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Research report

Hemisphere-dependent ipsilesional deficits in hemianopia: Sightblindness in the 'intact' visual field

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ABSTRACT

Objectives: In addition to exhibiting a severe contralesional deficit, hemianopic patients may also show a subtle ipsilesional visual deficit, called *sightblindness* (the reverse case of 'blindsight). We have tested for the presence, nature and extent of such an ipsilesional visual field (IVF) deficit in hemianopic patients that we assigned to perform two visual tasks. Namely, we aimed to ascertain any links between this ipsilesional deficit, the lesion side, and the tasks performed or the stimuli used.

Methods: We tested left and right homonymous hemianopic (right brain-damaged RBD and left brain-damaged LBD, respectively) patients and healthy controls. Natural-scene images, either non-filtered or filtered in low or high spatial frequency (LSF or HSF, respectively) were presented in the IVF of each subject. For the two tasks, *detection* ("Is an image present?") and *categorization* ("Is the image of a forest or a city?"), accuracy and response time were recorded.

Results: In the IVF the RBD (left hemianopes) patients made more errors on the categorization task than did their matched controls, regardless of image type. In contrast, the only task in which the LBD (right hemianopes) patients made more errors than did the controls was the HSF-images task. Furthermore, in both tasks (detection and categorization), the RBD patients performed worse than did the LBD patients.

Discussion: Homonymous hemianopic patients do indeed exhibit a specific visual deficit in their IVF, which was previously thought to be unaffected. We have demonstrated that the nature and severity of this ipsilesional deficit is determined by the side of the occipital lesion as well as by the tasks and the stimuli. Our findings corroborate the idea of

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hemispheric specialization at the occipital level, which might determine the nature and severity of ipsilesional deficits in hemianopic patients.

1. Introduction

After a retrochiasmatic lesion of the visual system, the most common defect observed is *homonymous hemianopia*, a contralesional visual field (CVF) blindness in each eye, whose characteristics depend on the lesion site and size (Tant, Brouwer, Cornelissen, & Kooijman, 2002) and on the normal visual detection capacities in the ipsilesional visual field (IVF). However, the CVF might not be absolutely blind as shown in visual (Cowey, 2010; Pöppel, Held, & Frost, 1973; Weiskrantz, Warrington, Sanders, & Marshall, 1974; Weiskrantz, 2004) and oculomotor tasks, (Fayel et al., 2014; Van der Stigchel, van Zoest, Theeuwes, & Barton, 2008) and likewise, according to recent experimental studies, the IVF might not be completely healthy. Indeed, Hess and Pointer (1989) proposed that spatial and temporal sensitivities in the IVF of hemianopic patients were lower than in control subjects. Similarly, Rizzo and Robin (1996), and Poggel, Treutwein, and Strasburger (2011), suggested that hemianopic patients can exhibit lower sensitivity to signals, compromised processing of temporal information and longer reaction times in both hemifields, as compared to control participants. Regarding visual detection and analysis, Paramei and Sabel (2008) reported that these patients exhibited diminished abilities to detect fragmented targets among a noisy background in the IVF, whereas Shadow et al. (2009) found deficits in the early and late visual processing of Gestalt patterns in the IVF. More recently, Bola, Gall, and Sabel (2013a) confirmed these findings and reported processing-speed deficits in a simple detection task in the IVF. The authors termed this phenomenon *sightblindness*, as the reverse situation of *blindsight* (Bola, Gall, & Sabel, 2013b): the former refers to visuo-attentional deficits in the IVF, whereas the latter refers to residual (although implicit) visual abilities in the CVF that are highlighted in forced-choice tasks (*e.g.,* Leopold, 2012; Weiskrantz et al., 1974). Conversely to the case of blindsight, which has been extensively studied in hemianopia patients, vision quality in the central VF and in the IVF of these patients has scarcely been assessed, and moreover, has traditionally been assumed to be fully conserved. However, as recently proposed, neither the central VF (Cavézian et al., 2010; Perez et al., 2013) nor the IVF of hemianopic patients (Bola et al., 2013a; 2013b) actually appear to be fully intact or functional. Moreover, as we recently proposed, the nature of the task and the type of stimulus might determine the central visual deficit and the pattern of cortical activation of hemianopic patients (Cavézian et al., 2010; Perez et al., 2013).

In the work reported herein, we addressed the possibility of an ipsilesional deficit in homonymous hemianopia. Based on reports that healthy subjects exhibit left-hemisphere superiority for low spatial frequency (LSF) processing and right-hemisphere superiority for high spatial frequency (HSF) processing (Fink et al., 1996, 1997; Heinze, Hinrichs, Scholz, Burchert, & Mangun, 1998; Musel et al., 2013; Peyrin, Chauvin, Chokron, & Marendaz, 2003; Peyrin, Chokron, et al., 2006; Peyrin, Mermillod, Chokron, Marendaz, 2006; Wilkinson, Halligan, Marshall, Büchel, & Dolan, 2001; Yamaguchi, Yamagata, & Kobayashi, 2000), we hypothesized that the characteristics of such an ipsilesional deficit might be influenced by the lesion side. To test our hypothesis, we assessed the performance of left and right homonymous hemianopic (right brain-damaged, RBD and left brain-damaged, LBD, respectively) patients and healthy control subjects in two image-based tasks: a low cognitive-demand one (*detection*) and a high cognitive-demand one (*categorization*).

2. Material and methods

2.1. Subjects

The study cohort comprised sixteen healthy men [*control group*; mean age ± standard deviation (SD): 45.82 ± 17.00 years; mean educational level ± SD: 12.37 ± 3.07 years], five men with isolated right homonymous hemianopia and left-brain damage (*LBD group*; mean age ± SD: 60.51 ± 8.40 years; mean educational level ± SD: 9.00 ± 5.34 years), and five men with isolated left homonymous hemianopia and right-brain damage (*RBD group*; mean age ± SD: 55.36 ± 12.36 years; mean educational level ± SD: 8.40 ± 5.32 years). The three groups were matched for age and educational level [ANOVA, $F(2,23) = 2.13$; $p = .14$ and $F(2,23) = 2.62$; $p = .09$ respectively]. Besides, LBD and RBD groups did not differ regarding their Mean Deviation (−14.6 in the LBD group and − 14 in the RBD group; Mann–Withney *U*-test: $Z = -.73$; $p = .46$) and Personal Deviation (14,4 in the LBD group and 14.8 in the RBD group; Mann–Withney *U*-test: $Z = -1.15$; $p = .25$) in the Humphrey perimetry examination.

The hemianopia patients were diagnosed according to a formal visual-field examination (Humphrey automatic perimetry test, 24-2 SITA-fast program), and brain lesion sites were determined from computed tomography scans or magnetic resonance imaging. All participants were right-handed (as assessed with the Edinburgh inventory; Oldfield, 1971), had normal or corrected-to-normal visual acuity and contrast sensitivity (assessed with the Pelli-Robson chart), and completed a consent form before entering the study. In addition, we gave patients a complete neurovisual examination, including the BEN (Azouvi et al., 2002), in order to exclude from the present study any patients with signs of neglect or visual agnosia. Finally, none of the subjects suffered from verbal or memory deficits, as revealed by a clinical neuropsychological examination, nor did they exhibit any signs of