



# Modulatory effects of aromatherapy massage intervention on electroencephalogram, psychological assessments, salivary cortisol and plasma brain-derived neurotrophic factor

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## Summary

**Objectives:** Aromatherapy massage is commonly used for the stress management of healthy individuals, and also has been often employed as a therapeutic use for pain control and alleviating psychological distress, such as anxiety and depression, in oncological palliative care patients. However, the exact biological basis of aromatherapy massage is poorly understood. Therefore, we evaluated here the effects of aromatherapy massage interventions on multiple neurobiological indices such as quantitative psychological assessments, electroencephalogram (EEG) power spectrum pattern, salivary cortisol and plasma brain-derived neurotrophic factor (BDNF) levels.

**Design:** A control group without treatment ( $n=12$ ) and aromatherapy massage group ( $n=13$ ) were randomly recruited. They were all females whose children were diagnosed as attention deficit hyperactivity disorder and followed up in the Department of Psychiatry, Jeju National University Hospital. Participants were treated with aromatherapy massage for 40 min twice per week for 4 weeks (8 interventions).

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**Results:** A 4-week-aromatherapy massage program significantly improved all psychological assessment scores in the Stat-Trait Anxiety Index, Beck Depression Inventory and Short Form of Psychosocial Well-being Index. Interestingly, plasma BDNF levels were significantly increased after a 4 week-aromatherapy massage program. Alpha-brain wave activities were significantly enhanced and delta wave activities were markedly reduced following the one-time aromatherapy massage treatment, as shown in the meditation and neurofeedback training. In addition, salivary cortisol levels were significantly reduced following the one-time aromatherapy massage treatment.

**Conclusions:** These results suggest that aromatherapy massage could exert significant influences on multiple neurobiological indices such as EEG pattern, salivary cortisol and plasma BDNF levels as well as psychological assessments.

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## Introduction

The overload of stress causes several physical and emotional distress and stress-related illnesses, depending on the individual's stress vulnerability. Therefore, several complimentary techniques such as meditation, muscle relaxation, and biofeedback have been developed for effective stress management.<sup>1</sup> Aromatherapy massage is commonly used for the stress management of healthy individuals, and also has been employed for therapeutic use of pain control and alleviating psychological distress such as anxiety and depression in cancer patients<sup>2</sup> and palliative care.<sup>3</sup>

However, the exact biological basis of aromatherapy massage is poorly understood. Very few have been published regarding biological outcome measures following these kinds of treatments. Aromatherapy massage induced a differential alteration of lymphocyte subset.<sup>4</sup> Massage intervention affected brain development and the maturation of brain electrical activity such as visual evoked potentials (VEPs) in human infants and in rat pups. In addition, higher levels of blood insulin-like growth factor (IGF) were found in massaged infants and similarly, IGF expression levels were increased in the cortex of massaged rat pups.<sup>5</sup>

Electroencephalography (EEG) is used as a neurophysiological evaluation tool to reflect the brain state or brain activity. EEG rhythms are categorized by their frequency range. Traditionally, four major EEG rhythms are used. These are delta waves (<4 Hz), theta waves (4–8 Hz), alpha waves (8–13 Hz) and beta waves (greater than about 13 Hz).<sup>6</sup> Several EEG studies have demonstrated significant alterations in spectral band frequencies during meditation. Brain activities of alpha rhythm were generally enhanced during meditation and theta rhythm activities were prominent in more experienced meditators.<sup>7</sup> Moreover, alpha waves in EEG have been the main target of training-induced alterations by operant conditioning in the neurofeedback. Several studies demonstrated that enhanced EEG alpha power by neurofeedback training improved the cognitive task performance.<sup>8</sup>

Therefore, we evaluated here the effects of aromatherapy massage interventions on multiple neurobiological indices such as EEG pattern, salivary cortisol and plasma BDNF levels as well as psychological assessments.

## Methods

### Participants

A total of 25 subjects aged 34–48 years volunteered to participate in the present study. They were randomly assigned to either the aromatherapy massage group ( $n = 13$ ) or control group ( $n = 12$ ). They were all females whose children were diagnosed as attention deficit hyperactivity disorder and followed up in the Department of Psychiatry, Jeju National University Hospital. This study was approved by the Institutional Review Board of the Jeju National University Hospital before obtaining written consents from the participants.

### Aromatherapy massage program

All participants in the treatment group were administered with aromatherapy massage for 40 min twice per week for 4 weeks (eight times in total). The interventions were conducted by trained therapists according to the following protocol. After bath, each subject was applied with 20 ml of Jojoba oil containing mixed essential oils of *Lavendula angustifolia* (lavender, 2%, ShirleyPrice Aromatherapy Co., UK) and *Pelargonium graveolens* (geranium, 2%, ShirleyPrice Aromatherapy Co., UK). The treatment dose was based on the previous reports.<sup>4</sup> Either lavender or geranium are currently in use as a aromatherapy agent to relieve anxiety, stress and depression.<sup>9</sup> The effleurage, friction, petrissage and vibration were included in the massage treatment. The same procedures were applied in all treatment group participants on the neck, shoulder, arms, back and legs at a moderate pressure, according to the same protocol.

### EEG recording and power spectrum analysis

The participants were seated with eyes closed in a comfortable armchair for EEG recording. EEG data were acquired for 2 min using the computerized EEG recording system BIOPAC MP36 (BIOPAC systems, USA). The recording electrodes were placed on Fp1 and Fp2 (prefrontal), and on O1 and O2 (occipital) scalp regions according to the international 10–20 electrode system (American Electroencephalographic Society, 1994) using an ECI electrode cap (Electro-Cap International, OH, USA). They were then

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