Prospective Psychophysiological Approach for Kansei Design

Knowledge sharing between psychophysiology and design

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Abstract: This paper introduces an interdisciplinary design method, based on psychophysiological knowledge used as inspirational means for Kansei design. After describing the interest for such method, this paper describes each step of the method, from pre-ideation steps to actual design process based on the knowledge of human behavior phenomena and of their mechanisms. This description is supported by two examples. The teaching of this method to design master students pointed out not only the great possibilities of this method as an interdisciplinary approach in Kansei design, but also the difficulties of using scientific literature and knowledge in design.

Key words: Kansei, Psychophysiology, Design method, Knowledge, Synaesthesia.

1. Introduction

The project introduced in this paper belongs to a larger research program aiming at expanding the relations between psychophysiology (brain science, behavioral science, psychology…) and design studies. These relations are mainly based on knowledge sharing, and can output design methods, evaluation tools, and inspiration means for the field of design. The aim of the current project is to use psychophysiological knowledge as an inspiration means for design projects centered on human perception and behavior. This paper intends to present the project in the academic context, to describe the method and the constraints required to process the design project, and to illustrate it with two case studies realized during a workshop dedicated to this design method.

1.1 Kansei

After decades of quiet existence, the term Kansei became popular at the beginning of the eighties, to characterize the change in consumption behavior in the rapid growth of Japanese economy. At this time of the Japanese intensive economical development, the design and the marketing efforts had to shift from a national consumption behavior following "rational principles", to the one following more "individualized principles". Design researchers associated this new consumption paradigm with the concepts of user's mental images and mental preferences. As this link became stronger, the term Kansei appeared as a keyword for this new field of design in both academic and industrial worlds. As detailed in previous articles (e.g. [1]), Kansei is usually described as a

mental function, and more precisely as being a higher function of the brain. Three aspects of Kansei can be specified:

- **Kansei process** gathers the functions related to emotions, sensitivity, feelings, experience, and intuition… (i.e. sensory qualities related functions), including interactions between them.
- **Kansei means** are all the senses (sight, hearing, taste, smell, touch, balance, recognition...) and – probably – other "internal factors" (such as personality, mood, experience, and so on).
- **Kansei result** is the fruit of Kansei process (i.e. of these function processes and of their interactions). It appears to be **a unified perception providing a qualitative meaning and value of one's direct environment**. In other words, Kansei result is how one perceives qualitatively one's environment. Therefore, Kansei result is a synthesis of sensory qualities.

The actual specificity of Kansei, compared to western approaches on subjective human behavior, does not concern the concept of Kansei itself, but the project of Kansei studies. This argument can be introduced by Nisbett's suggestion: "Confucianism has been called the religion of common sense. Its adherence are urged to uphold the Doctrine of the Golden Mean – to be excessive in nothing and to assume that between two propositions, and between two contending individuals, there is truth on both sides. But in reality, Confucianism, like Taoism, is less concerned with finding the truth [what Western philosophies are more concerned about (note from the author)] than with finding the Tao – the Way – to live in the world" [2]. The differences are mostly inherent to the philosophical goal of cultures and by consequences to the global understandings and interests of the concepts by each culture. Whereas the intentions of western philosophical approach would be to determine the essence of Kansei (and related concepts distinctively) and to integrate it to a philosophical project, the actual intentions of Kansei studies are mostly to apprehend and to improve the effects of Kansei on human beings and on their environment (i.e. the world). In other words, the aim is not to understand the inside of the black box, but to know what (and how) we can do with it.

1.2 Kansei Design

The global aim of Kansei Design is to bring Kansei aspects in design methods and in design output. The motivation of such a target is to improve the relationship between an individual (the user) and her/his environment (whether it is the physical or the social one) though the design of new products and systems. To do so, it mainly uses the tools and the knowledge created by Kansei studies, which gather all the activities aiming together at measuring Kansei, and at taking benefit of this to improve the world. Kansei Engineering was the first, and so far the most successful design method created to involve some Kansei considerations in the design process. However, many other research methods have been developed, to increase and to improve Kansei considerations in design [3].

2. Involving psychological knowledge in Kansei design

The involvement of psychophysiology in Kansei design is possible and relevant because psychophysiology creates scientific knowledge on human behavior related phenomena. The knowledge developed by psychophysiology does not describe only human brain's activities, but also human's behaviors, including both conscious and unconscious ones.

The main argument this project relies on is that psychophysiology provides scientific knowledge on human related phenomena, which can be used as a means for inspiration and as a knowledge basis for design process. Two important aspects of this knowledge are that it is both scientific and often concrete, i.e. usable directly for design purposes. The association between psychophysiology and design occurs on different levels:

- **Providing evaluation tools and methods to measure perception and behavior** – This activity is certainly the most active and the most prolific one between psychophysiology and design. It consists in using psychophysiological tools, such as electroencephalograms (EEG), near infrared spectroscopy (NIRS), or Electromyography (EMG) to create some knowledge useful to understand the users' behavior towards certain products and/or the designer's behavior towards the creation of products. On user's behavior aspects, users are often asked to manipulate some products while their psychophysiological activity is measured by previously mentioned tools. Also, interviews might be conducted after manipulation, to complete psychophysiological observations [4]. On designer's behavior aspects, comparative studies are done between design-educated people and non design-educated ones based on creative tasks in order to determine the influence of design education on design strategies (e.g. [5]).
- **Inspirational means for design** – The approach aims at using the knowledge produced by psychophysiology as an inspirational means for the designer interested in human behavior. This is the object of the current paper.
- **Completing design requirements** – Some design projects, especially the ones integrating human perception and human behavior as central concerns, may require the use of psychophysiological tools to achieve properly some design requirements. As an example, the design of a Computer-Mediated Communication software (CMC), called *MATiK*, and based on the principles of the cocktail party effect, required an experiment using event-related potential (ERP) techniques to quantify the decision weights for the communication system in order to create new flows of information, depending on criteria similar to the actual phenomenon taking place in the brain of us all [3].

In this paper, we are focusing on the middle point, i.e. the way to use knowledge output by psychophysiology as an inspiration means for Kansei design. The aim is to propose a design method which is built based on the two following points: properly integrating the psychophysiological knowledge in the design process (target related to the process structure); Making sure that the design method and each design project based on this method do respect the scientific quality if the knowledge used as inspirational means (target related to the processed content).

3. Psychophysiological knowledge as an inspirational means for Kansei design

3.1 Introduction

As most of existing design methods, this approach does not pretend to be universal in terms of usage. In other words, this approach may be adapted to a certain kind of design issue or design context, and may not be adapted to others. Considering the elements involving in the design process, it is obvious that this method is adapted to design projects taking highly into consideration one or more human behavior phenomena, in order to reproduce them artificially or to rely on them for their output (the product) to be relevant and useful.

To operate the design method, a few steps should be respected and will be described here (cf. Fig. 1). As a global description, the design process is based on a classic analysis-synthesis step process, yet applied twice. The first cycle aims at associating a phenomenon described by psychophysiology with a design objective (Ideation). It should be concluded by the formulation of one or more design opportunities inspired from the described phenomenon. The second cycle aims at investigating more deeply in the psychophysiological literature in order to determine the mechanisms and the factors involved in the phenomenon, and at using this knowledge as an opportunity to design (Design process).

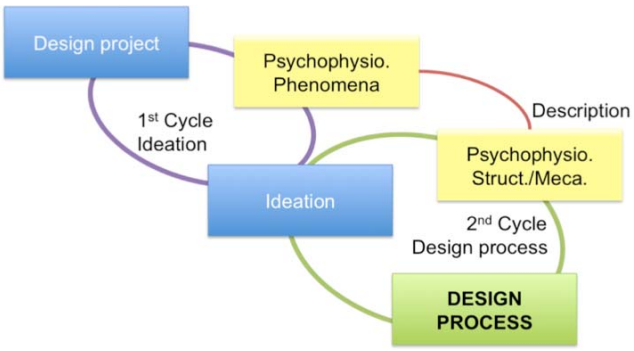

Figure 1: Chart flow of the design method

This method had been taught during a series of three lectures and one workshop (for a total of 15h) at the Graduate School of Comprehensive Human Sciences at the University of Tsukuba, to eight students master in Kansei Information Design. The first lecture consisted of an introduction about various ways to involve psychophysiological aspects in the process of Kansei design (cf. section 2). During the second lecture, the method was described, using a couple of examples of previous experiments done to test the method. The third lecture focused on the methodological requirements and techniques to read, to understand, and to use properly the knowledge contained in scientific papers. This aspect was pointed out as the most difficult task for the designer, as scientific papers are usually written for a specific public to which designers are mostly not included. The period covering these three lectures was also used by the students to start their own project (first cycle and psychophysiological mechanism description step) before the one-day workshop, during which the design process was done and presented.

As a support for the description of the method, two design examples are introduced. The first one is a design based on a design issue: How to express the intensity of the virtual network activity surrounding the user in a non-invasive and tangible way? The aim is to let the users know whether the virtual networks surrounding them are active or not and how much they themselves are concerned by this activity. The second one is a design based on the observation of a psychophysiological phenomenon. It proposes to a person having no specific neural or cognitive condition to experience such a condition related to perception: synaesthesia. These two examples will be detailed following the Kansei design method description.

3.2 Ideation

As the design project can be launched based on the consideration of either a design issue (or objective) or a phenomenon described by psychophysiology, the first cycle consists in structuring the relation between the design objective and the phenomenon, towards the ideation step.

If the project starts from a project issue, the aim of the first step is to evaluate whether this method is adapted to the project or not. To do so, the design issue should be analyzed in order to determine if it can be associated by analogy with a known phenomenon.

Project 1 - The first project starts with a project issue described as follow: "How to express the intensity of the virtual network activity surrounding the user in a non-invasive way?" The "non-invasive" constraint is due to the fact that the information might be emitted permanently, without being at any time a crucial information. A short reflection on the design issue pointed out the idea that the aim of the design is to inform the user about her/his (virtual) social network inclusion at a time. Therefore, the perception of social inclusion/exclusion plays a central role in the design. Yet, the topic of "social exclusion" is greatly treated in the scientific literature: "Social exclusion is a multidimensional process of progressive social rupture, detaching groups and individuals from social relations and institutions and preventing them from full participation in the normal, normatively prescribed activities of the society in which they live" [6].

If the project starts from the consideration of a psychophysiological phenomenon, the short study of the phenomenon should be done directly, keeping in mind that the aim is to get enough knowledge to propose some design ideas. This is the case for Project 2.

The first investigation of the literature aims at determining elements and mechanisms involved in the phenomenon, which could be useful for the design. The purpose of this step is for the designer to acknowledge the existence and the mechanisms of the phenomenon. If such existence is pointed out and if the output knowledge is consistent enough, then the relevancy of this approach as a design method is validated. Indeed, the existence of the phenomenon in the scientific literature points out the fact that this phenomenon is known and studied. The consistent of the knowledge in the literature shall also bring enough material to support the ideation process: the lower is the consistent, the higher is the risk of misinterpretation of the phenomenon. Yet, when successful, the investigations should not be pushed too much in this step, so that the designer may keep a great degree of freedom for the ideation step.

Project 1 - A quick investigation in the scientific literature shows that there is a great relation between the perception of social inclusion/exclusion and the feeling of warmness/coldness:

- Two experiments revealed that social exclusion literally feels cold [7]. The first experiment found that participants who recalled a social exclusion experience gave lower estimates of room temperature than participants who recalled an inclusion experience did. The second experiment found that social exclusion directly induced through an on-line virtual interaction, made "excluded" participants reporting greater desire for warm food and drink than "included" participants did.
- Other researches showed that "warmth" is the most powerful personality trait in social judgment [8]. Interpersonal warmth refers to a constellation of traits related to perceived favorability of the other person's intentions toward us, including friendliness, helpfulness, and trustworthiness. A brief warm or cold physical experience influenced participants' subsequent interpersonal judgments of a target person in the same way that presenting the words "warm" or "cold" was found to affect judgments of the target person in Asch's original study [9]. Moreover, participants in this study showed no awareness of the impact of the physical experience on their judgments.

In summary, these findings support the notion that social perception involves physical and perceptual content. Moreover, it was shown that experiences of physical temperature per se affect one's impressions of and prosocial behavior toward other people, without one's awareness of such influences.

Project 2 - In the case of the second project, the synaesthesia is a neurological condition in which stimulation in one sensory modality also rises to an experience in a different modality. However, conditions involving different qualities within one modality are labeled synaesthesia as well [citation]. For this design project, it had been decided to consider the synaesthesia as "seeing color while hearing sound", and is described as follow: when one who is a synaesthete hears some sounds, one perceives some spots of color related to the sound. Researchers noticed that the main musical note played by the sound was associated with one color.

Elisabeth Sulser explains [10]: "When I listen to music, I always see the colors and the forms […]. I cannot go anywhere without colors. I see a stripe and there are many colors on it. When I walk in the street and I hear a car, and when a mobile is ringing, then I always see the colors if I can hear the note. But also if I hear a dog barking, or birds, then it is like music, and there are many colors." Figure 2 is a photographic interpretation of what Elisabeth Sulser could see.

Figure 2: Example of sound-color synaesthesia (note for B&W print: each drop of water create a different musical note which is also perceived as a color ribbon by sound-color synaesthetes)

From the result of this first literature investigation, the ideation process can be set engaged. This step is not different from classic design ideation processes [11], yet taking into account that it should mandatorily supported by the knowledge output from the previous investigation.

Project 1 - The literature shows a bilateral link between social inclusion and sensation of heat. In one way, when feeling socially included one feels warmer. In the other way, the sensation of warmness inclines people to be more perceptive and reactive to the social context. Therefore, if the portable device from which the user accesses her/his social network can indicate the activity of the social network by a thermal indicator, then the device will not only inform the user in a non-invasive way about the situation of the social network activity, but also will probably motivate her/him towards a prosocial behavior (cf. Fig 3).

Project 2 - For a non-synaesthete to experience such synaesthesia, the best environment would be a place where sound is permanent and spatially distributed, yet without being too much noisy. Therefore, it was decided to propose such experience in the street, preferably on a rainy day (greater sound environment). Hence, the design idea was an umbrella capable to provide the user with such experience.

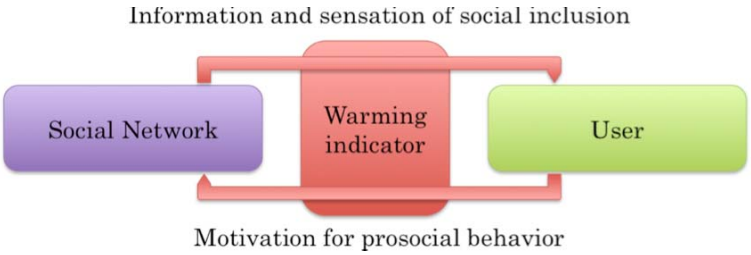

Figure 3: the loop caused by the warming indicator

3.3 Design process

Once the ideation step is achieved, the designer should investigate deeper in the literature the psychological knowledge related to the phenomenon involved in the design. This is the following step for the designer. The aim is to understand the mechanisms and the elements underlying the phenomenon, and to evaluate their possible implication in the design. This step is clearly a constructive validation process: acquiring knowledge on the phenomenon may push the designers to validate, to invalidate, or to modify proposed ideas. Moreover, the validation process may go through reinforcement of the design ideas, and toward a clearer structure of the design. Therefore, this step has to be taken with great attention by the designer, despite the difficulty of the task and the relative distance with usual design tasks (This was one of the recurrent comments from the students: this is not a work usually done by designers, and it is both exhausting and far from the motivating and enjoyable tasks of the usual design processes).

This step is probably the "steepest" step for designers, especially for the ones not trained in the reading of scientific papers. The difficulty of this reading is due to the challenging objectives (describing the phenomenon from a scientific point of view) despite the frame of mind in which this kind of papers are written and the turn of phrase often used to ease the speech and to be more understandable to their (specialized) public. Also, it is important for the reader not to ignore these aspects of the article content, in order to avoid misunderstandings and contradictions, which would lead to a non-sense design (from the point of view of the method). For instance, the designer should always consider the context and the hypothesis of an experiment, especially when the latest only tends to point out some tendencies towards a certain model intending to explain the investigated phenomenon. In this situation, the designer should understand the initial conditions and make sure that they might be of some interest for the design purpose. Also, when a "certain" model is studied, the designer should look for other models suggesting other explanations and mechanisms. The conditions in which these models are built, and the models themselves should lead the designer towards the adaption of one of the models for its design. The adopted model might not be the most relevant (or accepted) one from a scientific point of view, but can be the most workable and adapted from the designer point of view. All models seriously involved in the scientific debate are eligible for the design process, as long as they obtained a certain credibility from a scientific point of view.

The objective during this step is to gain enough knowledge and overview for the designer to be able to determine and to describe with preciseness (as much as possible) and exactitude the processes involved in the studied psychological phenomena. Knowledge is required to describe the phenomena and to prevent to make mistakes by misinterpretations. Overview is necessary in order to apprehend the phenomena in a way useful for the design. In other words, thanks to the capability of overviewing the phenomena related knowledge output from

psychophysiological literature, the designer will be able to shift this psychophysiological knowledge to design inspiration material. Therefore, the task of the designer is to find the related knowledge, to learn it, and to reflect on which knowledge and how it can be used in design.

Also it is to be noted that psychophysiology is a relatively new field of research compared to classic fields of science, including medical science, and the study of many phenomena is just beginning. Therefore, it may happen that the designer is not able to find a global and complete knowledge set concerning the studied phenomenon. In this case, missing parts can be speculated during the design process, as long as it remained both compatible with found resources and reasonable (even they might not be recognized as true, the speculated aspects are likely to be true or are the most probable among the possibilities).

Project 1 - The literature reveals a possible mental association between physical warmth and psychological warmth due to frequent early life experiences with the trustworthy caregiver. Indeed, according to Williams [8], *recent research on the neurobiology of attachment has added further support for the proposed link between tactile temperature sensation and feelings of psychological warmth and trust. This research has revealed that the insular cortex is implicated in processing both the physical and the psychological versions of warmth information. First, the dorsal posterior insula is active during both temperature and touch sensation. For example, activity in the right anterior insular cortex was strongly correlated with normal participants' reported perceptions of the thermal intensity of stimuli, and warm thermal stimulation with a fomentation pack (as compared to neutral thermal stimulation) produced an increase in activation of the contralateral insular cortex, among other regions.*

The insula is also involved in feelings of trust, empathy, and social emotions of guilt and embarrassment. Indeed, there appear to be specialized neurons for these social functions that have been observed in only two regions of the brain, one of which is the fronto-insular cortex. The insula is more highly activated after social exclusion or rejection than after social inclusion and acceptance, and heightened activity in the anterior insular cortex was associated with the rejection of unfair offers in an economic trust game.

However, no knowledge could be found in the literature explaining how, i.e. by which mechanism, both types of warmth are associated. This knowledge could have helped to build an original system to associate network activity and physical warmth produced by the device. As this mechanism has not been explained, the design may use any reasonable mechanism, adapted to the task and the technology to be used to make the function possible (cf. Fig. 4).

Project 2 - The literature on synaesthesia is rich. It has been proposed that synaesthesia is due to an anomalous connectivity between brain areas related to different sensory modalities. For example, "*numerous investigators have suggested that colour-phonetic synaesthesia might result from additional synaptic connections between brain regions that are responsible for processing auditory inputs and those involved in colour perception* [12]."

One model proposes that all humans experience synaesthesia in early life, and that synaptic pruning of cross modal connections results in the loss of synaesthesia experience [13]. Another model proposes that synaesthesia occurs due to the sprouting of additional synaptic connections [14]. Another theory [15] has proposed that synaesthesic experience is the result of the disinhibited feedback in exiting neural pathways. The absence of inhibitory mechanisms may enable the co-activation of "normally" independent pathways, causing anomalous sensory experiences.

Although these models provide some ways synaesthesic mechanisms could operate, these models are not

completely established yet. There is now global model explaining both cognitive and biological causes of the phenomenon. However, it can be pointed out that there are some specific connections between synaesthetic brain regions related to difference perceptive modalities. In non-synaesthetic brains, these connections may be inexistent, insufficient, or inhibited. Also, there is a general agreement to refute the possibility of a pre-sensory process that would provide information to various and independent sensory related brain regions. In the case of color-phonetic synaesthesia, one (or more) of the auditory sensory related brain regions (not necessary the auditory cortex) are actively connected with one (or more) of the visual sensory related brain regions (not necessary the visual cortex). These considerations help us to conceive a fairly simple mechanism for our umbrella. The information sensed by an auditory-sensing device (one of few microphones) is processed to be usable by a visual rendering system (projection, LED, OLED… - Technology has not been decided yet). Characteristics of sounds (pitch, loudness, source movements) are analyzed to determined characteristics of the visual information (hue, lightness, saturation, and movements of the rendering) (cf. Fig. 5).

Finally, once the phenomenon is described from a psychophysiological point of view, the ideations and the description can be gathered in order to be used as an inspirational material provided to the designer in order to start the actual design process. In this task, the way psychophysiological knowledge was taken care as a scientific knowledge should be pursued. Even though this task is considered as a design skill [16], it is important for the designer (or one of the designers) who took part of the previous steps to be in charge of this gathering. That would secure the proper use of the knowledge, as it was output from the research paper, preventing any misinterpretation of the knowledge put outside of its original context.
Moreover, for unknown part of the phenomenon, i.e. for knowledge required by the design but not yet understood by scientific research, trustable and reasonable speculation can be considered for the design, and for the design only! One should take care of this speculation and may require regular updates (especially when one wishes to use the same knowledge, or the same type of knowledge, for various design projects).

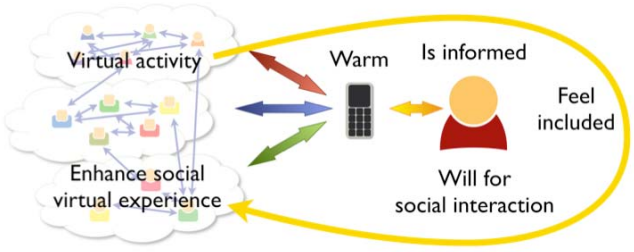

Figure 4: Effects of the device warming indicator

Figure 5: Lights reflect the auditory environment

4. Conclusion

Part of a wider project intending to study possible relations between psychophysiology and design, this paper has introduced a method aiming at using psychophysiological knowledge as an inspirational means for design. Its teaching to design master students pointed out one of the great difficulties of this method: the psychophysiological literature is not trivial, and its study might disturb designers' motivation. During the class, notable differences of behavior and of results could be observed between students with psychophysiological background (even a light one) and others. The authors believe that the relation between the two fields requires more investigation and understanding to improve this type of interdisciplinary design work.

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