The effect of pleasant olfactory stimulation on physiological responses

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Abstract

Using odors with the different concentration of essential oils, we studied the effect of a pleasant olfactory stimulation on physiological responses. We examined psychological response, mental task and changes in cardiac, immunity and EEG in responses to 150times solution (feel easily) and 500times solution (feel with difficulty) which of essential oil (called PCK) were diluted in propylene glycol, and neutral (water). The 150times solution that was felt pleasant produced significant differences ($p<0.05$) in relative power change of beta activity in the left frontal region (Fp1, F3, F7) of the brain, and heart rate (HR) deceleration after mental task. These results are consistent with substantial research that has documented cardiac and EEG responses to pleasant stimuli. What is more, 150times solution increased the concentration of s-IgA known as an index of immunity.

Key words: essential oil, pleasant olfactory stimuli, EEG, heart rate, the concentration of s-IgA

1. Introduction

An emotion can be activated by causes and processes within the individual or by a combination of internal and external causes and processes. The sense of smell will play a crucial role in our emotional well-being. One of the most important topics in olfactory realm related to human emotion is physiological responses to pleasant stimulation. Several studies have now documented that pleasant and unpleasant odors can effect on psychophysiolog -ical responses. For instance, as we are felt to be pleasant and refreshing to an odor, alpha in left frontal and anterior temporal sites of brain decreases [1)2)], and SNS activation decelerates[4)]. These result having documented, were studied using odors of various kinds. So, that the present study examined What does a pleasant olfactory stimulation effect on physiological responses during exposure to different concentration of an essential oil?"

2. Materials and Methods

2.1. Subjects and Experimental Environment

Fifteen college students (19-25years old males) participated in the study. The experiments were carried out in a laboratory remaining constant at 28 and 60% humidity levels.

2.2. Stimuli and Experimental situation

Three odorant conditions, water as neutral (no odor condition) and two solutions of essential oil (called PCK) having different concentrations, were presented randomly. Two solutions of essential oil were diluted in propylene glycol; 150times solution of essential oil is felt easily and 500times solution of essential oil is felt with difficulty. The experiment was performed on three separate days.

A olfactory stimulation in washing glass were delivered via an olfactometer at a flow rate of 3000ml/min and were presented via the odorant

nozzle positioned below the subject's nares. An extraction unit, placed about 30cm away from the subject's head, helped to remove residual environmental odors. Experimental situation is shown in Figure 1.

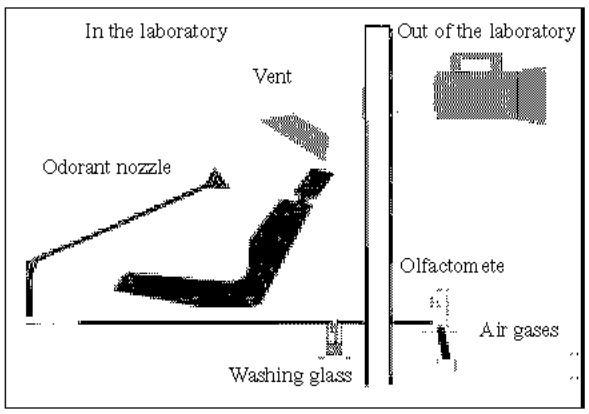

Figure 1. Experimental situation

2.3. Procedures

Initial baseline measurements of physiological signals were taken. In presentation of olfactory stimuli, We took measurements of physiological signals in parts of Section A (resting time), Mental task, Section B(resting time after mental task). Time schedule is shown in Figure 2.

2.4 Recordings and analysis

Subjects were asked to provide subjective reports of How relaxed, concentrated, like, pleasant etc and in addition intensity. They felt in response to the odorant on a 0-10 scale.

EEG data were collected from 19 electrode sites (Fp1, Fp2, F3, F4, F7, F8, Fz, C3, C4, Cz, P3, P4, Pz, T3, T4, T5, T6, O1, O2, monopolary referred to ipsilateral earlobe) in International 10/20system. EEG spectral power(FFT, Hanning window) was calculated for following frequency bands;• (0.5• • 3.99Hz)• • (4• 7.99Hz)• • (8• 12.99Hz)• • (13 • 30Hz).

ECG was acquired with sampling rate 1Khz. Heart rate (HR) was calculated and Inter-beat intervals of ECG were resampled at 10Hz basis and analyzed with FFT using Hanning window.

The Salvia sample was obtained from 4 different parts in the mouth. Salivary IgA was measured using capture ELISA.

Mental task was performed using an addition task and % of correct answers was calculated.

Statistical analysis was performed by SPSS package using One-Way ANOVA and t-test for paired samples, in parts of Base and from Part 1 to Part 4 for each 3minutes(Figure 2).

Results

In results of subjective report (Figure 3), pairwise comparisons indicated that 150times solution was rated as significantly more pleasant than water. Furthermore, 500times solution was not rated as significantly more pleasant than water.

(Minutes)

	No presentation of olfactory stimulation			Presentation of olfactory stimulation				
	Rest	Baseline		Section A		Subjective Report	Mental task	Section B
	(15)	(3)	(5)	(15)	(5)	(1)	(5)	(15)
EEG								
ECG								
Saliva								

• Analysis Base Part1 Part2 M Part3 Part4

Figure 2. Procedures

In results of EEG (Figure 4), we found increased relative left frontal activation with pleasant odor administration. The presentation of 150times solution to be felt pleasant resulted in increased beta compared to a neutral, no-odor condition (water) in left frontal (Fp1, F3, F7) of brain. But the present study could not find decreased significant alpha in any part of brain.

In result of heart rate(Figure 5) changes throughout the time schedule, 150times solution and 500times solution decreased heart rate in Section A(rest time; after presentation of a odor). Furthermore, we found heart rate decrease in presentation of only 150times solution after mental task.

In result of the concentration of s-IgA (Figure 6) that may involve neural-immune connections, only 150times solution to be felt pleasant induced significantly difference between Pre-stimulation and post--stimulation.

Conclusions

150times solution to be felt subjectively, compared to baseline, increased beta in left frontal of brain. According to a few studies documented EEG responses to pleasant stimuli, Van Toller et al. (1993)

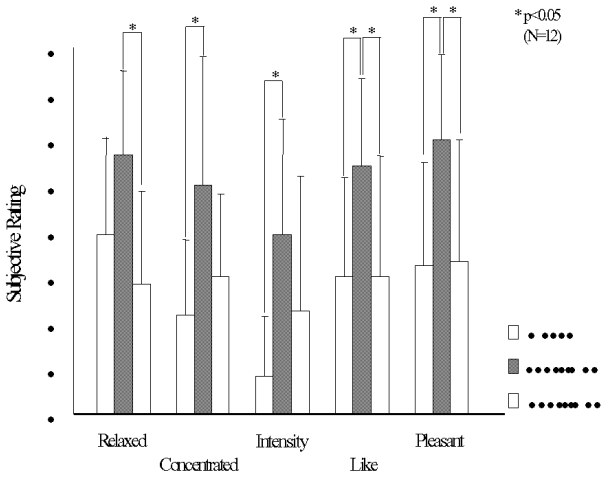

Figure 3. Subjective ratings for water, 150times solution and 500times solution.

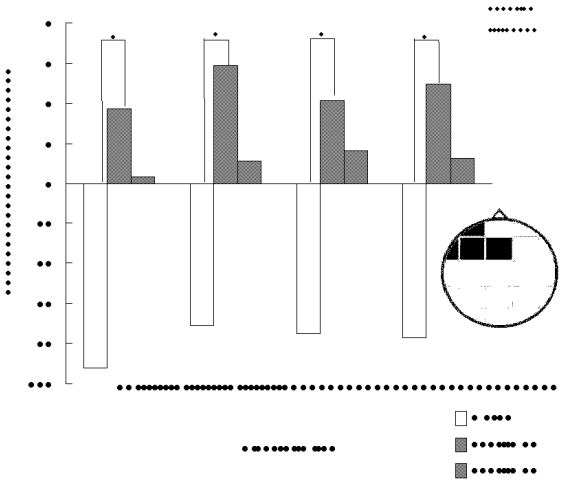

Figure 4. Significant differences in relative power change o• • beta (Fp1, F3, F7, Fpz) among each olfactory stimuli in the part2.

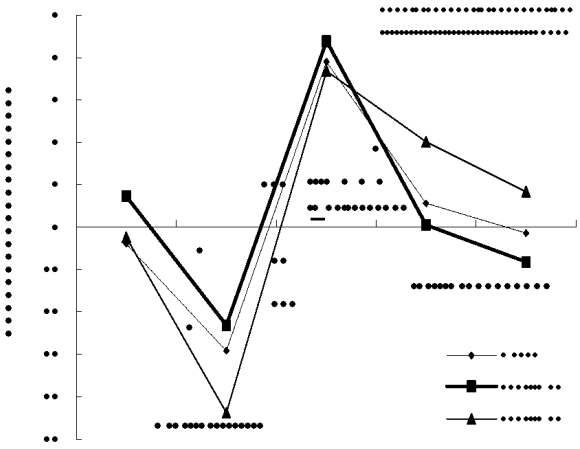

Figure 5. Heart Rate response throughout the time schedule

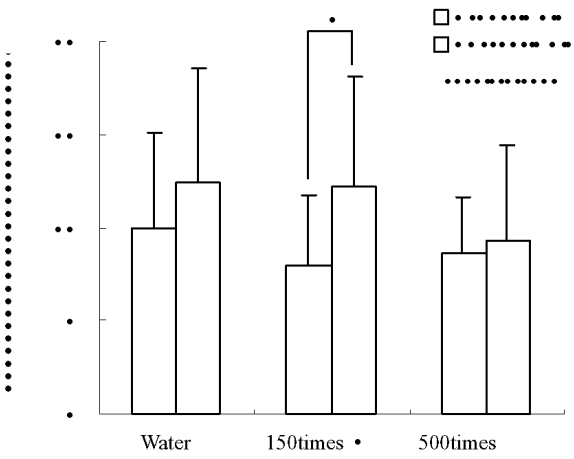

Figure 6. The concentration of s-IgA (Pre-stimulation vs. Post-stimulation)reported that a pleasant odor

decreased alpha over left frontal and anterior temporal sites compared to a blank control. John P. Kline et al. (2000) reported that a pleasant odor increased left frontal activation (decreased alpha). Obtained results of EEG responses in this study are consistent with those researches above, so that extend the phenomenon of left frontal activation in response to pleasant stimuli into the olfactory arena.

150times solution to be felt decreased heart rate in resting time (after presentation of a odor) and after mental task. HR decrease is yielded by SNS decrease or PNS increase. Miyazaki et al. (1996) reported that á-pinene, which is a major fragrance component of trees, was felt to be pleasant and decreased SNS activation. So that, HR decrease in response to pleasant stimuli could be considered to decrease SNS activation. However, 500 times solution not to be felt decreased HR as like 150 times solution at rest time. That can be assumed that using olfactory stimuli in this study have a component to make SNS activation decrease or PNS activation increase. But, 150 times solution decreased HR after mental task but 500 times solution did not. That was considered that 500 times solution did not have an intensity to make SNS activation decrease. Namely, it is considered that pleasant emotion have an effect on SNS activation decrease.

In the result of salivary IgA, 150times solution to be felt increased the concentration of s-IgA but 500 times solution did not. That is suggested that pleasant emotion have an effect on improving immune status. Schiffman et al. (1999) reported that taste and odor stimulation (flavor drops & sugar) increased immune status compared to a neutral, no-taste and no–odor condition (water). Pleasant and unpleasant emotions are generated by CNS and effect on ANS, Endocrine system and Immunity system.

References