ABSTRACT

Through the example of three projects, this paper describes emerging methods and means used in the field of Kansei design studies:

- The use of tools built for psychophysiology and for constructive psychology in order to support designers’ work focusing on human beings’ behaviours and mental schemes;
- The use of knowledge created by psychophysiological research as an inspirational source for industrial design, taking into consideration the latest scientific progress in psychophysiology.
- The use of psychophysiology tools to complete design requirements.

Each point presented here is supported by an applicative example.

INTRODUCTION

This paper aims at describing emerging methods and means used in the field of Kansei design studies. These methods and means are mostly an output of a collaborative work between the fields of industrial design and of psychophysiology. By working together, they are helping the progress and the improvement of design knowledge and of its impact on human behaviour concerning both users and designers (Human Behaviour in Design).

After providing a short introduction to Kansei and Kansei design, this paper will describe three different approaches involving psychophysiological tools in the Kansei design process. As a conclusion, a short reflection will be carried out on the specificity of this approach in Kansei design.

Kansei

After decades of quiet existence, the term Kansei became popular at the beginning of the eighties, to characterize the change in consumption behaviour 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 behaviour 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. Since then, the research field of Kansei has grown considerably: currently, the Japanese Society of Kansei Engineering [1] gathers more than 1500 researchers and industrialists; numerous successful products have been designed thanks to Kansei approaches; a few international conferences on Kansei have been organized in Asia and in Europe; and Kansei has become one of the key vectors of the Japanese Ministry of Economy, Trade and Industry (METI) to “enhance people’s lifestyles and invigorate the economy” [2].

As detailed in previous articles (e.g. [3]), 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 behaviour, 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" [4]. 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.

Concerning research activity, this difference, related to culture and to philosophy, is the reason why Kansei studies may be hard to be comprehended, and therefore to be accepted by westerners: the project and the method are unfamiliar to western approaches.

One of the key aspects that make the method unfamiliar to western approaches is the possibility that two different positions can both be considered as true. Indeed,
Kansei can be seen as a large and very complex system, that one cannot comprehend completely. Therefore, various individuals would have different views on the same system, due to the variability of experience, of knowledge, and of concerns (cf. Figure 1). However, these differences are not problematic, since there might be “truth on both sides” and may even be considered as a richness of the research field. An issue is raised if different points of view are conflicting, and the solution maybe found in a point where it makes sense for all, even if differences remain.

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 [5].

As other high-functions of the brain, measuring Kansei cannot be done directly. What is observed is not Kansei but the causes and the consequences of the Kansei process [6]. Therefore, to determine some characteristics of Kansei, researchers often work on correlating different elements “surrounding” Kansei. Kansei can be measured only indirectly and partially, by measuring sensory activities, internal factors, psycho-physiological and behavioural responses (with a high risk of over-interpreting results output from psycho-physiological measurements), and finally environmental elements. In the scope of Kansei studies, sensory activities are measured by evaluating the impact of a specific sense stimulus on brain activity. Physiological measures are done by evaluating responses to specific external stimulations.

THREE APPROACHES IN KANSEI DESIGN
In this paper, we are exploring various ways which have been investigated as a collaboration between design and psychophysiology in order to develop methods and means for Kansei Design. The exploration presented here is not exhaustive, and other approaches exist in the literature. However, the three approaches introduced here cover a great part of this interdisciplinary field. Moreover, it is to be noticed that, using psychophysiological tools, methods, and knowledge, a strong attention had been turned to the scientific constraints these methods are relying on.

Providing evaluation tools and methods to measure perception and behaviour
The use of tools built for psychophysiology and for constructive psychology is probably the most prolific and used approach in Kansei Design. It consists in using tools developed for psychophysiology and for constructivist psychology, in order to create knowledge related to users’ perception and reaction towards products. Mostly, this knowledge is used by the designer to create products more suitable to users, based on users’ own evaluation mental model structure.

Compared to classic investigation on users’ preference and satisfaction, this method uses subjective approaches, outputting qualitative or quantitative data, focusing on subjects’ own experience and evaluation model. Therefore, this approach does not intend to output objective data for the designers to operate design through an objective way. Quite differently, this approach expects to provide the designer with subjective knowledge that may stimulate her/his inspiration and creativity.

To do so, two kinds of tools are often used, either separately when the objectives are very specific, or together when they may bring complementary output:
Psychophysiological means are used to gather real-time and mostly quantitative information about a person’s experience (at conscious and unconscious levels). The output provided by these tools is usually very valuable as it may catch unconscious and immediate user’s reactions, which are mostly impossible to point out otherwise. Psychological responses to stimuli include:

- Central nervous responses – Brain waves can be measured using (among others) electroencephalograms (EEG) or event-related potential (ERP); Brain cognitive activity can be measured using (among others) functional magnetic resonance imagery (fMRI) or near-infrared spectroscopy (NIRS).
- Peripheral responses – Heart beats can be measured using electrocardiograms (ECG); Body temperature can be measured using Infrared thermography (IRT).
- Motor responses – Eye movements and pupil dilatation can be measured using eye tracking systems; Muscle activity can be measured using electromyography (EMG); body movements can be measured using 3D-accelerometers.

Constructivist psychological tools are numerous. However, the one we are focusing on here is the repertory grid technique. Interviews based on this technique gather information about user’s perception related to consumers’ preference behaviour in their own words from a subjective experience point of view. Derived from the Kelly’s Personal Construct Theory (PCT) [7], this technique was designed as an instrument for the elicitation of personal constructs. Therefore, the interviewer can obtain a description the subject’s mental model without any significant influence from her/his own mental model.

The example provided here uses both kinds of tools described previously, and associates them. This project aims at obtaining a more complete observation of the subjects on the usage and the evaluation of pens, and at providing this knowledge to the design as inspirational material. Details of this project can be found in [8].

As psychophysiological tool, an "HSK centre rhythm monitor slim device (cf. Figure 3) based on the Yoshida’s model has been used [9]. In Yoshida comfortableness evaluation model, left frontal α wave frequency fluctuations express human’s valence and the right frontal ones express arousal. The comfortableness degree is calculated from both left and right frontal α wave frequency fluctuations using the Fast Fourier Transform (FFT) algorithm. When both left and right frontal α wave frequency fluctuations are near the rhythm degree of “1/f fluctuation”, it means human is in the state of “calm comfort”.

Figure 2: The 6 pens used as samples

Figure 3: HSK data as they appear on the computer screen.
As constructivist psychological tool, an adapted repertory grid technique is used to gather information about user’s perception related to consumers’ preference behaviour in their own words from a subjective experience point of view (repertory grid interview to which are added analogies and scenario generative processes – cf. Figure 4).

![Figure 4: Constructivist psychological exploration process [8]](image)

While using the HSK device, the subjects were asked to process the five following tasks with each of the six pens which were presented to them separately: look (visual stimuli), manipulate (tactile and visual stimuli from the pen – writing is forbidden), use (tactile and visual stimuli from the pen and tactile and visual feedback from the writing), manipulate again. The second manipulation was used in order to track also a global impression after using the product for the first time. Finally, relax times (30s) were used as a separation time between products.

To avoid biasing the results with the time variable and to present the products with the same order, the pens were arranged differently to all the participants. The area used to make the experiment was done in a separate room with the minimum set up to avoid any external disturbance: measurement and recording devices, the technician verifying the obtained data and the facilitator for the interview.

After the experiment, the interviews (based in the RGT) were carried out for an average period of 60 minutes for each participant, where the pens were presented first in two groups of three elements (asking for which one they prefer and which not) to elicit the constructs and in the following iterations by grouping the best perceived products and the worst perceived ones. In addition, an ideal (fictitious) element was also use when the participants rated the elements with the elicited constructs. After this first step, the subjects were asked to generate analogies for each of the constructs and describe simply the reason of the generated analogy (e.g. to the construct “controllable, easy to work with, use it in multiple ways or clothing” was associated by analogy “a pair of scissors” with the description “direct feedback about what you do with it. Can be used in multiple ways”). Finally, each subject was asked to select and to group some of the analogies in order to built a scenario describing a great situation of use of a pen.

Respectively, these three different categories of information may be used as detailed design guidelines, experience ideas to develop interaction and functions, and inspirational means.

This on-going experiment has been done in many steps, changed at each steps the nationality of the subjects (Japanese, Dutch, Chinese...), in order to investigate also possible cultural influences. The results introduced here at the ones of the first step,
done with 5 Japanese subjects. The experiment was done in a controlled environment, as described previously. The EEG measurement of the participant 3 had failed, preventing the EEG results to be used relevantly.

**Various results** can be obtained from these two associated tools (for more details, see [8]).

Figure 5 shows the average of the comfort values for each of the tasks, for each of the pens. Therefore, it is possible to track the comfortableness changes between each task, for each participant. Different patterns can be then noticed:

- Ascendant patterns can be related to a rising enjoyment during the explorative experience. The user expectations and needs are fulfilled by the different tasks.
- Descendant patterns may express the opposite, in which user’s expectations are not meet by the product despite a first good impression (the pen looks great.).
- U patterns with a bottom during the use task may express a nice design pen despite a low level of writing qualities.
- \(\cap\) patterns with a top during the use task may express the writing quality of the pen, but non appreciation of its manipulation by the user.

![Figure 5: Average level of comfort (%) obtained during the explorative process](image)

Figure 6 shows a partial view of the sheet of one subject’s constructs. From left to right can be seen the constructs, the analogies, and the scenario. The red lines show global low qualities of current pens (the evaluation by the subject is low for all the pens), which can be seen as great opportunities for design improvements. The blue column is the favoured pen by the subjects, according to the grades.

The data can be also clustered or mapped to render more understandable and usable output for the designer (cf. Figure 7). These two renderings show the link between the various arguments of the constructs. The left figure shows the grades of each pen for each constructs, and the clusters structure of the pen (at the top) and of the constructs (on the right side). The right figure shows a two-dimensional projection of the results. The closer are the constructs or the pens, the more they are evaluated similarly by the subject. The closer a pen and a construct are, the higher the subject relates to this construct as an evaluation argument for this pen.
Figure 6: Sample from the RGT results (Translated from Japanese)

All the outputs were presented to designers, who have been using them for the new design of pens. The use of this experiment output as material for design inspiration had been shown relevant, as the presentations and the propositions made by the designers were highly related to the experiment findings.

Figure 7: Cluster structure and mapping of the constructs and samples

Inspiration means for design
In this section, we explore a way to use psychophysiological knowledge as inspiration means for design. Differently from the previous section, this approach does not intend to use psychophysiological tools to output knowledge usable in design. It use directly the knowledge output by the psychophysiological researchers,
in respect of the scientific constraints. Therefore, this approach is more to be regarded as a literature exploration for design inspiration, with two main targets:

- Properly integrating the study of psychological knowledge in a design process (target related to the process structure).
- Making sure that both the method and the designer using the method are respecting the scientific quality of the knowledge used as inspirational means (target related to the process content).

The figure 9 shows the main steps of the design process, as it is quickly reminded here:

![Figure 9: The chart flow of the Kansei design method](chart)

- The description of the design project (or design issue) is used for a first investigation in the literature in psychophysiology. This first investigation is issued to acknowledge the actual existence of psychophysiological phenomena which could be useful for the design project. However, the investigation is not pushed too much, so that the designer keeps a great degree of freedom for the ideation step.

- Based on the acquired knowledge obtained during the first analysis of psychophysiological literature, the designer processes a first synthesis to propose a set of ideas (ideation). That will help her/him to clarify the opportunities of design supported by the psychophysiological literature.

- Once the ideas are clarified, the designer will go deeper in the literature to validate, to invalidate, or eventually to modify proposed ideas. This step is also used for her/him to get a great knowledge about the phenomenon(a) to be involved in the design. At this time, it is very important for the designer to read carefully the scientific literature and to understand the mechanism of the phenomenon, the extent of scientific knowledge concerning this phenomenon, and the nuances about scientific conclusions (if a fact is proved, is refuted, shows a certain tendency, is believed...). This is probably the hardest step for the designer, especially when she/he doesn’t have a strong scientific background.

- Based on acquired knowledge extracted from the psychophysiological literature, the designer will be able to process the design project until its conclusion: the design output. The newly acquired knowledge will be helpful to process the design project correctly. Also, the extent of the knowledge will show the time when speculation and imagination may be required and fully accepted in the design process.

As an example, an ongoing project is introduced. It was initially presented as a conclusion of a class on design methods, taught to the master students in design of the Graduate School of Comprehensive Human Sciences at University of Tsukuba in Japan, in January and February 2009.

The project has intended to design a new experience: it proposes to “normal” persons (i.e. not having any specific neural or cognitive condition) to experience a specific neural condition related to perception: synaesthesia. This phenomenon is a
neurological condition that has a noticeable effect on perceptual experience of the subject. It is usually described as a condition in which stimulation in one sensory modality also rises to an experience in a different modality.

The ideation step for this explorative project based on the perception of synaesthesia has output the design proposal of an umbrella, which cloth would render colours related to perceived ambient sounds.

In the case of sound-colour synaesthesia, studies were conducted to show that (see details in [10]):

- This is a genuine form of synaesthesia (synaesthetes can be distinguished from non-synaesthetes);
- There is a consistency in synaesthetic associations (on subject always associate the same colour to the same note);
- There is a consistency over long time periods;
- This is automaticity (the subject does not turn the synaesthetic perception off);
- Most of synaesthetes tend to associate low pitch sounds with dark colours and high pitch sounds with light colours (cf. Figure 10);
- Most of synaesthetes report experiencing several colours rather than a fusion of colour when listening to notes played simultaneously. The association of colours occurs mostly at a single note level;
- Synaesthetic experience is influenced by the pitch, the timbre, the loudness, the tempo, the emotional response, the consonance/dissonance, the name or pitch class of the note, and the key or tonality of a piece (e.g. C major);
- Congruency between sound and colour (perceived with eyes) can result in spatial orienting of attention.

Figure 10: An example of the colours selected (on 2 occasions) for the 10 single piano, sine (or pure tone), and string notes for a synaesthete (left) and a control subject (right) [10].

Based on the psychophysiological description of synaesthesia, the proposition of an umbrella as a design output is reinforced. Indeed, the auditory characteristics of the street on a rainy day may provide a rich synaesthesia experience. Many auditory sources may provide interesting experiences, such as the rain itself, cars, people's conversations, animals, and so on. Moreover, the umbrella provides a wide surface to emit colours, related to sounds coming from anywhere: space distribution could also be rendered. Therefore, the umbrella of which the cloth could visually render auditory environment seems is planed to be designed.

On the technological aspects, a set of auditory captors should capture the street sounds. Concerning its placement, it is preferable if is placed inside the umbrella (i.e. under the cloth) than outside, as the auditory perception is supposed to be the one of the user while being under the umbrella. Then, the sounds should be analysed in order to determine different notes (specifying the pitch, the timbre, the volume for each of them...). Once analysed, these data should be converted into visual information (hue, saturation, lightness) and should be sent to a set of colour emitter (whether it could be a set of light, such as LED, or a projector) that will light up the
umbrella cloth with corresponding colours.

On the formal aspects, the umbrella should have a classic shape as much as possible. The original visual experience should be originated from the colours emission, not from the shape of the umbrella. Yet, the way the colour will be displayed is also a concern. Depending on the choice of the technology (e.g. LED, OLED, video-projector, colour changing textile...), the display technique will be different and will influence the way colours are shown. However, in order to design a pleasant umbrella, fashion designers are to get involved.

Figure 11: Illustration of colourful-rain umbrellas

The specificity of this design method is the scientific description of the phenomenon involved in the design inspiration. This point is required and should be executed with best care and rigor by the designer. We acknowledge that it might be difficult, because of the disciplinary background required to read and to understand properly psychophysiological research papers.

Completing design requirements

In this section, we intend to introduce briefly an experiment using psychophysiological tools aiming at completing design requirements. Details can be found in [11].

MATik is a computer-mediated communication system (CMC), to improve the quality and the efficiency of information flows in interdisciplinary workgroups. Classic filter systems cut off information flows in order to limit information pollution. Contrarily, the jump analyzer, core function of MATik, creates new information channels for the information to reach all person (in a defined workgroup) likely to be interested by the transferred information. Using a method very close to the one introduced in the previous section, it had been shown that the cocktail party effect, being a psychological phenomenon, was fully relevant to be used as a model for the design and the specification of the jump analyzer.

The cocktail party effect is defined by Barry Arons [12] as the ability to focus one’s listening attention on a single talker among a cacophony of conversations and background noise. It is based on three processes performed by the auditory system (Moray, 1959): the stream segregation process, the selective attention process, and the switching process. The stream segregation process separates the incoming auditory signal into individual channels. Cherry [13] proposed five factors on which the brain process is based to separate the sources: the spatial location of the sources, the visual information (lip-reading, gestures, source displacement, and so on), the differences between voices (pitches, speeds, gender, and so on), the accents, and the transition probabilities (subject matter, voice dynamics, and so on). The selective attention process allows the brain to select a few of the segregated channels, to bring attention to them, and to ignore others. The switching process involves the ability of the brain to switch attention from one channel to another one. This design project focuses especially on this process of the cocktail party effect, as it is the one used as model for the design of the jump analyser.

To send an email, one has to consider three lines (‘To’, ‘Cc’, and ‘Bcc’) to determine who should receive the message, and in which conditions. As this system is not relevant to MATik, another three-category system is proposed, based on a simpler categorization of people in the group: the ones which will receive the message because they are participating (or are wished to participate) to the discussion (RA on the Figure 12), the excluded people who won’t receive the message (EA), and the others who may receive the message, totally or partially, thanks to the cocktail party effect (MA). This system is much more relevant than that of email’s when
considering the fuzziness of the real world information flow.

The sender uses this three-category system to send the content of the message to members in the workgroup. Then the jump-analyser analyses both members’ personal data and the content of the message. Members in the RA will receive the message. Still, the jump-analyser filters to update its knowledge about the relationships between the sender and the members in the RA. The relationship considerations have great influences to evaluate the relevancy of a ‘cocktail party effect switch’ in MATIK. This analysis is also done for members in the EA, even if these persons don’t receive the message. Finally, the jump-analyser determines for each member in the MA if she/he should receive the message totally or partially, i.e. whether a switch occurs or not. During all these processes, the jump-analyser also updates its understanding of the workgroup flow and members’ relationship in order to improve dynamically its decisions concerning the cocktail party effect switches.

![Diagram of MATIK mechanism]

Figure 12: Mechanism of MATIK

Therefore, the jump-analyser has a double function to understand continuously the relationship between members of the workgroup, and to evaluate the relevancy concerning a cocktail party effect like switch for each message, for each member in the MA.

In order to build the jump analyzer, it is required to determine and weight the criteria it may use to evaluate the relevancy of a switch in the information flow. For example, two obvious criteria are the ‘individual relevancy’ of some of the words included in the message and the familiarity of the voice. However, which one influences more the cocktail party effect switch? How can that be quantified? To answer these questions, an experiment based on the measure of cocktail party effect characteristics has been done. The aim is to specify by quantification of the reaction of the brain concerning different factors resulting on the switch to unattended channel. The switch reaction in the cocktail party effect is activated based the following criteria [13]:

- The spatial position of the source – This includes not only the interpersonal distance [14], but also the spatial position of the source (related with the concept of personal space [15].

- The volume of the message received by the subject – This volume is related with the volume of emission of the source, the importance of the background noises, and the distance between the source and the receiver. The hypothesis is that the louder is the stimulus, the greater will be the reaction.

- The content of the message – This is probably one of the most fundamental criteria launching cocktail party effect. The subject’s name or place he/she lives... may be contents being keyword hits for the subject’s reaction. The hypothesis is
that the greater is the ‘self-relevance’ of the content, the greater is the cognitive reaction [16].

- Recognizing source voice – This aspect of the stimulus is related with the notion of ‘auditory face’ [17]. Therefore, the hypothesis is that the voice pattern would create a brain reaction, stronger if the voice is already known (i.e. the speaker is known by the subject).

- Familiar way of speaking – This criteria may be wild, but we will limit here to the language pattern (such as way of speaking, accent, intonation...). It is expected that, even if the subject understands a foreign language, a word said in the subject’s native language (by a compatriot) would have more impact than the same word said in a foreign language (by a foreigner).

Cherry [13] proposed some other criteria that are not listed here since they don’t correspond with the objective of this study (such as grouping processes, and continuities, visual or timing aspects).

The question this study intends to answer is: Is there any pattern defining the influence of the selected factors structuring the switching ability on the brain reaction? By weighting each of these criteria, we expect to be able to build a structure which contributes to the evaluation of the impact that could have a message for each user of MATIK. To be able to answer completely to the question, the equivalences between the cocktail party effect characteristics and the MATIK’s ones need to be noticed. These are illustrated by the Figure 13:

Figure 13: Equivalences between criteria of flow jumps in the real world and in MATIK

The expectation is to find a good correlation between the relative reactions of the subjects on each of these criteria. In order to control a maximum of parameters, it was decided that this explorative study will be done in an electro-magnetic isolated laboratory environment, to prevent any interference with the electroencephalogram (EEG) system. This requires the use of a surround technology, supported by a 6.1 channel system. Findings by Kallinen and Ravaja [18] convinced to prefer the use of headphones to the use of speakers. The fact that the used cordless headphones would not have any impact on the EEG was checked and validated.

Measuring the brain reaction to the cocktail party effect events can be done with event-related potential (ERP) techniques (using ‘time-lock’ and ‘average’ methods for calculus). ERP techniques are based on the classical paradigm ‘stimulation-response’. The stimulation can be electric or natural (in this paper, the sound as a natural one) and the response is the brain reaction shown by electrodes. Two types of data can be observed: the latency (in millisecond) and the amplitude (in microvolt) of response (Meunier, 1996). To synchronize the sound player and the ERP measurement system, a trigger system is used. This trigger is activated once, when the sound starts to be played. Then it is possible to know when the sound, controlled by a computer, is played while checking the raw data output from the ERP.

A rich literature suggests that two auditory selection processes occur and are elicited by the N100 and the P300 [19]. The earlier reflecting an initial selection between channels based on easily discriminatory cues (endogenous criteria). The later indexing a subsequent target selection within each channel following a more elaborated and detailed processing of the relevant stimulus properties (exogenous criteria).
Most of the hypothesis had been already discussed in the literature, besides the volume hypothesis. This hypothesis, being endogenous, should still be noticed in an ERP with a latency close to 100ms. However, all the hypotheses may be observed, and then validated or undermined, by the ERP analysis. Two great groups of latencies should catch the attention during the analysis: before 100ms for the endogenous-related hypotheses, and around 300ms for the exogenous-related ones. Therefore, the data analysis will be split into two parts according to the two groups of latencies.

Also, this analysis points out that the amplitude of the ERP peaks are hardly, if ever, communicated or used as quantitative information in ERP analysis. However, a few techniques were proposed to work on this unused source of information [20], and their usage seems nonexistent in the literature.

The design of the auditory sets (i.e. the auditory content subjects hear) is very important. In the first time, the setting up of a synopsis is important and as to be precisely defined. Then, according to this synopsis, sounds need to be recorded. Finally, the auditory set can be built on the computer.

The auditory background is a mix of conversations. That is all the more relevant that it is necessary to recreate a cocktail party effect environment, asking the brain to segregate the incoming sound in different channels. For this purpose, five radio conversation shows had been recorded on the Internet radio, and included in the audio-editing software. To the mixed conversation were added specific information likely to provoke a cocktail party effect based on one of the criteria previously described. Therefore, an auditory set gathering ten sequences has been set up:

- **Sequence 1:** The benchmark – This sequence in the benchmark one, with which most of the other sequences are compared ($r=0$ and $\theta=0$).
- **Sequence 2:** Front source – This sequence is equivalent to the sequence 1 except that the source location is in front of the subject ($r=1$ and $\theta=0$).
- **Sequence 3:** Side source – This sequence is equivalent to the sequence 1 except that the source location is on the left side of the subject ($r=1$ and $\theta=n/2$). It is used to evaluate the impact of the distance between the source and the listener when the source is on the side. This evaluation is a partial response to the criterion ‘the spatial position of the source’.
- **Sequence 4:** Back source – This sequence is equivalent to the previous sequence 1 but the source is placed in the back of the subject ($r=1$ and $\theta=n$).
- **Sequence 5:** Loudness – This sequence is equivalent to the sequence 1 except that the source volume is 10dB higher. This evaluation is a response to the criterion ‘the volume of the message received by the subject’.
- **Sequence 6:** Unknown name – This sequence is equivalent to the sequence 1 except that the content is an unknown name for the listener (the voice is similar). This evaluation is a partial response to the criterion ‘the content of the message’.
- **Sequence 7:** Own name – This sequence is equivalent to the previous sequence 1 except that the source location is on the right side of the subject ($r=1$ and $\theta=-n/2$). It is used to evaluate the impact of the distance between the source and the listener when the source is on the side.

![Figure 14: ERP components](image-url)
except that the content is the listener’s name.

- **Sequence 8: Own country** – This sequence is equivalent to the previous sequence except that the content is the listener’s own country.
- **Sequence 9: Known voice** – This sequence is equivalent to the sequence 1 except that the voice of the speaker is known by the listener (the speaker is still foreign for the subject). This evaluation is a response to the criterion ‘recognizing the voice’.
- **Sequence 10: Native language** – This sequence is equivalent to the sequence 8 except that the speaker’s native language is the similar to the listener’s one. This evaluation is a response to the criterion ‘familiar way of speaking’.

Each sequence lasts 200 seconds, with a break of 15 seconds between.

As each member switches on different contents (a person may switch on one’s name, more hardly on somebody else’s name), each auditory set has to be prepared with a prior brief investigation on each subject. For each potential subject, the information were requested in English, in Japanese and in their own native language. Out of thirty persons, four refused to provide information, cancelling their potential participation to the study. According to the requirement of ‘known’ and ‘unknown’ speakers, 11 persons read the information previously gathered while being recorded. Then, the recordings were edited and normalized in terms of volume, and the blank parts on the beginning and the end of the sound were trimmed. Finally, the sounds were brought in a surround console (6.1 channels) and spatially placed to create a real-like auditory environment. The auditory set lasts 36:25’.

Three subjects participated to the study (N=3), one female and two males. Each subjects listened to complete auditory set. Relevant raw data were selected, filtered and analysed to determine relevant peaks, according to the analysis criteria. Few peaks have been found. Yet considering the literature, and the actual overview of all the output, the analysis focuses firstly on the ‘P300-like peak’, that will be noted P300* (positive peak at 300ms, concerning the semantic (exogenous) aspects of the stimulus), and then on the P30* (positive peak at 30ms, concerning physical (endogenous) aspects of the stimulus).

The lack of relevant data, mainly due to the to few numbers of relevant blocks, prevents to confirm any hypothesis of this study. However, it is possible to show tendencies which goes pro or against the hypothesis. Detailed can be found in [11].

Concerning the analysis of the P300*, the comparisons 5,6,7,8 are supporting the hypothesis. The first three (subtraction between the sequences 6,7,8, respectively, and 1) point out a tendency that support the hypothesis related to the self-relevant word (the more the word has a self-relevancy, the more the brain reacts). The comparison 8 (subtraction between the sequences 9 and 1), aiming at determining the impact of the voice (between a known voice and an unknown one), was only measurable for the subject 3, whose reaction supported the hypothesis. The tendency remains weak, because of the lack of support. Nevertheless, the comparison 9 (subtraction between the sequences 10 and 8), which aims at determining the impact of the used language, is in contrast with the hypothesis, as shown by the results found on the subject 1.

Concerning the analysis of the P30*, the comparison 1 (subtraction between the sequences 2 and 1) is contrasting between the subjects 2 and 3. Therefore, no conclusion can be output concerning the impact of the distance between the source and the listener. The comparisons 2 and 3 (subtraction between the sequences 3 and 1) are supporting the hypothesis since there are both inferior to the comparison 1, and the comparison 3 is also inferior to the comparison 2. This result support the idea that a frontal position of the source (θ=0) has a greater impact on the brain activity than a lateral position (θ=π/2), and even greater on a back position (θ=π). The hypothesis of the source position is thus supported by the study analysis. The comparison 4 (subtraction between the sequences 5 and 1) is greatly supported by the results of the subject 3, but slightly contrasting the results of the subjects 1 and 2. Then, no conclusion can be emitted concerning this hypothesis.
The study of the P30* supports the hypothesis concerning the lateralization of the source, without supporting (neither invalidating) the effect of the distance. The volume hypothesis is neither validated nor invalidated. As for the P300* analysis, the P30* one cannot bring any prove, but only tendencies. A deeper analysis is required to obtain more relevant results, and determine quantitative data.

The current state of this explorative study does not provide yet definite results which can be used directly in the design of MATIK. However, from the tendencies described in the analysis, it is possible to transfer back the results found for the Loft to the validation of MATIK’s criteria. More work (such as refining the experiment and involving more subjects) is required.

CONCLUSION

This overview of three projects, illustrating three different approaches emerging in Kansei design, shows the importance of the relationship that has risen between design and psychophysiology. Indeed, Kansei design has an interdisciplinary nature, which evolves progressively towards a transdisciplinary domain, becoming a field of application related to Kansei Science.

The issue then, which appears in each of the approaches, is the relation between the designer and the psychophysiologist. The earlier intends to remain as concrete as possible, exploring the world and finding new opportunities directly applicable; the later intends to observe the world from a scientific point of view, and to explain behaviours from this point of view. Both have strength; none of them can process a Kansei design project alone. Therefore, the wise behaviour is to consider and to achieve design opportunities together. To do so, three requirements have to be followed:

• A clear knowledge and understanding of the problem and the objective of the study for each of the members.
• A permanent and open-minded dialogue between the members concerning the proposition made to progress on the design of the study.
• A systemic reflection on each decision, in order to ensure to reach the best compromise between the involved disciplines without distorting the issue, the method, and the objective of the study.

These three points may seem to be obvious, but one has to have them clearly and permanently in mind to succeed the entire realization of such interdisciplinary and exploratory projects. Therefore, the success of such explorative study cannot be reached only by application of Kansei design methods, but also by acceptance of wise compromises, brought out by human beings.

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