Brain information processing for affective (kansei) response investigated by simultaneous non-invasive brain measurement and psychophysical approaches, and development of brain function models

Supervisor (Principal Investigator)

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1. Objective

The main interest of this research is to investigate higher and more complex responses concerning human perception, recognition and judgment concerning affective (kansei) responses, rather than the simple responses traditionally measured in physiological and psychophysical experiments. In addition, brain function models, which are suitable to explain information processing and cognition and to predict human judgment, will be constructed quantitatively and mathematically. These new brain function models should also be practical and phenomenological for applications developed for practical purposes.

2. Project Outline

(1) Background:

Some types of brain activity are connected with the early stages of information processing, in which information from the environment is analyzed and integrated. Higher stages of information processing in the brain include activities for recognition, judgment, decision-making, and preparation for behavior with memory control. Even in simple stimulation and response scenarios, such brain activities are very complex and have interactions between them. It has been difficult for traditional physiological approaches to investigate the relations between activities in different areas of the brain, even in non-human primates. On the other hand, the psychophysical method using human observers is a good way to investigate more complex relationships for conforming affective (kansei) responses, but it is available only in terms of input-output relationships, i.e. as a black box.

Recent non-invasive brain measurement techniques, especially EEG (Electroencephalogram) and fMRI (functional Magnetic Resonance Imaging), enable the investigation of interaction between different areas of the brain, provided the experimental paradigm and setup are sophisticated enough, although it must be noted that such measurements are not localized enough in terms of area and cell response. Thus, especially in the main interest of this research, human judgment for affective response will be on higher and more complex processes than ones for visual perceptions traditionally measured in physiological and psychophysical experiments. It is envisaged that based on results of those measurements, brain function models, which are suitable for use as cognition models that predict human perception, recognition and judgment for affective response, can be constructed quantitatively and mathematically. Even if the new brain function models are more practical and phenomenological than traditional models, the models can still be useful as prediction tools. While giving due consideration to the error rates found in the models, they will be used as the basis for the development of practical applications.

(2) Subproject research areas:

This project has two research areas, as follows.

(a) Evaluation to quality of objects:

Evaluation scales of quality for objects, especially commercial products, can be defined in many different ways. The basic concept currently used in such evaluation of quality is referred to as KANSEI (affectivity). Evaluation in KANSEI ordinarily depends on a complex interaction between localized evaluation scores in many aspects of evaluation belonging to a set of evaluations for one kind of objects. In a psychological manner, the semantic differential (SD) method is used to find the set of semantics and principal components in the set. However, keyword evaluation in the set of semantics is often distorted by the semantics of words. Additionally, although there are many evaluation scores in the set, the basis for evaluation cannot be directly expressed verbally. More direct measurement of brain activities will enable us to answer to some extent the question of how these evaluations can be determined.

(b) Color Perception and Color Processing Models:

Some people have dichromatism in color vision in which only two independent colors rather than three are available for matching a certain color. Red-green dichromatism is a typical one; it causes reduced prominence of both redness and greenness. However, dichromatic people can identify color chips accurately, although they cannot discriminate red and green in color test conditions. In this area, further investigation will be made to clarify this unexpected conflict by the measurement of brain activities. [See also the documentation for this lab's other project, entitled "Human color and visual information processing investigated by psychophysical approaches and development of applications with computational model simulation."]

3. Expected Performance

In this project, the successful candidate would be expected to:

(a) Make good proposals regarding a project including experiments, especially for a Ph.D. (SSP) project. (This part will be initially evaluated by the research proposal in SSP application documents)
(b) Contributing to the supervisor's project to learn protocols and procedures for high quality research.
(c) Working independently in experimental preparation and procedures and data analysis.
(d) Assisting the senior members (most likely masters students) in the lab in all aspects of research activities.
(e) Share routine work in terms of managing the laboratory.

4. Required Skills and Knowledge

The successful candidate for this project will have the following knowledge and skills:

(a) Experience of measurement by EEG and fMRI is preferred.
(b) Ability to communicate effectively in English, including writing research papers in English.
(c) Some background in vision, brain and/or psychological research is strongly preferred.
(d) Ability to adapt quickly to new research areas.
(e) High motivation to conduct basic research on human factors.
(f) Ability to collect and analyze data and report to English research publications.
(g) Programming skill (MATLAB), and strong ability in mathematics are preferred.

SSP status is restricted to a three-year period; all SSP students have to write at least two excellent research papers for established English language journals within three years. Thus, it is strongly recommended that the accepted candidate join the supervisor's project immediately and soon establish a project in one of the four research areas as the core of his/her Ph.D. thesis. Additionally, the candidate's proposals for new, creative, and interesting research subprojects are welcome.

References

1) Keizo Shinomori and John S. Werner: "Aging of human short-wave cone pathways," Proceedings of the National Academy of Science of the United States of America (PNAS), 109 (33), pp.13422-13427, 2012.
2) Keizo Shinomori and John S. Werner: "The impulse response of S-cone pathways in detection of increments and decrements", Visual Neuroscience, 25(3), pp.341-347, 2008.
[See also the documentation for this lab's other project, entitled "Human color and visual information processing investigated by psychophysical approaches and development of applications with computational model simulation."]

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