



# A randomized, placebo-controlled trial of bright light and high-density negative air ions for treatment of Seasonal Affective Disorder

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## ABSTRACT

This study, conducted over the course of 5 years, assessed the antidepressant efficacy of two active treatments, bright white light and high-density negative ions, and the efficacy of two placebo treatments, dim red light and low-density negative ions, for Seasonal Affective Disorder (SAD). In a controlled laboratory setting, 73 women with SAD were exposed to one of the four treatment conditions over 12 consecutive days. Pretreatment expectation ratings did not significantly differ among the four treatment groups; however, expectation scores and treatment benefits were positively related. Over the course of treatment, subjects in all four groups showed significant score decreases on the Structured Interview Guide for the Hamilton Depression Rating Scale–Seasonal Affective Disorder Version–Self Rating (SIGH-SAD-SR) and on the Beck Depression Inventory (BDI). For raw scale scores, neither main effects of treatment nor interactions between treatment and time were significant. When remission outcome criteria were used, bright white light was significantly more effective than any of the other three treatments, and exposure to high-density negative ions was more effective than either of the two placebo conditions, although the difference was not significant.

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## 1. Introduction

Seasonal Affective Disorder (SAD) is a subtype of recurrent mood disorder with a characteristic pattern of onset and remission (American Psychiatric Association, 1994). Episodes of SAD predominantly occur in fall and winter and are characterized by typical symptoms of depression as well as atypical symptoms including excessive sleep with difficulty waking, craving for carbohydrates, weight gain, irritability, social withdrawal, daytime fatigue, and loss of concentration (Rosenthal et al., 1984a,b; Tam et al., 1997; Thompson et al., 1999; Partonen and Rosenthal, 2001). The incidence of SAD is four times more prevalent in women than in men (Blazer et al., 1998) and is highest among individuals with a history of recurrent mood disorders (Lam and Levitt, 1999). Explanations of how SAD develops include delayed circadian rhythms (Lewy et al., 1988), irregularities in the level and/or regulation of specific neurotransmitters, and genetic factors (Madden et al., 1996; Lam and Levitan, 2000).

Although antidepressant medications are effective in alleviating the symptoms of SAD (Ruhmann et al., 1998; Kasper et al., 2001; Moscovitch et al., 2004; Lam et al., 2006), bright light is also a viable

treatment for individuals with this disorder (Terman et al., 1989; Terman and Terman, 1995; Tam et al., 1995; Wesson and Levitt, 1998; Terman and Terman, 2005). Light therapy has relatively few side effects as compared to those of antidepressant medications (Labbate et al., 1994; Terman and Terman, 1999, 2005). The superiority of light therapy over placebo treatments, however, remains equivocal. Whereas some investigations found light therapy to be more effective than dim or brief duration light control conditions for treating SAD (Rosenthal et al., 1985; Terman and Terman, 2005), others reported little or no difference in antidepressant response between bright light and an inert photic placebo treatment (Levitt et al., 1996; Wileman et al., 2001). For example, Eastman et al. (1992) reported that treatment with either a deactivated ion generator or bright light produced significant and equivalent reductions of depression ratings in patients with SAD. Exposure to high levels of negative air ions is also an effective treatment for both the depressive and atypical symptoms of SAD (Terman and Terman, 1995, 2006; Terman et al., 1998). More broadly, exposure to high levels of negative ions increases relaxation and mental alertness, decreases irritability and tension, enhances motor performance and energy level, and alleviates depressed mood (Charry and Hawkinshire, 1981; Tom et al., 1981; Buckalew and Rizzuto, 1982; Yates et al., 1986; Baron, 1987; Nakane et al., 2002). Exposure to high concentrations of positive air ions, in contrast, typically produces opposite effects including tension, irritability, depression, insomnia, social withdrawal, and reduced motor performance (Krueger and Reed, 1976; Charry, 1987).

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Previous research suggests that bright light and high-density negative ions are generally more effective than either photic or nonphotic control conditions, but not both (Eastman et al., 1998; Terman et al., 1998). To assess the effectiveness of bright light as compared with that of high-density negative ions for treating SAD and to further evaluate the degree to which placebo expectancies contribute to the effects of these treatments, the present study utilized a parallel-group design to evaluate the efficacy of both treatments not only relative to each other but also relative to dim red light and to low-density negative ions. Unlike previous studies in which subjects self-administered treatments in their places of residence, this study required that all subjects received treatments in a controlled laboratory setting.

We predicted that exposure to bright white light or to high-density negative ions would produce comparable reductions in the depressive and atypical neurovegetative symptoms of SAD and that the efficacy of either of these treatments would be superior to that of dim red light or of low-density negative ions.

## 2. Methods

### 2.1. Subjects

A total of 73 female students and staff at Hollins University in Roanoke, Virginia (latitude 37° 16', North; average sunrise time ~0732 a.m.) participated in this study that was conducted each January over 5 consecutive years. The group included 67 White (90.5%) and 7 Black (9.5%) women, and subjects ranged in age from 18 to 51 years ( $M = 20.8$  years;  $S.D. = 5.69$  years). None had prior experience with either light or negative ion therapy.

A request for subjects was announced in campus media in November prior to each January study. Respondents to these announcements completed the Seasonal Pattern Assessment Questionnaire (SPAQ; Rosenthal et al., 1984a,b), a retrospective self-report rating of pattern and degree of seasonal variation in sleep, social activity, mood, weight, appetite, and energy level. The global seasonality score (GSS), derived from categorical scales of mood and behavior, ranges from 0 to 24. To meet the initial screening criterion for inclusion in the study, a respondent was required to score the following on the SPAQ: a GSS of at least 11, a winter pattern (feels worse, eats more, socializes less, and sleeps more in the winter months than in summer months), and to experience at least moderate personal discomfort as a result of these seasonal changes.

Subjects were instructed to maintain pre-established prescription medication regimens, if any, throughout the 12 consecutive treatment sessions and during the week prior to the study and to also verify these regimens in a posttreatment questionnaire. Of the 73 subjects, 11 remained on prescribed medications other than psychotropic drugs, and 8 remained on a psychotropic medication regimen of either a selective serotonin reuptake inhibitor (6 subjects) or a norepinephrine/dopamine reuptake inhibitor (2 subjects). The distribution of these latter 8 subjects across the four treatment groups was, respectively, 2, 2, 3, and 1.

During each January study, subjects received research participation credit in psychology courses and were eligible for a monetary lottery drawing following completion of the study. Subjects read and signed a written informed consent prior to their participation, and the study received institutional review approval from Hollins University.

### 2.2. Apparatus

#### 2.2.1. Light boxes

Two light boxes (Bio-Light Ultra, Enviro-Med, Vancouver, WA) were each located in similar testing rooms each measuring approximately 2.0 m × 3.0 m × 2.5 m. The bright white light (BWL) box consisted of three 40 W, 4100 K twin tri-phosphor fluorescent tubes mounted within a 30.5 cm × 61.0 cm rectangular metal box equipped with a white reflector and a translucent plastic diffusing screen. The BWL unit provided approximately 10,000-lux illuminance (measured with a digital lux meter: Model LX-101, D.A. S. Inc., Suffield, CT) of white light at a distance of 37 cm from the center of the diffusing screen to the subject's eyes. The dim red light (DRL) box contained a single twin tube and was equipped with a translucent red plastic panel mounted in front of the unit's diffusing screen. This modified box provided approximately 300 lux illuminance of red light at a distance of ~61.0 cm from the center of the screen to the subject's eyes.

Each light box was mounted vertically on a 76.0-cm high table at an approximately 30° glancing angle immediately to the right side of a television monitor on which subjects could watch a variety of pre-recorded movies during treatment sessions. The center of the light box screen was located at eye level so that maximum light was directed toward the subject's face. Furthermore, to ensure that the correct distance between the subject's face and the light box screen was maintained throughout treatment sessions, each subject was instructed to maintain contact between her forehead and the end of a lightweight bead chain that was suspended at the criterion distance from the front of the light source.

#### 2.2.2. Ultraviolet and ozone measuring devices

Because of safety concerns associated with bright light exposure (Kogan and Guilford, 1998; Terman and Terman, 2005), ultraviolet (UV) radiation and ozone emitted directly from the fluorescent tubes and at distances of  $\geq 3$  cm from the light box diffusing screen were measured with a UV meter (Model UVP J-225, UVP Inc, Upland, CA, USA) and an ECO ozone meter (Model EZ-1X, Eco Sensors, Inc. Santa Fe, NM, USA). Because ozone levels can vary greatly within a closed space, we monitored ozone at various locations within the testing room during light box operation.

#### 2.2.3. Negative ion generators

Two negative ion generators (Model VI-2500, SphereOne, Inc., Silver Plume, CO, USA), each measuring 19.7 cm × 16.5 cm × 7.6 cm, were located in testing rooms similar to those containing the light boxes. The generator was placed on a 76.0-cm high table that was identical to those that supported the light boxes and positioned ~46.0 cm to one side of a television monitor. Although identical in appearance, the two generators emitted high and low levels of ionization. The ion output of both generators was measured using AlphaLab Air Ion Counters (AlphaLab, Inc., Salt Lake City, UT, USA). At the subject's sitting position of ~60 cm from the generator, the ion output of the high-density unit was  $\geq 2.0 \times 10^6$  ions/cm<sup>3</sup>, while that of the low-density unit was  $\sim 4.0 \times 10^3$  ions/cm<sup>3</sup>. A grounded wrist strap maximized ion flow toward the subject's body, and doors to the testing rooms were closed during treatment sessions.

### 2.3. Treatment assessment inventories

#### 2.3.1. Treatment Expectation Questionnaire (TEQ)

This self-report scale, modeled on the concepts of Borkovec and Nau (1972), provided a rating, ranging from 0 to 4, of the subject's belief that she would benefit from completing her assigned treatment, her expectation that the treatment would make symptoms worse, her belief that the treatment was logical, and her degree of comfort in recommending her treatment to a friend with SAD. Rating data from all four questions on the TEQ were used for analysis.

#### 2.3.2. Structured Interview Guide for the Hamilton Depression Rating Scale–Seasonal Affective Disorder Version–Self Rating (SIGH-SAD-SR)

The SIGH-SAD-SR consists of two scales: a structured interview for the 21-item Hamilton Depression Rating Scale (HAM-D) and an 8-item scale that assesses the atypical characteristics of SAD (ATYP) (Williams et al., 1994) including hypersomnia, hyperphagia with associated weight gain, and daytime fatigue. Previous studies (Terman and Terman, 1995; Terman et al., 1998) reported that both scales of the SIGH-SAD were of value in determining treatment response to light as well as to negative ions. The self-rating version of the SIGH-SAD (SIGH-SAD-SR) has been shown to produce results consistent with the interviewer-administered version (Terman and Williams, 1994, 2001) and has been used as a primary measure of seasonal depression (Partonen et al., 1993; Partonen et al., 1998; Wileman et al., 2001) and nonseasonal depression (Ando et al., 1999; Loving et al., 2002; Leppämäki et al., 2004).

#### 2.3.3. Beck Depression Inventory (BDI)

The BDI (Beck et al., 1961) is designed to assess the severity of depression in adolescents and adults and has been validated in college populations (Bumberry et al., 1978; Goel and Grasso, 2004). Each of the 21 multiple-choice questions on the BDI consists of a 4-point scale ranging in symptom severity from 0 to 3. Total scores of 0–9 are within the minimal range, scores of 10–16 are indicative of mild depression, scores of 17–29 designate moderate depression, and scores of 30–63 indicate severe depression.

#### 2.3.4. Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) criteria for Seasonal Affective Disorder

As specified by the DSM-IV (American Psychiatric Association, 1994), the criteria for Major Depressive Episodes in Bipolar I Disorder, Bipolar II Disorder, or Major Depressive Disorder, Recurrent, With Seasonal Pattern include (1) a history of either Bipolar Disorder (Manic Depressive Disorder) or Major Depressive Disorder (Unipolar depression without episodes of mania), (2) depression, over the past 2 years during particular, predictable seasons of the year, (3) no other depressive episodes outside of recurrent seasonal episodes of depression over the past 2 years, and (4) more episodes of seasonal than nonseasonal depression throughout the individual's lifetime.

### 2.4. Inclusion criteria

Each respondent meeting the initial SPAQ screening criteria 6 weeks prior to the beginning of the study was required to complete the SIGH-SAD-SR, the BDI, and a DSM-IV criteria checklist within 24 h prior to the first treatment session. To qualify for inclusion in the study, a respondent was required to score at least 20 points on the overall SIGH-SAD-SR, including a score of at least 10 on the Hamilton Depression Rating Scale and a score of at least 5 on the atypical symptom scale (Terman et al., 1990). Respondents were also required to meet each of the four DSM-IV criteria for SAD by answering "yes" to the four questions provided in a symptom checklist derived from the Criteria for Seasonal Pattern Specifier (DSM-IV, 1994, p. 291). No pretreatment criterion score was required on the BDI.

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