Chapter 17
Kansei’s Physiological Measurement and its Application (1):
Salivary Biomarkers as a New Metric for Human Mental Stress

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ABSTRACT
Recent behavioral medicine studies have revealed that various human secretory substances change according to mental states. These substances, the hormones and immune substances show transient increase against mental stress. Therefore it is frequently introduced as an objective index (biomarker) of mental stress. Especially the biomarker which is detectable by human saliva is expected to be a new and practical stress measurement as it can be sampled in less stressful and noninvasive manner unlike blood and urine. In this chapter, the biomarker research, its background, methodology, experiment, and numerical simulation approaches are introduced. Also in the end, it is stated as a possible approach towards a measurement of Kansei.

1. INTRODUCTION
Issues on mental health are an acute and global problem. It is not only a problem for individuals but also a social problem. International Labor Organization (ILO) reported different impacts on the societies, e.g., the social cost of mental health problem in European Union was estimated to be on average 3 to 4% of GNP (Gabriel, 2000). However generally speaking, the mental stress is quite difficult to be aware of personally. It is hard for anyone to manage mental stress by on his/her own. Therefore it is an urgent task to figure out a “practical” methodology to evaluate, manage and control the mental stresses.

On the other hand, recent developments of the molecular analysis techniques enable scientists to assess tiny amount of substances containing in the human secretory fluids. It has been revealed that some hormones and immune substances secreted within human body change its level in responding to human mental state. For instance, salivary
Immunoglobulin-A shows a transient increase against short-term psychological stressors such as mental arithmetic task, stroop task, academic presentation (Valdimarsdottir, 1994). Such a change in the secretion can occur even if a given stressor was relatively mild one by which the heart rate and/or blood pressure could not show any significant change. Thus such a biochemical substance can potentially be a practical biomarker for human mental stress. Currently number of such possible biomarkers have been reported in behavioral medicine and psycho-physiological studies (Izawa, 2004; Wakida, 2004), and it forms a new interdisciplinary research field called psychoneuroendocrinology (PNE) and/or psychoneuroimmunology (PNI) (Ader, 2001) (hereafter, we use the term psychoneuroendocrine-immunology (PNEI) to indicate both PNE and PNI).

PNEI must be a contributory research field which should possibly establish a “practical” criteria for objectively evaluating human mental state, however because PNEI is a new and developing research field basic knowledge on these possible biomarkers as an objective marker for mental stress have not yet been demonstrated, e.g., the precise stress response of these biomarkers in the time series, the scope of application other than the “acute” stressors, and the relationship with other biological measures for mental stress such as heart rate, blood pressure, and brain waves.

In this chapter, PNEI research, its background, method, experiments, and kinetic model approach are introduced. Also in the end, PNEI is stated as a possible approach towards the measurement of Kansei.

2. BIOMARKERS

HPA and SAM Systems as the Stress Reaction Pathways

An array of secretory substances has already been reported to be changing according to given stressors (Izawa, 2004). Thus, these substances are taken as “biomarkers” for human psycho-physiological state. In the PNEI studies, mainly seven biomarkers falling under the categories of hormones, immune substances, proteins and enzymes; Immunoglobulin A (IgA), cortisol, human Chromogranin A (CgA), alpha-amylase, Dehydroepiandrosterone (DHEA), Dehydroepiandrosterone sulfate (DHEA-S), and testosterone (TE) has been frequently employed (Deguchi, 2006; Bosch, 2002; Michael, 2000; Nakane, 1999; Kirschbaum, 1994).

The reaction mechanism of the substances against the human mental stress is considered in relation with the human physiological stress reaction pathways. The existing two internal stress reaction pathways are namely: (1) hypothalamus-pituitary-adrenal (HPA) and (2) sympatho-adrenal-medullary (SAM) system (Kirschbaum, 1994) as shown in Figure 1. These seven biomarkers