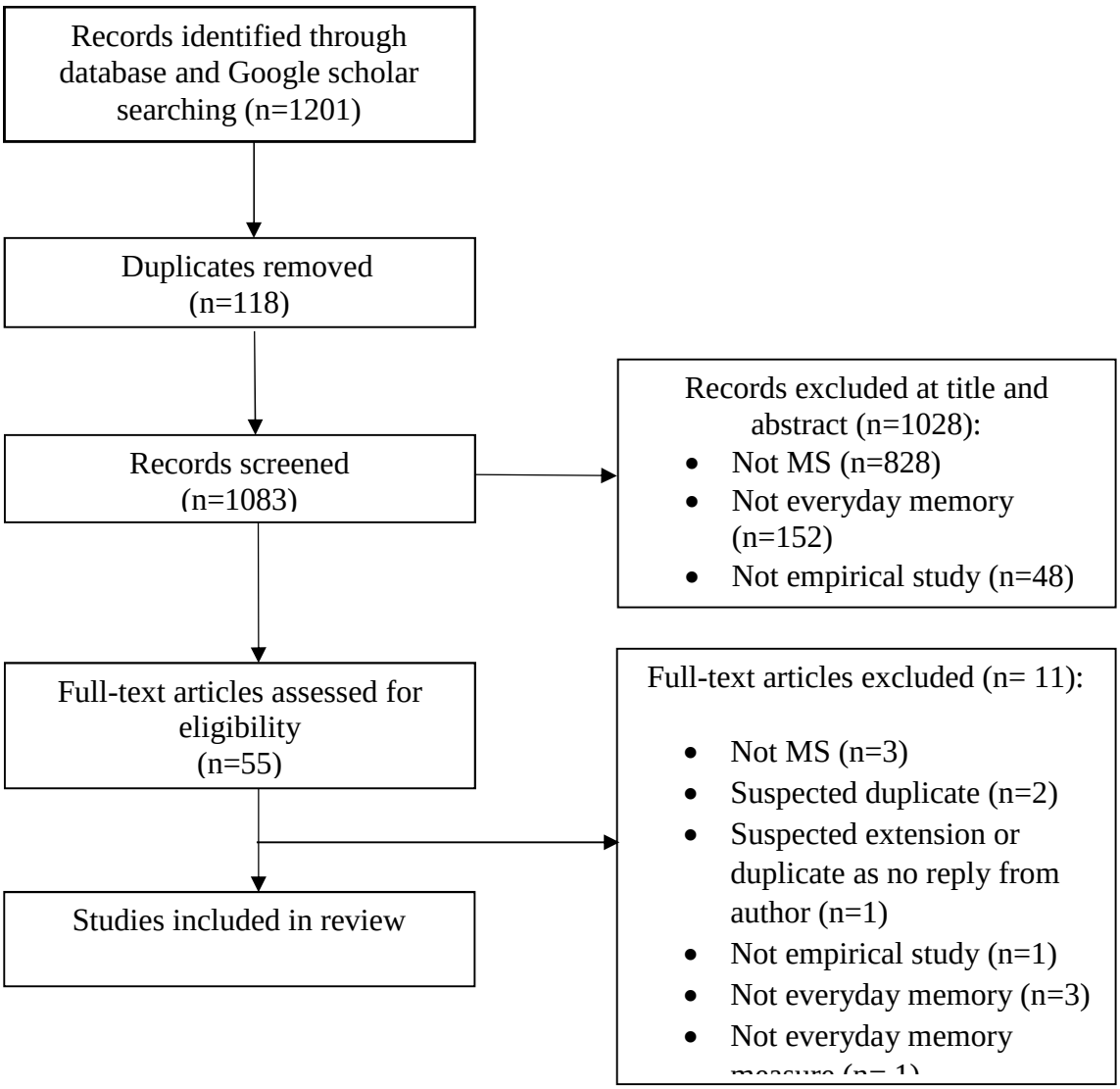

Figure 1. PRISMA flowchart for searches.

Supplementary Materials

A: OVID Search Strategy

1. MS/
2. disseminated sclerosis/
3. multiple sclerosis/
4. Everyday memory/
5. daily memory/
6. real life memory/
7. Everyday memory questionnaire/
8. cognitive failures questionnaire/
9. multifactorial memory questionnaire/
10. memory failures of everyday/
11. comprehensive assessment of prospective memory/
12. memory functioning questionnaire/
13. prospective and retrospective memory questionnaire/
14. memory rating scale/
15. subjective memory rating scale/
16. subjective memory complaint clinical/
17. subjective memory questionnaire/
18. memory assessment clinics self-rating scale/
19. memory assessment clinics questionnaire/
20. questionnaire or memory efficiency/
21. memory complain questionnaire/
22. self-efficacy questionnaire/
23. memory self-report questionnaire/
24. memory observation questionnaire/
25. memory problem questionnaire/
26. short memory questionnaire/
27. computerized everyday memory battery/
28. Rivermead behavioural memory test/
29. Cambridge prospective memory test/
30. virtual week/
31. everyday memory interview/
32. 1 or 2 or 3
33. 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31
34. 32 and 33

B: Data extraction form

Reviewer:		Date:	
Author:			
Year:		Journal:	
Country:			
Record Number:			

STUDY METHOD					
RCT	☐	QUASI-RCT	☐	LONGITUDINAL	☐
RETROSPECTIVE	☐	OBSERVATIONAL	☐	CASE STUDY	☐
COHORT STUDY	☐	OTHER	☐	_____	

PARTICIPANTS DEMOGRAPHICS
Population:
Sample size:
Gender (%F):
Age:
MS Type (No):
Education (Years):
Ethnicity:

AIM

MEASURES

USE OF MEASURE

RELIABILITY

VALIDITY

REVIEWERS NOTES AND CONCLUSIONS

C: Sample demographics and EM measure details.

Paper #	Author / Year / Country	MS group						EM Measure(s)	Use of Measure	
		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
1	Chipchase & Lincoln (2001) UK	51 (informal carers= 51)	58	M=44 SD=9.41 Range= 26-64	Not Reported	Not Reported	Not Reported	EMQ	Postal administration at 2 time points (baseline & 4 months after recruitment)	As a predictor variable for carer strain
2	Haupts et al. (1994) Germany	35 (healthy controls= 30)	63	M=35.9 SD=+/- 7 Range=21-61	'Education was scored in levels of formal education…' (p. 159) Not reported in years	Not Reported	FM=6 RR=20 PP=9	German RBMT	Face to face inferred. Administration at one time point	To compare EM tasks between MS and control groups
3	Honan et al. (2015) Australia	111	70	In paid employment M=44.34 SD=10.35 unemployed M=50.94 SD=10.53	Expressed according to employment status In paid employment	Not Reported	In paid employment RR=46 SP=10 PP=3 Other=3 unemployed	CAMPROMPT	Face to face inferred. Administration at one time point	As a predictor variable for work outcomes

Paper #	Author / Year / Country	MS group						EM Measure(s)	Use of Measure	
		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
					M=13.82, SD=2.17 Unemployed M=14.37, SD=2.32		RR=28 SP=13 PP=5 Other=3			
4	dasNair & Lincoln (2012) UK*	MS=39 TBI=16 Stroke=17	56[a]	M=47.7[a] SD=10.2[a]	Expressed according to intervention group allocation Compensation group treatment: M=13.5, SD=2.6 Restitution group treatment: M=13.6, SD=2.6 Self-Help group control:	Not Reported	Not Reported	EMQ RBMT	EMQ: Postal inferred. RBMT: Face to face inferred. Administered at 3 time points (baseline, 5 months and 7 months after randomisation)	EMQ: Primary outcome RBMT: secondary outcome measure. To compare EM between intervention and control group

Paper #	Author / Year / Country	MS group						EM Measure(s)	Use of Measure	
		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
					M=12.4, SD=2.1[a]					
5	Rendell et al. (2012) Australia	30 (healthy controls= 30)	80	M=47 SD=9.46 Range=28-60	M=14.2 SD=3.14	Not Reported	Not Reported	Virtual Week	Computer administration in the lab at one time point	To compare PM between MS and controls across positive, negative and neutral emotional task conditions
6	Krch et al. (2011) USA	64	75	M=47.7 SD=+/-9.3 Range=18-55	M=15.7 SD=+/- 2.4	Not Reported	RR=47 PP=2 SP=1 Unknown=1	MFQ	Administration method not reported. Administered at one time point	To correlate subjective memory with other cognitive tests (objective memory)
7	Phillips et al. (2009) UK	86	73	M=44.8 SD=8.9 Range=27-67	Not Reported	Not Reported	RR=61 PP=17 Not Recorded=8	CFQ	Postal administration at one time point	As a predictor variable for Quality of Life (QoL), measuring self-reported failures of attention
8	Royle & Lincoln (2008)	160 (Stroke patients=	70	M=43 SD=11 Range=17-71	Not Reported	Not Reported	Not Reported	EMQ	Not reported 'Data were drawn from two	To analyse the internal consistency and

Paper #	Author / Year / Country	MS group						EM Measure(s)	Use of Measure	
		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
	UK	90, Healthy Controls= 98)							sources for three groups' (p. 116)	factor structure of the EMQ
9	Lincoln et al. (2002) UK*	223	70	M=43 SD=10	Control Group age 16 Assessment Group age 16 Intervention Group age 16	Not Reported	Control Group SP=35 RR=37 PP=6 Unknown=4 Assessment Group SP=33 RR=35 PP=6 Unknown=5 Intervention Group SP=26 RR=35 PP=7 Unknown=12	EMQ	Face to face inferred. Administration at 2 time points (4 and 8 months after recruitment)	Outcome measure. To compare EM between cognitive assessment, intervention and control groups
10	Richardson (1996)	115	61	M=48.5 Range=32-73	Not Reported	Not Reported	Not Reported	EMQ	Postal administration	To classify people with MS as

Paper #	Author / Year / Country	MS group						EM Measure(s)	Use of Measure	
		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
	UK								at one time point.	impaired/ unimpaired for EM, and to compare informant and patients responses
11	Carr et al. (2014) UK*	48	69	M=54.3 SD=11.0 Range=34-72	Not Reported	Not Reported	PP=16 SP=8 RR=16 Benign=2 Unknown=2	EMQ	Postal administration at 3 time points (baseline, 4 and 8 months after randomisation)	Primary outcome measure. To compare EM between cognitive intervention and control groups
12	Rendell et al. (2007) Australia	20 (Healthy Controls= 20)	80	M=42.9 SD=8.87 Range=29-55	M=13.7 SD=3.77	Not Reported	RR=18 PP=2	Virtual Week	Face to face board game. Individual administration at one time point	To compare prospective memory between MS and control groups.
13	Bruce & Arnett (2004) USA	73	79	Non depressed M=47.3 SD=9.8 Mild depressed	Non depressed M=14.8 SD=2.4 Mild depressed	Caucasian	Non-depressed RR=17 PP=3 SP=7 PR=0	MRS-C	Administration method not reported. Administered at one time point	To investigate relationship between depression and perceived EM compared with

Paper #	Author / Year / Country	MS group						EM Measure(s)	Use of Measure	
		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
				M=43.1 SD=6.9 Moderate depressed M=49.7 SD=6.4	M=14.9 SD=2.6 Moderate depressed M=14.9 SD=2.3		Mild-depressed RR=14 PP=2 SP=5 PR=0 Moderate depressed RR=15 PP=2 SP=6 PR=2			depression and objective memory
14	Randolph et al. (2004) USA	48	77	M=49.6 SD=7.8	M=15.1 SD=2.3	Not Reported	RR=28 SP=13 PP=6 PR=1	MFQ	Face to face inferred. Administration at one time point	To evaluate the associations between mood and executive function on metamemory (MFQ)
15	Erlanger et al. (2014) USA	60	72	M=47.9 SD=7.9 Range=26-61	Not High school graduate=2% High School Degree=27%	Caucasian=87% African-American=5%	RR=46 SP=14	MFQ MSNQ	Face to face inferred. Administered at two time points (45 days apart)	To compare MFQ and MSNQ (patient and informant) with another cognitive test

Paper #	Author / Year / Country	MS group						EM Measure(s)	Use of Measure	
		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
					Associate Degree=18% Bachelor's Degree=28% Master's Degree=21% Advanced Degree=5%	Hispanic=5 % Other=3%				(objective memory) in order to evaluate the validity of the objective memory test, and to compare correlations between MS type
16	Thelen et al. (2014) USA	86	88	M=47.17 SD=+/-10.56	M=14.9 SD=+/-1.93	Caucasian= 89.4% African-American=5 .9% Hispanic/La tino=3.5% Other=1.2%	RR=75 SP=9 PP=2	PRMQ MIST	Face to face inferred. Administered at one time point	To compare EM between MS groups with polypharmacy and without polypharmacy
17	Stuifbergen et al. (2012) USA*	61	89	Not Reported	High school=20 Associate degree=5 Bachelor's degree=19	White=89% African-American=3 %	Not Reported	MSNQ PDQ	MSNQ: Administration method not reported. Administered at 3 time points	MSNQ: Outcome measure. To compare between cognitive training intervention and control group

Paper #	Author / Year / Country	MS group						EM Measure(s)	Use of Measure	
		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
					Graduate degree=17	Multiple categories= 3% Other=5%			(baseline, 2 and 5 months follow-up) PDQ: Telephone administration at one time point (during screening)	PDQ: To screen for eligibility to take part based on perceived deficits
18	Bruce et al. (2010) USA	79 (Healthy Controls= 20)	90	M=47.2 SD=10.82	M=14.85 SD=1.96	Caucasian= 87% African-American=6 % Latino=4% Unspecified =3%	RR=71 SP=8	PRMQ	Face to face inferred. Administered at one time point	To correlate with other cognitive tests (objective memory, executive function, information processing) and variables (mood and dissociation)
19	Middleton et al. (2006) USA	221 (Healthy Controls= 31)	74	M=44.8 Range=20-71	M=14.8 Range=10-22	Not Reported	RR=65% SP=21% PP=12% PR=2%	CFQ	Face to face administration at home or in clinic at one time point	To compare EM between MS and control groups, to correlate with other cognitive tests (objective

Paper #	Author / Year / Country	MS group						EM Measure(s)	Use of Measure	
		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
										memory), and to investigate other variables (education, depression, anxiety, fatigue and disability) as predictors of perceived cognitive function (CFQ)
20	West et al. (2007) USA	1	100	71	Ed.D (Doctorate in Education) in Psychology	Not Reported	RR=1	PRMQ Virtual Week	Face to face administration at 2 time points (1 year apart)	Part of a battery of tests to describe memory deficit in one individual case
21	Kardiasmenos et al. (2008) USA	24 (Healthy Control= 24)	46	M=44.4 SD=8.2	M=15.0 SD=2.0	Not Reported	RR=8 SP=6	Virtual Week	Face to face administration at one time point	To compare PM between MS and controls, and as an outcome measure to evaluate the effect of an implementation-intentions strategy on PM

Paper #	Author / Year / Country	MS group						EM Measure(s)	Use of Measure	
		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
22	Demers et al. (2011) Canada	30 (Healthy Control= 24)	67	MS Mild M=45.9 SD=7.5 MS Moderate/ Severe M=44.3 SD=8.5	MS Mild M=14.1 SD=2.3 MS Moderate/Severe M=13.2 SD=2.6	Not Reported	MS Mild RR=8 SP=3 PP=3 MS Moderate/Severe RR=7 SP=7 PP=2	PRMQ	Face to face administration in the lab or at participants home. Administered at 3 time points (90 minute sessions)	To correlate EM with another variable (mood) and compare across MS mild, MS moderate/severe cognitive deficit and control groups
23	Dagenais et al. (2013) Canada	41	70	M=44.51 SD=7.43	High school=12 College=8 University=21	Not Reported	RR=35 SP=6	MSNQ	Face to face inferred. Administered at one time point	To correlate patient and informant EM with other variables (objective memory, mood and executive function) and to evaluate the concurrent validity of a cognitive screening test
24	Cutajar et al. (2000)	40	70	M=38.67 SD=+/-7.44	Not Reported	Not Reported	RR=40	RBMT	Face to face inferred.	To correlate EM with other

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	Italy			Range=20-50					Administered at 4 time points (one every 9 months)	variables (QoL, mood and frontal lobe function)
25	Kujala et al. (1996) Finland	45 (Healthy Control= 35)	Cognitively Preserved=52.2 Cognitive Decline=50	Cognitively Preserved: M=43.3 SD=8.7 Cognitive Decline: M=43.3 SD=7.2	Cognitively Preserved: M=11.6 SD=3.5 Cognitive Decline: M=11 SD=2.9	Not Reported	Cognitively Preserved: RR=11 CP=9 SP=3 Cognitive Decline: RR=6 CP=13 SP=3	Measure of self-evaluation of everyday memory and learning	Self-administered at one time point	To compare the pattern of memory and learning deficits between MS cognitively declined, MS cognitively preserved and control groups, and to compare with other cognitive tests (objective memory)
26	Campbell et al. (2016) UK	62	69	M=49.35 SD=8.88 Range=31-63	Normal cognitive performance M=14.05 SD=2.34	Not Reported	RR=44 SP=18	MSNQ	Face to face inferred. Administration at one time point	Part of a battery of questionnaires to compare QoL, behaviour and subjective impairment

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					Cognitively Impaired M=13.8 SD=2.78					between MS normal cognitive performance and cognitively impaired groups
27	Miller et al. (2014) USA	96 (Healthy Control= 29)	78	M=45.5 SD=10.5	M=14.4 SD=2.3	Caucasian=90% Africa-American=3% American-Indian=4% Hispanic=1% Declined=1%	RR=62 SP=9 PP=2 PR=3 Uncertain=20	MIST	Face to face inferred. Administration at one time point	To compare prospective memory between MS and control groups and to correlate with other variables (depression and pain) as a predicted variable of PM impairments.
28	Dagenais et al. (2016) Canada	39 (Healthy Control= 18)	79	M=45 SD=+/- 11.21 Range=20-65	M=14.2 SD=+/- 2.82	Not Reported	RR=27 SP=5 PP=5 Clinically isolated syndrome=2	MSNQ	Face to face inferred. Administered at one time point	To screen for cognitive dysfunction in MS alongside other screening measures of

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		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
										cognition, anxiety and depression
29	Moradi et al. (2016) Iran	200 (Healthy Control= 100)	Not Reported	M=37.96 SD=9.12 Range=22-53	Not Reported	Not Reported	Not Reported	PRMQ	Administration method not reported	To compare cognitive performance between MS and control groups alongside measures of autobiographical memory and working memory
30	Sonder et al. (2012) The Netherlands	121 (informants= 121)	62	Median=53 IQR=45-63	High education (College/University)=37 Moderate education (Secondary school)=40 Low education	Not Reported	RR=43 SP=40 PP=34 Clinically isolated syndrome=4	MSNQ-P MSNQ-I (Dutch translation)	Self-administered and postal administered	To investigate psychometric properties and determine the interpretability (the degree to which one can assign qualitative meaning to quantitative scores) of a Dutch

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		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
					(Primary school)=42					translation and correlate it with measures of anxiety and depression, cognition and disability
31	Mäntynen et al. (2014) Finland*	102	78	Intervention group M=43.5 SD=8.7 Control group M=44.1 SD=8.8	Intervention group M=13.6 SD=2.3 Control group M=13.8 SD=2.6	Not Reported	RR=102	PDQ MSNQ-P MSNQ-I	Face to face inferred. Administered at 3 time points (baseline, after 3 months and after 6 months)	PDQ: one of three primary outcome measures to compare between MS and control groups. MSNQ-P and MSNQ-I: one of eleven secondary outcome measures to compare between MS and control.
32	Rosti-Otajärvi et al. (2013)	78	79	Intervention group	Intervention group	Not Reported	RR=78	PDQ MSNQ-P MSNQ-I	Face to face inferred.	PDQ: one of three primary outcome measures to

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		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
	Finland*			M=43.7 SD=8.7 Control group M=45.5 SD=9.4	M=13.5 SD=2.4 Control group M=13.4 SD=2.6				Administered at I year follow-up	compare between MS and control groups across four time points. MSNQ-P and MSNQ-I: one of eleven secondary outcome measures to compare between MS and control groups and to compare across four time points.
33	Shevil and Finlayson (2010) USA	35	74.3	M=52.4 SD=10.3 Range=26-70	<12 yrs=3 13-15yrs=13 >15yrs=19	Caucasian=80% African-American=14.3% Other=5.7%	Not Reported	MSNQ	Telephone administered at one time point.	As a phase 1 screening measure for eligibility (included if score was ≥ 23) alongside other screening measures of fatigue and depression. It was supplemented by

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		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
										an objective screening battery (phase 2 screening)
34	Benedict et al. (2008) USA	76 (Healthy Control= 25)	74	M=47.6 SD=+/- 8.4	M=14.7 SD=+/- 2.2	Caucasian= 91% Not Reported=9 %	RR=63 SP=11 PP=2	MSNQ	Administered face to face at monthly intervals for 6 months following initial evaluation.	To investigate reliability as a screening measure at monthly intervals. To compare between MS and control groups, to compare correlations between each time point and as a predicted variable across each time point by measures of cognition and depression
35	Carone et al. (2005) USA	122 (informants= 122) (Healthy Control=	72	M=44 SD=8.8	M=14.5 SD=2.1	Caucasian= 92%	RR=88 SP=30 PP=2 RP=2	MSNQ	Face to face inferred. Administered at one time point	To compare discrepancy scores between MS (and informants) and

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		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
		37, informants=37)				Not Reported=8%				control (and informants) groups. To categorise MS patients into groups based on discrepancy scores. To correlate with a battery of neuropsychological tests. To investigate psychometric properties
36	Christodoulou et al. (2005) USA	53	67.9	M=44.2 SD=7.7 Range=20-55	M=14.8 SD=2.2 Range=10-20	Not Reported	RR=58.5% SP=37.7% PP=3.8%	PDQ	Administration method not reported. Administered at 2 time points (baseline and 24 weeks)	One of three measures of self-reported cognitive impairments to correlate with neuropsychological tests

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		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
37	O'Brien et al. (2007) USA	48 (informants= 48) (Healthy Control= 40, informants=40)	80	M=45.1 SD=9.1 Range=27-56	M=14.7 SD=2.1	Not Reported	RR=68.8% PP=10% SP=21.2%	MSNQ-S MSNQ-I	Face to face inferred. Administered at one time point	To compare scores between MS and healthy control groups. To correlate with other variables (neuropsychological functioning, mood and daily functioning). As a predictor variable of daily functioning and neuropsychological functioning. To determine its sensitivity and specificity
38	Samartzis et al. (2014) Greece	100	64	M=40.5 SD=+/- 10.3	Primary Education=19%	Not Reported	Not Reported	PDQ	Self-administered at one time point	To correlate with another variable (depression) and as a predictor variable for QoL

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		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
					Secondary Education=57% Tertiary Education=24%					
39	Lovera et al. (2006) USA	49	76	M=49.3 SD=+/- 7.6	Not Reported	Caucasian=94% African-American=1% Other (except Asian or Pacific Islander, Native American or Hispanic)=2%	RR=32 SP=15 PP=2	PDQ	Postal administered at one time point	To correlate with two measures of cognitive impairment and one measure of depression

Paper #	Author / Year / Country	MS group						EM Measure(s)	Use of Measure	
		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
40	Pérez-Martín et al. (2017) Spain*	62	52	Treatment Group: M=44.93 SD=+/-9.89 Control Group: M=40.88 SD=+/-8.5	Treatment Group: M=10.21 SD=+/- 2.64 Control Group: M=11.59 SD=+/- 3.03	Not Reported	RR=57 SP=2 PP=3	MSNQ	Face to face at 2 time points (baseline and at 3 months post intervention)	To compare scores between treatment and control groups alongside a battery of neuropsychological tests and other questionnaires (anxiety and depression, fatigue and QoL) at baseline and 3 months post intervention
41	Strober et al. (2016) USA	70	81	M=48.97 SD=9.26	M=15.5 SD=2.47	Not Reported	RR=52 PP=4 SP=13 PR=1	PDQ	Administration method not reported. Administered at one time point.	To correlate subjective cognitive concerns with a battery of objective neuropsychological tests. To correlate with other variables of

Paper #	Author / Year / Country	MS group						EM Measure(s)	Use of Measure	
		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
										psychological heath (depression, anxiety, fatigue and self-efficacy)
42	Walker et al. (2016) Canada	57 (Healthy Control= 51)	72	M=45.44 SD=9.93 Range=18-59	M=15.44 SD=2.68	Not Reported	RR=44 SP=9 PP=4	MSNQ-S MSNQ-I	Face to face inferred at 2 time points (baseline and follow-up session (one to three weeks later))	To compare self and informant reported cognition between MS and control group at baseline and follow up session. To correlate with a cognitive assessment at baseline and at follow-up and with another variable (depression)
43	Chiaravalloti et al. (2005) USA*	28	Experimental Group=64	Experimental Group: M=45.14 SD=13.78	Experimental Group: M=14.64 SD=2.71	Not Reported	RR=17 PP=4 SP=7	MFQ	Face to Face at 3 time points (baseline, 6 weeks and 11 weeks)	As part of a neuropsychological assessment to compare cognitive functioning pre and

Paper #	Author / Year / Country	MS group						EM Measure(s)	Use of Measure	
		Sample Size	Gender (%F)	Age (years)	Education (years)	Ethnicity	MS Type		How Administered	Why used
			Control Group=57	Control Group: M=46 SD=9.28	Control Group: M=15.04 SD=2.82					post treatment between experimental and control groups
44	Sullivan et al. (1990) Canada	1180 (Healthy Control= 200)	72	M=49 Range=17-84	M=12.8	Not Reported	Not Reported	PDQ	Posted in a newsletter at one time point.	To evaluate psychometric properties

Note. Key: *RCTs: randomised control trials, [a]: statistics include MS, TBI and stroke patients.
Abbreviations: CAMPROMPT: Cambridge Prospective Memory Test; CFQ: Cognitive Failures Questionnaire; EM: Everyday memory; EMQ: Everyday Memory Questionnaire; IQR: interquartile range; M: Mean; MFQ: Memory Functioning Questionnaire; MIST: Memory for Intentions Screening Test; MRS: Memory Rating Scale; MS: Multiple Sclerosis; MSNQ: MS Neuropsychological Questionnaire (MSNQ-P: patient self-report version; MSNQ-I: Informant version); PDQ: Perceived Deficits Questionnaire; PP: primary progressive; PR: progressive-relapsing; PRMQ: Prospective and Retrospective Memory Questionnaire; QoL: Quality of life; RBMT: Rivermead Behavioural Memory Test; RR: Relapsing-remitting; SD: Standard deviation; SP: secondary progressive.