Visual changes mediated by beer in retrobulbar neuritis – an investigative case report

SARAH L ALVAREZ,¹ NICHOLAS A JACOBS,² AND IAN J MURRAY¹

From the ¹University of Manchester Institute of Science and Technology, Manchester, and the ²Manchester Royal Eye Hospital, Manchester

SUMMARY A patient with established retrobulbar neuritis and Uhthoff's phenomenon who claimed that his visual acuity improved after drinking beer was assessed by detailed quantitative psychophysical tests. Studies of electrophysiological responses and biochemical levels of blood serum before and after drinking on several occasions were also made. The results of tests of contrast sensitivity, spectral sensitivity, flicker sensitivity, and visually evoked potential confirmed his observation. Some mechanisms for this phenomenon are considered.

Since its description by Uhthoff in 1890¹ the exacerbation of symptoms in patients with demyelinating disease, associated with increase in body temperature, has been reported frequently in the clinical literature.² In vitro, drastic effects on the conduction of partially demyelinated axons have been demonstrated following slight changes in temperature and extracellular fluid composition.³ In vivo, however, the relevance of such variations is less well understood.

The visual pathway, especially the optic nerve and optic chiasm, is particularly sensitive in multiple sclerosis (MS).⁴ The electrophysiological and psychophysical investigation of visual parameters is effective in the detection of clinically 'silent' lesions⁵ and is helpful in the understanding of the underlying pathophysiology in demyelinating disease.⁶ Carefully standardised and comprehensive measurement of visual performance is used here to evaluate the claimed improvement in visual symptoms after drinking beer. This method of achieving a remission has not been reported previously, and seems to be a type of 'reversed' Uhthoff's phenomenon.

Patients and methods

PATIENT

The patient, a 40-year-old joiner, suffered an episode of retrobulbar neuritis (RBN) in 1976 affecting his right eye, after which his visual acuity recovered. In

1977 a second episode in the same eye reduced his visual acuity to counting fingers (CF). The left eye was also involved by RBN in 1981 and again in April 1982. In September 1982 examination showed the cerebrospinal fluid to be normal. On both the last occasions of an attack of RBN ACTH treatment was given. Other than Uhthoff's sign there are no other indications of demyelinating disease.

Examination of the fundus revealed a pale grey right disc and temporal pallor of the left disc. Owing to the difficulty in central fixation and the poor acuity in the right eye, most psychophysical tests were carried out on the less defective left eye only. The Amsler grid showed a paracentral scotoma for the left eye, though the patient has central fixation in this eye (Propper projection ophthalmoscope grid).

Visual acuity for the right eye seems stable at CF at 1 metre, regardless of environmental factors. Left visual acuity remains stable over any one day, 6/9 on a 'good' day, 6/60 on a 'bad' day, unless some specific aggravating factor is experienced, notably strenuous exercise, increased temperature or emotional stress. He finds two to three pints (1.2–1.8 l) of beer (taken once a week) always improves his visual acuity to its peak, even on a day when it is persistently low.

Methods

Methods for measuring the patient's responses are considered under the following categories: spectral sensitivity, flicker sensitivity, contrast sensitivity (for pattern and movement), visually evoked potentials, and biochemical assessment. Measurements are re-

Correspondence to Mr N A Jacobs, FRCS, Department of Ophthalmology, Charing Cross Hospital, Fulham Palace Road, London W6 8RF.

lated to immediately before and approximately one hour after drinking 2.25 pints (1.3 l) of beer and to an average normal response. The patient was studied for changes in visual responses with drink on six separate occasions, each beginning at 11.30 am after a 30-minute rest period.

Results

SPECTRAL SENSITIVITY

The data for spectral sensitivities were derived from the Maxwellian view apparatus described by Zisman *et al.*⁷ and Alvarez *et al.*⁸; they have been shown to be sensitive in the assessment of abnormal visual function. Thresholds were determined for a 1°, 1 Hz spectral test spot on a 1000 troland (td) white background. The subject was instructed to fixate four black fixation spots, in the centre of which appeared the test spot. The examiner controlled the test spot intensity by the method of descending limits; the subject had no feedback with regard to normal or previous performance. The average results for 19

normal eyes (± 1 SD) are shown in Fig. 1A and 1B by the solid line with error bars.

The results for the patient are shown by the filled circles and the crosses in Figs. 1A and 1B; the dashed line with crosses represents his mean spectral sensitivity before drink. Responses are seen to be depressed more than 3 log units relative to normal. The light source for the apparatus was unable to produce a high enough intensity at wavelengths shorter than 475 nm to be detected by the patient (before drink). After drinking beer at approximately 20° C (Fig. 1A, trial 1) and beer kept at 37° C (Fig. 1B, trial 4), an increase in spectral sensitivity of 1.5 log units was noted (solid line with filled circles). This remarkable overall increase in sensitivity in a period of less than two hours correlates with an improvement of the Snellen acuity to 6/9 for both trials (Table 1).

FLICKER SENSITIVITY

Temporal properties in vision are frequently reported as being disrupted in demyelinating disease.⁹⁻¹¹ The patient's flicker responses were tested monocularly

Fig. 1A

Fig. 1B

Fig. 1 Spectral sensitivity curves for 0.5 s flashes with a 1° foveal test stimulus on a 1000 td white (3200 K) background. Fig. 1A compares average normal response (solid line with error bars for 1 SD) with the patient's response before drinking (dashed line with crosses) and after drinking (solid line with filled circles) beer kept at 20° C. Fig. 1B compares average normal response (solid line with error bars for 1 SD) with the patient's response before drinking (dashed line with crosses) and after drinking (solid line with filled circles) beer kept at 37° C.

Table 1 Psychophysical and electrophysiological test results before and after drinking 2.25 pints (1.3 l) of beer kept at different temperatures

Trial	Temperature of fluid (beer)	Spectral sensitivity (log units)		Critical flicker fusion (Hz)	Contrast sensitivity resolution limit for detection in cycles/degrees		VEP (peak amplitude)	VA (Snellen)
		At 525 nm	At 600 nm		Pattern	Movement		
1. A Before	20° C	0.86	0.72	8	—	—	—	6/60
B After		2.26	2.42	17	—	—	3.4	6/18
2. A	10° C	2.2	2.5	8	16.3±0.66	9.5±0.5	6.5	6/12
B		2.5	2.4	10	22.5±0.3	8.0±0.3	8.0	6/9
3. A.	37° C	2.3	2.64	8.5	20.2±0.3	8.0±0.64	7.0*	6/12
B.		2.62	2.25	11	24.6±0.8	8.5±0.5	8.9	6/9+
4. A	37° C	0.12	0.06	8	16.7±0.5	9.0±0.7	—	6/36
B		2.10	2.08	11	21.8±0.8	8.0±1.1	7.5	6/9

* See Fig. 4.

by means of flicker modulation sensitivity.¹²

Measurements were made on a Telequipment D16A oscilloscope screen subtending 2 by 1.8° with a green, P31 phosphor at a luminance of 9 cd/m² (viewing distance of 285 cm). The patient was not aware of his performance, since the flicker frequency was selected randomly by the examiner and the contrast was continuously varied by the subject. The average flicker modulation sensitivity range for 20 normal eyes is shown by the error bars (±2 SD) in Fig. 2. It can be seen that the patient's response to flicker before drink (dashed line with cross, Fig. 2) was greatly depressed (only a small peak in sensitivity for flicker detection at 7 Hz). After 2.25 pints (1.3 l) of 20° C beer the flicker modulation sensitivity,

Fig. 2 Modulation sensitivity functions for monocular viewing of a 2° (horizontal) × 1.6° screen: screen luminance, 9 cd/m². Results for average normal response (solid line with error bars for 1 SD). The patient's response before drinking (dashed line with cross) and after drinking (solid line with filled circles) beer kept at 20° C.

measured within two hours, showed an improvement greater than 1 log unit (solid line with filled circles, Fig. 2).

CONTRAST SENSITIVITY-PATTERN AND MOVEMENT DETECTION

For this experiment a Tektronix 608 oscilloscope was used to generate a grating pattern; stimulus and data collection were controlled by a PDP 11-23 computer. The patient indicated when he had reached the relevant threshold by pressing a button, and four settings were obtained for each spatial frequency. Frequent rests were required, and adjacent spatial frequencies were never tested consecutively to avoid adaptation effects. The patient was again unaware of his performance, as there was no baseline from which he could judge his previous endpoint. At the viewing distance of 114 cm the stimulus subtended 5° visual angle. Screen luminance was now 46 cd/m² and the sinusoidal grating was reversed at a rate of 2 Hz.

The data from various trials (Table 1) indicate how the patient's visual sensitivity and resolution changed as a result of his drinking approximately 2.25 pints (1.3 l) of beer. The marked pattern contrast sensitivity increase across all spatial frequencies is shown in Fig. 3. A contrast threshold of 1.0 represents 100% contrast, while 0.3 is equivalent to 30% and 0.1 to 10%. The spatial resolution limit, depicted by p, increased from 17 c/deg to 23 c/deg, corresponding to an improvement in Snellen visual acuity (VA) (which was measured at each 'before' and 'after' contrast sensitivity session) of 6/18 to 6/9. A localised loss of sensitivity or a spatial frequency 'notch' was observed at approximately 7 c/deg in all trials on this apparatus with VA worse than 6/9. When the pattern was reversed in phase by 180° (at 2 Hz in this experiment; dark bars became light and light bars became dark) an illusion of movement was noted; the bars of the grating appeared to 'march' from left to right across the screen. The patient's task was to adjust the

Fig. 3 Pattern and movement thresholds before (open symbols) and after (filled circles) drinking. Standard errors are within symbols. Arrows indicate resolution limits for pattern (p) and movement (m) sensitivity. A 'notch' in sensitivity is noticeable at approximately 7 c/deg. Pattern detection (including the resolution limit) shows a marked improvement after drinking, while movement detection remains unchanged.

contrast until the 'movement' just stopped. The threshold for movement was taken at five different spatial frequencies (Fig. 3). Sensitivity for movement remained constant (filled and unfilled circles, Fig. 3) regardless of fluctuations in pattern vision. The spatial resolution limit—that is, the finest gratings which allowed detection of movement—at 100% contrast also remained constant and coincided with that predicted by extrapolation—that is, equivalent to the movement threshold 'cut-off'.¹³

VISUALLY EVOKED POTENTIALS

Visually evoked potentials (VEPs) as measured in

cases of RBN often show an increase in latency and decrease in amplitude.¹⁴ VEPs were generated by contrast reversal (checkerboard pattern) from a Medelec TV pattern generator and displayed on a conventional 26 inch (66 cm) television viewed at 114 cm. The average luminance of the screen was 40 cd/m² and the contrast between squares was approximately 50%. Electrodes were placed 1 cm and 5 cm above the inion and both referenced with respect to a mid-frontal electrode. Amplifier corner frequencies were 0.3 and 70 Hz, and the Medelec system was used to average and record the VEP (128 averages).

On the two separate occasions when the VEP was recorded for this patient the P100 component showed a significant and consistent delay for all check size stimuli (Table 1), both 'before' and 'after' drinking. There was, however, a marked amplitude change 'after' drinking which was confined to the smaller check stimulus, similar to the recovery in RBN, which usually takes several weeks (Fig. 4).

BIOCHEMICAL ASSESSMENT

The possibility of significant alteration in the serum biochemical profile mediated by drinking beer was investigated by measuring the following: urea, electrolytes, calcium, glucose, acid/base state (with venous samples), and osmolality. These parameters were measured before and again one hour after drinking on three separate occasions. No significant changes were noted.

Discussion

One or more episodes of RBN, which strongly correlate with the presence of demyelinating disease, may affect the visual performance via optic nerve

Fig. 4 Representative VEPs from the patient derived monopolarly (reference: midfrontal) from 2 cm above inion. Large checks (60') generate virtually the same VEP regardless of visual acuity (VA), whereas a large difference in amplitude ($\times 3$) is obtained with 30' checks. Latency is prolonged (146 ms) compared with the time in normal persons (100 ms) and does not change with changes in VA.

fibres in two ways: (1) a non-selective mechanism depressing responses in luminance channels (measured by deLange curves) and colour/acuity channels (measured by spectral sensitivity, VA, and contrast sensitivity); and/or (2) a specific mechanism that blocks conduction of fast impulses (measured by critical flicker fusion (CFF) and 25 Hz chromatic flicker). Each of 30 cases of RBN tested previously¹⁵ demonstrated at least two of the features of mechanism (1). Of those patients that also demonstrated a defect classified in mechanism (2) persistent symptoms of 'faded' vision in the affected eye and long latencies in VEPs were observed, even when visual acuity had improved to 6/6 or better. We suggest that the results for our patient may follow this categorisation of responses in RBN.

Improvement in spectral sensitivity (Figs. 1A, 1B, and Table 1), Snellen visual acuity (Table 1), and achromatic flicker sensitivity at all temporal frequencies (Fig. 2) for our patient indicates that ingestion of the beer improves both luminance and colour/acuity channel response (though his highest sensitivities are still subnormal). The improvements measured indicate an increase in sensitivity of greater than 1 log unit. Frisén¹⁶ has attempted to quantify loss of visual acuity in terms of the proportional response of visual channels. In accordance with his suggestion, the variation in Snellen acuity from 6/60 to 6/9 reflects a variation in number of functional foveo-cortical channels from 0.59% to 25.3%.

Contrast sensitivity for pattern detection increased with drinking beer while the movement sensitivity remained constant (Fig. 4). This inconsistency between the two tests led to a change in the pattern to movement (P:M) ratio from 1.4 to 1.76. The P:M ratio is reported to remain normal (1.6) even in conditions such as amblyopia¹⁷ and optic atrophy,¹⁸ though MacCana *et al.*¹⁹ have described an abnormal P:M ratio of 1.23 in a case of MS. Contrast sensitivity, amplitude of VEP, flicker modulation sensitivity, and spectral sensitivity all seem to improve with drink. This may correlate with the relatively transient effects seen in mechanism (1). Movement sensitivity and latency in VEP remain constant for this patient regardless of the other improvements with drink and may be part of a second disease site referred to here as mechanism (2).

A site for the effect in mechanism (1) may be postulated from the spectral sensitivity results. In normal spectral sensitivities, increasing the brightness of the background raises the threshold across all wavelengths. The spectral sensitivity results for our patient (Figs. 1A and 1B) show no loss for any specific wavelength. The colour opponent mechanisms measured seem to be attenuated as if we had increased the background brightness 10-fold (after-

drink measurement) to 1000-fold (before-drink measurement). The observation that he uses central fixation and that the dark adaptation curve in his case shows little or no rod function excludes, we consider, the possibility of rod contribution to his spectral sensitivity responses. We might postulate that the site for improvement may be located at the area for retinal brightness control in normal photopic vision.

The VEP recorded in optic neuritis often shows prolonged latency of the major P100 wave, persisting sometimes long after recovery of visual acuity.^{20,21} The VEP results with our patient showed a significant increase in latency relative to normal even when his vision was excellent and Snellen VA was >6/9. The perceptual consequences of 'timing errors' from lesions that affect the transmission characteristics of the visual pathway—that is, VEP latency increase—may be paradoxical. Bodis-Wollner *et al.*²² found that although VEPs revealed interocular latency differences, the 'slower' eye (in terms of latency) appeared, in that specific case, to have the more sensitive response as measured psychophysically. A spatial frequency 'notch' (Fig. 4) has been described by other workers. Regan *et al.*²³ demonstrated both orientation and spatial frequency specific changes in MS. Neurons responding to particular spatial frequencies have been demonstrated only in the striate cortex. A recent nuclear magnetic resonance (NMR) study has shown that 19 out of 31 patients presenting with their first attack of isolated optic neuritis had multiple lesions, some in the occipital white matter (W. Ian McDonald, personal communication). This may account for a 'scrambling' of information at the input level of the visual cortex. Retrograde degeneration of axons damaged by RBN affords an alternative explanation. R. Hess (personal communication) has suggested that such 'dips' are due to a loss of paracentral retinal ganglion cells. Regardless of the site of damage, in the case of our patient, rapid changes in vision including loss of the dip in contrast sensitivity, indicate that the effect is reversible or that damage is not permanent.

A biochemical model for transitory changes in nerve conduction has been offered by Davis *et al.*²⁴ in relation to levels of calcium ions in patients with MS. The concept of a 'safety factor' for nerve conduction was defined as being proportional to the action potential and inversely proportional to the threshold intensity (minimal stimulus required to produce a impulse).²⁵ A lowering of the threshold intensity was achieved by decreasing ionised calcium, with a resultant improvement in visual function for MS patients. For our patient neither serum calcium nor acid-base state showed any significant changes.

It is emphasised that significant improvement of our patient's visual function was observed (Table 1

and Figs. 1A and 1B) after two control trials with beer heated to body temperature. We believe these results rule out a pure temperature (cooling) effect on nerve conduction by the beer.

A transient improvement of visual function has been reported recently²⁶: 4-aminopyridine reduced the depth of scotomata in two patients with MS. How the slight visual improvement of these MS patients relates to the dramatic improvement in our case of recurrent RBN is unknown.

CONCLUDING COMMENTS

The results of the psychophysical and electrophysiological evaluations support our patient's observations that his vision improves substantially after drinking beer. He has also observed that the 'darker' the beer the more marked the visual improvement. After more than six experimental sessions the reliability of his observations encouraged some 'home experiments' to be attempted. Using a portable Snellen chart at home, he found drinking an equal volume of orange juice or water did not increase the visual acuity. Without drinking beer, the diurnal variation in VA throughout the day (measured hourly from 10 am to 9 pm) was negligible.

Identification of the precise factor initiating visual improvement after drinking beer is problematical. Neither a trial with the alcohol equivalent to the 2.25 pints (1.3 l) of beer (by five short measures of spirit (whisky)) nor one with alcohol-free lager improved his VA. The latter observation suggests that a light distillate product responsible for this effect is removed during dealcoholisation of alcohol-free lager.

The results shown here indicate several visual parameters that were labile in our patient's condition. Further study of these factors may lead to a pharmacological means of temporary relief in the symptoms associated with recurrent retrobulbar neuritis.

We thank Mr S K Bhargava, consultant ophthalmologist at Manchester Royal Eye Hospital, for the use of diagnostic equipment and the help of his department.

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Accepted for publication 20 June 1985.