■ 研究論文

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Effects of Fragrance on Brain Activity

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ABSTRACT

Among many kinds of odors, some are known to have effects of sedation or stimulation on brain activity. In this study, brain activity levels affected by four kinds of fragrance - lemon, lavender, jasmine, and rose - were tested using EEG recording. In the first experiment, the quality of alpha wave was examined under controlled rest condition. In the second experiment, the event-related potential (ERP) and contingent negative variation (CNV) were investigated during a simple reaction tasks (SRT) against auditory signal. EEG data obtained for the rest condition were analyzed using "3-Dimensional Viewer (3D Viewer)" which was developed by ourselves to show the chaotic attractor of the signal. Power spectrum were also calculated using FFT. EEG data obtained during the SRT were analyzed by comparing CNV amplitudes about each odor condition. Results confirmed the sedative effect of the lemon and the lavender, and the stimulative effect of the jasmine and the rose.

INTRODUCTION

Among many kinds of odors, some are known to have effects of sedation or stimulation on brain activity. There have been attempts to measure the psychological effects of odors using EEG recording (Dodd and Van Toller, 1983). But, no electrical brain wave responses to odors have been confirmed (Allison and Goff, 1967; Pattig and Kobal, 1979; Tonoike and Kurioka, 1982).

It has been well known that low-frequency high-amplitude wave of EEG (alpha wave: frequency band:8-14 Hz ; amplitude range:5-100μV ; awaked, relaxed, in closed eye condition) is generated from relaxed brain, while high-frequency low-amplitude wave (beta wave: frequency band:14-25Hz ; amplitude range:2-20μV ; awake, alert, in eye open condition) comes from highly activated brain.

In 1964, Walter et al. found an electrical phenomenon in the human brain that they called the contingent negative variation (CNV). CNV is an upward shift in the brain waves affected by the psychological factors such as attention (Tecce and

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Scheff, 1969), expectancy (Walter et al., 1964), conation (Low et al., 1966), and altered states of consciousness (Naito, Johnson and Lubin, 1971; Yamamoto, Saito and Endo, 1984). Torii et al.(1986) examined and asserted the relations between the degree of CNV shift and the effect of odors.

Correlation methods were also applied to EEG signal analysis problems, such as recognition or comparison of waveforms (Shaw, 1967; Lange, 1967; Shaw, 1974; Remond, 1977). Rapp et al.(1989) considered EEG as a chaotic system signal. Chaotic system, one particular class of dynamic system, can be very simple and deterministic - yet it can display highly disordered, turbulent behavior. Chaotic signal can be represented using two dimensions, fractal and correlation dimension. Values of these dimensions can be estimated using the Grassberger-Procaccia algorithm (Grassberger, and Procaccia, 1984).

EXPERIMENTS

Three healthy undergraduate students participated in the experiments (a female and two male subjects). Four kinds of fragrance were tested. Perceived intensity level of each fragrace was pre-tested by twenty panels. Then, all fragrance diluted to have the same perceived intensity (the volume concentration of lavender was 20%, lemon was 5%, jasmine was 10%, and rose was 5%). EEG was recorded by monopolar method using Ag-AgCl surface electrodes. Active electrodes were attached at Fz, Cz, and Pz points on the scalp following the

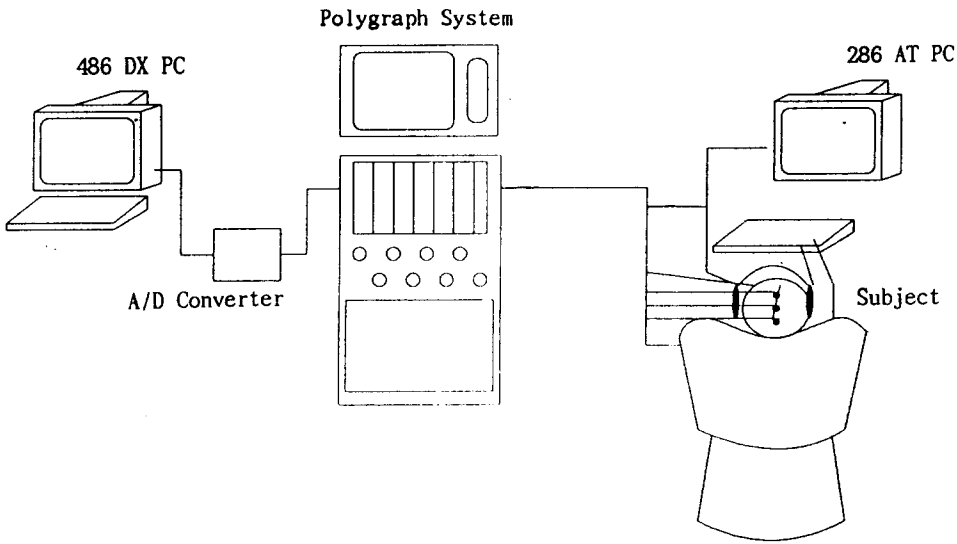
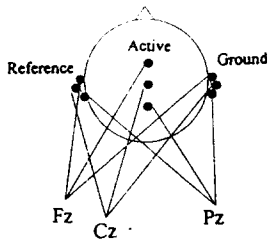
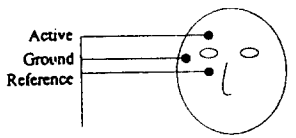


Figure 1. Schematic diagram of experiment.

a) EEG



b) EOG



c) ECG

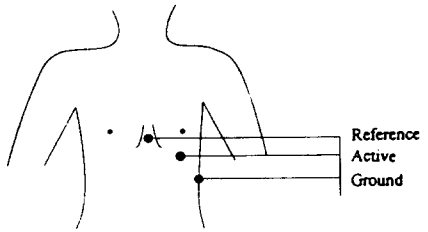


Figure 2. Electrode attachment

international 10-20 electrode system. Reference and ground electrodes were attatched at the left and right earlobe. EOG and ECG were also recorded during the test for checking the artifacts. Schematic diagram of the experiment and locations of electordes were presented in figure 1 and 2, respectively.

Experiments were performed for randomly selected two odor conditions-one has sedative and the other has stimulative effect-on each day per a subject. Experimental procedure was divided into two parts.

Experiment I was for investigating the effects of odors on the relaxed brain. Subjects were seated in a comfortable chair closing their eyes, and were instructed not to move eyeballs during the experiment. When the brain activity level of a subject became low, showing alpha wave in EEG, an odor was provided without any notification. EEG was continuously recorded.

Experiment II was for recording the ERP and CNV in SRT. Two auditory stimuli (S1 and S2 with 1600 miliseconds of inter-stimulus interval) were provided in order. Subject was instructed to push down a key against S2 as quickly as possible. A personal computer was used to generate sounds and to measure simple reaction time for S2. EEG was continuously monitored during the SRT, and digitized from one second before S1 to one second after S2.

Those biosignals were digitized at 512 samples/second using A/D convertor, and saved for analyses.

ANALYSES

Experiment I : Digitized EEG data were analyzed using 3D Viewer to show the scatter diagram of the chaotic attractor. Correlation dimension (also refered as "Delay") was estimated to 5 using Grassberg-Procaccia algorithm. In the 3D Viewer, only 50 points of digitized signal were continuously examined. Power spectrum was calculated using 512 points FFT to show the composition of EEG signals.

Experiment II : Digitized EEG data were analyzed by averaging to investigate CNV. In a set of EEG data of a SRT, data with eye movement were discarded. Therefore, number of samples for a CNV of a subject were varied. Averaged EEGs for different odors were compared with those of no odor within subjects.

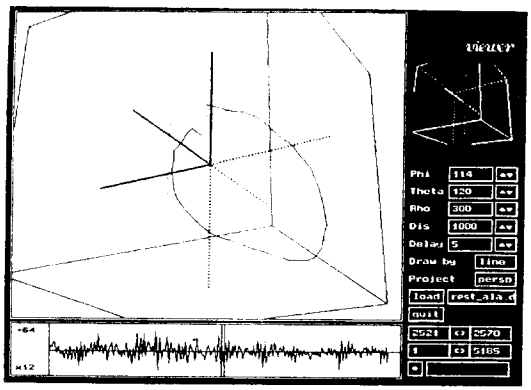
RESULTS

Raw EEGs and FFT analysis did not show differences between odor and no odor conditions. However, scatter diagrams for lemon and lavendor were round and egg-shaped, while those of jasmine and rose had rough and saw-toothed shapes. This implies that EEGs recorded in the lavendor and lemon odors have relatively pure alpha wave components, and that EEGs in the jasmine and rose odors have higher frequency component. Since low frequency wave relates with mental relaxation, lavender and lemon can be said to have effects of relaxation, and jasmine and rose have arousal effects. Figure 2 shows raw EEG, FFT results, and attractor scatter diagrams.

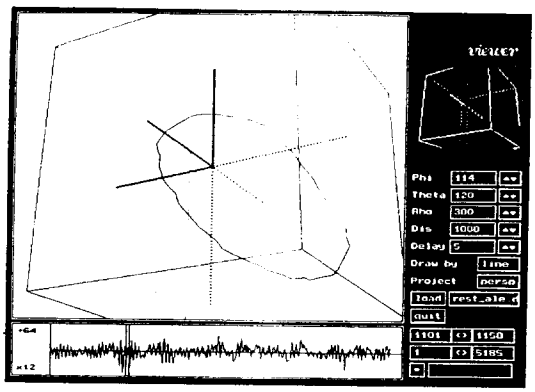
Figure 3 shows averaged EEG signal (CNV) obtained in the SRT for all odor conditions, and Table 1 summarizes the mean amplitude values at several regions. The results are similar to those of other study (Torii et al., 1986). Averaged EEGs in the jasmine and rose odor conditions have higer amplitudes than those in lemon and lavender conditions. This means jasmine and rose have an enhancing effect on brain activity so it can be classified as stimulative odor, while the lemon and lavender have a sedative effect.

CONCLUSIONS

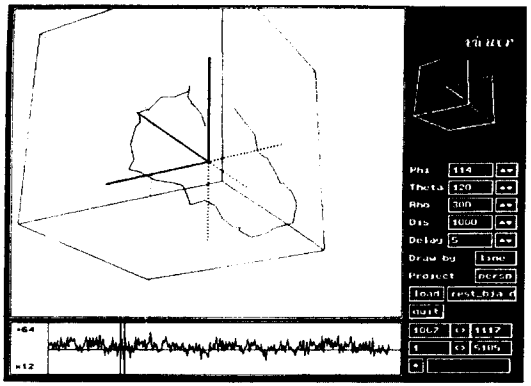
The chaotic attractor scatter diagram and CNV of EEG signal were analyzed to evaluate effects of odors on brain activity level. It was confirmed that lemon and lavender have sedative effect while jasmine and rose have stimulative effect.



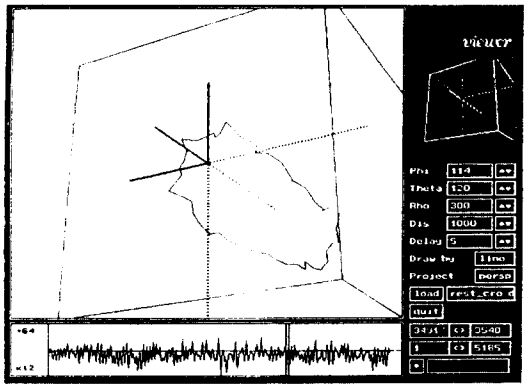
a) Lavender



b) Lemon



c) Jasmine

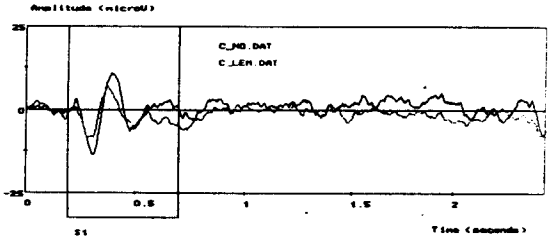


d) Rose

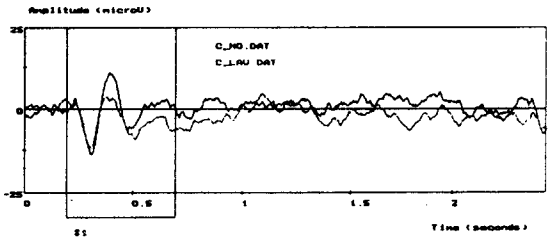
Figure 3. Chaotic attractor scatter diagrams of EEG (Subject A)

Table 1. Amplitudes of the averaged EEG during SRT (Subject A)

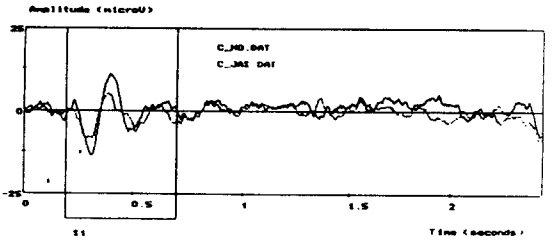
Odor Type	Negative Peak	Positive Peak	Region 1 (0.5-0.8s)	Region 2 (0.8-1.4s)
Lemon	8.82	6.81	-3.6417	0.1204
Lavender	11.96	3.67	-5.1981	-0.7205
Jasmine	9.09	5.27	-2.1015	1.1252
Rose	6.48	7.07	-1.2582	1.3168



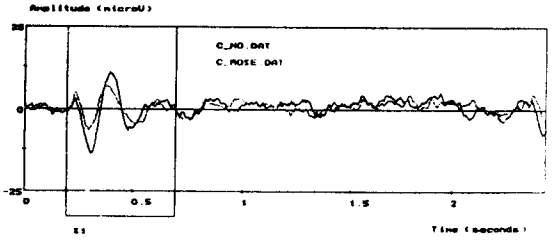
a) Lemon vs. no odor



b) Lavender vs. no odor



c) Jasmine vs. no odor



d) Rose vs. no odor

Figure 4. CNV comparisons between various odor conditions (Subject A)

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Contingent negative variation (CNV) and the psychological effects of odour.