A Foundation for Emotional Expressivity

Anna Ståhl
SICS
Box 1263
SE-164 29 Kista, Sweden
annas@sics.se

Petra Sundström
DSV, KTH/SU
Forum 100
SE-164 29 Kista, Sweden
petra@dsv.su.se

Kristina Höök
DSV, KTH/SU
Forum 100
SE-164 29 Kista, Sweden
kia@dsv.su.se

Abstract
To express emotions to others in mobile text messaging in our view require designs that can both capture some of the ambiguity and subtleness that characterizes emotional interaction and keep the media specific qualities. Through the use of a body movement analysis and a dimensional model of emotion experiences, we arrived at a design for a mobile messaging service, eMoto. The service makes use of the sub-symbolic expressions; colors, shapes and animations, for expressing emotions in an open-ended way. Here we present the design process and a user study of those expressions, where the results show that the use of these sub-symbolic expressions can work as a foundation to use as a creative tool, but still allowing for the communication to be situated. The inspiration taken from body movements proved to be very useful as a design input. It was also reflected in the way our subjects described the expressions.

Keywords
Affect, Handheld Devices and Mobile Computing, Interaction Design, User-Centered Design/Human-Centered Design, User studies

Project/problem statement
Emotional communication between people depends on what media is used and the specific qualities that characterize that media channel. It is also dependent on the shifting situations in which the communication takes place.

In face to face communication the spoken word is only one part of the communication. The emotional content of what is said is conveyed also in subtle ways through

tone of voice, facial expressions and body language. Parts of this happen unconsciously, but are still important for the understanding and interpretation of meaning and the emotional content of a message.

In attempts to mirror real life meetings, like in videoconferencing, most of the emotional content gets through, but not exactly as in face to face communication. This form of communication holds different qualities and therefore affects the emotional communication in another way.

In text messaging such as SMS (Short Messaging Service), IM and email the communication unfolds in different ways. The media specific qualities open up possibilities for us to convey different emotions than what we transmit unconsciously in face to face situations, we can hide where we are and we can choose to answer at a later stage. The emotional communication channel in text messaging is often very narrow, leaving the user with smilies and emoticons that hardly mirror the shifting situations in which the communication take place. This opens up for emotional augmentation of text messages that can hold the media specific qualities and allow for the shifting communication situations.

Our goal in this project is to add media channels to mobile text messages for emotional expressivity, this is realized in the eMoto system. The targeted user group for this service is women around 30. This group has consequently been used in the design process and user studies.

One of the problems with adding media channels for emotional expressivity concerns how to capture the subtleness and richness that characterizes emotional communication and still keep the media specific qualities within text messaging. The way we express ourselves is ambiguous and allows for many different social processes to take place. The emotions themselves are not clear-cut singular states that need to be expressed, neither should the design be context-free or simplistic signs. For example, a shrug can mean many different emotions depending upon context and how it is mediated [25]. It may be a shrug asking for forgiveness or it may simply mean *I do not know*. Emotions are not residing solely in the brain, but also in our bodies, [5] and [4]. Using sub-symbolic expressions when adding media channels, such as colors, shapes, animations, sounds or haptics, may offer an alternative route where we address more of this subtleness. This may also allow for an intuitive, physical reaction to the expressions, which in turn will address the physical nature of emotional experiences. The question posed here is whether we can mirror some of the subtleness and ambiguity of emotional interaction through creating a richer medium than what is available in mobile text messaging today, but still keep the media specific qualities? Below we present the resulting design expressed in the mobile service named eMoto and a user study of the expressions we designed. Our aim is to show that the way we realized ambiguity in the design of the expressions, their sub-symbolic form, and how we made use of an analysis of body movement from the design process, did indeed produce a design foundation that users could use as a creative tool for emotional expressivity.

Background

eMoto is an ongoing research project at the Interaction lab at SICS (Swedish Institute of Computer Science) and DSV (Department of System Sciences) at Stockholm University/KTH in Kista, Sweden. It is part of the Mobile Services project initiated in October 2002 and financed for three years by Swedish Foundation for Strategic Research. Focus in the project is on future mobile services. The project is conducted in cooperation with partners from the industry, the receiver of the research results from the eMoto-project is Sony Ericsson. This part of the project was conducted by members of the Interaction lab at SICS. The group consisted of one interaction designer/researcher, two

Kiss Communicator
In kiss communicator designed by Heather Martin and Duncan Kerr of IDEO a kiss is blown into an oval shaped product, which in turn creates a red, blinking light in the other person's device.

The White Stone
Concern for the other is shown by holding one of the stones in your hand, which in turn makes the other person's stone warm, thereby communicating affect.

ExMS
Is an avatar-abased messaging system where users create short pieces of animated film to send to each other on their mobile phones.

AffectiveColor
AffectiveColor is not for emotional communication, but for structuring existing text from an emotional perspective, using color.

Kinedit System
In this system a combination of shape and animation of text in a message is used to convey emotions.

Human Computer Interaction researchers with programming skills.

Challenge
The specific focus in this project is on mobile messaging, and thus limited by the restrictions offered by mobile devices in terms of size and communication bandwidth, so-called baby interfaces.

Solution
In this section we categorize existing systems and artefacts for emotional communication, we describe the design requirements for designing for emotional expressivity, the eMoto system, and the design process of how we arrived at the expressions using the sub-symbolic form of colour, shape and animation.

Process
Categorizing emotional communication artefact
Finding novel ways of expressing emotional communication through interactive media has been tackled in different ways by designers before us. Besides the smilies and variants of smilies, such as emoticons, we can distinguish between three classes of solutions: communicating through specifically designed artifacts, communicating through composing multimedia messages (MMS, Instant messaging with photos and emoticons, etc), and communication of affect through adding sub-symbolic expressions, such as colors or animations, to textual media of different kinds.

The first set of solutions, the designed communicating artifacts, typically involves equipping two people who have a close relationship with some kind of artifacts that can communicate wirelessly (e.g. [24], [20], [1], [11]). These solutions can often communicate presence or indicate that the other party is showing some kind of concern. Examples of systems using this kind of communication is the Kiss Communicator [2] (see sidebar) and the White Stone [23] (see sidebar). These

solutions have obvious constraints when it comes to communicating different and complex emotions. They are also dependent on specific devices for the communication. But what is interesting about them, is the simplicity of expression and the use of physical interaction means.

Our second category of communicating affect is through various multimedia possibilities. Many communication media allows for emoticons, photographs, avatar expressions or other ways of communicating affect. Here the emotional expression is entirely within the hands of the user. They choose which smiley, emoticon or avatar expression to pick, and it is subsequently shown to the other party. An example is ExMS [16] (see sidebar).

Visualization of affect, through sub-symbolic expressions, has been used in several systems. One example is AffectiveColor [14] (see side bar). A combination of shape and animation of text in a message to convey emotional content is used in the Kinedit system [9], (see sidebar). Apart from adding color and animations, some have also attempted to add haptics to the multimedia communication channels, see e g the system ContactIM [17]. Many of these systems tend to emphasize the positive emotions that we communicate to others, but in our relationships with one-another, dealing with negative emotions are oftentimes equally, or even more important.

Design requirements
First, in interaction between people, emotions are seldom labeled and explicitly expressed. Emotions are complex states conveyed dynamically through combinations of signals in body language and what is spoken. In this sense, they are mostly sub-symbolic expressions, not phrased in words or other symbols. They are understood from the specific context in which they are said. Emotions may be suppressed or emphasized depending on what the sender wants to achieve e.g. expressing pride to support a kid or anger

to balance an intimate relationship. Any medium designed to express emotions must similarly avoid explicit labeling of emotions, but instead strive to have less sharp edges. We may feel slightly angry, as in *close to giving up* rather than *furious*, or we may feel happy as in *excited* or happy as in *satisfied*. Emotions tend to blend into one another without any defined borders. This needs to be mirrored in the way affective content is represented.

At the same time, simply providing a richer channel, such as videoconferencing or other attempts to mirror *real life*-meetings, does not harmonize with the media-specific qualities of text messaging interaction channels such as SMS, IM and email. In text messaging the communication unfolds in different ways than face-to-face meetings. We can choose to hide exactly where we are, we can leave messages for others to pick up at a later stage, and we can convey somewhat different emotional content than what we are transmitting unconsciously *for real*. Thus, any solution that tries to create a richer, more expressive media, as part of existing text messaging needs to take the media-specific qualities seriously so that its advantages are not lost.

In addition, a medium for expressing emotions using sub-symbolic expressions needs to strike a balance between making the expressions too abstract or too depictive. Too abstract expressions will lead to random interpretations and make it hard to find suitable expressions. Too depictive and symbolic expressions on the other hand, makes its hard for the sender to express herself freely and does not allow enough leeway for interpretation.

Finally, we understand each other from a dialogue and knowledge about each other. Raising an eyebrow to your mother might have a different meaning than doing so to your boyfriend. It is about your knowledge of the other party, the specific dialogue you are in, and the social setting of where you are meeting, any representation of this need to allow for you and the other party to interpret and agree upon the meaning of the message.

eMoto

We have explored how to design for emotional expressivity in the mobile application eMoto.

eMoto is designed for a specific targeted user group, a persona [3] was set up. In short, the persona is named Sandra, she is 29 years old, Sandra does not care much of how things work technically, but she likes new cool features.

Let us provide a short description of the system. eMoto is built in Personal java and runs on Sony Ericsson's Symbian phones, P800 and P900, both have touch sensitive screens that the user interacts with through a stylus. In eMoto the interaction is done through an extended stylus with an accelerometer and a pressure sensor added (see sidebar, Figure 1).
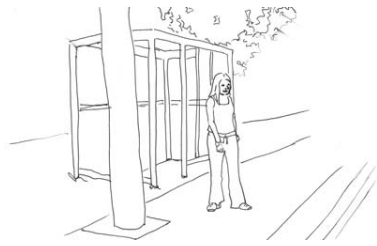
Imagine that Sandra is waiting for the bus that is delayed as usual. Sandra is on her way to the city, she has planned to meet her friend Mia later. She starts to write a message in eMoto to Mia. Sandra and her friend have recently discussed that the bus from where Sandra lives is always late. So Sandra writes: I am enjoying another pleasant bus trip to the city centre! (See sidebar, Figure 2)

The navigation in eMoto is done by gestures, consisting of a combination of pressing and shaking the extended stylus to navigate a background with colours, shapes and animations (see Figure 3).

The navigation starts out from the centre of the background. By different strength in pressure on the stylus the user navigates horizontally, more pressure lead to the dark and purple expressions and less pressure to the yellow areas. By more or less vigorous shaking the user navigates vertically, more shaking lead to the red areas and less shaking to the blue areas. By a combination of pressing and shaking at the

Figure 1. The p900 phone with the extended stylus.

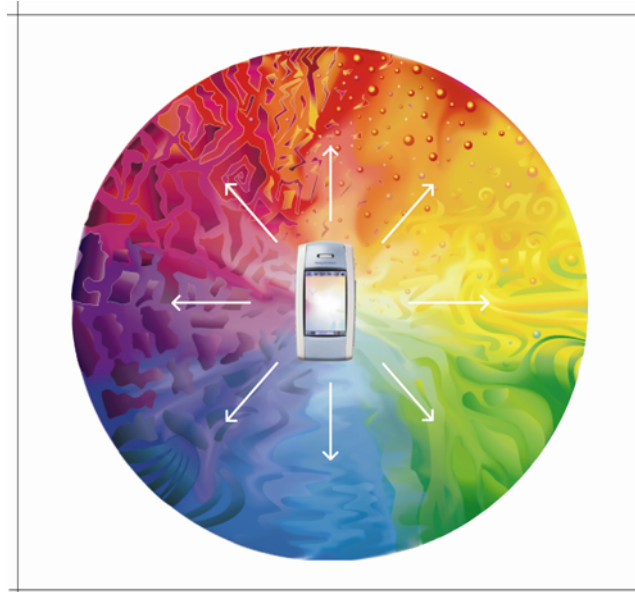same time the user can navigate the whole background.

Figure 3. The background with colors, shapes and animations.

To express this irritation over the delayed bus, Sandra starts pressing the stylus quite hard and shakes it just a little bit. The background of her message starts changing, moving from the white starting point and taking lighter blue shades with slow animations. Sandra puts more pressure on the pen and keeps the amount of shaking and the background gets even darker. Now she is pleased. This background together with the text will make Mia understand. (See sidebar, Figure 2).

The expressions in the background are built up by a combination of colours, shapes and animations. Vertically in the circle, different strength in arousal is expressed, low arousal in the blue areas with few and slow animations and high arousal in the red areas with many and fast animations. Horizontally, negative expressions are on the blue-purple-red side with

sharper objects and positive expressions on the green-yellow-orange side with softer, rounder shapes.

Mia receives Sandra's message with the bored dark-purple colours and slow animations. She immediately understands the irony in the message. (See sidebar, Figure 2).

In eMoto, it is important that the gestures and the response from the system form a coherent whole that empowers the users to express themselves, not something that hinders them and has to be consciously reflected upon.

In eMoto we want to address the physical, almost bodily aspects of emotional experiences, and thus we decided to analyze emotional body language as a starting point for our design. This analysis is presented elsewhere [8], but in short summary, we analyzed the body language of an actor expressing different emotional processes through using a so-called Laban-analysis [6] (see sidebar). Four examples of the resulting analysis are presented here (see Table 1).

Emotion	Shape
Excitement	Extremely spreading, rising and advancing
Anger	Somewhat spreading, rising and advancing
Surprise-Afraid	Enclosing, somewhat descending and retiring
Sulkiness	Enclosing, somewhat rising and retiring

Table1. Examples from Laban-analysis

Together with a dimensional model of emotion, using the two dimensions of *valence* (from positive to negative emotions) and *arousal* (from high to low arousal), we could create a description of a large set of emotions, blending into one another. In a sense, we could also describe how these emotions are experienced. The dimensional model we picked is named a circumplex model of affect and was created by psychologist Russell who in turn had based it on how a

Sandra is waiting at the bus stop

Sandra composes a message

Mia receives Sandra's message

Figure 2. Scenario of use.

Laban
Was a famous choreographer who invented a notation for describing the *shape* and experience, or *effort*, of different body movements. Laban's theory oftentimes referred to as LMA (Laban's Movement Analysis).

large amount of subjects placed different emotions in a circle created by the two dimensions [18] (see Figure 4).
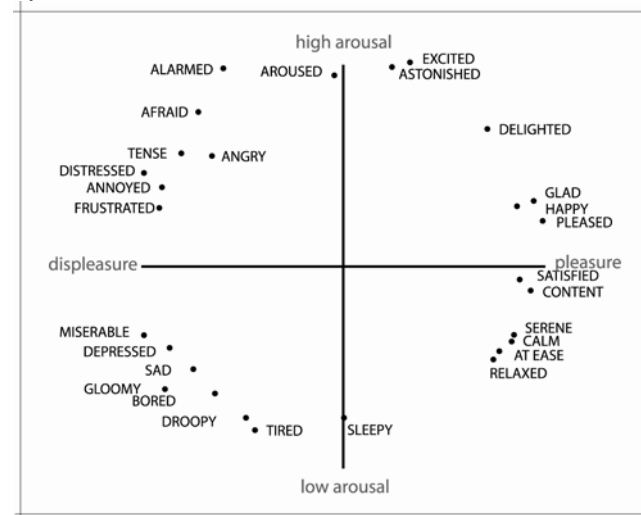

Figure 4. The circumplex model of affect

First, we turned these findings into a set of gestures that are described elsewhere [8], [21]. Basically, the gestures are designed to pick up on the two dimensions arousal and valence, where arousal is expressed through the more or less vigorous shaking of the stylus with inbuilt sensors, and valence is expressed through more or less pressure on the same stylus.

Creating expressions from color, shape and animations

We used the characteristics expressed in the variables *shape, arousal* and *valence* of the emotional body movements, described above, as a basis for the design. Different colors, shape of objects and animations can be used as a medium to express the characteristics of each emotional expression and thereby position them in Russell's circumplex model of affect. By allowing objects of different shapes to move at different speeds, in different directions and for different durations, it

Figure 6. Transformation of Itten's circle

should be possible to mirror the shape and arousal of emotional body movement. Thereby let the gestures and affective content form a coherent whole.

As a starting point to find suitable expressions both in color, shape and animation an image board was put together as inspiration (see Figure 5, illustrations in the end). Where different photos, representing the expressions we wanted to achieve, were placed at different locations in the circular model. For example, pictures showing high energy, i.e. high in arousal, such as a picture of lightening, were placed in the top right-end corner. Those pictures in turn inspired the design in that area to include smaller, sharp-edged objects, animated with faster movements and for shorter durations. Pictures showing less energy, calmer emotional expressions, such as pictures of water, were placed in the bottom right-end corner. They inspired the design of objects to be bigger, more connected shapes, and the animations to be slower and wavelike.

Color, the theories of color psychology attempts to generalize people's initial reaction to different colors, it is for example claimed that the color red raises blood pressure and therefore should be a good color to represent anger. There is a debate to what extent these color theories are generally applicable and how much is cultural dependant. The difference is that these theories deal with the initial reaction to the color, something that then should precede the learnt cultural interpretation.

We decided to use the color theory by Ryberg [19] that does not take cultural interpretation into account, but only talks about the energy of different colors and then test this against our user group (in our user study described below). Thus, we would not claim that our choice of colors is culturally independent or even relevant to all users groups within a culture. According to Ryberg's theory, red represents the most powerful and strong emotions, moving along a color scale ending with blue, representing less energy. This concurs nicely with how colors are distributed in different theories
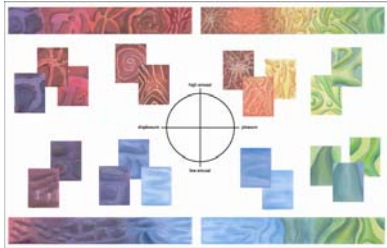
[10], [13] where colors are placed in a circular model, complementary to each other (see Figure 6).

Colors are often associated with specific qualities like warm–cold, light–heavy, passive–active and so on. Goethe writes about positive and negative colors, where the negative colors are blue, red-blue and blue-red, and the positive colors are yellow, red-yellow (orange) and yellow-red.

Our starting point became Itten's color system that was adjusted to fit Russell's circumplex model of affect. This meant making the colors gets weaker towards the middle of the circle where arousal and valence are on neutral. The colors in Itten's circle were also reflected and turned so that the negative colors, described above, were placed on the negative valence side of the circle and the positive on the positive valence side. We ended up with a color circle as in Figure 6. The colors that are most powerful, like red, are placed at the top of the arousal/energy scale, while blue, that is considered to be more peaceful, ends up at the bottom-part of the circle. The colors were then smoothed into one-another in the circle in order to allow the corresponding affective expressions blend into one another without any sharp boundaries (see Figure 6).

Shapes, in product semantics within the field of industrial design, products' and objects' physical shape and its relationship to how they are interpreted are discussed. Round shapes with soft curves are interpreted as friendly and positive while angular, harder shapes are interpreted as more negative.

The shape of an object is a sign to the user; the more depictive the object is, the less meaning users can read into it. For example, a rectangular volume shape with random proportions is more ambiguous and can be open to many more different interpretations than can an emoticon portraying a smiling face. These insights were used when designing objects to add to the colored background. [15].

We used the shape-descriptions from the Laban-analysis, e.g. designing the objects to allow for the

Figure 7. Sketches, (for bigger picture see illustrations in the end).

Figure 9. All of the objects.

more energetic emotions, so when animated they could be inspired by the upwards, rising movements found in the analysis.

The shapes of the objects, that are supposed to be spread all around the circle, were first sketched out using pen and paper (see Figure 7), exploring the shapes and trying to find the right expression that later on could be animated. Based on product semantics and the image board, objects placed on the positive valence side in Russell's circumplex model of affect were designed with some roundness in shapes and lines. Objects placed on the negative valence side in the circle were made more angular and sharp in their expression (see Figure 8).

Figure 8. The objects, on the positive side, negative side.

Excitement and sadness are the two extremes on the arousal scale, in-between those extremes the objects' shapes are modified to go smoothly towards less arousal or more arousal and to be able to keep their characteristics in shape when animated (see Figure 9). The objects' shapes also entail the different strengths in each emotional expression, like the background colors, the strength of the objects' color get weaker towards the middle of the circle, the objects are also smaller in shape and there are fewer animations taking place in the middle.

Figure 10. The whole circle with color, shapes and animations. The circle with animations can be downloaded from:
Hhttp://emoto.sics.se/animationsH
For bigger picture see illustrations in the end.

Animations. Using familiar patterns of movements that we can recognize from our daily life, like body language or movements in nature like a lightening or a calm sea is one way of conveying affect in animations. Harmony and disharmony of animation as conveyed through objects' movements can also be used. Disharmonic movements that e.g. make it seem as if objects are close to colliding can portray negative expressions, while harmonic, soft movements may be interpreted as more positive. Affect in animation can also be created in the way the objects are laid out, by using depth in the picture, creating overlays. [22].

These insights were complemented with the Laban-analysis of the characteristics of both shape and arousal found for each emotion. For example, to create an animation expressing *sadness*, which according to the Laban-analysis is *enclosing*, *descending* and *retiring* in its shape, the object has to entail these qualities in its visual shape. That means that the object has to be big and connected in its shape, since a set of small, divided objects would not easily portray an enclosing, descending and retiring movement. On the other end of the circumplex model, it would be difficult to create movements for the emotion *excited* with one big connected shape, since this emotion is extremely *spreading*, *rising* and *advancing* in its shape, and thus is more easily expressed through a set of small, divided objects.

Adding animations allows for more emotional expressive powers since not only the arousal-parameter but also the characteristics of the shape parameter from the Laban-analysis can really come forward here. In order to entail the arousal-parameter, emotions with higher arousal are moving faster, and an even higher impression of hastiness is created through letting objects appear and disappear, enabling a blinking sensation. With higher arousal the numbers of animated objects are higher. With lower arousal the animations are slower and have more wavelike

movements and the numbers of animated objects are fewer.

To portray the difference in positive and negative valence within the animations, the animated objects on the positive side, make much more harmonic, smoother, rounder movements, while on the negative side the movements entail more disharmony and are harder and jerkier in their appearance.

When the user has chosen an affective expression that suits the written message and stopped navigating around in the circular area in eMoto, the entire picture that fits within the baby interface space, starts moving slightly. This creates a depth in the picture, making the background less static.

Thus, in summary the whole circle with color, shapes and animations combined, forms the affective feedback with a basis in shape, arousal and valence (see Figure 10).

Solution details

To see if the designed expressions could work as a foundation for emotional expressivity the expressions were tested in a user study, which we describe in detail in this section, the tasks and procedure and the results, which in turn lead to a redesign of the expressions are described. To sum up, a discussion concerning the results of the study and the redesign is held.

User Study

In order to get feedback on the designed expressions, we set up a user study. Our aim was to show that the way we realized the sub-symbolic form, the ambiguity and subtleness in the design of the expressions and how we made use of the Laban-analysis, did indeed produce a design foundation that users could use as creative tool of emotional expressivity. We wanted to know whether:

- the design captured the ambiguity and subtleness that characterizes emotional communication

- the sub-symbolic form (color, shapes and animations) in the expressions was interpreted and could be used as a common foundation for creating emotional expressions
- our design inspiration from body movements (the Laban-analysis) was reflected as intended in the colors, shapes and animations

Important to remember is that there is not really any right or wrong here. We can only compare to what we as designers intended and whether this came through in the design or not. We are looking for clues that will help us to redesign the expressions to better convey our design intentions. To find these we are looking for those instances where the designer had intended for one kind of expression and it was altogether misunderstood by the subjects.

Subjects

We recruited the subjects through putting up notes around Kista, a working area outside Stockholm, asking for female subjects between 25 and 35 who were frequent mobile phone and SMS users. 12 subjects signed up for the user study.

Tasks and procedure

The subjects worked in pairs during the study [17] and the pairs knew each other from before. The idea was that if they were acquainted it would make it easier for them to talk aloud about what they were seeing and experiencing, especially as they would be talking about emotional expressions. Both of the subjects were placed in front of the computer, with a camera filming them from the front. In situations where only one of the subjects was supposed to see the computer screen, the other subject moved to a second chair opposite to the screen. One of the tasks in the study was projected onto a wall, for the subjects to see the whole designed circle in full scale. The subjects then moved and stood next to the projection (see Figure 10). The study was divided into four tasks.

Cut-out-task. In the first task, *the cut-out task*, subjects were shown cut-outs of four emotional expressions each. The cut-outs from the circle had the size of the screen of a P900 mobile phone (208x256px). They were asked to take turns in describing the expressions to each other using adjectives that fitted with what they saw. The second subject would listen, sitting in a second chair where they could not see the computer screen. Before starting this task, they were given an example, where a cut-out of an expression was shown to them which was described as: leafy, green, alga-like, soothing, peaceful, billowing, relaxing, calm and soft. In total, eight expressions were described this way by each subject pair (see Figure 9).

8 expressions. Second in the *8 expressions–task*, pairs sat together in front of the computer, viewing all eight expressions they had previously described to one another. They were now asked to agree upon one emotional word suitable for each expression. Since they had to agree upon one word, they had to discuss and motivate to each other what and why they experienced the expression as they did. (See Figure 11)

Figure 11. The eight cut-outs, representing different parts of the circle, shown to the subjects.

Scenarios:

Countryside visit: You want to go the countryside together with your boyfriend to relax after a stressful week. You send him an SMS about your wish.

Housecleaning: You and your boyfriend had agreed upon him vacuum cleaning, when you come home he has not done it yet and your parents are coming over for dinner tonight. You send him an SMS.

Racist: You and one of your closest friends where not allowed at the pub where the rest of your girlfriends were hanging. The guy at the door suggested that people like your friend did not fit at the pub. Your friend happens to be colored. You decide to write an SMS to tell the others.

SPA-weekend: You are at a SPA-weekend, having a nice relaxing time. You reply to a message from a friend asking what you are up to during the weekend.

Dinner: You went to a nice dinner at a friends place yester, nothing special but nice. Now you want to thank her for the dinner through sending an SMS.

Job: You've just finished your education and have applied for a position that is absolutely perfect for you and that you really want. Now you've just been told that you got the job amongst more than a thousand applications. You write to tell your boyfriend about this.

Post-its. During the third task, the *post-its task*, the whole circle with colors, shapes and animations was projected, in full size, onto the wall. The subjects were asked to place post-it notes with different emotions written on them where they thought that emotion was expressed in the circle. If they could not find a suitable place, they were to place it outside the projection. The emotions written on the post-its were: *excited, happy, frustrated, angry, depressed, bored, relaxed* and *pleased*. The reason for choosing these were to get different parts of the circle tested.

When the subjects had agreed upon a place the experimental leader asked them what in the expression chosen that resembled the emotion. If no expression had been found, they were asked to describe what they were missing.

Scenario. The fourth and last task, *the scenario task*, was to navigate in the circle to find an affective expression fitting a pre-written text message and a scenario read by the experimental leader. The subjects navigated using buttons in the interface as input for moving up, down, left and right, seeing only the cut-out representing the screen of the P900 mobile phone. Eight scenarios were tested (see side bar).

After each scenario and chosen expression the subjects were asked which emotion they wanted to convey and what it was in the expression chosen that expressed that emotion (since these scenarios are not necessarily associated with one single emotion). If they could not find anything suitable, they were asked to describe what they were missing.

In all of the four tasks, except for *the cut-out task*, the subjects were allowed to make one choice each, if they could not agree upon an expression between themselves.

Results

The results are divided into the three main questions asked before the study:

- the design captured the ambiguity and subtleness that characterizes emotional communication
- the sub-symbolic form (color, shapes and animations) in the expressions was interpreted and could be used as a common foundation for creating emotional expressions
- our design inspiration from body movements (the Laban-analysis) was reflected as intended in the colors, shapes and animations

Ambiguity and subtleness

One of the design intentions was to try to capture the ambiguity and subtleness that characterizes emotional communication that emotions blend into one another and that users could make use of the expressions as a creative tool.

Blending and ambiguity

As mentioned above, emotions blend into each other and are ambiguous. For example, satisfied can be more towards satisfied-relaxed or towards satisfied-happy. In the *post-it task* when placing the notes with the emotion *satisfied* one of the groups saw satisfied as close to happy and therefore placed there note high up towards the intended area of happy (see Figure 10).

> *Satisfied – I would like to have it here actually. It is warmer than happy. Yes, I am more towards that end of the scale. A sunny warm day…*

Another group interpreted satisfied as being of a more relaxed character and therefore placed their note further down closer to the intended area of relaxed (see Figure 12).

> *Down towards this blue here, it feels kind of satisfied sort of, that kind of relaxed content.*

Work-out: You've decided with a friend that you are going to go to the gym after work, but you discover that you do not have time enough and want to send a message to express that you're sorry but there is just no time.

Break-up: You've been together with your boyfriend for three years and you think it has been pretty good, but now he has told you that he wants to break up. You have no energy to phone so instead you send a message to tell your friend about the break-up.
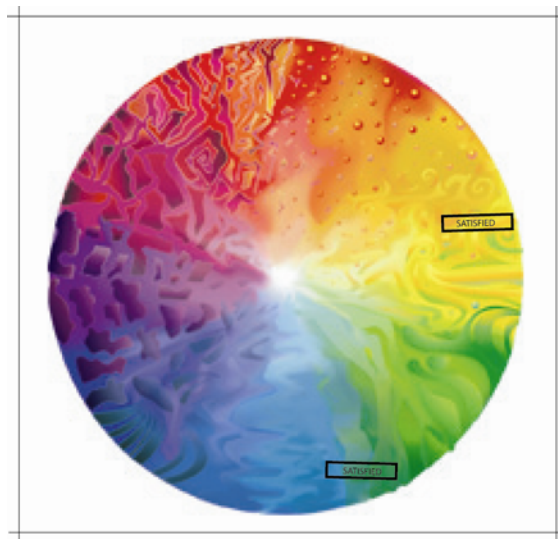

Figure 12. Placement of post it satisfied by the two groups.

When letting the subjects choose different affective expressions to the emotion they want to convey, it is shown that the affective expressions must allow for blending and ambiguity. As can be seen in Figure 13 (see Figure 13, illustrations in the end), different groups have placed their notes in different parts of the circle. This shows that the circle allows for ambiguity and works as a foundation for creating expressions, since they remain the area intended. In both the scenario task and the post-it-task, the difference in placement show that the expressions allow for ambiguity within the emotions.

Studying the results from the scenario-task it became evident that a larger area of affective expressions gets covered when expressing some emotions – some emotions require a larger difference in strength, blending and ambiguity than others. This might be an indication that the whole expression area should not have the shape of a perfect round circle with equal slices for each emotion area. On the other hand, it

might be that those areas of expression are important as they provide a counterbalance.

Communicating through the expressions
It is important that users can use the expressions and feel that they can communicate through them, mirror their specific way of expressing emotions, also when having a specific receiver in mind. In some tasks it became evident that the subjects made a different choice of affective expression when they started to reflect over who the receiver of the message was. They had the receiver's personality and their relationship in mind. Following is from the scenario-task when picking out an expression to the house-cleaning scenario:

> Subject 1: I would be pretty angry.
> Subject 2: OK.
> Subject 3: But I would not express it that way, then he would just be angry in turn and then we would start fighting and then there would certainly not be any vacuuming done.

The sub-symbolic form
The tasks *8 expressions* and *post-its* both tried to discern whether the affective expressions with their sub symbolic form of color, shape and animation could be used as common foundation without any previous knowledge or shared context.

In the same ballpark but individual
The illustration of the result in *post-its-task* (see figure 13, illustrations in the end) shows where the six groups placed the eight post-it notes with different emotion labels. This result shows that for each emotion almost all post-its were placed generally within the intended expression-area for that emotion. This means that the affective expressions work as a common foundation for emotional expressivity. With the exception of about one note each in *depressed, relaxed and happy*. Important to note here is that we would and should not, expect all

notes to be placed at the exactly same location. The interpretation of an emotion varies, and the circle is designed for ambiguity and for emotions to gradually blend into one-another and allow for users to pick different expressions in order to express their own personality and experience.

An extreme example of this occurred for the post-it with the word *depressed*. All subjects but one placed the notes in the area intended. The subject who picked a different location, decided to place her note in the yellow *happy* area. She claimed that sunsets made her depressed and the color in that area reminded her of that.

A similar situation arose for the post-it *relaxed*, where one subject placed her note in the *happy*-area. She explained that she interpreted relaxed as a very positive relaxed emotion. This also shows that our understanding of different emotions can be very individual.

For the post-it *happy* one note was placed in the area intended for frustrated emotions. The subject said that it was placed there because of the colors, although she did not think the shapes were suitable for the emotion happy.

The result of the scenario task is indicating the same result as the post-it-task (see Figure 14, illustrations in the end): the circle works as a foundation for the creation of expressions, but allows for letting context, own experience and personality be reflected in the choices. For example, for anger/disappointment one subject picked an expression from the area with calm expression. The subject motivated this from being scared of her dentist who had this color on the walls of his reception:

> Here we are with the dentist, at his office. Genuinely 80ties plastic green, dentist chair really. Quite unpleasant. Like, yes, textile wallpaper in a waiting room that someone has intended to be nice, but which really is not nice at all.

Mixed emotions
An interesting category that appeared was *mixed emotion*. Subjects sometimes wanted to express a little bit of everything and none of it very strongly. For example, in the countryside-scenario one subject motivated her choice to express a combination of the tired feeling of a long hard week working and the positive feeling expected from being at the countryside:

> This tiredness, it is kind of green, these darker colors that come up here, but then you see the light at the horizon there at the top, that it is fun at the country-side, there the sun will be shining. But right now, when you have this dark here mostly, kind of, it is slow on Friday afternoons.

Neutral emotion expressions
Choosing a "neutral" expression, that is picking the middle of the circle, was something that occurred when the subjects did not think the message was really emotional at all or needed any added emotional expression. Picking a neutral expression does not always mean that the subjects did not want a background to the message. It might as well be a way of showing that the message does not have such a strong emotional content. For example, in the work-out scenario, the message was simply neutral emotionally to one of the subjects.

> Yes. Because this is yet anyway in the middle, all of it, it is not sad and not like really happy either, neutral. Like: "I am sorry but I cannot, there is no time"

Depictive – non-depictive
When designing for affective expressions it is important to have the right balance between expressions that are too abstract or too depictive. As discussed in our requirements above, users should not become totally confused about the meaning of the expressions, on the
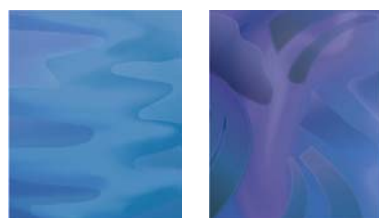
Cut-out 1.

Cut-out 2.

Cut-out 3.

Cut-out 4.

Cut-out 5.

Cut-out 6.

Cut-out 7.

Cut-out 8.

Figure 15. The cut-outs representing different parts of the circle.

other hand, they need not be so definite in their form so that they get in the way. People often try to read in symbolic meaning into abstract patterns of shapes and try to construct a story around it [12]. But some shapes or pictures seem to carry a stronger symbolism and be bearer of stronger emotional content than others. Certain shapes are also more culturally dependent than others. In our culture roses are associated with courting, an abstract shape reminding of a rose, might make users think of romance. Here the cultural notion overtakes the expression – the shape is too depictive. On the other hand, animations of circles that remind the user of champagne bubbles might trigger interpretations of bubbly feelings, and the link to champagne provides for the right association with happiness and thus will not get in the way for the interpretation. In the cut-out task three out of six groups associated cut-out number 6 in figure 15 (see sidebar) with a rose and thereby with romance rather than the frustrated expression it was supposed to portray. On the other hand four of six groups associated cut-out number 8 in figure 15 (see sidebar) with partying, bubbles and champagne and thereby got the right connotations – an excited expression. In our view, roses have much symbolism associated to them and are a strongly culturally dependent, while bubbles in champagne can be associated with the upwards movement they make and the energy they contain.

Dark ends need more darkness
We transcribed all the words that our subjects used to describe the different expressions. When analyzing the words, the expressions for the areas of *relaxed*, *happy*, *calm*, *excited* and *angry* seem to work very well, the expressions for the areas of *sad* and *depressed* seem to work quite well, but the expression for the area of *frustrated* (see sidebar, cut-out 6 in Figure 15) seems not to be interpreted in the way intended at all. Words like *love*, *passion*, *a flower*, *artistic* and *cool* were

frequently recurring for that cut-out. Like one subject put it:

> *Almost something towards James Bond with all those ladies… or I see it a little bit in the background anyway. And then there is… now it is warm colors. Lilac and red. It is kind of stylish, a bit cool kind of.*

Our interpretation is that the expressions for *frustrated*, *sad* and *depressed* are a bit contradictory in their appearance; the shapes are sharp, the movements in the animations indicate collisions, but the colors are fairly bright in their appearance. To work as a common foundation for emotional expressivity they need more darkness in order to convey their negative nature.

Design intentions: conveying the Laban-analysis
The design of the affective expressions originates in the analysis (Laban-analysis) of emotional body movement in terms of *shape, arousal* and *valence*. Some of the descriptions our subjects gave are easy to tie back to the shape and arousal variables for the different emotion characteristics, while others are harder. For example, the emotion *excited* has, according to the Laban-analysis, a shape that in its movements is *extremely spreading, rising* and *advancing*, its arousal is very *high*, and it is placed on the *positive* valence side. The subjects described the expression excitement in terms that can easily be interpreted as *spreading, rising* and *advancing* movements: *bubbly, carbonized, simmering, lively, sparkling, bouncy, twinkling,* and *pulsating*. The words subjects used that might be interpreted as high level of energy were: *party, high energy, movement, full of life, crazy party, colorful, boiling soup, lively, happy,* and *warm*. That the expressions is understood as a positive emotion may be indicated by: *the sun, party, warmth, warm colors, happy, harmonic, nice, red, positive emotions, this makes you feel good, amused,* and *happy*.

When analyzing all the words that our subjects used to describe the expressions, it is possible to see that some descriptions directly match the circumplex model of affect by Russell, while others need more analysis in order to be interpreted. For example, through using the theories of color, shape and animation, described above, we can make a tie from subjects' descriptions, via their meaning in terms of color theory, back to shape, arousal and valence. For example, in color psychology, red and yellow contain high energy and are considered to be positive and warm colors. This means that whenever subjects use these color words or words strongly associated to them like the word *the sun*, they can be viewed as indication of high energy and positive valence.

The same analysis can be used on descriptions of objects that in their shape can be found as soft and round in curvature, and thereby give an indication of belonging to the positive valence side or vice versa. The shape of the emotion *angry/frustrated* is described as somewhat *spreading, rising* and *advancing* movements. It is *high* in its arousal and has *negative* valence. When looking at the words describing the cut-out in the area intended for this emotion, it was harder to find words that can by analysis be found to match the description. Some words can be directly matched to the circumplex model of affect, but these are quite few, like *aggressive, angry* and that *it looks frustrated*. The descriptions *restless movements* or *messy* do create associations with the right shape properties, and arousal can be associated with the descriptions *fire*, *heath* and *pulsating*. The valence can be shown by words like *thorny, sharp, angular shapes* and *stressful*. But a predominantly part of the words, like *artistic, creativity, cool, love, modern, passion,* and *a rose* cannot be tied back to the characteristics found in the emotion of frustrated.

The words used to describe the cut-outs of the areas *relaxed*, *calm*, *happy*, *anger*, and *excitement* contain to a large extent words that this way can be tied back and

thereby seem to convey the emotion intended. The cut-outs for depressed and sad contain less of these characteristic and the cut-out from the area of frustrated contain even less than the previous two. Thus, this helps us to find the problematic areas that may need some redesign in order to convey our design intentions properly.

In summary it is, with a few exceptions, possible to tie the subjects' experiences of the expressions back to our underlying design intentions.

Redesign

The redesign aims for the affective expression to work as a common foundation for emotional expressivity without any previous knowledge or shared context. The intentions of the study were to lead to a redesign, for users to have a foundation of expressions, working as a basis for emotional creativity. The expressions for frustrated, sad and depressed are all placed next to each other and do also blend into one another. Therefore some of the problems with the expressions may be covering the area of all three, more serious in some parts of the area. The words used to describe the area of frustrated with both containing words such as aggressive and thorny, but is by the same subject described as love and passion, indicates that there might be a double message conveyed from the expression. Our interpretation is that the color does not have the right hue to convey the same message as the shapes and their animations. In the areas of sad and depressed, the contradiction is not as evident as in frustrated but it is still there.

In the expression for frustrated, different pictures are also read into the expression, such as roses and women, these pictures in combination with the color leads to even more misinterpretations. The background color and the color of the shapes were therefore redesigned, reducing the brightness, adding much more grey hue. In the area of the expression frustrated some of the shapes were also redesigned to avoid the

Figure 16. The redesigned circle, For bigger picture see illustrations in the end.

depictiveness found earlier (see side bar, Figure 16). This was subsequently tested in a second study [21].

Discussion of results

As the result show, adding channels for emotional expressivity in mobile text messaging, with the limitations that comes with the mobile devices in terms of size and communicative bandwidth, does not have to be a problem as long as the media specific qualities within SMS are taken into account.

Emotional communication is in itself subtle and ambiguous and therefore situated, dependent on context to convey meaning and open up for interpretation. The results of the study show that to be able to capture these characteristics require creative tools for expressivity with a common foundation for understanding, rather than providing users with ready-made expressions chosen by a majority of the subjects. Providing people with an expressive channel in text messaging means helping users to get started in their creation of expressions, but keeping a balance between providing the users with material to take in use and on the other hand giving them too much freedom, leaving them with a blank paper.

The results also show that it works to use the sub-symbolic expressions of color, shape and animation, to help the users get started making use of the expressions. The subjects are all first time users, without any knowledge about the expressions and many of the tasks in the study are without context, but all of the subjects can approximate suitable expressions. By using the sub-symbolic media it is possible to create expressions that are interpreted as emotions and can help getting users started with their messages. The intentions with this study were to get input to a redesign of the affective expressions. Some parts of the affective expressions seem to work better, like the areas expressing *relaxed, calm, happy, excited* and *angry*. The areas intended to express *frustrated, sad* and *depressed* were not as successful and need to

be altered. The expression for *frustration* seems to have the wrong level of abstractness, which lead the subjects to interpret objects as pictures being bearer of cultural meaning. The expressions for frustrated, sad and depressed might also be a bit contradictory in their appearance, which caused confusion by the subjects, since the shapes were sharp and negative, the movements on collision course, but the colors were too bright and positive.

The design also shows that the affective expressions allow for ambiguity and blending of emotions. Subjects do place emotional words within the areas intended for a specific emotion, but still their choices were spread out over the whole area, just as emotions tend to blend into one another without having defined borders or sharp delimiting definite meanings.

The subjects seemed to be able to develop their own way of using and interpreting this new creative tool for expressivity, by adopting the expressions and using them in context. In composing messages aimed for other people the expressions opened up for different interpretations depending on whom the expression was aimed for.

Making the expressions too open and ambiguous, might lead too confusion, on the other hand too little ambiguity would not allow for interpretation to happen. The affective expressions, when situated, seem to have the right balance of ambiguity to allow for this to happen, building a foundation for the users to start out from, developing their own ways of using them in their own communicative realities.

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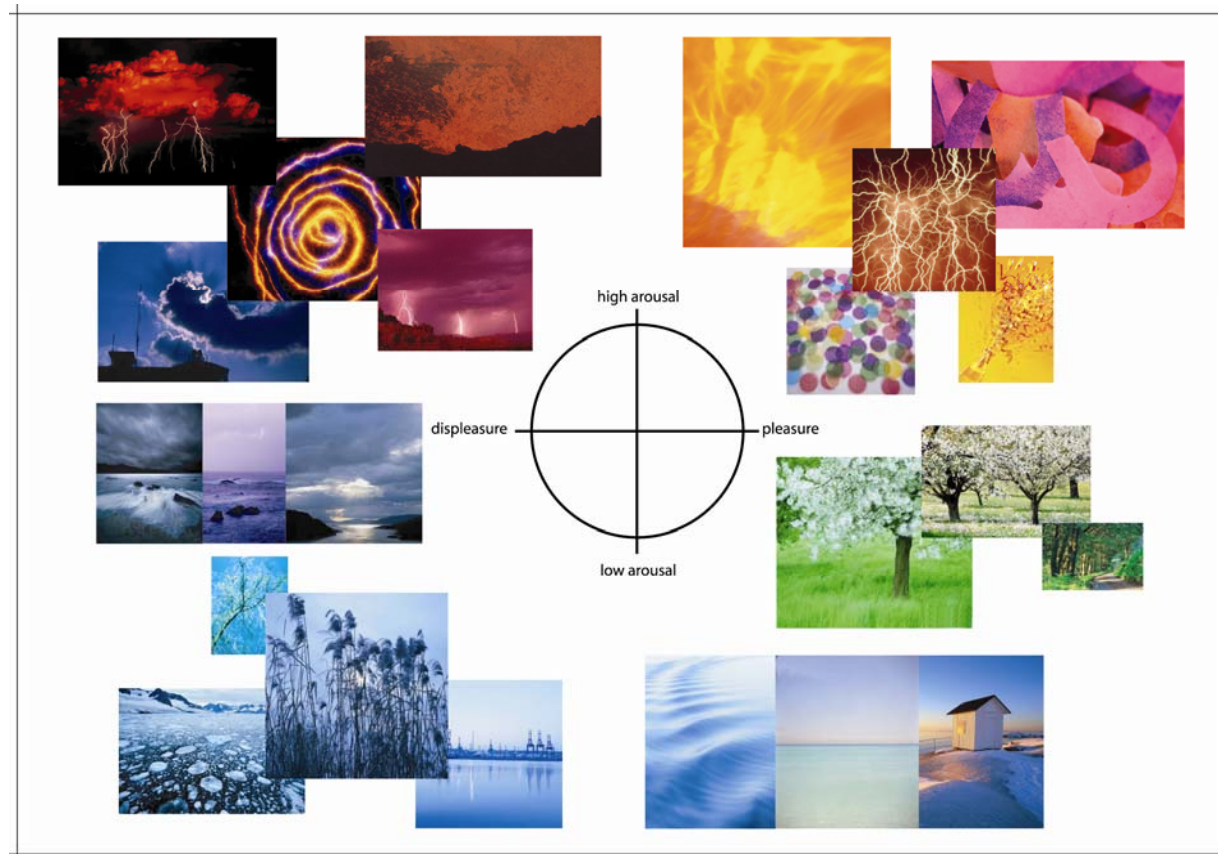## Acknowledgement

Further Illustrations

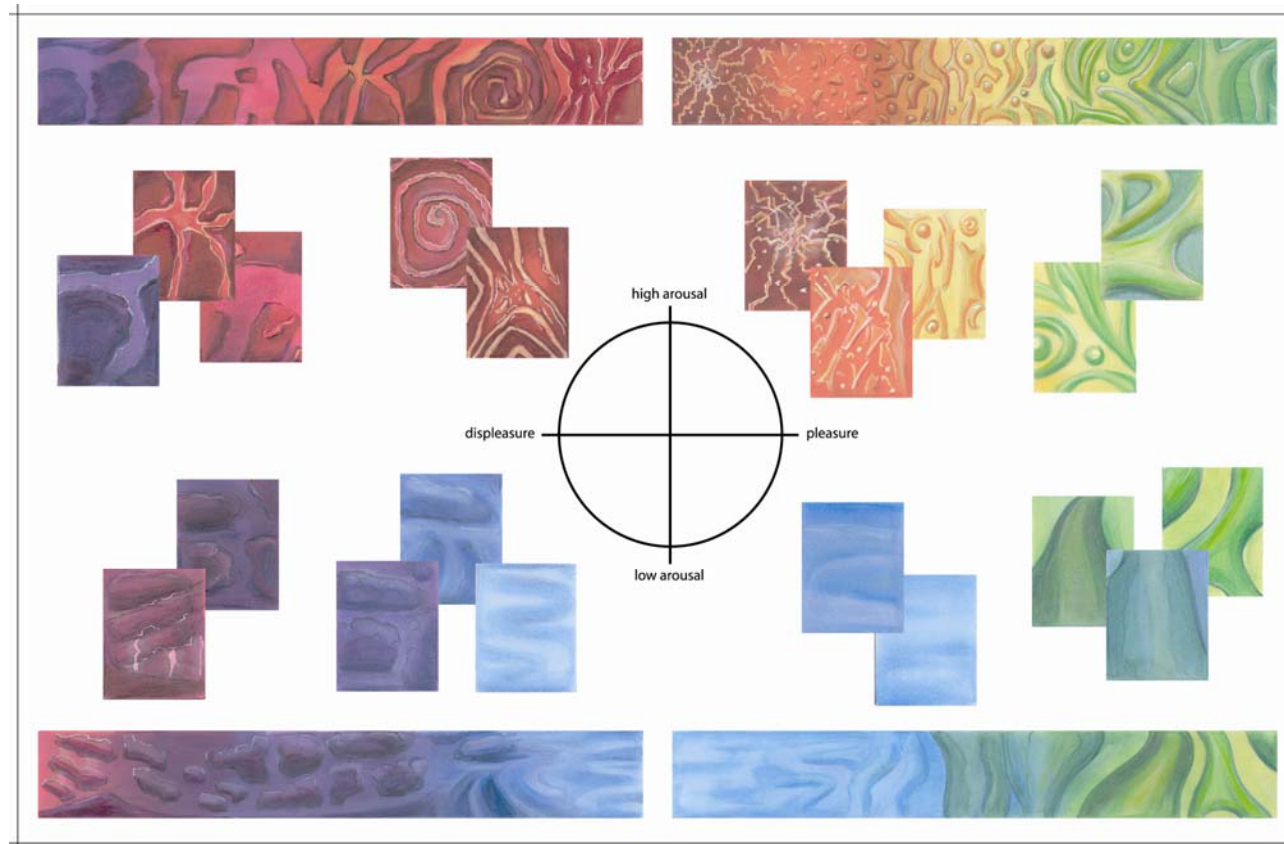**Figure 5.** The image board, used as inspiration.
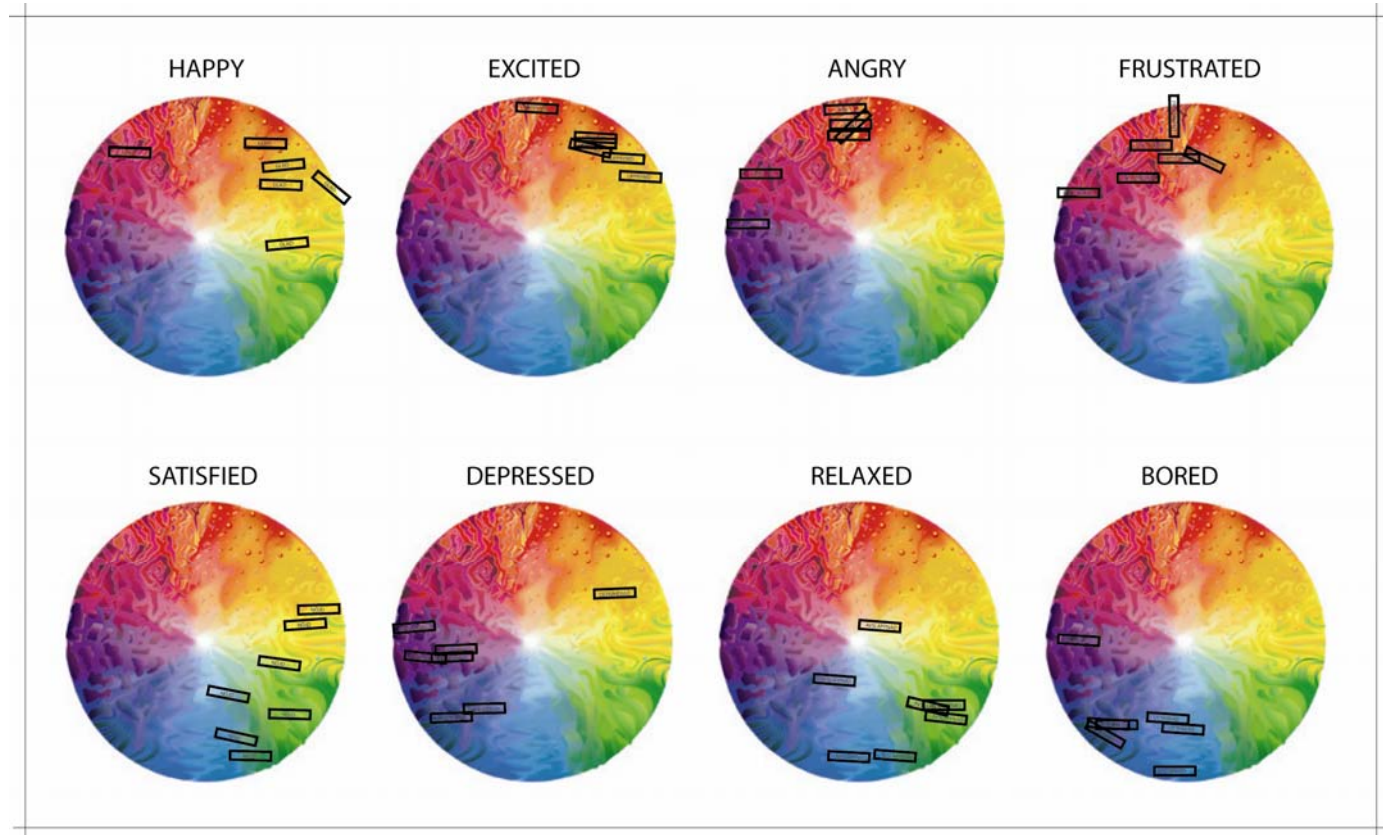
Figure 7. Sketches of the objects.
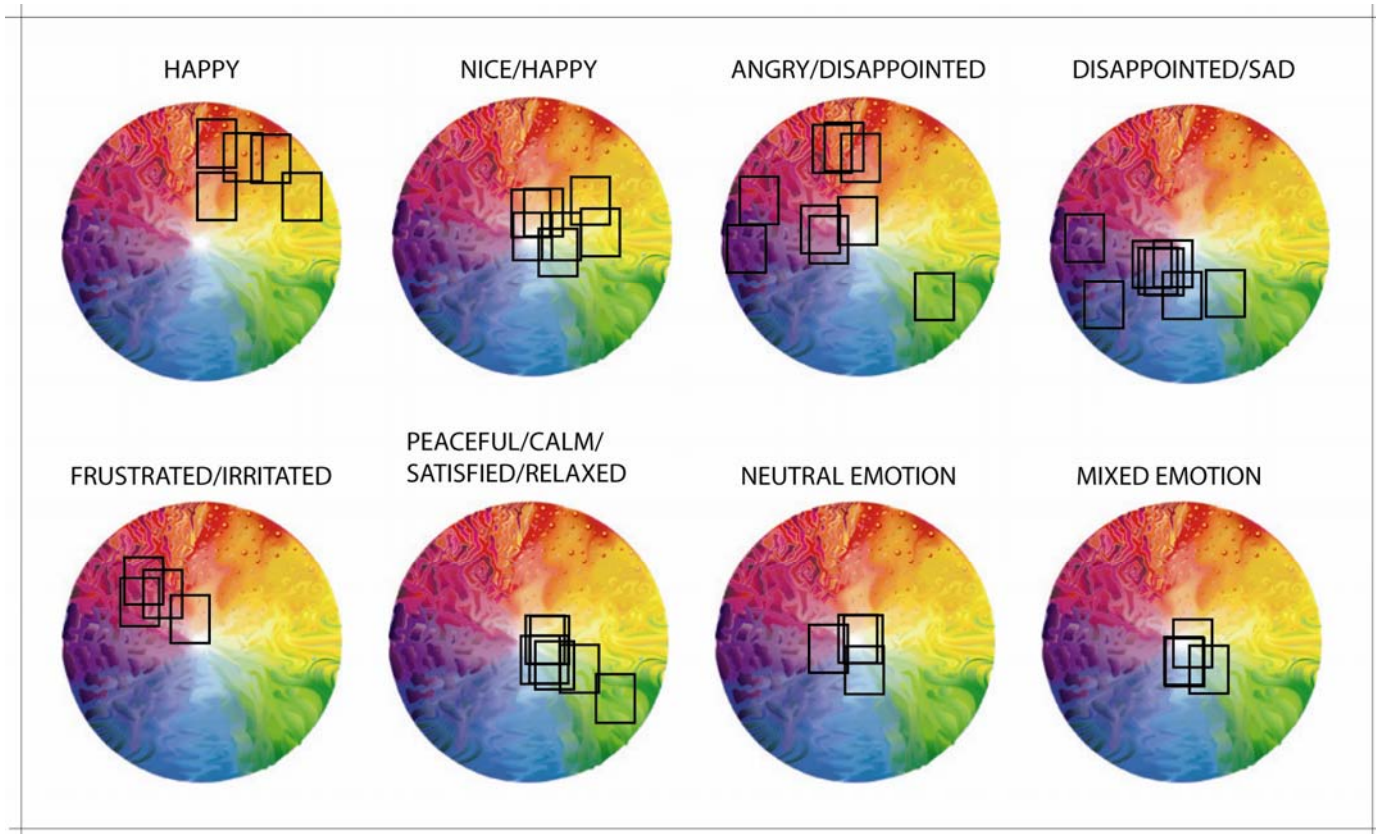
Figure 13. Result of the post-its-task.

Figure 14. Result of the scenario-task, where the squares indicate the chosen background to the emotion the subjects wanted to convey.

Figure 10. The whole circle with color, shapes and animations. The circle can be downloaded from: http://emoto.sics.se/animations

Figure 16. The redesigned circle.