

Masako HASEGAWA-OHIRA¹, Shusaku NOMURA¹

THE EFFECT OF THE ODOR OF ISOVALERIC ACID AND JAPANESE CYPRESS ON HUMAN IMMUNE AND ENDOCRINE SECRETION – A PRERIMINALY STUDY

The effect of pleasant and unpleasant odor on human physiological state was preliminary investigated by assessing salivary substances. A term “pleasant” (or unpleasant) is rather showing one’s subjective and thus mental state meanwhile the odor itself should give an impact to both human mind and body. This study was aimed at investigating an effect of pleasant/unpleasant odors on human body and mind. In the experiment the odor of isovaleric acid, as an unpleasant odor, and Japanese cypress, as a pleasant one, were exposed to subjects for 18 minutes. Salivary immune substance (Immunoglobulin A: IgA) and glucocorticoid (cortisol) were determined every three minutes as for an indices of the impact of the odors on human immune and endocrine secretion. As a developing result, IgA showed an increase by isovaleric odor whilst cortisol decreased, even though the concentration of that unpleasant odor was too low to be aware of. These changes in the secretion of the substances were discussed in relation with human physiological stress reaction mechanism.

1. INTRODUCTION

1.1. IMPACTS OF THE ODORS ON HUMAN BODY AND MIND

Considerable research has been demonstrated that odors possess both physiological and psychological effects. Diego et al. (1998) showed that the lavender aroma contributed to induce relaxation as represented by EEG pattern. Moreover it also contributed to improve the performance of a given task, i.e. the improving accuracy and duration against a given arithmetic task [4]. Atsumi et al. (2008) demonstrated that the lavender aroma stimulated parasympathetic nervous system and induced antioxidant system activity, meanwhile a typical unpleasant odor, isovaleric acid, did not give any impact on antioxidant system [2].

On the other hand, effects of the odor of Japanese Cypress, which is a species of cypress native to Japan, are getting a lot of attention. This cypress is a popular and high quality timber in Japan and has a unique scent. It is known to alleviate psychological mood states such as fatigue, anger, depression and tension, lower the blood pressure, and improve performance in the work place [5].

As just described, the effects of odor on human body have been frequently assessed by autonomous and central nervous system indices. In this study, by contrast, the effects of odors on human body and mind were investigated focusing on the secretion of hormone and immune substances. The background is briefly described in the next.

1.2. PSYCHONEURO(-ENDOCRINE)-IMMUNOLOGY (PNEI)

Recent development on molecular analysis techniques has revealed a close relationship between human mental state and secretions of hormones, immune and other secretory substances within human body. Currently more than ten kinds of such substances were known to change its level sensitively according to his/her mental state, especially human mental stress [11]. Therefore these substances are

¹ Top Runner Incubation Center for Academia-Industry Fusion, Nagaoka University of Technology, Japan.

considered to be an objective barometer of human mental state. This relatively new field of study, investigating human somatic-mental interaction, has nowadays formed an interdisciplinary scientific field, named “Psychoneuro(-endocrine)-immunology (PNEI)” [1].

According to the past PNEI studies, these substances are known to increase by various psychological stressors. Then it has been frequently considered as possible stress bio-markers. On the other hand, there were some PNEI studies investigating the effect of subjects’ positive affection or intervention. A few studies have reported the effects of music on human secretory endocrine and immune system [7]. According to these studies, music alleviated stress-induced enhancement of these stress bio-markers. Moreover music makes a recovery from enhancement of these stress bio-markers more rapidly than noise and silence conditions [8]. A study targeting on the mental workload of air traffic controllers showed that the adequate social support also alleviated the stress induced bodily change of the workers [12].

As just described PNEI studies can be a possible methodology investigating a relationship and/or intervention between the positive and negative mental states and his/her physiological modulation. However there is few studies targeting on the effects of odor in the stream of PNEI studies so far [10]. Odors certainly give various impacts on human psychological and physiological state simultaneously as described above. Since “odor” is originally comprised of “chemical substances”, so it should possess physiological or even pharmacological behaviors. Therefore PNEI study in which hormones and immune systems are emphasized should be an ideal and direct methodology to investigate the odor-induced human somatic-mental chain interactions rather than a battery of conventional psycho-physiological measures, such as heart rate, blood pressure, brain waves and so on.

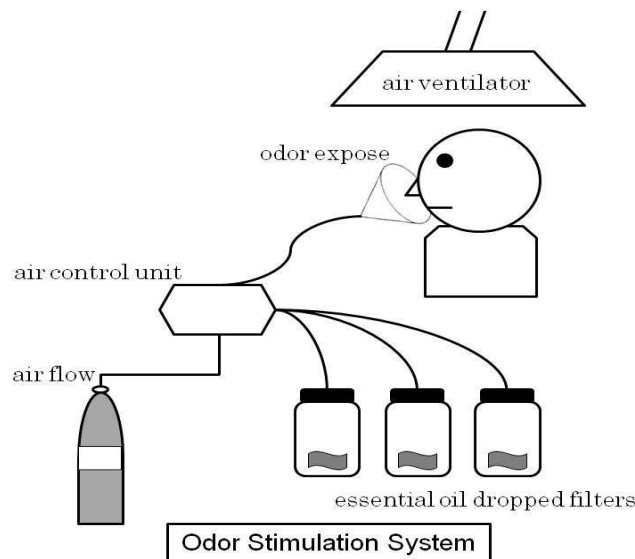


Fig. 1. Schematic design of the experiment.

2. METHOD

In this study, the effects of the odor of Japanese cypress, as a pleasant odor, and isovaleric acid, as an unpleasant one, on human hormonal and immune secretion were investigated.

With regard to secretory substances, Immunoglobulin A (IgA) and cortisol contained in saliva were assessed. Both substances have been frequently introduced in the past PNEI studies. IgA is one of the most important immune substances which work on protecting human body from virus infection and preventing from bacteria colonization [3]. Cortisol, a steroid hormone, is a dominant glucocorticoid. It is secreted from adrenal cortex and regulates blood glucose level. In addition, cortisol is released into a blood stream reflecting the activation of hypothalamus-pituitary-adrenal axis (HPA axis), which is a major human stress reaction pathway. Since HPA axis is considered to be a primary stress reaction pathway in our body, cortisol was frequently called as a “stress hormone” [6]. Both substances play

a very important role for maintaining our somatic health, and therefore it is of worthy to investigate the odor-induced modulation of these substances.

Fig.1 shows the schematic design of the experiment. Subjects were exposed to the odor of Japanese cypress or isovaleric acid for 18 minutes in the temperature and humidity controlled room. In addition these odors in the high or low concentrations were prepared by Odor Stimulation System (HR-01: Hakuya Shogyo Co. Ltd., Japan), by which the air flowing rate was controllable. This system enables experimenter to present an odor in high or low concentration to a subject by the constant stream of odor-serving air. Pleasant (or unpleasant) odor is prepared in the manner of dropped the essential oil of Japanese cypress (or isovaleric acid) on the filter paper.

Saliva samples were taken at 3 minutes before and after the odor exposure, and every 3 minutes during the odor exposure session. IgA and cortisol concentration were determined by Enzyme-linked Immunosorbent Assay (ELISA) (Salivary EIA Kit; Salimetrics Inc., USA). Total amount of each substances secreted during every 3 minutes were calculated by multiplying each concentrations by the saliva volume collected in each 3 minutes.

3. RESULT AND DISCUSSION

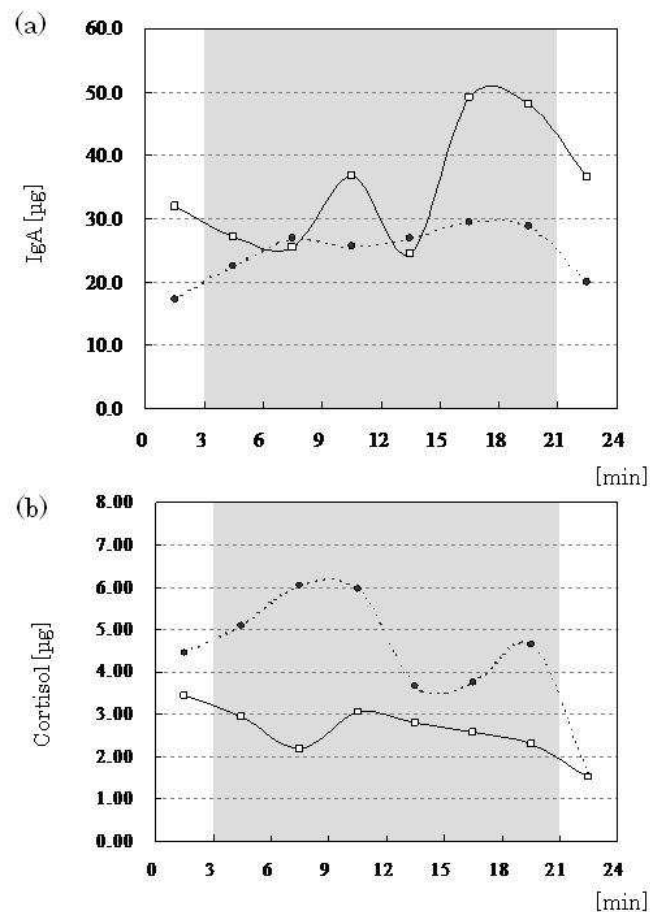


Fig. 2. Change in (a) IgA and (b) cortisol by exposure of pleasant and unpleasant odor. Gray background represents the odor exposure period. Solid and dashed line represents the isovaleric and cypress condition.

Fig. 2 shows the change in IgA and cortisol concentration during pleasant (cypress) and unpleasant (isovaleric acid) exposures. IgA increased after 18 minutes of exposure of isovaleric acid, meanwhile cortisol decreased for both isovaleric and cypress as shown in Fig.2. The total IgA was significantly higher in the isovaleric exposure than in the cypress ($p < .05$). By contrast the total cortisol was significantly lower in the isovaleric exposure than in the cypress ($p < .01$).

In the past PNEI studies, temporal IgA elevation was reported to associate with acute psychological stressors, such as a mental arithmetic task and computer game [3], whilst lower cortisol was reported to

associate with mental stress and negative affection [9]. Therefore, the elevation of IgA and lower cortisol observed in this study might be taken as reflecting subjects' stress and negative mental states.

On the other hand, Fig. 3 shows the change in IgA and cortisol during isovaleric acid exposure either in the high or low concentration. As a result, almost the same profile of IgA and cortisol changing was observed irrelevant to the concentration of the odor. The air volume per unit time raised by above-mentioned Odor Stimulation System was more than 20 times greater in the high odor concentration condition than that in the low condition. Then roughly speaking the amount chemical substance of the isovaleric acid exposed in the high condition was expected to be as 20 times much as that in the low condition. In fact the frequency of subjects' perception of the isovaleric odor counted during these high and low exposure sessions were significantly different as shown in Fig.4.

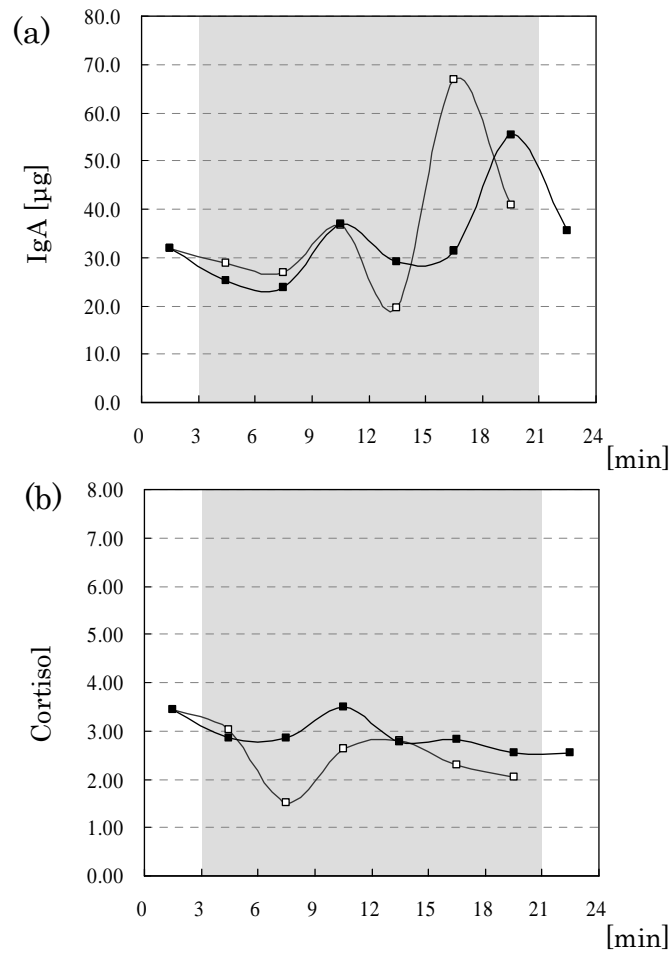


Fig.3. Change in (a) IgA and (b) cortisol by exposure of two different concentration of isovaleric odor. Gray background represents the odor expose period. The profile in the black and gray line represents the high and low concentration exposure session. It should be noted that the baseline of the substances were averaged and adjusted to the same level.

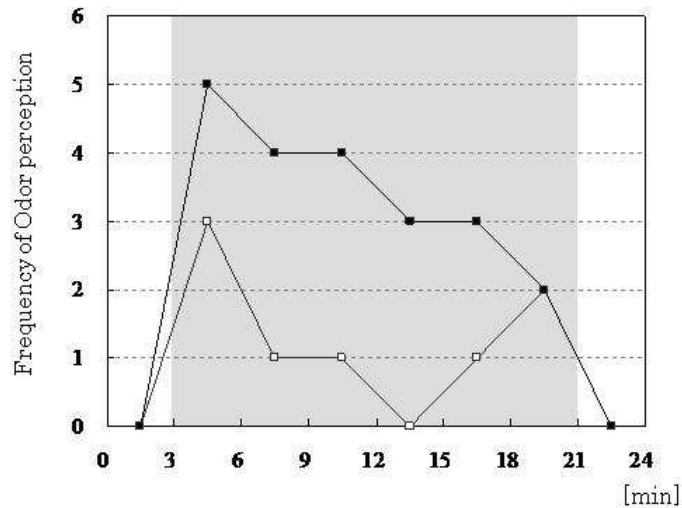


Fig.4. Frequency of subjects' perception of the isovaleric odor. Gray background represents the odor exposure period. The profile in the black and gray line represents the high and low concentration exposure session.

There might be two possible interpretations for the results of this study. One is that the “*anticipation*” of unpleasant odor exposure induced a sort of negative affection. Then such a negative mental states as a result initiated the physiological stress reaction as represented by the elevation of IgA and lowering of cortisol. On the other hand, more intriguingly, when one refers to the result in the high or low odor concentration sessions (Fig.3), such a physiological stress reaction could be taken place even if subjects were “*not aware of*” the unpleasant odor; it can be said “our body might knows much more than we knows”.

It cannot be concluded so far whether the change of human somatic state would precede the mental state or vice versa. To say the least there is no doubt that the subjectively “pleasant” or “unpleasant” odor gives a certain impact on human body in relation with physiological stress-reaction mechanism even though the odor is not enough strong to perceive. Although PNEI is still a new field of study and has a lot of challenges to be solve, the result of this study leads us to an idea of ambient controlling of our body and mind by aroma presentation in the abiding and/or work place.

BIBLIOGRAPHY

- [1] ADER R., FELTEN L., COHEN N., (Eds.), Psychoneuroimmunology, 3rd ed, Academic Press, 2001.
- [2] ATSUMI T., TONOSAKI K., FUJISAWA S., Salivary free radical-scavenging activity is affected by physical and mental activities, Oral Dis, 14, 2008, pp. 490-496.
- [3] BOSCH J.A., RING C., de GEUS E.J., VEERMAN E.C., AMERONGEN A.V., Stress and secretory immunity, Int Rev Neurobiol, 52, 2002, pp. 213-253.
- [4] DIEGO M.A., JONES N.A., FIELD T., HEMANDEZ-REIF M., SCHANBERG S., KUHN C., MCADAM V., GALARNAGA R., GALARNAGA M., Aromatherapy positively affects mood, EEG patterns of alertness and math computations, Int J Neurosci, 96, 1998, pp. 217-224.
- [5] ISHIMATSU S., OHGA Y., Ishidao T., HORI H., Antimicrobial activity of hinokiol against Legionella pneumophila, J UOEH, 25, 2003 pp. 435-439 (in Japanese).
- [6] KIRSCHBAUM C., HELLHAMMER D.H., Salivary cortisol in psychoneuroendocrine research: recent developments and applications, Psychoneuroendocrinology, 19, 1994, pp. 313-333.
- [7] KNIGHT W.E., RICKARD N.S., Relaxing music prevents stress-induced increases in subjective anxiety, systolic blood pressure, and heart rate in healthy males and females, J music Ther, 38, 2001, pp. 254-272.
- [8] NOMURA S., TANAKA H., NAGASHIMA T., A Physiological index of the mental stresses caused by the deskwork with VDT and the relaxation by music. in Proceedings of The International Conference on Sensors and New Techniques in Pharmaceutical and Biomedical Research, 2005, pp. 130-134.
- [9] SCHLOTZ W., SCHULZ P., HELLHAMMER J., STONE A.A., HELLHAMMER D.H., Trait anxiety moderates the impact of performance pressure on salivary cortisol in everyday life, Psychoneuroendocrinology, 31, 2006, pp. 459-472.

- [10] TANAKA H., Imai J., NOMURA S., KANEKI N., SHIMADA K., KASUGA N., NAGASHIMA T., Effects of the Odor of Lavender on the Change of Immunoglobulin A Level during Repetitive Cognitive Task, *Journal of Asian Design International Conference*, 1, 2003, pp. 135-140.
- [11] WAKITA S., TANAKA Y., and NAGAI H., High Throughput Screening for Stress Marker, *Bunseki*, 2004, pp. 309-316, (in Japanese).
- [12] ZEIER H., BRAUCHLI P., and JOLLER-JEMELKA H.I., Effects of work demands on immunoglobulin A and cortisol in air traffic controllers, *Biol Psychol*, 42, 1996, pp. 3413-3423.