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Combined non-adaptive light and smell stimuli lowered blood pressure, reduced heart rate and reduced negative affect

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HIGHLIGHTS

- A non-adaptive light-smell stimulus protocol is described
- Lemon, lavender and peppermint essential oil odours were tested
- Light + smell stimulation reduced blood pressure and heart rate
- Light + lemon odour induced the greatest mood changes
- The combination of light + smell was more effective than either smell or light alone

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ABSTRACT

Bright light therapy has been shown to have a positive impact on seasonal affective disorder (SAD), depression and anxiety. Smell has also has been shown to have effects on mood, stress, anxiety and depression. The objective of this study was to investigate the effect of the combination of light and smell in a non-adaptive cycle. Human subjects were given smell (lemon, lavender or peppermint) and light stimuli in a triangular wave (60 s cycle) for 15 min. Blood pressure and heart rate were monitored before and after each session for 5 consecutive days and a Profile of Mood States (POMS) test was administered before and after the sensory stimulation on days 1, 3 and 5.

The light-smell stimulus lowered blood pressure, both systolic and diastolic, and reduced heart rate for all odours compared to control. Of the two sensory stimuli, the odour stimulus contributed most to this effect. The different aromas in the light-smell combinations could be distinguished by their different effects on the mood factors with lemon inducing the greatest mood changes in Dejection-Depression, Anger-Hostility, Tension-Anxiety.

In conclusion, combined light and smell stimulation was effective in lowering blood pressure, reducing heart rate and improving mood. The combination was more effective than either smell or light stimuli alone, suggesting that a light-smell combination would be a more robust and efficacious alternative treatment for depression, anxiety and stress.

1. Introduction

Light therapy is an established treatment for seasonal affective disorder (SAD) and mood disorders [10,30,32], having been successfully used for over 20 years. Bright light therapy (BLT) is the recommended first-line treatment of the majority of cases of SAD, with improvements in symptoms observed with as little as 20 min of light exposure. A Cochrane Review [45] to evaluate clinical effects of bright light therapy in comparison to an inactive placebo treatment for non-seasonal depression found a "modest though promising antidepressive efficacy" and a later systematic review of the treatment of nonseasonal depression came to the conclusion that "overall, bright light therapy is an excellent candidate for inclusion into the therapeutic inventory available for the treatment of nonseasonal depression today, as adjuvant therapy to antidepressant medication" [8]. Since then further clinical trials have been conducted on specific groups and their findings lend further support to the efficacy of BLT. For example in the treatment of Major Depressive Disorder (MDD) in the elderly, a randomised, placebo controlled trial demonstrated that BLT was comparable to antidepressant medication in effectiveness [25]. In another study both antidepressant

Abbreviations: SAD, seasonal affective disorder; POMS, Profile of Mood States; BLT, Bright light therapy; MDD, Major Depressive Disorder; GAD, Generalised Anxiety Disorder; TMD, Total Mood Disturbance; CB, Confusion-Bewilderment; AH, Anger-Hostility; DD, Dejection-Depression; TA, Tension-Anxiety; FI, Fatigue-Inertia; VA, Vigour-Activity; BP, blood pressure; HR, heart rate.

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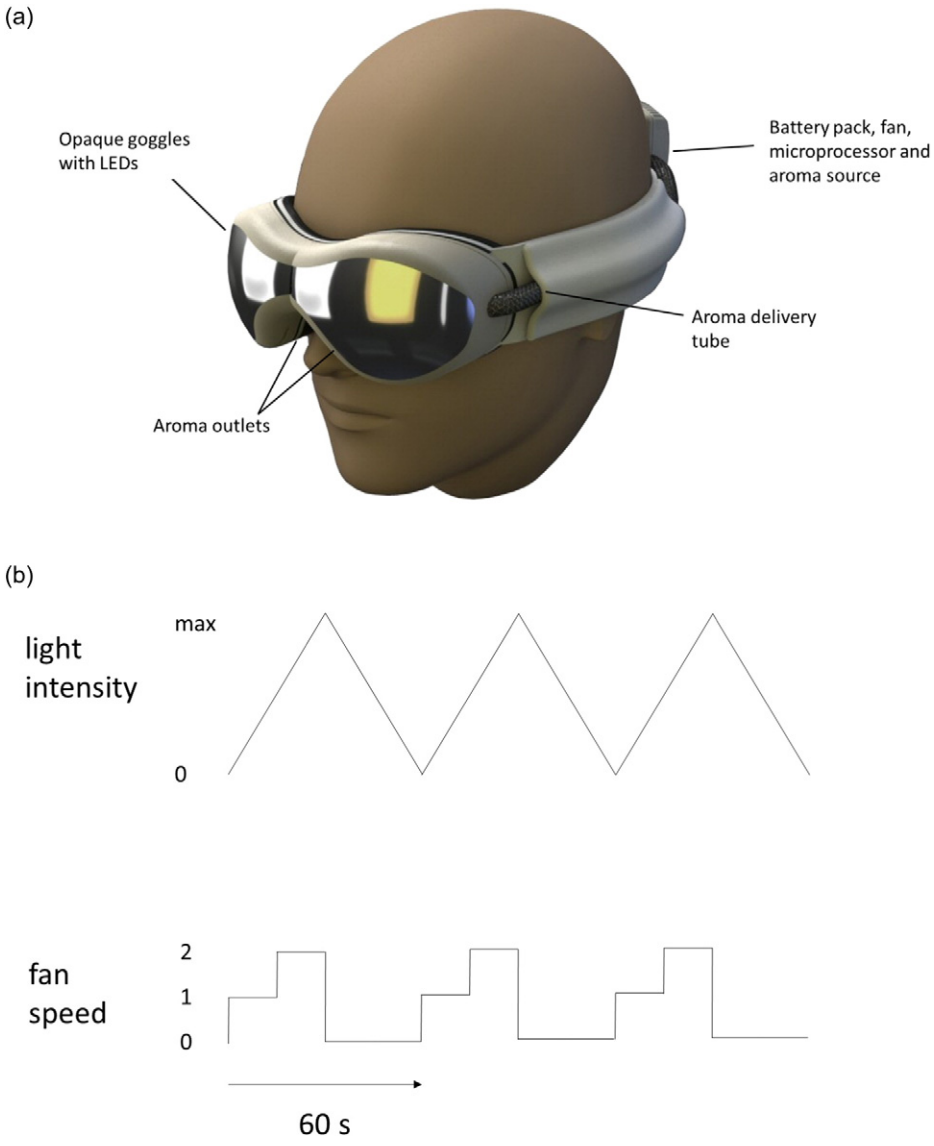

Fig. 1. (a) The stimulus delivery apparatus (see Methods for details). (b) The light and smell stimulus protocol. Diffuse full-spectrum white light (maximum 2500 lx) was presented as a triangular wave starting from zero light, rising to a maximum (2500 lx) linearly over 30 s and then declining linearly to zero over 30 s. Simultaneously an airstream containing essential oil vapour was delivered to the nostrils at two flow rates (0.17 and 0.33 l/s) to coincide with the up-ramp of the light stimulus. Three cycles are illustrated. The reason for delivering the stimuli in this manner was to overcome olfactory adaptation/habituation.

(venlafaxine) and antidepressant medication + BLT treatment strategies significantly reversed the depressive mood of patients with severe MDD; however, the latter induced significantly stronger and more rapid beneficial effects [11]. BLT has been found to be effective in treating antepartum depression in three trials [7,31,51] although in a Cochrane Database Review in 2013 only one BLT study, that of Wirz-Justice et al. (op.cit.), met its inclusion criteria and further, controlled, longer lasting studies were recommended [4]. While there is evidence to support the use of BLT to treat depression, light boxes are not regulated nor approved by the US Food and Drug Administration (FDA) nor the National Institute for Health and Care Excellence (NICE) in the UK for the treatment of depression of any sort.

Smell has been shown to have effects on mood, stress, anxiety and depression [1,6,12,15,47]. Three odours in particular, lemon, lavender and peppermint, have been demonstrated to have marked effects on mood, depression and anxiety. Work on animals showed that citrus fragrance could restore stress-induced immunosuppression [40,41] and lemon odour, as well as its main component citral, was found to be antidepressant in rats [22] and humans [23]. Lemon balm (main constituent citronellal) exhibited modulation of mood and cognitive performance [17]. Lavender (*Lavandula angustifolia*) essential oil, has been used in folk medicine for the treatment of anxiety since ancient times and mechanisms of action have recently been suggested, including the inhibitory action of linalool at sodium channels [24], a block of voltage activated calcium channels [42] and agonist activity at 5HT-1A post-synaptic receptors [2]. Peppermint odour has positive effects on mood [9,28] but there are disagreements on its effect on arousal with both an increase [3] and decrease [39] being reported. Peppermint augments cognitive performance and administrative tasks [3,28] and has been found to enhance athletic performance [27,36,37] with suggestions that both cardiovascular and central nervous system mechanisms are involved [27,46].

A recent study has demonstrated the additive beneficial effects of smell (lemon) and light administered simultaneously [49] on frontal alpha asymmetry – a metric for depression, anxiety – and mood. The following study was designed to test the effect of this combination of sensory stimuli on physiological (blood pressure and heart rate) and psychological (mood state) measures for repeated trials over five