Beyond emotional design:
Evaluation methods and the emotional continuum

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Abstract
Emotional design and neurodesign are current trends in which designers and firms try to understand not only the user, but also his/her feelings, desires and expectations, to which end methods for evaluating emotions, rooted in different disciplines, have been proposed and used. However, the understanding of emotions is still in its infancy, as is their use in the design-decision-making process. In this paper, we present a list of emotional-evaluation methods and analyze the latter in order to propose a model aimed at clarifying the relationships between the different methods and the emotional continuum.

Keywords
Emotional design, neurodesign, emotional evaluation, Kansei engineering, neurosciences

Introduction
The creation of meaningful experience is one of the 21st century's principal design objectives. Large companies increasingly interested in their clients, and, as more and more technological tools become available for use in the different branches of design, the said companies employ increasingly sophisticated methods so as to make a profit in their everyday operations, with the ultimate purpose of finding out what people are thinking and what they wish to achieve in their everyday lives, for which purpose various emotional-evaluation methods have been proposed, piloted and used during the design process.

It is very difficult to evaluate emotions due their complex, subjective nature. Though some of the existing methods are simple and rapid, requiring only pencil and paper, the results they achieve are superficial, while, in contrast, neuroscience is supplying more precise answers to many questions about needs and desires that are hard to express either verbally or non-verbally, though neuroscientific research is complex and expensive.

After reviewing the aforesaid emotional methods in this paper, with a view to understanding them, identifying their potential, and ascertaining their usefulness and relevance, we go on to present a taxonomy of them, analyzing each one, in order to propose a model that can help us to choose the most appropriate tool for each design process.

The emotions and the cognitive process
Psychologists have been studying the concept of emotion for decades. This endeavour to understand the relationship between emotion and behaviour is reflected in the different historical definitions of emotion. For example, Young (1976, p. 90) defined emotion as "a strongly visceralized, affective disturbance, originating within the psychological situation, and revealing itself in bodily changes, in behaviour, and in conscious experience". Around the same time, Strongman (1973) determined that "emotion is feeling, it is bodily state evolving various physical structures, it is gross or fine-grained behaviour, and it occurs in particular situations". Both Young and Strongman state that, while emotion is a complex phenomenon that involves different structures, nevertheless those structures and their interactions remain indeterminate.

The psychologist, Izard, proposes a revolutionary definition, arguing that emotion has substantial and measurable effects on cognition and action, so that emotion, cognition, action and consciousness are all interrelated. He states: "Emotion feelings are a phase of neurobiological activity and the key psychologi-

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cal/motivational aspect of emotion. They constitute the primary motivational systems for human behaviour" (Izard, 2009). Not only is this statement remarkable in its assertion that emotion feelings, along with other processes such as cognition and perception, are a part of neurobiological activity, but also, if it is true, then the influence of emotions on action is clear and definitive, given the latter's motivational aspect. We designers are particularly interested in the role played by users' emotions when they choose or utilize a product.

On the one hand, Donald Norman (2004) explains that the action of choosing a product is primarily emotional, and can be visceral, behavioural or reflective, while the research carried out by Izard confirms that the decision-making process is driven by emotion feelings, as Norman predicted, and, on the other hand, the trend in emotional design is towards emotional usability - i.e. towards creating products that evoke a specific emotional state in the user and fulfill their function better (Dormann, 2003). This is why we need to study and understand emotion in order to better comprehend the target user of the product we are designing, since the final aim of the study of emotions is to make design decisions by predicting the user's emotional response.

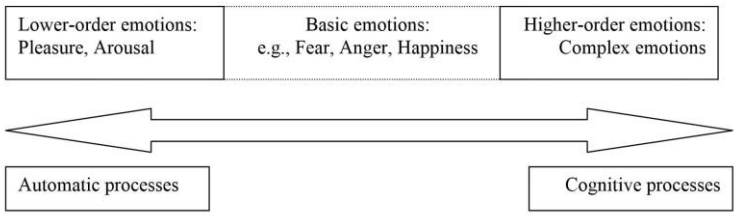

Fig. 1: The Emotional Continuum (Poels & Dewitte, 2006)

Types of emotion

Emotions can be classified according to their intensity, using Ekman's universal emotions classification or based on their relationship to cognitive processes. Poels and Dewitt (2006) propose an Emotional Continuum (See Figure 1) – i.e. a scale that grades the complexity of emotions depending on their interaction with the cognitive processes. The lower-order emotions, which are immediate and correspond to the visceral emotions described by Norman, occupy the left end of the continuum, while the higher-order −or most complex− emotions, which affect the cognitive processes and are the most difficult to comprehend, are grouped at its right end, which corresponds to the reflective emotional state posited by Norman. The basic emotional states −including Ekman's universal emotions and the behavioural emotional state proposed by Norman−are grouped in the centre of the continuum.

Evaluating the emotional response

Designers are showing growing interest in emotions not only because they want to increase sales, but also because they wish to produce personalized objects and assess the emotional effect they produce when users interact with them (Caicedo & van Beuzekom, 2006). In response to this interest, several assessment methods have been proposed and used, being classifiable, depending on the type of information source, as self-reporting methods, autonomic methods and the Kansei Engineering method, which are reviewed below:

Self-reporting methods

Self-reporting methods use one or other of the following means to measure the subject's emotional feelings as expressed by himself:

Visual measures, whereby subjects report their emotional state by choosing an image that best expresses it. As with verbal measures, different emotional models can be used. For example, the Self Assessment Manikin (SAM) (Bradley & Lang, 1994) uses the same model as PAD, the Emocards measure (Desmet, Overbeeke, & Tax, 2001), the PrEmo measure (Desmet, 2005), and Russell's circumflex model of affection. The biggest advantage of these kinds of measure is that they can be used to assess diffuse, vaguely defined emotions, since they place no limitations on the language that can be used. These methods are designed to assess low-order emotions, with the number of dimensions used by the model determining the complexity of the emotions that can be measured.

Moment-to-moment, whereby the emotional state is monitored continuously, with the subject moving a pencil (warmth monitor) or a cursor (feelings monitor) in response to a stimulus. Though these methods are the simplest and easiest ones to use, since they are one-dimensional, they can only evaluate low-order emotions.

Autonomic methods

Methods that infer the subject's emotional state using different indicators are called autonomic. These methods are the most scientific ones because they are based on anthropological or neuroscientific theories. The indicators they use are:

Facial Expressions. Based on his research, Ekman concludes that there are universal emotional expressions (Ekman, 1992), so that it is possible to recognize a person's emotional state by reading certain visible facial codes (FACS). Although this method's reliability has always been questioned, it is widely used to assess basic emotions.

Biometrics. Emotion feelings are physiological phenomena that can be measured via skin conductance (SC), electromyography (EMG), heart rate measurement (EKG) or eye-tracking, among other things, using what is called biofeedback equipment. All these methods are quantitative and their variables always need to be cross-checked. Though their design is still not definitive, they are useful for tracking more complex emotions - even high-order ones.

The neurosciences. In recent years, technology has evolved that is more capable of helping us to understand the brain and neural activity, and hence the neurosciences have become a very effective tool for evaluating the emotions. Given their great complexity, more information about these methods is provided below.

The neurosciences and neurodesign

The approach to design via the neurosciences that is called neuromarketing arose from marketing, and, with the help of neuroscience, has developed a set of tools and procedures that helps firms and other organizations to get a better understanding of their markets. Neuroscience is a fusion of various disciplines, including molecular biology, electrophysiology, neurophysiology, behavioral biology, neurology, cognitive neuropsychology and the cognitive sciences.

Several experiments have confirmed some of the conjectures that have been made to date about users' needs and desires, placing even greater emphasis on studies that have led to new insights into the relatively irrational behavior exhibited by people when they make purchase decisions and consume products.

For example, in an experiment in which Electroencephalography (EEG) and Event-Related-Brain- Potential (ERP) measurement were used on the subjects, Wang, X., et al. (2012) found that there is a measurable affective response to aesthetic experience. The aforesaid tools can differentiate between objective aesthetic value and subjective aesthetic evaluation, and the researchers concluded that emotional arousal seems to occur at the early stage of aesthetic processing.

Professor Leon Zurawiki emphasizes the implications of using neuro-imaging tools for marketing analysis, since the said tools are becoming mainstream instruments in different areas of marketing and product development (Zurawiki 2010). However, it should be stressed that ethical concerns continue to exist about the use of neuroscientific methods for commercial purposes.

The success of neuromarketing and neurodesign mainly resides in their ability to capture the whole emotional spectrum, while traditional surveys and other methods work only for a given order of emotions. Moreover, though a subject can try to outwit a traditional method by expressing feelings and thoughts that are different from those s/he really has, his/her physiological responses are unmistakeable – i.e. neurobiological methods are always accurate.

"With the use of brain imaging technology, researchers are better equipped to test the attractiveness of the products (separately and relative to each other), compare the appeal of alternative communications, choose the most appropriate media, study the propensity to conform to fashion or the intriguing phenomenon of loyalty". Even if many of the brain functions are still not known, many scientists −among them, Damasio and Craig (2009) − are looking for ways to more accurately locate the parts of the brain where emotions arise.

Kansei Engineering

The Kansei Engineering (KE) methodology was developed by Professor Mitsuo Nagamachi, Professor Tatsuo Nishino, and their colleagues at the University of Hiroshima for the purpose of making design decisions aimed at fulfilling emotional needs. The main objective was to understand sentimental, emotional and affective needs from Voice of Customer (VOC) and translate them into new objects, services and experiences – i.e. to design a satisfactory product or service that serves its purpose and/or generates pleasure.

Defined by Nagamachi as "needs, wants, affects, emotions and everything that is related to

them", the word "Kansei" refers to feelings generated through sight, hearing, smell and taste. KE technology has been developed since 1975 and KE, which is seen as comprising over six main generations, is considered one of the few methods currently available for constructing models that links affective elements to a new product-development process (Shutte, 2005) and is capable of designing for the whole emotional continuum. The six KE generations are: KE type 1, KECC (KE Category Classification) KES (KE System), VIVA (Virtual KE System), RSKM (Rough-sets Kansei Model) and KEM (Kansei Ergonomic Model).

Method		Specific Resources needed	Specialized personnel	qualitative (QLY) / quantitative (QNT)	Type of information
Verbal Measure	Likert scales	Questionnaires	Examiner / Psychologist	QLY	Intensity of emotion feeling
	Semantic Differential	Questionnaires	Examiner / Psychologist	QLY / QNT	Type of emotion feeling
Visual Measure	SAM	SAM scale	Examiner	QLY/ QNT	Valence, arousal and dominance of emotion feeling
	Emocards	Emocards scale	Examiner	QLY / QNT	Arousal and pleasantness of emotion feeling
	PrEmo	PrEmo digital Platform	Examiner	QLY/ QNT	
Moment to moment	Warmth Monitor	Paper and pencil	Examiner	QLY	Intensity of emotion feeling
	Feelings Monitor	A computer	Examiner	QLY	
Facial Expressions	FACS	Video recording	Examiner / Anthropologist	QLY	Type of emotion
Biometrics	Skin Conductance	Biofeedback equipment	Examiner / Medical personnel	QNT	Type and intensity of specific emotional states (variables crosses are needed)
	Heart Rate	Biofeedback equipment	Examiner / Medical personnel	QNT	
	EMG	Biofeedback equipment	Examiner / Medical personnel	QNT	
	Eye tracking	Eye tracker	Examiner	QNT	
Neurosciences	EEG	Biofeedback equipment	Examiner / Neuroscientist / Medical personnel	QNT	The relation between stimulus and emotional responses
	MRI	MRI scan		QNT	
	PET	PET scan		QNT	
	ERP	Biofeedback equipment		QNT	
	MEG	Magnetograph		QNT	
Kansei		A computer	Kansei Engineer	QLY / QNT	The relation between form and emotional responses

Table 1 – Characteristics of Emotional-Evaluation Methods

As part of the evolution of KE, computers have been included in the system in order to speed up analysis and deal with the complexity of processing "rough-set" data, and these changes have made the design-process response time shorter.

The three aims of Okamoto's research (Hirata, 2009) are: (i) to find more effective means of developing a product or service by translating affective and emotional needs into design characteristics; (ii) to close the gap between VOC, the definition of design parameters, and product-development specifications; and (iii) to show that the satisfaction of emotional, affective and sensorial needs plays a crucial role in determining an organization's success by differentiating it from its competitors.

In order to develop further (Schmorrow, 2007; Hirata, 2009), KE needs to obtain more neuroscientific and biometric tools so as to better understand the user and the emotional impact of design (arousal) and its interaction with needs and the achievement of Kansei goals.

How to choose a method?

As stated above, all the methods reviewed in this paper have different scopes and evaluate different segments of the emotional continuum, added to which there are other differences that should be taken in account when choosing a method for a specific project, along with other factors such as the resources needed, the disciplines involved, and the nature of the data analyzed and the information obtained. While not including all the available methods, Table 1 below provides a comparative overview of the characteristics of the methods that are most common or most frequently used.

The Emotional-Method spectrum shown in Figure 2 below is also proposed as a comparative tool for use when choosing an emotional-evaluation method. The horizontal axis on the Cartesian plane depicts the emotional continuum, since the type of emotions to be evaluated play a key role in the choice of a method. The vertical axis shows how complicated the different methods are, in terms of resources time and the need for specialized staff, while the color coding indicates how invasive (i.e. uncomfortable) each method is. It is recommended that neuroscientific methods, which use radiation and invasive medical equipment, not be used frequently.

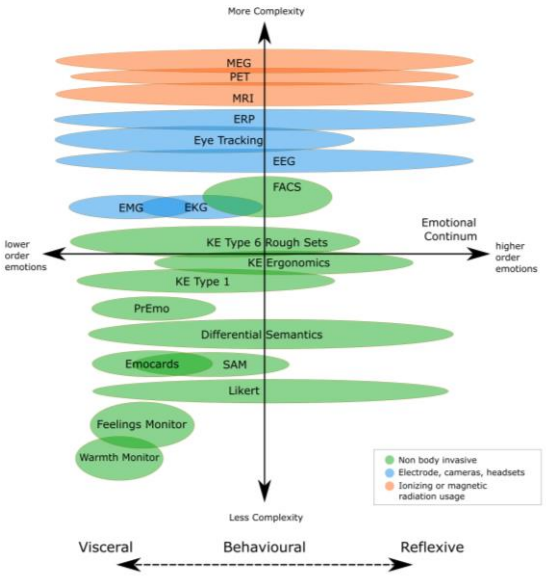

Fig. 2: The emotional-method spectrum

We are aware that other methods may need to be included in the said "Spectrum" in the future, and consider both this analysis, and the table and figure contained in it, to be works in progress that can embrace other methods and tools in the future.

Conclusions

Emotional design and neurodesign set out to satisfy the user's sentimental and emotional needs, to which end different disciplines have proposed emotional-assessment methods that differ in their complexity and scope. In this paper, we have analyzed and compared some of the said methods in order to show their potential and usefulness as emotional-evaluation tools. Given that the most complex and sophisticated methods tend not to be the most efficient ones, we need to determine the purpose of any evaluation that we plan to carry out, and ascertain its requirements, in order to identify and use the best method for a given design process. While there are many design problems that we are still unable to solve, nevertheless it is clear that design is evolving into a new multi-, inter- and trans- discipline capable of creating a better future and environment for human beings.

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