Recording Inner Life

Developing a physical input system for emotions

Submitted by

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2. Background research

This chapter provides background knowledge in the fields of this thesis that are mainly not design related. The title of this thesis is "Recording Inner Life" which addresses my focus on the "inner part" of human life in contrast to the social part of life which is call "outer life" in this work. How is "inner life" defined then? "Inner life" is our moods, our feelings and affective states including bodily reactions. In sum "inner life" refers to what we feel, to our emotions. The science that deals with these phenomena is psychology, the psychology of emotions to be more precise. Although the discussion about emotions, their origin and their purpose started in ancient philosophy at least, the psychology of emotions as independent field is quite young (for an overview about the development see for instance (Ulich, 1995) chapter "5. Theorien und Denkmodelle der Emotionspsychologie"). This development and the complexity of the topic may be the reasons for the lack of agreement regarding the definition of emotions. For this reason, this background chapter begins with a section about emotions and continues with the other related fields that are important for this thesis.

2.1 Emotions

To start with, a quote how emotions are defined in the field of psychology according to Encyclopædia Britannica:

"a distinct feeling or quality of consciousness, such as joy or sadness, that reflects the personal significance of an emotion-arousing event. In modern times the subject of emotion has become part of the subject matter of several scientific disciplines—biology, psychology, psychiatry, anthropology, and sociology.
Emotions are central to the issues of human survival and adaptation. They motivate the development of moral behaviour, which lies at the very root of civilization. Emotions influence empathic and altruistic behaviour, and they play a role in the creative processes of the mind. They affect the basic processes of perception and influence the way humans conceive and interpret the world around them. Evidence suggests that emotions shape many other aspects of human life and human affairs." (Encyclopædia Britannica, 2009)

As we can see in the quote, emotions influence wide aspects of our being and are thereby studied and described not only in psychology. However, there are still numerous unanswered questions and disagreement amongst researchers. To focus on the area of emotion research that is important for my work I have looked into models describing emotions. These models are related to the question whether emotions are learned or innate. The theory of basic innate emotions assumes that there are few primary emotions that developed with evolution and these cannot be disjointed further (like the primary colours). There are different sub theories defining different emotions as the basic ones. A prominent model consists of six basic emotions: surprise, anger, fear, disgust, happiness and sadness. It was derived from the analysis of emotional facial expressions by Ekman (Paul Ekman, 1994) One critique on the theory of basic emotions is the fact that their supporters cannot agree on how many and which emotions are the basic ones (the range is from two to eighteen basic emotions). This discrepancy results in

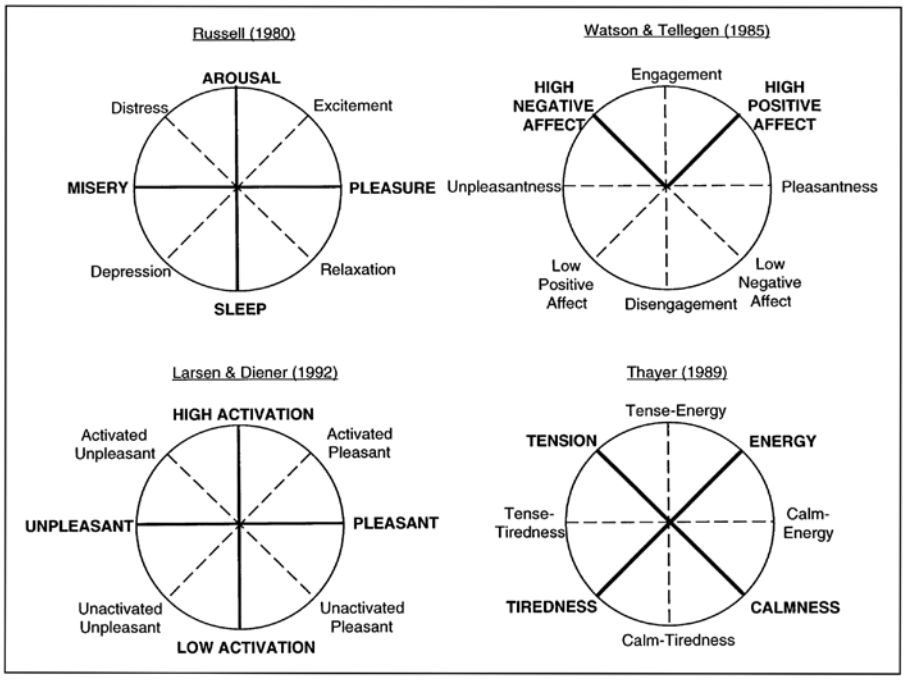

Figure 2.1 - 1 An overview about different dimensional models.

different definitions of emotions as well as in different derivation methods (see also (Otto, et al., 2000)).

On the contrary, there is the assumption that emotions are learned constructs. The limbic system in our brain is said to influence the emotional experience at most along the scales of a dimensional model of emotions (see also (Brave, et al., 2008). The dimensional models are the second main model to classify emotions. They describe emotions as a position in a mostly two-dimensional coordinate plane whose dimensions are valence (from positive to negative) and arousal (from high to low). See Figure 2.1 - 1 for a selection of two-dimensional models. The two-dimensional models are proven in many empiric studies but there is discussion as well. Especially on the definition of arousal as "low arousal" is easily mixed up with "fatigue" instead of "calmness". A critique towards a two-dimensional model is that different emotions like fear and anger are to be found almost in the same position within the model (see also (Otto, et al., 2000)). There are, too, models adding dominance as a third scale. This dimension depicts how much control we feel we have in a situation.

Altogether the approach to describe emotions with a combination of values on different scales is very promising for my project.

2.2 Self report methods used in psychology

My work is to design an input device that allows people to record their emotions in a computational system. During the input process the emotion becomes data, no matter how the input is done. It is a challenge to generate data that is computational usable but still meaningful to a human. In their research psychologists need to describe and record emotions or affective states of their test persons in a way that it becomes comparable data as well. This section and the following will describe currently used methods of self report and measurement.

There are a lot of methods based on language in order to rate emotions since language is an important tool to express emotions. For my design language shall not be used as people who are able and like to verbalize their emotions either do not need my device (if used in therapeutic context) or probably prefer to write a common diary. For this reason, only the semantic differential is named as a very widespread method using language. For a semantic differential the participant receives a list of opposite pairs on which he can mark his emotion between two extremes. There are many variations of this list used that differ in the number of items and gradation. To name a few:

- Differential Emotions Scale by Izard, Dougherty, Bloxom and Kotosch, 1974
- EWL by Janke and Debus, 1978
- Mood Adjective Check List (MACL) by Nowlis, 1965

Especially interesting for this thesis are non-verbal methods used in research. Below, three methods that go further than ticking smileys.

Self-Assessment Manikin (Bradley, et al., 1994)
The three dimensions of the dimensional model of emotions, valence, arousal and dominance, are visualized by the little manikin to be seen in Figure 2.2-1. The test person is asked to tick on each line those, matching his/her state the best. The state is visualized by facial expression (first line: valence), by a visualisation of rumble (second line: arousal) and by different sizes in relation to the environment (third line: dominance).

Affect Grid (Russel, et al., 1989)
The affect grid is a self report tool based on the two dimensions arousal and valence. It is a square divided into nine sub squares for each dimension. The test person ticks the box that matches his level of arousal and valence (see Figure 2.2-2).

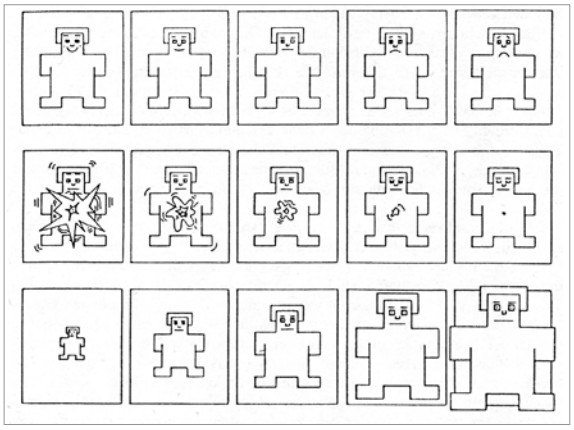

Figure 2.2-1 The Self-Assessment Manikin (SAM)

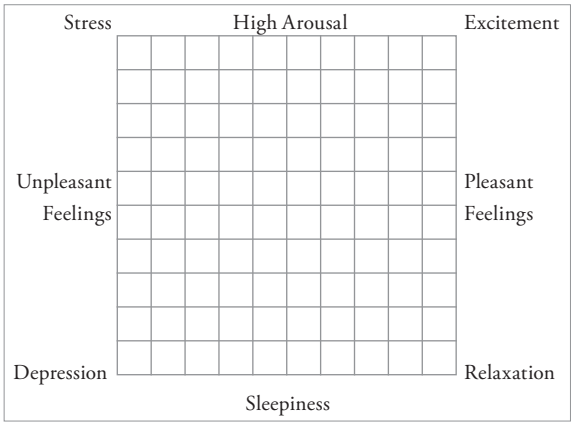

Figure 2.2-2 Affect grid after Russel, Weiss and Mendelsohn

Rating Dial
Through turning an ordinary knob either left or right the test person expresses whether he feels good, bad or stays neutral. Other test setups use the different directions for the expression of high or low arousal. This one-dimensional kind of mapping allows a very limited expression only. Nevertheless, this approach is worth mentioning because it uses a gesture of the participant. A similar method was developed by Wolfgang Vehrs in 1986. The participant uses a lever which he pulls forward or backward depending on his emotional state.

These non-verbal methods were developed because verbalization of emotions by the test persons can led to biases. These can be caused by the social situation in which the experiment is set, but also by discrepancies in the use of language. Amongst others these problems are reasons for the research that is introduced in the following subsection.

2.3 Bodily expressions of emotions and their measurement

Humans show signals while experiencing affect or being in a certain mood. These signals include voice, mimic and gestures as well as bodily aspects mostly controlled by the vegetative nervous system. Beginning with the bodily reactions as there were supposed to be less influenceable and therefore have been the subject of high interested in recent research. Below, a list of the most important bio signals and their possibilities of measurement:

- Heart rate with electrocardiography
- Blood pressure with a sphygmomanometer
- Muscle activity measured with electromyography
- Movement of the whole body with accelerometers and pedometers
- Skin temperature with a thermometer
- Galvanic skin response with electrodes on the skin
- Peripheral perfusion usually with a finger clip
- Brain activity with electroencephalography and functional magnetic resonance imaging (view of the particularly active zones of the brain)
- Levels of several hormones

It suggests itself to connect the physiological measures with the dimensions of the dimensional model of emotions and is often done. Prof. Dr. Schmidt-Atzert has three arguments against this: firstly, there is no universal concept of physiological arousal. He says that physiological variables correlate only very little so that every signal if at all indicates another kind of arousal. Secondly, a lot of the physiological changes occur with mental or physical work as well. At last, there is very little correlation between physiological changes and other indicators for emotions despite two exceptions: startle response and sexual arousal (compare (Schmidt-Atzert, 1996) pages 102 to 104). So even if a person shows a "significant physiological pattern", it has not necessarily anything to do with what the person experiences!

Assuming the user wants his emotions recorded, he does not hold back with his mimics, voice and gestures. Is it not common knowledge that humans are excellent in recognizing how another human feels by interpreting these expressions? And can this not be done by computational systems too, if we just figure out the pattern? Some of these patterns are so well known already that animators who have to convince the audience that their drawn characters are alive and have emotions use them. Like real actors they are not only paying attention to the characters face but to the whole posture. Figure 2.3-1 shows a famous example from the book "The Illusion of Life: Disney Animation" (Frank Thomas, 1995). The abstraction of a sack filled with flour helped the animators to understand which movements are distinctive for the expression of particular emotions. A more abstract example is "Polly's World" by Ken Perlin (Perlin, 2002) (see Figure 2.3-2). The geometric figure can move (or "walk") in different ways and thereby gives the impression of different emotional states.

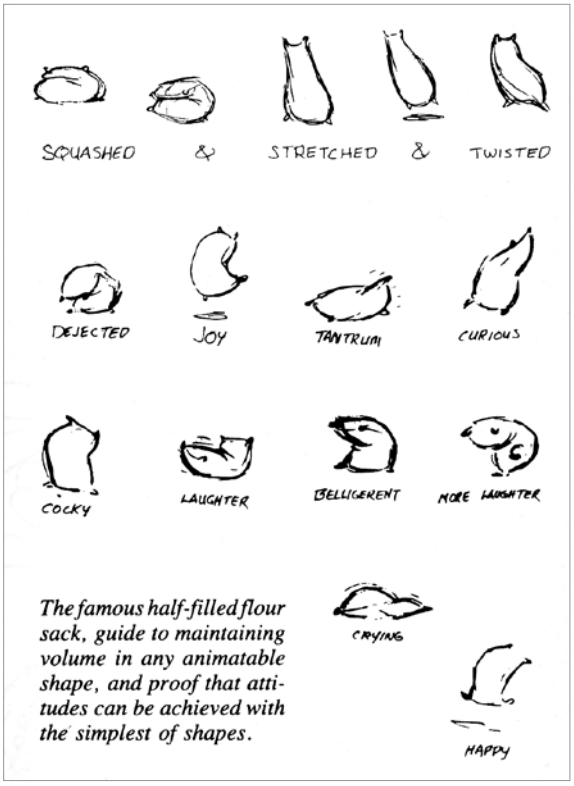

Figure 2.3-1 The flour sack

A short objection: only because we assume to recognize how another person feels does not always mean we are right. But indeed humans are good at decoding emotional expressions. However, this is more complex than measuring voice frequencies or the movement of facial muscles with electromyography. In real life we know about the context of these signals. We usually share knowledge about each other or at least about the current situation that helps us to decode the others' behaviour (see (Schmidt-Atzert, 1996) sections 4.2 and 4.3). Computational systems do not have this contextual knowledge, at least until now (see also 2.6 Lifelogging). Nonetheless, I have looked into research concerned with the recognition of emotion in order to decide how my system should work.

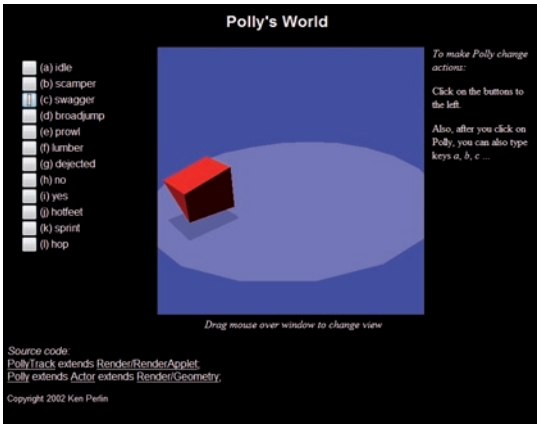

Figure 2.3 - 2 Ken Perlins "Polly's World"

Extensive research was done on the question how well emotions can be recognized from photographs or videos. A prominent researcher in this field is Paul Ekman. In his studies from the 80s he achieved very high recognition rates of 74% to 90%. He also developed a system to describe facial movements systematically: the Facial Action Coding System (FACS) (1978, together with his colleague Friesen). A major critique of these studies is that he only used pictures that showed very distinctive expressions of surprise, anger, fear, disgust, happiness and sadness. Today's research concerned with the recognition of emotions by computational systems is a large part of the field called affective computing. Rosalind Picard leads the "Affective Computing Group" at the MIT. Studies done at her institute achieve a very high recognition rate of about 81%, however, as Rosalind Picard states herself in an interview in "Affective Interactions" (Paiva, 2000)

"Much of the data collected for facial expression or vocal expression recognition is exaggerated or gathered from actors trying to express and not necessarily feel the emotion, and it is hard to tell how much that has biased the results." (Page 221)

Nevertheless, this research into the recognition of patterns in different signals is very valuable and has great influence on various fields. Artificial Intelligence researchers for instance try to incorporate emotions in their models as value judgment. Of course, they would profit from a consistent pattern, but also from methods of recognizing emotions such as for robotic-human interaction. To conclude, I can say that I will not use a totally automatic recognition system for my design and I would like to finish this sub-section with a last quote from the interview with Rosalind Picard:

"Q: Some part of the research of your group goes into capturing emotional states of the user, from the sensing to the recognition of emotions. Can you briefly describe what processes and techniques would be needed for example, for my computer to be able of recognise my emotions at the present moment?

A: We still don't know exactly what would be needed in the minimal sense of this word; it is too early to tell, and it may differ for different people. The issue is complicated by many factors, perhaps the biggest factor being that individuals have vastly different comfort levels with different kinds of sensors, and I think the human needs and desires should come first. Some people are happy to have a camera pointed at their face and to show genuine facial expressions to the system, while others consider a camera a major privacy invasion." (Page 220)

2.4 Expressions of emotions using media

The preceding section discussed bodily expressions of emotions, however, humans also use media for the recording or sharing of emotions with others. In order to express emotions, we write texts, create pictures by painting or photography, create sculptures, compose music, film or use our bodies to dance or act. I will not consider semiotics and semantics of emotional signs at this point as I want to design an input device with which the user can develop his own language. However, part of my design is to determine a set of functions the user can choose from. Therefore I will describe the ways of expression used in the above mentioned media: all these media consists of one or more of these means of expression: language, colour, shape, material, sound and movement. Through different possible combinations, people can create complex signs that refer to inner states. By choosing materials, colours and shapes for instance, he can create a painting. These combined signs as well as their components themselves have denotations. These often derive from human perception of body and environment. Some of these are so basic that cognitive scientists speak of "image schemata". Image schemata are embodied concepts we have in mind that are even deeper than the level of verbalisation (for more information on image schemata see (Kövecses, 2003). Two examples for colour from a study carried out by the Technical University Berlin (Sad is Heavy and Happy is Light, 2009): the metaphor "angry is warm" had a rate of 82% acceptance when presented with differently coloured objects. And "happy is warm – sad is cold" was accepted by 91% when presented with a red and a blue object. Although these two examples seem contradictory in the first place, they illustrate well that especially emotion expressions are often derived from bodily experiences in and of the environment.

Of course the interpretation and conscious knowledge about the meaning of language, colour, shape, material, sound and movement is influenced by the cultural environment. For instance using colours as expressions for certain emotions is more likely to be accepted than using shapes. Although this may be a concept in our cognitive structure as well, we are not used to use shapes as much as to colours because of the influential use of colours in our environment (see as well 3.4 The sensual evaluation instrument).

To choose a medium and the ways of expressing emotions is a very individual process, just as the perception and the experiences of the world differ from person to person. For this reason, I do not aim to design an emotion input that works for everybody. I consider this to be impossible, since the expression of emotions is a very individual one, beginning with the choice of media. Nevertheless, I will follow the principle of "Natural but designed expressions" (see 3.3 eMoto) and choose means that probably work for a lot of people.

2.5 Psychotherapy

For this work, psychotherapy is an area of interest because the developed device can be used as an assistive technology in the process of reflecting and expressing of emotions, which is an important part in today's psychotherapy. To begin with a definition of what psychotherapy is:

"any form of treatment for psychological, emotional, or behaviour disorders in which a trained person establishes a relationship with one or several patients for the purpose of modifying or removing existing symptoms and promoting personality growth. Psychotropic medications may be used as adjuncts to treatment, but the healing influence in psychotherapy is produced primarily by the words and actions of the therapist and the patient's responses to them, which in combination are meant to create a safe, intimate, and emotionally meaningful relationship for the open discussion and resolution of the patient's concerns." (Encyclopædia Britannica, 2009)

The influential psychologist Carl Rogers described the optimal result of psychotherapy in his concept of a "fully functioning person":

"It appears that the person who emerges from a theoretically optimal experience of client-centered therapy is then a fully functioning person. He is able to live fully in and with each and all of his feelings and reactions. He is making use of all his organic equipment to sense, as accurately as possible, the existential situation within and without. He is using all of the data his nervous system can thus supply, using it in awareness, but recognizing that his total organism may be, and often is, wiser than his awareness. He is able to permit his total organism to function in all his complexity in selecting, from the multitude of possibilities, that behaviour which in this moment of time will be most generally and genuinely satisfying. He is able to trust his organism in this functioning, not because it is infallible, but because he can be fully open to the consequences of each of his actions and correct them if they prove to be less than satisfying.

He is able to experience all of his feelings, and is afraid of none of his feelings; he is his own sifter of evidence, but is completely engaged in the process of being and becoming himself, and thus discovers that he is soundly and realistically social; he lives completely in this moment, but learns that this is the soundest living for all time. He is a fully functioning organism, and because of the awareness of himself which flows freely in and through his experiences, he is a fully functioning person." ((Rogers, 1963), page 7)

This is exactly what I would like to accomplish with my system: supporting the process of gaining insights into oneself through the conscious dealing with one's emotions.

People that need a therapy often have affective disorders. A group that is especially affected by feeling "unemotional" are patients with depressions. Depression is a disease pattern with various types and can be treated with different methods (see (Hoffmann, et al., 2000) for an overview). What kind of therapy is applicable is very case depended and what works for one type can be worse for the illness of other patients.

First, I would like to give a short description of one method that focuses especially on the conscious dealing with our emotions which is what I want to support with my device. This method is called cognitive therapy and was developed by Dr. Aaron T. Beck. This form of psychotherapy aims at the cognition of situations in daily life. Here "cognition" includes the perception of an event and its (emotional) appraisal. Patients with depression often appraise their surrounding and themselves with biased criteria. Additionally, they are not able to identify the real causes for their loss of positive emotions which stresses them. The therapist helps the patient by talking about current events and also past life of the patient. In doing so, they work on two fields: one is a less biased cognition of events, especially of the reactions of other people. The other is to identify the emotional responses to these events and their causes.

Therefore, some patients have to train to perceive their emotions more clearly again as these are signals for actions that can help to find a balance again. This can be supported by writing down their plans for the day or a diary about what they did. These records are discussed between therapist and patient in the following session. They help to perceive the own and the environments behaviour and the emotional appraises towards it (see (Beck, et al., 1992) chapter twelve for a detailed description).

Another form of therapy I would like to introduce is art therapy. This method used in psychotherapy from time to time is relevant for me because it uses non-verbal means of expressions. The term "art therapy" stands for a wide variety of approaches that have developed over the years. They all deal with the following aspects but with different foci:

- the aesthetics of the produced piece and his parts (methods that root in anthroposophy)
- the emotional, cognitive and behavioural associations towards the produced piece (cognitive approaches)
- the relationship between the patient, the therapist and the piece

For a more detailed description of the different approaches and their development see (Menzen, 2001).

Interesting for my work are the following aspects of art therapy that can support cognitive behavioural psychotherapy:

- *Ein Ausgestaltetes ist weniger naturalistisch und gefährlich als die Phantasie.*
- *Ein Ausgestaltetes ist weniger flüchtig als die Phantasie; es steht zur Verfügung, zeigt eine quasi objektive Spur zur Lösung hin.*
- *Ein Ausgestaltetes entscheidet sich in Farbe und Form, wirkt so auf die Phantasie zurück.*
- *Ein Ausgestaltetes wird öffentlich und regt zur Interaktion an.*
- *Ein Ausgestaltetes kann als Schönes positiv-verstärkend und intervenierend-belohnend sein.*
- *Ein Ausgestaltetes lässt sich im Sinne der humanistischen „sensory awareness" sinnlich und körpergefühlshaft erleben.*
- *Ein Ausgestaltetes ermöglicht im Sinne unserer rechtshemisphärischen körpergefühlshaften Kompetenzen eine längere Verweildauer beim Produkt.*
- *Ein Ausgestaltetes gibt im Sinne eines operationalisierenden Bewusstseins den vagen Phantasien Form und trägt sie der bewussten Verarbeitung zu.*
- *Ein Ausgestaltetes veräußert das symbolisch-metaphorisch Innere.*
- *Ein Ausgestaltetes versetzt aus einem künstlich-künstlerischen Raum in einen alltäglichen.*

((Schuster, 1997) cited from (Menzen, 2001), page 132)

In English (author's translation):

- Something shaped is less naturalistic and dangerous than fantasy.
- Something shaped is less volatile than fantasy; it is available and shows a quasi objective trace to solution.
- Something shaped decides in colour and shape, thereby affect the fantasy.
- Something shaped becomes public and encourages interaction.
- Something shaped as beauty can be potentially positive and intervened rewarding.
- Something shaped can be experienced sensuously and with coenaesthesia following the humanistic principle of sensory awareness.
- Something shaped enables a longer retention time at the product in terms of our right-hemispheric coenaesthesiatic competences.
- Something shaped concretises vague fantasies in the sense of operationalising consciousness and conveys them to conscious coping.
- Something shaped externalises the symbolic metaphoric inside.
- Something shaped turns an artificial-artistic environment into an everyday one.

Art therapy that is rooted in depth psychology says *„Das Gestaltete stellt also eine Synthese zwischen Unbewußtem und Bewußtem dar."* (Schrode, 1995) (English: "The representation is, hence, a synthesis of the unconscious and the conscious." (Translation by the author))

Whether this represantation is a painting, a sculpture or a piece of music depends on the therapist and the patient. Besides the final piece as means of expression, the process of creating the piece itself is an important part for the following conversation with the therapist too. The process of creation is not always easy for the patients, especially in the beginning of an art therapy session and even more in music therapy. Music therapy uses music as non-verbal means of expressions and a specialty is the joint play of therapist and patient. A good description about the difficulties in the beginning of a music therapy is provided by Decker-Voigt, (Decker-Voigt, 1991) pages 321-323: first abashment for the patient is the therapists demand to use a professional tool (an instrument in this case) which he was not trained to use. To request such an "unprofessional behaviour" from him is in contrast to the serious problems he seeks the therapists help for. When the patients start to play, some already have notions about the sense of their playing. They think it will be analyzed or that it should cause a cathartic relief. Either is true, but what is most important for the therapist is the joint play with his patient. There he can explore his patients' behaviour and reactions.

A central feature of both non-verbal therapy forms, art and music, is that the process of creation helps the patient to open up for reflection, consciously and unconsciously. This encourages my aim to design a device for non-verbal expression as I want to support reflection about oneself.

2.6 Lifelogging

The desire to document the own existence is part of human nature and belongs to the process of developing an own identity. Of course the methods and intensity of documenting varies from person to person and changes during lifetime. An extreme form of recording the own life is a phenomenon called lifelogging. This term describes the action to capture everything a person experiences. The phenomenon inspired my project as I wondered about the aspects of life, people like Steve Mann (Mann) capture. He captures his life with a camera mounted to his head since 1980. However, not only individuals like Steve Mann and his followers are interested in this topic. Research institutes ran projects to record not only every visual and auditory signal, but focused very much on pattern recognition to improve software supporting the user. The project that developed the term lifelogging was carried out by the Information Processing Technology Office of the Defense Advanced Research Projects Agency (DRAPA) which is a part of the Department of Defense of the United States of America:

"Program Description:
The goal of the LifeLog is to turn the notebook computers or personal digital assistants used today into much more powerful tools for the warfighter.

The LifeLog program is conducting research in the following three areas:

1. *Sensors to capture data and data storage hardware*
2. *Information models to store the data in logical patterns*
3. *Feature detectors and classification agents to interpret the data"*

(Drapa – Information Processing Technology Office)

Other projects capture and add the data we generate by using technical devices, like e-mails, networks we accessed or search queries. For instance, Microsoft Research has undertaken several individual and cooperative projects of which one is "MyLifeBits":

"The experiment: Gordon Bell has captured a lifetime's worth of articles, books, cards, CDs, letters, memos, papers, photos, pictures, presentations, home movies, videotaped lectures, and voice recordings and stored them digitally. He is now paperless, and is beginning to capture phone calls, IM transcripts, television, and radio." (Microsoft Research)

To enable this collection, a team around Jim Gemmell and Roger Lueder developed software that supports: *"hyperlinks, annotations, reports, saved queries, pivoting, clustering, and fast search. MyLifeBits is designed to make annotation easy, including gang annotation on right click, voice annotation, and web browser integration. It includes tools to record web pages, IM transcripts, radio and television. The MyLifeBits screensaver supports annotation and rating."* (Microsoft Research) They also collaborated with another project from Microsoft Research: the SenseCam.

"SenseCam also contains a number of different electronic sensors. These include light-intensity and light-color sensors, a passive infrared (body heat) detector, a temperature sensor, and a multiple-axis accelerometer. These sensors are monitored by the camera's microprocessor, and certain changes in sensor readings can be used to automatically trigger a photograph to be taken." (Microsoft Research)

SenseCam is also used to support patients with Alzheimer

Figure 2.6-1 The SenseCam camera

disease and shows how small the technological equipment became that is needed for this capturing. One step further is the project of Rob Spence, a film maker who received extensive media attention at the end of 2008, announcing to equip his artificial eye with a camera to do documentaries (Spence, et al.) (see Figure 2.6-2 for a picture of the implant).

Microsoft Research lists numerous lifelogging projects on their website "Memex - Digital Memories" (Microsoft Research). As the title reveals most of these projects are inspired by the vision of "Memex", the computer system proposed by Vannevar Bush in his article "As We May Think" in 1945 (Bush, 1945). This system is a personal assistant that knows everything about us, about the things we are dealing with. Thereby it understands his human user.

To fulfill the vision of Memex researchers feed computer system with massive amounts of data as in the project described above. The true challenge today is not the collection of data, but the classification of them and the recognition of pattern. In short: the making sense of them. Although private lifeloggers are not necessarily interested in

Figure 2.6-2 Rob Spence and his implant

Figure 2.6-3 The iPhone application of Memiary

pattern recognition they are interested in an all-embracing coverage of their activities. Web 2.0 brought several new possibilities for the documentation of private life. First were blogs with text and pictures. Interestingly enough these did not develop into multimedia supported narrative structures that construct a kind of "story of life". Instead several specialized services developed: Twitter (Twitter Inc.) for short messages about daily life and Flickr (Yahoo! Inc.) for photos to name two very popular services. While blogs, Twitter and Flickr have social aspects too, the following example is more private: Memiary (Yadav, 2008). This website in combination with an iPhone application enables the user to enter up to five headlines for each day. As a result of this formal limitation, its usage is faster than writing in whole sentences about the day and thereby encourages regular usage.

Other websites specialized on statistics about every day activities. A prominent example is Last.fm (Last.fm Ltd.), a website and application that automatically log every song the user listens to, either on his computer, MP3 player or mobile phone. Other statistic websites offer an environment to enter various kinds of data: Bedpost (functional, inc.) provides users with the option to keep statistics about their sex life. Daytum (Daytum) and mycrocosm (Yannick Assogba) allow the users to keep statistics about whatever they want.
Writing texts, taking pictures and keeping statistics is nothing new itself. The innovation part, besides the partially automation, is the eased management of data through databases that allow fast searching and recombination. In order to support access to the data the use of categorizing techniques such as tagging has increased. The recombination of the segmented data is called a mashup and will maybe lead to the overall "story of life" somewhere along the road.

To conclude, there are possibilities to create huge amounts of data about a person's daily life: Whether this is in form of automatically logged activities, manually entered statistics, taken pictures or written texts. What I wondered about is the contrast between the enormous amount of data that is generated about daily activities (especially with taken pictures) and the little amount of information it contains about a very important aspect: how we felt that time of our life.

For a joint conclusion of this and the following chapter see section 5.1 Concluding chapter 2, 3 and 4.

3. Related Work

Within this chapter I introduce two projects that deal with the recording of emotions with computational systems as well. Following I describe three projects that developed affective expressions in Human Computer Interaction (HCI) and conclude with a discussion position about affect in HCI.

Figure 3.1 - 1 Screenshot of the profile page

Figure 3.1 - 2 Screenshot of the Moodstats software input interface

Figure 3.1 - 3 Screenshot of the data re-visualization

3.1 Moodstats

Moodstats (Cuban Council, 2001 - 2003) is software to record different aspects of your daily life including your mood. For each day the user can set values for up to six categories between zero and ten with a software slider. There are three basic categories: "Mood", "Creativity" and "Stress". Two more categories can be picked out of 76 predefined ones and a last category can be named by the user himself. Displayed next to each slider are the average value, the last value and the number of entries for that category. Additionally the user can leave a short note to each category and also write a diary entry.

Although the software refers especially to the moods there is only the possibility to rate "mood" in general on a scale between zero and ten. All the other categories refer to activities that can influence the mood (for instance your stress level) but do not describe the mood anyhow.

My critiques to that software are basically two points: First the little differentiation of "mood". Only one category with a scale from zero to ten can at most represent one scale of the dimensional model of emotions. So if the user defines for himself that zero equals "very sad" to ten "very happy" he still misses at least the important information about the arousal and vice versa. The second point is the input itself. The input options on the users' profile page are playful and rather descriptive then exact (see Figure 3.1 - 1). Unfortunately the input options for the mood scale are only numbers. I appreciate the project for their recording approach and that they connect regular diary entries and statistically usable data about the user's daily life. But I want to develop an input system that meets more of the complex nature of emotions.

3.2 Affective Diary

"Affective Diary" is a project by the Interaction Lab of the Swedish Institute of Computer Science (SICS) in cooperation with Microsoft Research Cambridge. This project covers the span from early development till first user testing. The authors emphasise the knowledge and reflection about the own past as a very valuable part of live. Also they rate the involvement of the body for our emotional experiences and perception of the personal environment in general very high. Thus they developed a system, the Affective Diary, to record bio signals and the use of mobile technologies like text messages and combined this data in a joint picture that shall support the user in his reflection of past situations.

To represent the body status they chose two scales: How much the person had moved (measured by a pedometer) and her arousal (measured by a galvanic skin response sensor). These sensors were worn around the arm over the day and their data was transferred to a tablet PC when being at home again. The mobile phone captured sent and received text messages, taken pictures and Bluetooth devices that were located near the user. This data was transferred to the tablet PC as well (for the user study the pictures were uploaded manually to the tablet by the authors due to technical limitations). Examples for the combined output are to be seen in Figure 3.2-1 and Figure 3.2-2. Horizontally, the time axis ranging from morning at the left side (bluish background) over noon (green background) to evening (yellow merging into brown) To represent the bodily state they decided to use figures whose posture represents the amount of movement and their colour represents the level of arousal. For the mapping of arousal and colours they refer to colour psychology.

The composed pictures include also the text messages, photographs and detected Bluetooth device. Additionally the user can add notes and drawings by writing onto the tablet PC. The whole day can be played as an animation over 24 hours as well. The user study included four persons each of them using the diary between two and four weeks (three in average).

I appreciate the approach to support users in generating a narrative structure including the data that is generated during the day (especially the use of modern communication devices). However, I am a bit sceptical about is the value of automatically measured bodily activities. The authors discuss that issue themselves in their paper "Experiencing the Affective Diary" (Ståhl, et al., 2009). One point is how the measured data matches the experienced bodily reactions. Some situations the users remembered themselves as being very excited were not reflected in the measured data for instance. This is one example which shows that even emotional states involving a lot of body reactions cannot be measured reliable outside a lab environment. But that was not the main goal of the project:

"On the other hand, our aim was not to inform users about their emotional states, but to allow them to interpret the bio-data based on their own experiences." (Page 371)

This leads to another critical point: The interpretation by the users. One person could not relate to the data because it was already transformed into the figures. Another one read more information into them then it contained. In general it is hard to relate to automatically measured body signals after a

Figure 3.2-1 One hour at noon.

Figure 3.2 - 2 One hour during early afternoon.

certain time had passed. I wore a heart rate monitor myself for one week in the beginning of my thesis and even with a lot of dedication I could hardly relate to the generated data. The developers of the Affective Diary did some short pre-studies wearing monitors themselves:

"When studying those graphs, it felt as if the body had lived a life of its own—it was no longer our own bodies but some strange organism that had its own ups and downs. Our conclusion was that events during the day (as picked up by the sensors) needed to be represented in such a manner that it resembled and reminded us of our own bodies. We found moving away from graph-like representations to the body postures and colours discussed above encouraged a more holistic, bodily grounded, experience." (Page 370)

Thus, the decision to transform the data seems logical but I think the users should be enabled to add some information about experienced emotions as well, for instance by modifying the figures, maybe animate them. This would encourage the process of reflection the authors aim at.

One last interesting point I want to refer to is the inclusion of data about the social contacts (through text messages and Bluetooth). I think this information definitely helps the user to remember and thereby reflect upon his day. However, it could emphasised a bit more in the visual representation and could use more data sources as well (phone calls, e-mails for instance).

Figure 3.3 - 1 The eMoto expression space.

3.3 eMoto

Together with the Stockholm University the Swedish Institute of Computer Science realized the project "eMoto" (Petra Sundström, 2003-2007). They looked into ways to transmit more of the affective state of a person sending a text message by a mobile phone.

Therefore they developed a system that allows input with a gesture and a graphically visualisation the receiving persons sees as background of the text message on his mobile phone. Several papers were published during the development of eMoto. Following I refer to (Designing Gestures for Affective Input: an Analysis of Shape, Effort and Valence, 2003) because this gives insight particularly into the development of the emotion input. The authors analyzed emotional gestures performed by an actor with the help of Laban movement analysis (a system to record and analyze human movement, develop by Rudolf Laban). These gestures were separated into movement segments and related to Russells model of emotions (see also 2.1 Emotion). Then they used theories of colour psychology to relate colours to the emotion movements. The final "expression space" is the circle to be seen in Figure 3.3 - 1. It consists of colours and animated shapes. The navigation within this space is explained by the following quote:

"We call these combinations of the two movements the circumplex affective gestures […]:

- *Moving along the valence scale towards displeasure is done hrough increasing the pressure on the stylus, decreasing the pressure on the pen results in higher pleasure on the valence scale.*
- *Shaking and making faster movements, with the hand holding the pen, requires more effort and therefore result in higher arousal, while more swinging, not so direct movements result in lower arousal.*

The circumplex affective gestures are inspired by the shape, effort and valence analysis. Emotions with negative valence are associated with strain and tension, while positive emotions often involve less pressure and strain. Emotions with high effort are stronger in weight, more flexible in space and quicker in time, while emotions with less effort are less controlled, lighter and smaller in space. While the user is performing the circumplex affective gestures, the system is responding through showing the emotional expressions in color, shape and animations […]" (Page 62)

I think this is a very valuable project and I strongly agree on the emotion raising powers of colours and also on the expressiveness of gestures for emotions. My critique concerns the direct linking between emotions and gestures and colours. It sounds logical on first sight because the theoretical models were combined using shared variables. But all these models themselves are still discussed in psychology what makes it a bit vague. Although these combined models are used as underlying model only and are not represented directly to the user, he still has to perform gestures that were derived from emotional expressions to achieve a certain colour. But maybe projects like this can help to prove the psychological models and links between them: our emotion expression and perception. Additionally the system is used between friends who have a lot of contextual knowledge to decode the expression. The second

Figure 3.3-2 The eMoto system: a Java application running on a mobile phone plus the extended stylus.

Figure 3.3-3 The same text but two different messages.

critique is that colours and shapes and the movement are combined fixed. They could be three means of expression that could be combined by the user to achieve more options for expression.

During their process they developed four principals they considered applicable for the design of affective inputs in general. I cite them below as I found them very affirming to my own thoughts:

1. Embodiment

"Designing for embodied affective interaction thus entails both looking for the physical artifact embodiment of abstract emotion concepts, as well as allowing for social practice and interpretation of meaning of the emotional expressions." (Page 58)

Applied to my project I see the input action itself that shall be adequate to the data the user enters (see also 5.4.2 Input actions).

2. Natural but designed expressions

"An application is a designed artifact and can therefore not build solely upon (whatever is meant by) 'natural' emotional expressions. On the other hand, using mainly designed expressions bearing no relation whatsoever to the emotional experiences people have physically and cognitively in their everyday lives, would make it hard for the user to recognize and get affected by the expressions. Therefore we argue that emotional expressions should be aiming to be natural but designed expressions." (Page 58)

This is what I am aiming at too: To chose and design means of expression users can relate to. I am aware that a design for emotional expression cannot work for everybody even within the same cultural background. It is simply too personal. I want to design input scales the users can interpret and combine individually (see also 5.4.1 Input design).

3. Affective loop

"The aim of the affective loop idea, is to couple the affective channels of users closely to those of interactive applications, so that the user's emotions are influenced by those emotions expressed by or through the application, and vice versa. Through designing for physical expressions of the end-user (e g body posture, gestures, tangible input through toys, speech) that makes sense with regards to the design of the overall interaction or narrative or the system they interact with, we try to make users involved both physically and cognitively." (Page 58)

Expressing emotions in whatever form also releases emotions, maybe even changes them. Although they aim more at the physical expression of emotions and the maybe resulting cathartic effect, for me this addresses the reflection time I want to support with my device.

4. Ambiguity

"For example, if a system was to have buttons where each was labeled with a concrete emotion, users might feel extremely limited since they would not be able to convey the subtleties of their emotional communication to others." (Page 59)

Ambiguity is at the risk of arbitrariness naturally. Nevertheless, I share the opinion that input systems that shall represent emotions cannot be as determined as an on/off-button. Additionally, for my design I have the easement that it is intended for two persons at maximum. These two are patient and therapist and they talk about the input from face to face. There is no emotion sharing feature beyond that setting. Anyways the means of expression have to be chosen carefully because I want to enable long time recording and the user should be able to relate to the input so that he himself is able to decode it later.

3.4 The sensual evaluation instrument

"The sensual evaluation instrument: Developing a trans-cultural self-report measure of affect" (Isbister, et al., 2007) this is the title of a joint project of the Rensselaer Polytechnic Institute New York and the Swedish Institute of Computer Science. Being discontented with current methods of self-report (see also 2.2 Self report methods used in psychology) they looked for a method to measure the affective states of users while they interact with computer systems. After first tries with colour coding similar to what was used for the eMoto project (see 3.3) they decided for a plastic model. They looked into physical emotion expressions and commissioned a sculptor to design shapes matching these descriptions:

- *Confusion (I don't get what's going on here)*
- *Frustration (what the system just did drove me nuts; or, I can't solve this level and I hate this right now)*
- *Fear (the game is making me anxious; or, I think I might've erased the wrong files)*
- *Happiness at success (I just cracked a level; or, I just figured out how to do a new thing)*
- *Surprise (positive – something good happened I wasn't expecting)*
- *Surprise (negative – something bad happened I wasn't expecting)*
- *Satisfaction (something happened that I like)*
- *Contentment (all is okay, going smoothly)*
- *Frantic stress (things are out of my control, too much going on)*
- *Flow (I'm in my groove right now, really enjoying working with the system, we feel as one)*
- *Neutral (not feeling emotions right now, just working…)*

(Page 318)

In the end they had eight shapes (see Figure 3.4-1) that they tested in a user study. It was carried out in Sweden and in the USA with 12 participants each (10 male and two female in the USA, 8 male and four female in Sweden). The test took about an hour and they went through five stages:

- *Explanation of research purpose and orientation to the Objects*
- *Use of objects with a subset of the IAPS (International Affective Picture Set)*
- *Use of objects with a computer game*
- *Use of objects during a chat*
- *A discussion of how it was to use the objects to give affective feedback*

The participants were encouraged to take the objects that

Figure 3.4 - 1 The sensual evaluation instrument (SEI)

represent their state and pull them closer or hold them in their hands instead of speaking about their emotions. In evaluating the outcomes the authors found indications that some shapes match the dimensions of the dimensional model of emotions: Round shapes for positive valence, spiky forms for negative valence and even, regular shapes for little arousal versa irregular shapes for high arousal. Additionally they found cues for a relation between “calmness” and symmetric shapes and “chaos” and asymmetric shapes.

This study encourages relations designers already use for their work when designing an object to have a certain effect.

3.5 Push Me, Shove Me and I Show You How You Feel

Wensveen, Overbeeke and Djajadiningrat from TU Delft where looking into ways how products could recognize the emotions of their users from the way the users (physically) interact with them. They designed an alarm clock that uses twelve circular arranged sliders to set the alarm time:

"The prototype of the clock consists of two displays and twelve sliders. The front display shows the current time, the central display shows the alarm time.

When the sliders are slid from the starting situation [...] towards the central display the alarm time appears in this display [...]. With the first displacement of a slider, time is added to the current time to make up the alarm time. With each successive displace-ment, more time is added to (moving towards the centre [...]) or subtracted from (moving towards the edge [...]) the alarm time. Each slider ranges from 0 to 60 minutes. Upon reaching the preferred wake up time the central display is pressed [...] and the alarm is set [...]."

((Push me, shove me and I show you how you feel: recognising mood from emotionally rich interaction, 2002), page 336)

Figure 3.5 - 1 The alarm clock

In their papers (Touch me, hit me and I know how you feel: a design approach to emotionally rich interaction, 2000) and (Push me, shove me and I show you how you feel: recognising mood from emotionally rich interaction, 2002) they describe the design process and in the second a user study with thirteen participants and an average recognition rate of 60% (for whole pattern, higher rates for single factors like arousal and valence).

What is special about their project is the approach to change the common interaction (the time setting actions in this case) in order to gain more information from the user. Although a lot of research has to follow I assume this field to be very valuable for future interaction design especially in consumer electronics.

For my thesis the project is interesting as an example for emotional input. Besides the difference that I want to design an input for emotions and not an emotional input, I want to enable a more subtle input mechanism than the sliders.

3.6 Affect: From Information to Interaction

Researchers from Cornell Information Science (Ithaca, USA) and University of California (USA) thought about the role of emotions in HCI and the influences from the field of affective computing. They argue against seeing emotions as just another factor in a calculable model of how cognitive science.

They suggest a shift in the treatment of emotions in HCI: Away from the piece of information that solely exists and is caused "inside" the user and that has to be incorporated into a computational system somehow. Towards dealing with emotions in a broader cultural context and value the interactions done for input of emotions into a computational system and their context. In both of their papers (Affect: from information to interaction, 2005) and "How emotion is made and measured" (Boehner, et al., 2007) they discussed different aspects of HCI when treating emotion as information and when treating it as interaction. They present five principles I want to cite here as they, similar to the principles of 3.3 eMoto, affirmed this project:

"The interactional approach recognizes affect as a social and cultural product
[…]
Indeed, Affector [a design example, authors note] only works in the context of an ongoing relationship outside of the system that provides the grounds for meaning-making with the system." (Page 283)

For my design this is the relationship a person has with itself so to speak.

"The interactional approach relies on and supports interpretive flexibility
[…]
By leaving the definition of emotion and its interpretation to users, EmoteMail, SEI and Affector allow emotional meanings to emerge in a situated way over the course of interaction." (Page 284)

"The interactional approach avoids trying to formalize the unformalizable
[…]
The interactional approach does not require emotion to be formalized by the system or in evaluation; instead, the users can supply the emotional meaning in the system." (Page 284)

The two principles above encourage my attempt to design a device that provides different scales that can be interpreted and combined freely by the user.

"The interactional approach supports an expanded range of communication acts
[…]
Instead of users thinking, 'I feel excited. The pointy object represents excitement in this system. Therefore, according to the system language, I feel pointy,' an alternative is to allow users to express themselves directly or to use the expressive capabilities of the system to demonstrate, rather than represent, their feelings: 'I'm feeling pointy. Pointy demonstrates how I'm feeling right now.' In this example, the exact interpretation of what 'pointy' means is left open to the people involved and depends on the detailed situation of their discussion." (Page 284)

For my work I refer this to the intense relationship between the therapist and his patient. They together discuss the emotion input, the reasons and consequences.

"The interactional approach focuses on people using systems to experience and understand emotions
[…]
The important thing from the interactional perspective is not making systems more aware of emotions but making people more aware of emotions through system use and design." (Page 284)

This is exactly what I want to achieve with my device. Awareness for a part of life that should be the most important but somehow slips away with stress and routine of daily life.

Their papers encouraged me very much in my approach to design a system that within itself is freely determinable and interpretable by the user. It is not to enable any computer system to "understand" or "know" about the users emotional state. It is about providing the user a system whose use gives him time and space to get to know the own emotional state over a long time.

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