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Original Article

Physiology Section

Effect of Aromatherapy using Lavender Oil on Audio and Visual Reaction Time: A Quasi-experimental Study

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ABSTRACT

Introduction: Recently, the aromatheraphy has been a topic of interest in field of research and is reported to exert psychomodulatory effects through the limbic system. Lavender oil is widely researched for its effects on nervous system and shows calming effects.

Aim: To evaluate Auditory Reaction Time (ART) and Visual Reaction Time (VRT) after 30 minutes of inhalational of lavender oil.

Materials and Methods: This quasi-experimental study was conducted on 30 healthy volunteers after obtaining the clearance from ethics committee and informed consent from the participant. The audiovisual time was recorded twice for each subject, before and after the intervention i.e., 30 minutes of inhalation of lavender oil using aroma lamp. The data was analysed using Statistical Package for the Social Sciences (SPSS) version 20.0.

Results: The present study showed significant prolongation of both ART and VRT (p-value=0.04 and 0.01, respectively) after 30 minutes inhalation of lavender oil from pre-exposure value of ART increased from 0.76±0.25 msec to 0.91±0.31 msec and VRT increased from 0.62±0.20 msec to 0.74±0.18 msec was observed.

Conclusion: The prolongation of ART and VRT indicates the inhibitory effect of the inhalational lavender oil on the central neuron especially in the limbic system, through the activation of GABA (gamma-aminobutyric acid) receptors. Hence, it results in calming effect on the brain, inducing relaxation and sedation.

Keywords: Complementary therapy, Mind body therapy, Phytotherapy, Psychophysiology

INTRODUCTION

Reaction time is defined as the interval between the application of a stimulus and the initiation of a voluntary response when individuals are instructed to respond as quickly as possible. It serves as an effective indicator of cognitive function, involving both sensory and motor systems [1]. When a stimulus is presented, receptors perceive it, transmitting the information to the sensory system, which then relays impulses to the motor system. These signals travel through the spinal cord to the corresponding muscles, resulting in a response. Despite the complexity of this process, it typically occurs within milliseconds. In healthy adults, average reaction times are approximately 20-40 ms for visual stimuli and 8-10 ms for auditory stimuli [2]. Various physiological and pharmacological factors can influence reaction time, including arousal, age, gender, hand dominance, practice, fatigue, fasting, distraction, personality type, punishment, stress, exercise and cognition [3].

Over the past decade, extensive research has been conducted on various essential oils, including lemongrass, lavender, peppermint, rosemary and eucalyptus [4-6]. Recently, lavender oil has garnered attention for its effects on brain wave activity, the autonomic nervous system, stress, pain and emotional states. Diego MA et al., noted that inhaling lavender oil increased mid-frontal alpha power in Electroencephalogram (EEG) readings, leading to greater relaxation and improved mood [7]. Motomura N et al., demonstrated that lavender reduced stress scores while increasing Theta 1 (3.5-5.5 Hz) brain wave activity and decreasing Beta 1 (13.5-20 Hz), which is associated with relaxation [8]. Additionally, Tongnit K et al., reported significant decrease in blood pressure, heart rate and respiratory rate [9]. However, the impact of lavender oil on reaction time has not been extensively explored. Recent studies have focused on aromatherapy, particularly its effects on the Central Nervous System (CNS) [10,11]. This research aims to further investigate how lavender oil influences neural signal processing, with a specific emphasis on the utility of reaction time as a measure of cognitive function. Therefore, this study was designed to assess the effects of lavender oil on neuronal excitability and synaptic transmission by measuring ART and VRT.

MATERIALS AND METHODS

This quasi-experimental study was carried out in Department of Physiology, Geetanjali Medical College and Hospital in Udaipur, Rajasthan, India. The study was started after obtaining permission from Human Research Ethics Committee (HREC) (GU/HREC/2019/1707) and took place from July 2019 to May 2024. The participants were recruited into study after taking their consent to participate.

Inclusion criteria: A total of 30 healthy participants between 18 and 20 years were included in this study.

Exclusion criteria: Participants having cold, hearing defects, or visual impairment was excluded from the study.

Sample size: A total of 30 healthy, age-matched participants were included in this study according to sample size was calculated from the Standard Deviation (SD) of 21 and confidence level of 95%, and precision of 7.5% [12].

Pre-exposure recording: After the preliminary work-up, the audiovisual reaction time was measured in a quiet room using the RTM-608 machine, provided by Medicaid, Chandigarh, India. This device features a sensitive quartz clock capable of measuring time up to 1/10th of a millisecond with an accuracy of ±1 digit [13]. To ensure accuracy and alleviate any fear or apprehension, each subject was familiar with the apparatus and procedure before the test. The test itself was conducted with participate seated comfortably in a chair. Each participate was instructed to use their dominant hand to press the switch on the apparatus upon perceiving the stimulus. Prior to measuring VRT, participate was familiarised with the flashing of red, green and yellow lights. They were then instructed to turn off the light as soon as they perceived it. Overall, nine random stimulation were presented to each subject, which included three stimulation

for each colour of light. To measure ART, the subject was instructed to focus on the sound signal and immediately turn it off by pressing the corresponding button. The stimuli consisted of three sound signals: a continuous beep at 250 Hz, 500 Hz, and 750 Hz. Each of these sounds was randomly presented nine times to participate to record three reaction time readings for each stimulus [14].

Intervention: After the pretest was completed, an aroma lamp was lit five minutes before participants entered the room to ensure the lavender aroma was evenly dispersed. A ceramic aroma burner with a 40 mL capacity was used for the chamber on top. The chamber was filled with water, and 10-12 drops of lavender oil were added. A tea light candle, with a burn time of 45 minutes, was placed under the chamber. Participants were then seated in the room for 30 minutes and instructed not to use mobile phones for games, music, or any other activities that could stimulate the sympathetic or parasympathetic systems. After 30 minutes of exposure to aromatherapy, participants proceeded to the post-test.

Post-exposure recording: The ART and VRT were recorded after 30 minutes of exposure to lavender oil in the same way as done for the pre-exposure.

STATISTICAL ANALYSIS

The data obtained was analysed by IBM SPSS version 20.0. Parameters like age, reaction time were analysed for central tendency as mean ± SD. As this study measured pre- and post-exposure of lavender oil, so Student's t-test was used, and a p-value of ≤0.05 was considered as significant.

RESULTS

The ratio of males to females is this study was 14:16. Mean age of participants, with a standard deviation, was 19.34±0.72 years. [Table/Fig-1] showing the difference of mean VRT and ART (msec) during pre-exposure and post-exposure of 30 minutes inhalational of lavender oil. It was observed that 30 minutes of inhalational lavender oil exposure using an aroma lamp significantly increased VRT and ART (p-value=0.01 and p-value=0.04, respectively) from the pre-exposure levels.

Exposure	Mean VRT±SD (msec)	Mean ART±SD (msec)
Pre-exposure	0.62±0.20	0.76±0.25
Post-exposure	0.74±0.18	0.91±0.31
p-value	0.01**	0.04*

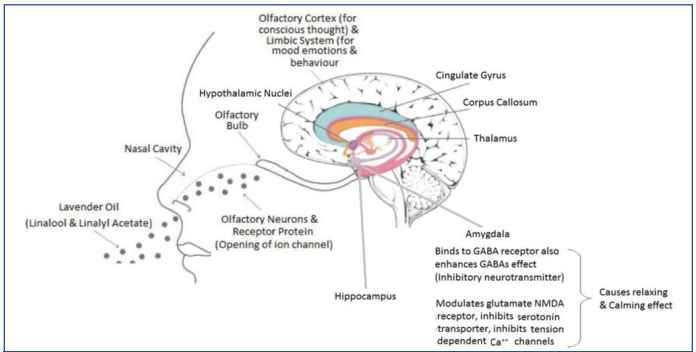
[Table/Fig-1]: Pre-exposure and post-exposure VRT and ART among the study population.
*Significant with p<0.05; **Highly Significant with p<0.01

DISCUSSION

The results of this study indicate that a 30-minute exposure to lavender oil aromatherapy significantly prolongs both ART and VRT in healthy participants. These findings are consistent with previous research, such as that by Moss M et al., who noted that lavender essential oil can impair reaction times in tasks related to memory and attention [15]. Sayorwan W et al., further demonstrated that inhaling lavender oil promotes relaxation more effectively than base oils, suggesting that the calming effects of lavender may contribute to changes in cognitive performance. The mechanisms underlying these effects may involve the modulation of GABAergic neurotransmission [16]. Koulivand P et al., highlighted that lavender oil enhances the inhibitory tone of the nervous system, potentially leading to increased relaxation and altered reaction times [17]. Similarly, Bavarsad N et al., found that lavender oil exerts calming effects through the inhibition of GABA receptors, with linalool, a key component of lavender, binding to glutamatergic N-methyl D-aspartate (NMDA) receptors in specific brain areas such as temporal gyrus [18]. This dual interaction could explain the observed prolongation in reaction times, as it may influence cognitive processing and attentiveness.

Additionally, Shimizu K et al., found that lavender oil aids in maintaining sustained attention during tasks, reinforcing the notion that aromatherapy can have a measurable impact on cognitive function [19]. Furthermore, research by Sriboon R, supports these findings by showing that lavender oil reduces respiratory rates and enhances feelings of calmness, indicating a broader influence on both physiological and psychological states [20].

Thus, this study suggests that inhalation of lavender oil interacts with the nervous system, affecting cognitive and behavioural outcomes. The active compounds in lavender, particularly linalool, linalyl acetate, and β-caryophyllene, likely play significant roles in these effects. This evidence underscores the potential applications of lavender oil in enhancing calming actions and promoting relaxation in various settings. This is shown in [Table/Fig-2], where aromatic molecules of lavender oil enters the nostrils and then goes to the olfactory mucosa. These aromatic molecules stimulate receptor neurone and then it sending electrical signal to olfactory bulb, and then travels to brain which finally connects to limbic system. Lavender oil, hence modulates the limbic system and affects reaction time by: a) Linalool binds to GABA receptor and inducing relaxing and sedative effects while also enhances GABAs effect which is inhibitory neurotransmitter in the amygdala and increases inhibitory tone of the nervous system [21,22]; b) Lavender oil modulates the glutaminergic NMDA receptor, inhibiting the Serotonin Transporter (SERT), 5HT1A receptors, and tension-dependent Ca++ channels, hence lavender oil exerts calming and relaxation effects that increases reaction time [23-25].



[Table/Fig-2]: Showing the mechanism of action of lavender oil on Central Nervous System (CNS).

Limitation(s)

Although the study was carefully designed to evaluate the effect of inhalational lavender oil on ART and VRT, a longer exposure period, such as one month, might have yielded more significant results. Additionally, the absence of a control group limits the ability to rule out the placebo effect.

CONCLUSION(S)

The present study proposes that the lavender oil, when used in inhalational form, results in prolongation of ART and VRT, indicating slowing of synaptic transmission by exerting the inhibitory effect through GABAergic, glutaminergic NMDA receptor, serotonergic receptors in limbic system. Future studies can explore the effects of long-term exposure lavender oil on the reaction time or attention span of the participants.

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