

CLINICAL NOTE

Eye Patching Biases Spatial Attention After Thalamic Hemorrhage in a Patient Without Spatial Neglect: A Case Report

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ABSTRACT. Barrett AM, Crucian GP, Heilman KM. Eye patching biases spatial attention after thalamic hemorrhage in a patient without spatial neglect: a case report. *Arch Phys Med Rehabil* 2004;85:1017-20.

Monocular patching has been advocated as a treatment for spatial neglect. Eye patching, however, is also reported to increase spatial bias. Thus, patching brain injury patients for ocular conditions may also impair their attention. To learn if an eye patch may induce asymmetric attention in a patient without spatial neglect, we tested a woman with diplopia after a left thalamic-intraventricular hemorrhage. She had no spatial neglect on bedside attention tasks. Using a laser pointer, she bisected a blank space at near (279mm) and far (914mm) distances under 3 conditions: unpatched and wearing a right or left eye patch. Unpatched, she showed no bias. She erred further leftward with right patching at both distances. Right eye patching appeared to induce neglect of right space when the patient performed this task. With left patching, leftward error tended to increase in near space only. Clinicians prescribing eye patches to patients with brain injury even for purely ocular indications, should evaluate them for spatial neglect once the patch is in place.

Key Words: Attention; Case report; Hemispatial neglect; Rehabilitation; Vision, monocular.

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SPRAGUE¹ SHOWED THAT the superior colliculus plays an important role in orienting behaviors. When cats with contralesional orienting deficits from unilateral cortical lesions received surgical ablation of the contralesional superior colliculus, their deficit improved. Sprague hypothesized that ablating the superior colliculus opposite the cortical lesion disinhibited the ipsilesional colliculus, improving contralesional orienting.

Patients with unilateral spatial neglect after right hemisphere stroke do not orient appropriately to stimuli on the left side of

space.² These patients also make errors deviating toward the side of space ipsilateral to their brain lesion. Posner and Rafal³ proposed that inhibiting left (contralesional) collicular activity might lessen these patients' orienting deficit. They hypothesized that the input to the superior colliculi from the eyes may be predominantly monocular and contralateral,⁴ and thus, a right eye patch may sensory deprive the left colliculus. This would be expected to release right-sided collicular-cortical systems from inhibition and improve leftward orienting. Some investigators⁵ subsequently reported that right eye patching reduced neglect in patients with right hemisphere damage.

If an ipsilesional eye patch improves contralesional orienting, a patch on the contralesional eye may impair orienting and worsen neglect. Investigators who used eye patching to treat unilateral neglect reported no adverse effects. However, in a patient with right hemisphere stroke and left-sided, primarily perceptual-attentional neglect (a primary defect in awareness rather than intention to move), right eye patching increased rightward bias.⁶

Neurorehabilitation patients seen by neuro-ophthalmologists commonly receive a monocular patch.⁷ Thus, it is possible that a monocular patch prescribed for a patient with brain injury for purely ocular reasons may have a detrimental influence on perceptual-attentional bias.

In this study, we wanted to learn whether a monocular eye patch prescribed for ocular reasons would induce asymmetric visuomotor behavior in a patient with brain injury without spatial neglect. If monocular patching can induce orientation asymmetry or unilateral spatial neglect, patching may affect the functional abilities of patients with brain injury and perhaps even retard recovery.

CASE DESCRIPTION

A woman in her late twenties was admitted to the Neurological Rehabilitation Service of a medical center after she experienced a left thalamic-intraventricular hemorrhage caused by bleeding from an underlying arteriovenous malformation. Before her transfer to rehabilitation, she had had a cranial computed tomography (CT) scan that revealed a large (90mL) thalamic hemorrhage, with intraventricular extension of blood. Almost the entire thalamus, particularly the posterior medial and lateral regions, was obscured by bright signal (blood) on the CT image (fig 1). For hydrocephalus secondary to the hemorrhage, the patient had a ventriculoperitoneal shunt placed.

General neurologic examination at rehabilitation admission revealed no evidence of a right homonymous hemianopia on bedside visual field testing by neurology and neuro-ophthalmology resident staff. Noted were bilateral VI nerve palsies causing diplopia and right hemihypesthesia. A mental status examination found adynamic speech and a paucity of endo-evoked behavior, with mild bradyphrenia and bradykinesia in response to an exo-evoked behavioral set. There was no evidence of aphasia, nor was there evidence of spatial neglect on bedside standard testing; her performance on double simultaneous stim-

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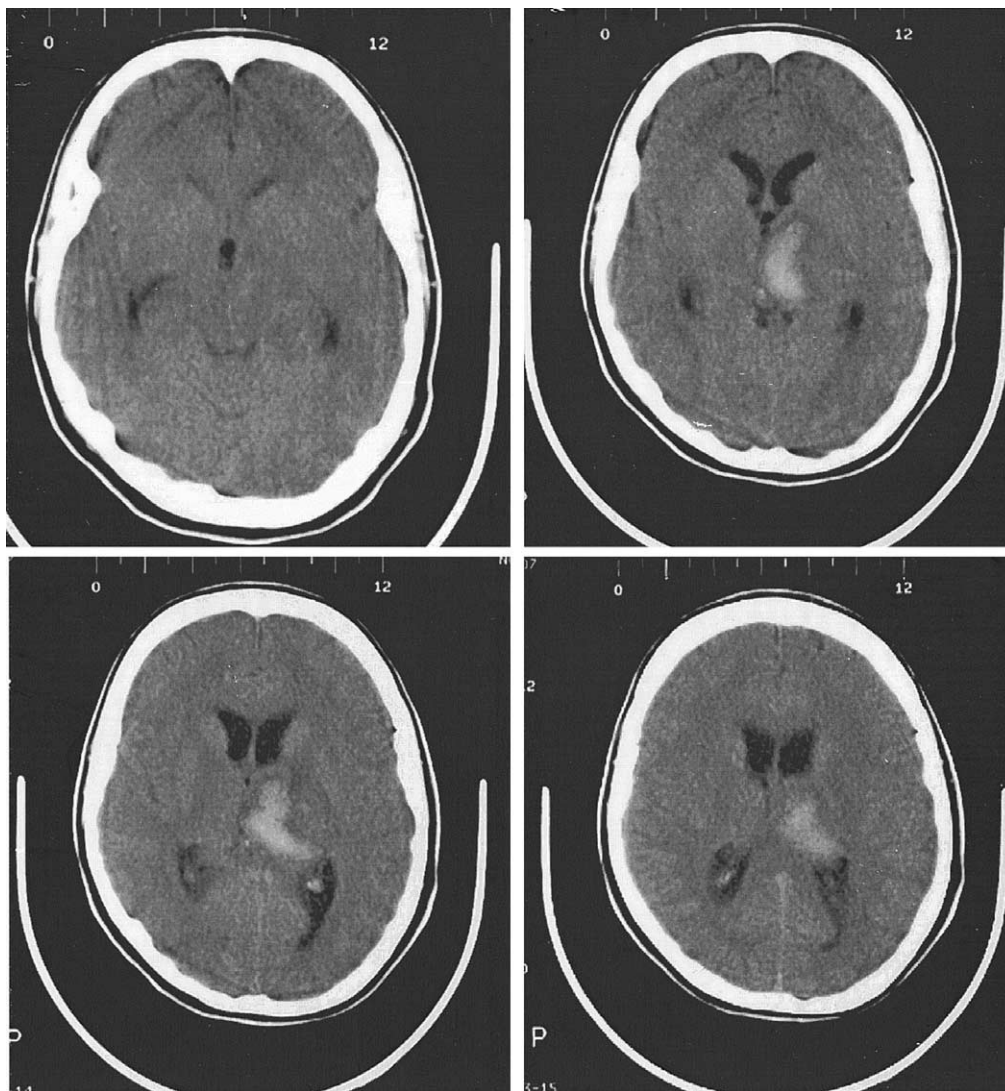


Fig 1. A noncontrast CT scan of the subject's brain, 1 month after presentation. The hemorrhage (bright signal) can be seen effacing most of the left thalamus (right side of scan). Cerebral angiography revealed an underlying arteriovenous malformation.

ulation tasks in all modalities, line bisection, and line cancellation tasks was normal, and she showed no evidence of asymmetry of spontaneous spatial behavior or anosognosia with respect to her thinking problems. To manage the diplopia, neuro-ophthalmology staff recommended that either eye be occluded with a patch. Because we thought parietal perceptual-attentional regions in the left hemisphere might be functionally deafferented by her left thalamic lesion, we were concerned that right eye patching would produce right spatial neglect.

METHODS

Thalamic injury may cause asymmetric attention,⁸ which may be more marked in far space.⁹ We had the subject bisect a blank space at eye level with a laser pointer. The blank space was either near the subject (279-mm distance; a piece of white paper) or far from the subject (914-mm distance; a section of white wall marked by 2 vertical lines). The near distance was comparable to that used in previous experiments.¹⁰ The far distance was shorter than that used by others (1677.5mm⁹; 2440mm¹⁰), although still beyond peripersonal, reaching distance. In the far condition, the distance from the marked section of wall to the nearest corners or other edges was more than 180cm bilaterally. The subject performed 5 trials in near space

without an eye patch and while wearing a right patch and then left patch. She also performed 5 trials in each of the same 3 conditions in far space. Conditions were pseudorandomized (the order of presentation was mixed by picking cards). An extra trial (total 6) was accidentally performed in the right patch condition in near space.

Mean lateral error (bias) was calculated for unpatched and right, and left patch conditions separately in near and far space. Leftward error was coded as negative, and rightward error was coded as positive.

We compared errors in near and far space with perfect performance by using 2-tailed, 1-sample *t* tests. We then used 2-tailed, paired-sample *t* tests to assess for an effect of eye patching and to compare errors in near and far space. When using a laser pointer, subjects may be limited in the smallest degree of angular adjustment they can make. For a given angular adjustment of the laser pointer in the hand, error in millimeters will always be greater in far space than in near space. To minimize the effect of apparatus-induced errors, angular error (the amount of angular deviation to 1 side of a line defined by the patient's midsagittal plane and the center of the spaces to be bisected), rather than linear error, was analyzed for all near-far comparisons.

RESULTS

Our subject's ability to bisect a blank space at near and far distances was compared with perfect performance (using 2-tailed, 1-sample *t* tests) to determine if she showed bias consistent with spatial neglect. Without an eye patch, she erred 2.03 ± 6.30 mm rightward (mean \pm standard deviation); the angular error was $.07^\circ \pm .22^\circ$ when bisecting a near space and -15.24 ± 24.43 mm leftward (angular error, $-.12^\circ \pm .19^\circ$) when bisecting a far space. This performance did not differ significantly from perfect performance (near: $P=.516$; far: $P=.235$, not significant [NS]). Therefore, when not wearing an eye patch, the subject showed no evidence of spatial neglect affecting this task.

Right and left patch conditions were then compared with the unpatched condition in both near and far space (using 2-tailed, paired-sample *t* tests) to determine if there was an effect of eye patching on either or both sides. With the right patch, the subject erred further leftward in both near (-22.86 ± 9.05 mm; angular error, $-.66^\circ \pm .20^\circ$; $P<.005$) and far space (-66.04 ± 56.37 mm; angular error, $-.44^\circ \pm .34^\circ$; $P=.034$). The left patch had no effect except for a nonsignificant increase in leftward error in near space (-4.82 ± 1.89 mm; angular error, $-.17^\circ \pm .07^\circ$; $P=.096$; far space, 3.556 ± 12.00 mm; angular error, $.02^\circ \pm .10^\circ$, $P=.222$, NS). Because it appeared that the effect of left patching in near space was smaller in magnitude than that induced by right eye patching, we performed a paired-samples *t* test comparing right and left patch conditions. This confirmed that right eye patching produced a greater near space effect ($P=.024$).

We observed no differences when near and far performances were compared for the unpatched ($P=.344$, NS) or right patch ($P>.20$, NS) conditions. With the left patch, the subject erred more leftward in near than in far space ($P=.038$).

Figure 2 illustrates the subject's performance.

DISCUSSION

The thalamus contains important components of the ascending reticular formation (centromedian and parafascicular nuclei), sensory gating systems (reticular nucleus), and nuclei (dorsomedial and pulvinar) that have reciprocal connections to areas of the cortex important in the spatial allocation of attention (frontal and parietal lobes). Therefore, thalamic injury is often associated with neglect. Although in the unpatched "natural" condition our subject showed no evidence of spatial neglect, her thalamic brain injury may have decreased left collicular-cortical activity. This may have left her vulnerable to developing hemi-inattention when we occluded her right eye with a patch. Right eye patching did induce leftward bias (relative unawareness of right space) on the visuospatial space bisection task. In contrast, left eye patching did not induce significant performance asymmetry.

It is known that tasks with higher attentional demands can induce greater bias in subjects with spatial neglect.¹¹ Although it is theoretically possible that far spatial computations may be more difficult (attentionally demanding) than similar near computations, previous reports of unimpaired subjects^{12,13} and subjects with spatial neglect^{10,14} do not support far distances as being uniformly more difficult than near distances for this kind of task.

If eye patching affects the spatial distribution of attention, the mechanisms of this effect are not entirely clear. A patch can have ocular effects (eg, in subjects with asymmetric visual acuity). Some researchers contend that inhibiting the superior colliculus itself does not result in recovery of response bias after cortical injury; rather, orienting may be re-established by

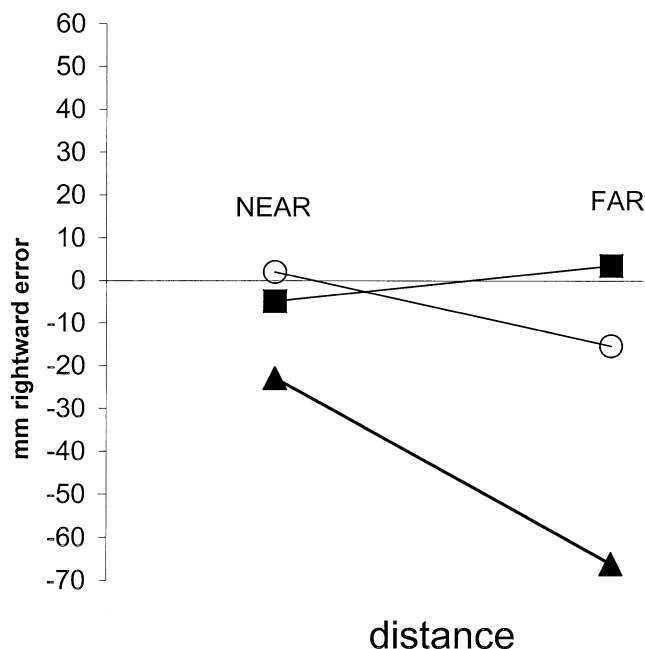


Fig 2. Bisection performance of our subject. Near and far space are labeled on the x axis. Error in millimeters is shown on the y axis, with leftward error coded negative and rightward error coded positive. Without an eye patch (no patch condition, open circles), the subject's errors (mean, 2.03mm rightward when bisecting a near space; mean, 15.24mm leftward when bisecting a far space) did not differ significantly from perfect performance (no evidence of spatial neglect). When wearing a right eye patch, however (right patch condition, filled triangles), her errors shifted leftward (mean, 22.86mm in near space; 66.04mm in far space).

interrupting inhibitory projections from the substantia nigra.¹⁵ Patching may affect these other, subcortical brain structures.

Our results are consistent with those of McCourt et al,¹⁶ who reported that right eye patching may induce leftward errors on a perceptual line bisection task in unimpaired subjects. It is unclear, however, why our subject tended to err further leftward in near space when wearing a left patch than she did when not wearing a patch. McCourt¹⁶ reported that eye patching decreased precision of line bisection judgments. Although decreased precision in the left patch versus unpatched conditions may have made an underlying bias more manifest in near space in our patient, this particular hypothesis does not explain why our subject did not make greater (or leftward) line bisection errors in far space while wearing a left eye patch. Further experiments investigating the effects of eye patching in near and far space would be needed to understand this effect.

Previous studies of eye patching as a possible therapeutic intervention for ipsilesional bias in spatial neglect have reported varying results. Contralesional eye patching is reported to both worsen^{17,18} and improve^{6,18} ipsilesional bias in individual neglect patients. Thus, subjects with brain injury may be variable in their response to contralesional eye patching, and our patient's response may not generalize to groups of subjects after brain injury. We also cannot comment on whether our patient's altered behavior with eye patching was abnormal. Although, as reviewed earlier, our results were in some ways consistent with previously reported results in unimpaired subjects, we did not compare our patient with the performance of age-matched controls tested under the same conditions. Even if the effect of patching on her performance were entirely com-

parable to that in unimpaired controls, it is still possible that the effect may have greater functional impact in the context of brain injury. This requires further study.

CONCLUSIONS

Based on our results, we recommend that clinicians exercise caution in using monocular patches in patients with brain injury, even if eye patching is recommended for another ocular condition and not for treatment of spatial neglect. Assessing for spatial bias with a task such as line bisection after a contralesional eye patch is in place will help to ensure that the patch neither induces nor worsens spatial neglect. Reassessment after placing an ipsilesional eye patch will ensure that spatial bias does not occur or increase paradoxically.

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