



Light therapy increases visual contrast sensitivity in seasonal affective disorder

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Received 23 January 2003; received in revised form 6 September 2003; accepted 18 December 2003

Abstract

The purpose of this study was to investigate the effects of light therapy on visual contrast sensitivity in patients with seasonal affective disorder ($n=10$) and healthy control subjects ($n=10$). Static and dynamic visual contrast sensitivity was measured using a Venus system before and after 4 weeks of light therapy (10 000 lux, 30 min, 5 times a week). Light therapy increased static visual contrast sensitivity in the patients. We found no significant difference between the patients and controls either before or after light therapy. These results raise the possibility that light therapy induces retinal sensitization in seasonal affective disorder.

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Keywords: Winter depression; Light therapy; Visual contrast sensitivity; Retina

1. Introduction

In the last decade, light therapy became the first choice treatment of seasonal affective disorder (SAD). The antidepressant effect of light therapy is thought to be mediated by retinal phototransduction (Wehr et al., 1987). This therapeutic success raised the possibility that retinal factors may contribute to the pathophysiology of SAD. Accord-

ing to Remé et al. (1990), patients with SAD show retinal subsensitivity, failing to adapt to lower winter light intensity by increasing sensitivity. In contrast, Beersma (1990) hypothesized that patients with SAD display retinal supersensitivity in winter, leading to the abnormal regulation of circadian rhythms.

The available experimental data are not sufficient to determine which of these two assumptions is correct. Low electrooculographic (EOG) ratios have been consistently demonstrated in SAD, suggesting abnormal retinal pigment epithelium in winter (Lam et al., 1991; Ozaki et al., 1995).

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Interestingly, light therapy does not seem to normalize this dysfunction (Ozaki et al., 1993). Lam et al. (1992) found lower amplitudes of the b-wave in the electroretinogram (ERG) of female SAD patients, whereas the opposite effect appeared in the case of male patients. The finding from the female patients, together with a recent ERG study conducted in 12 patients with subsyndromal SAD (Hébert et al., 2002), supports the retinal subsensitivity hypothesis.

Measuring the time course of dark adaptation, Oren (1991) demonstrated that SAD patients adapted to dim light more rapidly than controls. Similarly, lower cone threshold and faster rod recovery have also been found in SAD using a photopic and scotopic light detection paradigm (Terman and Terman, 1999). It is notable, however, that Oren et al. (1993) failed to find any evidence for ophthalmic pathology, despite the wide range of tests used.

In this study, we used visual contrast sensitivity (VCS) measurements to gain more insight into the potential visual pathophysiology of SAD. Luminance contrast is an essential parameter to detect a stimulus against its background on the basis of luminance difference. The minimal contrast that is indispensable for stimulus detection is called contrast threshold, and its reciprocal is VCS (Kelly, 1977). Therefore, lower contrast threshold is expressed as higher sensitivity. VCS is predominantly determined by retinal factors and neuronal mechanisms related to the lateral geniculate nucleus and primary visual cortex. Higher order visual cortices show lower VCS (Avidan et al., 2002). To explore the effect of light therapy, VCS was measured before and after 4 weeks of light therapy.

2. Methods

2.1. Subjects

Ten unmedicated patients with SAD (three male and five female; mean age: 40.0 years, S.D. = 16.4) and 10 healthy volunteers (four male, and six female; mean age: 24.8 years, S.D. = 12.3) participated in the study. The diagnosis was based on DSM-IV criteria (American Psychiatric Association, 1994). Each participant, including the

controls, was screened with the Mini International Neuropsychiatric Interview (Lecrubier et al., 1997). The exclusion criteria included comorbid psychiatric disorders and neurological/ophthalmological diseases. All participants had normal or corrected-to-normal visual acuity. Before the light therapy, the mean Hamilton depression score was 19, while after treatment the mean score was five.

2.2. Light therapy

A standard 10 000-lux light box (Alaska Northern) was used. The duration of the light treatment was 30 min between the period of 08:00–10:00 h in wintertime. The subjects were told to look into the lamp at least five times per minute but not continuously. During the treatment, subjects were allowed to read a magazine or book. The light treatment was given five times per week for 4 weeks.

2.3. Visual contrast sensitivity

The subjects participated in VCS measurements in the pre-treatment period while they were depressed, and in the post-treatment period after 4 weeks of light therapy at 10 000 lux. For the evaluation of VCS, we used a Venus system (Neuroscientific Corporation, USA) (for a methodological description, see Kéri et al., 2002a). Stimuli were horizontal luminance-contrast gratings with a sinusoidal luminance profile. Luminance changed periodically between minimal (L_{\min}) and maximal (L_{\max}) values (Fig. 1). Contrast (C) was defined according to the Michelson formula ($C = (L_{\max} - L_{\min}) / (L_{\min} + L_{\max})$). Spatial frequency was the number of cycles per 1° of visual angle (cycles/degree, c/d). In the static condition, steady patterns were used. In the dynamic condition, there were eight phase reversals during a second between L_{\min} and L_{\max} bars. Temporal frequency referred to the number of phase reversals during a second (8 Hz).

Two temporal frequencies (0 Hz (static) and 8 Hz (dynamic)) and nine spatial frequencies were used (0.5, 1.2, 1.9, 2.9, 3.6, 4.8, 5.7, 7.2, and 14.4 c/d). The stimulus display subtended $13^\circ \times 13^\circ$ from a viewing distance of 1 m. The luminance of

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