Journal of Clinical Neuroscience 34 (2016) 187–192

Contents lists available at ScienceDirect

Journal of Clinical Neuroscience

journal homepage: www.elsevier.com/locate/jocn

Clinical Study

Divided visual attention: A comparison of patients with multiple sclerosis and controls, assessed with an optokinetic nystagmus suppression task

Isla M. Williams [a,*], Peter Schofield [b], Neha Khade [a], Larry A. Abel [c]

[a] Department of Medicine, Monash University, Clayton, VIC 3800, Australia
[b] Centre for Translational Neuroscience and Mental Health, Newcastle, NSW, Australia
[c] Department of Optometry and Vision Sciences, University of Melbourne, Parkville, VIC, Australia

ARTICLE INFO

Article history:
Received 14 April 2016
Accepted 27 June 2016

Keywords:
Divided visual attention
Multiple sclerosis
OKN

ABSTRACT

Multiple sclerosis (MS) frequently causes impairment of cognitive function. We compared patients with MS with controls on divided visual attention tasks. The MS patients' and controls' stare optokinetic nystagmus (OKN) was recorded in response to a 24°/s full field stimulus. Suppression of the OKN response, judged by the gain, was measured during tasks dividing visual attention between the fixation target and a second stimulus, central or peripheral, static or dynamic. All participants completed the Audio Recorded Cognitive Screen. MS patients had lower gain on the baseline stare OKN. OKN suppression in divided attention tasks was the same in MS patients as in controls but in both groups was better maintained in static than in dynamic tasks. In only dynamic tasks, older age was associated with less effective OKN suppression. MS patients had lower scores on a timed attention task and on memory. There was no significant correlation between attention or memory and eye movement parameters. Attention, a complex multifaceted construct, has different neural combinations for each task. Despite impairments on some measures of attention, MS patients completed the divided visual attention tasks normally.

1. Introduction

Memory and complex attention are impaired in many patients with multiple sclerosis (MS) [1–4], but may be overlooked unless patients are tested with sensitive neuropsychological tests such as the Audio Recorded Cognitive Screen (ARCS) [5,6]. Clinicians use conventional MRI which has difficulty detecting grey matter damage [7,8], the pathology of which is found in patients with specific cognitive defects [9]. Whilst many studies report impaired attention in patients with MS, automatic processing of memory is preserved whilst memory requiring effort is not [10]. Paul et al. [11] tested MS patients with Posner's spatial attention test [12], in which subjects fixate a central X and pay attention to a peripheral target whose location might or might not be cued. The results were normal but the MS patients in Paul's study were noted to have an impaired performance on tasks which required controlled processing or those sensitive to speed of response [11].

Optokinetic nystagmus (OKN) is an ocular oscillation elicited by the movement of a wide field visual stimulus moving past the eyes. The response can largely be suppressed by normal subjects fixating a stationary target [13]. Suppression relies on the conscious effort of the subject. In previous studies we examined the degree to which such suppression can be maintained when other visual tasks are added [14,15]. We quantified the effect by measuring OKN gain, the ratio of eye velocity to stimulus velocity. Gain, as a measure, is independent of the specific attention task but still affected by it.

In this study we tested the ability of patients with MS and age-matched controls to divide attention between a central fixation target and a stimulus, peripheral or central, static or dynamic, and measured the degree to which the response to a full field optokinetic stimulus was suppressed during each task. We reasoned that dividing attention between two stimuli and suppressing the optokinetic response would require cognitive effort with sustained attention and that performance of these tasks might be negatively affected by cognitive impairment. Accordingly, all subjects were examined with the ARCS, using this test to examine memory and attention in particular [5,6].

* Corresponding author at: 15 Collins Street, Melbourne, VIC, Australia. Tel.: +61 3 9650 1606.
E-mail address: isla.williams@monash.edu (I.M. Williams).

http://dx.doi.org/10.1016/j.jocn.2016.06.015
0967-5868/

2. Methods

2.1. Study participants

Patients with MS, each fulfilling the 2010 revisions of the McDonald criteria for MS [16], and were recruited from private practice between February 9th and August 17th 2010. Controls, recruited through colleagues of the investigators, were required to have no history of vestibular, ocular or neurological disease. Inclusion criteria included unaided visual acuity of 6/36 or greater (Snellen chart), normal binocular colour vision (Ishihara colour chart), no strabismus, normal eye movement and no medication affecting eye movement. A neuro-ophthalmological examination was performed on all participants.

Previous studies conducted by two of the investigators (IMW, LAA), with samples sizes of 11 [14], and 25 [15], provided sufficient power, using similar techniques to the current study, to demonstrate important relationships at statistically significant levels. Participant recruitment was stopped at 19, thought on the basis of the previous studies to be adequate. Table 1 describes the clinical features of the seven patients with MS.

2.2. Eye movement recording

Horizontal eye movements were recorded with binocular infrared oculography (Microguide, Inc, Downers Grove IL) with a bandwidth of DC-100 Hz and a system sensitivity of one minute of arc horizontally within ±30° of the centre on a horizontal plane [17]. The positions of the eyes and the push-button responses were displayed on a computer screen and were digitised at 1000 Hz. The recording system was calibrated with a range of ±10°. A programme was created in Matlab 7.0.4: MathWorks, Natick, MA for data acquisition and stimulus control. The signals from the two eyes, the target marker and the push-buttons were recorded on a Graphtec rectilinear chart recorder with a band width of DC-85 Hz.

2.2.1. Optokinetic stimulus [14]

Each subject was seated with head restrained inside a full field optokinetic curtain with a diameter of 159 cm. The curtain, 75 cm in front of the subjects' spectacle frame, was white with 18 columns of coloured letters 19.25 cm (14.7° apart). Each letter had a line thickness one-fifth the size of the letter which measured 10 × 10 cm and subtended 7.6° at the nodal point of the eye. Each column consisted of red Cs and blue Ts in random order. The eye level row included three red Ts on the third, twelfth and seventeenth columns. The curtain was diffusely illuminated and rotated at 24°/s [14].

2.3. Fixation lights

Laser spots were projected onto the curtain at eye level. A red light fixation light appeared in the primary position. Green laser spots were projected onto the curtain 7.5° to the right or left of fixation for tests requiring a peripheral stimulus. Target detection was indicated by a button push.

2.3.1. Procedure

After calibration, the tests in Table 2 were performed. In each test the curtain moved to the right or left for 21 s. There was a break between each rightward and leftward trial. The tests were either dynamic, that is the feature of the curtain (a red T) attended to was moving – or were static, that is the attended feature (a light blinking) was fixed in space. Table 2 describes the tests performed.

Table 1
Clinical features of the seven patients with multiple sclerosis

Patient	EDSS	Binocular VA unaided	Ishihara colour chart	Humphrey VF		Optic discs		EOM	MRI brain scan	Medication
			Binocular	OS	OD	R	L			
1	2.5	6/6	N	Scotoma upper temporal quadrant	Full	Pale	Pale	Full No nystagmus 1° position, gaze evoked nystagmus R & L	ALL HAD CHANGES CHARACTERISTIC OF DEMYELINATION	Interferon beta-1a
2	3.0	6/36-1	N	Full	Full	N	N	Full		Glatiramer acetate
3	2.5	6/9	N	Full	Centro caecal scotoma Central vision spared	N	Pale	Full		Interferon beta-1a
4	1.0	6/6-1	N	Full	Full	Pale	Pale	Full		Glatiramer acetate
5	2.5	6/36	N	Full	Full	N	N	Full no nystagmus 1° position, gaze evoked nystagmus R & L		Interferon beta-1b
6	2.5	6/12	N	Full	Inferonasal & temporal segmental VF defect in part due to drusen optic nerve	Pale and drusen	Pale and drusen	Full		Glatiramer acetate
7	6.0	6/9 + 3	N	Full	Full	Pale	Pale	Full		Natalizumab

EDSS = expanded disability status scale, EOM = extrinsic ocular movement, L = left, MRI = magnetic resonance imaging, N = normal, OD = right eye, OS = left eye, R = right, VA = visual acuity, VF = visual fields.