

The Interactive Sensual Evaluation Instrument

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Abstract—When designing and evaluating for emotions, a common approach is to methodically map emotional states onto spectrums as quantitative data. However, recent research criticize these methods, arguing that interpreting and experiencing emotions in full complexity is needed to reach a useful level of understanding affect. A recent study proposes the Sensual Evaluation Toolkit (SEI), consisting of different shapes, meant to allow for nonverbal communication of affect. This study aims to build upon that research, introducing vibration and shape forming to the toolkit - calling it the Interactive Sensual Evaluation Toolkit (ISEI). This study shows that the added modalities expand the non-verbal expressiveness of the toolkit, and that the ISEI has the ability to transfer information about emotional states between users nonverbally.

Index Terms—Nonverbal communication, HCI, emotions, shapes, vibration, Sensual evaluation Instrument

I. INTRODUCTION

Evaluating emotions during interaction with products or services can be a valuable tool in any design process. However, dominant strategies used in these kinds of evaluations have until recently been grounded in the notion of affect as quantitative information, which arguably forces the user to match their emotions with the expectation of an often limited evaluating system. Instead, if emphasis is put on gathering qualitative data regarding subjective experiences, emotions can be negotiated and constructed in order to reach a more nuanced and constructive understanding of subjective experiences [2].

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This project aims to build on research regarding the Sensual Evaluation Instrument (SEI) that shows the utility of trying to bypass conventional means of reporting when evaluating emotions [1]. Through the use of physical objects modeled to evoke emotions related with typical experiences users have when interacting with products or services, the SEI provides a way for users to non-verbally report on emotions during interactions and experiences. This study aims to create an interactive toolkit with modalities and evaluate its affordance.

The first stage of the study was concerned with the exploration of the SEI toolkit, where the team used a first-person perspective to familiarize themselves with the concept of emotional evaluation through shapes.

Following a brainstorming session, a modular toolkit was conceptualized and prototyped in order to allow participants to shape and modulate the instrument to convey their emotions. It consisted of a basic shape, 18 attachable shapes and a vibration module.

Two experiments were conducted, in which two users form a shape with the toolkit and other two users were asked to interpret the conveyed emotion. Therefore the study validates the toolkit as an instrument to represent and convey emotions from users.

The new version of the SEI toolkit will be referred to in this paper as the **ISEI toolkit (Interactive Sensual Evaluation Instrument)**

II. BACKGROUND

P. Dourish and colleagues argue in their study [1] that researchers should move from the old model of emotions as objectively measurable in favor of a model where emotions are seen as interactionally constructed and subjectively experienced. The paper shows that there are multiple ways to conceive the nature of emotions, and so there are multiple ways to approach it usefully in practice.

One such approach is the Sensual Evaluation Instrument (SEI) [2] developed in a Swedish lab. The SEI (Fig. 1) is a set of 8 different shapes modeled to be mapped over a valence/arousal spectrum. The study found that participants with this toolset could detect and express different emotional states.



Fig. 1. Inductance of oscillation winding on amorphous magnetic core versus DC bias magnetic field

Several studies [2][3][7][8], in which participants associated various shapes with different emotions, concur in shapes with sharp edges tend to be associated with negative feelings. In contrast, rounded shapes were associated with positivity.

Computer programs such as Emotive Modeler [6] helps in the modeling and creation of objects that convey specific emotions. It does so by integrating knowledge about our emotive perception of shapes into a CAD tool that uses descriptive adjectives as an input.

Another study [3] explores how users embody emotion within the form. The authors describe 3 distinct strategies for the embodiment of emotions: visual representation, which looks of a shape; metaphor, by symbolizing and experience; and, motion, based on the movements and manipulations during construction.

In the Human-Computer Interaction field, research studies implement new technologies for measuring affect and emotions based on biometrical data such as galvanic skin response, movements of the muscles, and heart rate. Other studies are based on haptics stimulations to carry emotional information [10][12]. A study [9] found vibration, heat, and color to be an expressive modularities that varies in emotional range. Thus different modalities are suggested as a potential way of expanding the expressiveness of the SEI toolkit.

When communicating emotions, because of its abstract nature, it can be hard for people to describe them verbally [5]. Lumi-Touch [11] aims to communicate emotions nonverbally through a pair of interactive picture frames that communicate emotional content.

III. METHOD

Part I. Exploration

In the earliest stage of this study an exploration session was held with the SEI toolkit developed in the study by K. Isbister et. al (2006) [2]. This session was held in order to get familiarized with the concept of sensual evaluation through shapes, as exploration through a first-person perspective is a suggested method when researching soma related solutions. Each member took turns individually evaluating out loud what kind of emotions the ISEI toolkit evoked when handled, while another member took notes. As it was not feasible to create a larger set of shapes for testing, this exercise also served the purpose of narrowing down the set to three shapes or emotions that was deemed interesting to explore. It

was found that all members had similar experiences with the shapes named *spiky*, *bubbly* and *stone* (fig. 2), Due to the relative consistency in what emotions these shapes evoked, it was decided that these would act as an inspirational source for the ones that would be included in the new version of the SEI toolkit - the ISEI toolkit.

Part II. The ISEI prototype

The thinking process behind the prototype was to create a new toolkit that allow users to customize and mold the shape. Therefore, the resulting toolkit would consist of a basic cube shape in which different modules that can be attached on its six sides. The basic cube would be hollow and a vibration module would be placed inside. The attachable shapes would be based on the three original shapes *spiky*, *bubbly* and *stone*. The criteria for the selection of these shapes was based on the spectrum of emotions concluded in the exploration phase. Therefore, *stone* and *spiky* are located in the edges of it, whereas *bubbly* is placed in between.

Different ways of attaching the shapes to the cube were discussed (velcro, joints) but magnets seemed the most intuitive and user-friendly way, specifically neodymium magnets due to their strength.

By choosing a modular design, it was postulated that the participants would have a wide range of expression available to them, as they could combine the basic shapes into a multitude of different combinations that could represent more complex emotions. This was evident in the SEI study [2], where participants used combinations of different ISEI shapes to emotionally evaluate their experience. The added vibration modality would be another dimension for the participants to make use of, as several studies point to the value of vibration as a tool for emotional evaluation [9][10][12].

The final product would be a compact sensual evaluation instrument, where you could customize the shape of the ISEI

in conjunction with different intensities of vibration.



Fig. 2. The chosen SEI shapes



Fig. 3. The attachable shapes

Part III. Material specification

The prototype used in the project was first modelled using the 3d-modelling application Zbrush (2018 Pixologic, Inc), and later printed using an Ultimaker 3 3d-printer (2018 Ultimaker B.V.). Neodymium magnets with a diameter of 10mm, height of 2 mm and a pull force of 0.9 kg were used for attaching shapes. To enable vibration, a vibration motor with a diameter of 30 mm and height of 6 mm connected to a turn knob to adjust intensity, was placed inside the core shape. The core shape (Fig.4) was 42 mm wide on all axes with an hollowed out interior. The wall thickness of this shape was 3.5mm. A lid was constructed with a height of 4 mm and attached to the body with 8 press-joints consisting of 8 beveled cylinders (height: 2.5mm, diameter: 2.5 mm) and 8 cylindrical recesses in the core shape (height: 3 mm, diameter: 3 mm). To accommodate the neodymium magnets used to connect the attachable shapes with the core shape, cylindrical recesses that had a diameter of 10.5 mm and a depth of 2.8 mm were made in the center of each of the six facets of the shape, including the lid. Each attachable

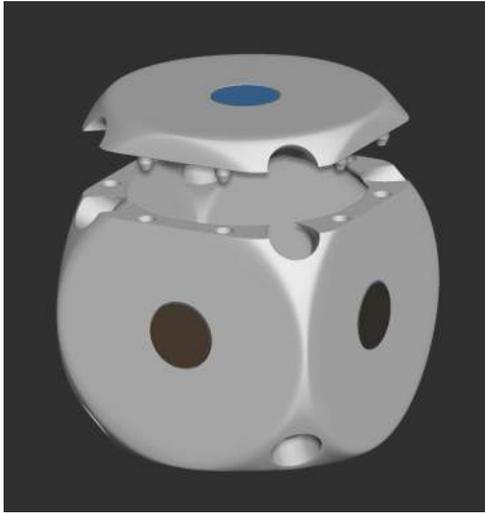


Fig. 4. The core shape

shape (Fig. 3) also had this recess on its flat side. Holes with a diameter of 8 mm was made in each corner to allow eventual wiring. The attachable shapes consisted of three versions: *Stone*, *Bubbly* and *Spiky*. Each of the shapes had the same base, a disc with 41 mm in diameter and the aforementioned recess for a magnet in the center. From this disc three different variations were sculpted that corresponded to the shapes chosen from the SEI, *stone* with a height of 5 mm, *bubbly* with a height of 15 mm and *spiky* with a height of 20 mm.

Using Cura, a 3d-printing setup application made to work with the Ultimaker 3, a total of 18 attachable shapes was printed (6 copies of each shape) in addition to the lid and body of the core shape. The prints were sanded and cut to remove any sharp edges or residue from the printing process and a total of 24 neodymium magnets were placed inside the recesses and affixed with superglue. Care was taken so that the poles of the magnets on the attachable shapes would attract the poles of the magnets on the core shape. The vibration motor was placed inside the shape and packed tightly with paper so that the vibrations could transmit easily and finally the lid and body of the core shape was joined.

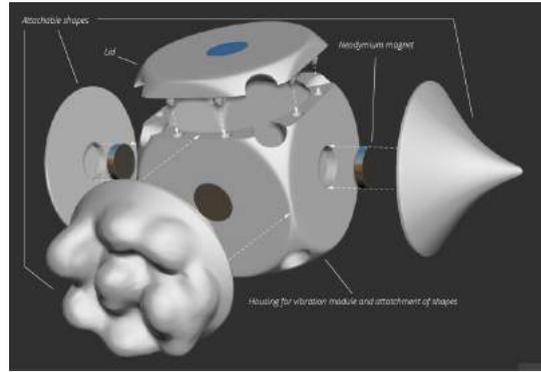


Fig. 5. The finished 3d-model of the ISEI



Fig. 6. The 3d-printed and assembled ISEI

IV. EXPERIMENT

Design

The current study aims to validate the tools ability to communicate emotions non-verbally. The experiment consisted of two parts. First, one participant formed and modulated the tool in order to express an emotional state. Later, a second subject was asked to decode and understand the emotion which the first subject intended to express through the tool.

The whole session was audio-video recorded under the participants permission. In addition, the user was asked to think out loud during the test. Hereunder, each part is described in detail.

Shaping the ISEI

This part aims for the participant to configure the tool to express an emotion. First, the tool (Fig. 7) consisting of the main shape with a vibration module and 18 modules (6

spiky, 6 *stone* & 6 *bubbly*) were provided to the participant. In this exploration phase, the participant got to interact with the given modules in order to become familiar with its functions and behaviours. Instructions were given that they may use the shapes and vibration in any way they please in order to convey any emotion they might have from stimuli described below. Sec-



Fig. 7. The material provided to the participant before starting the test

ond, the participant was then left alone in the room with stimulus that appeared on a screen in front of them. The stimuli consisted of three short video clips from one out of four categories (anger, fear, happiness, and sadness), and are detailed below under in Stimuli. The category was chosen randomly for each participant who were not aware of the different categories or the category of the stimuli presented to them. The clips were left playing on a loop.

In accordance with the perceived emotion of the stimulus, the user added modules to the basic shape and tuned the amplification of the vibration module.

Once the participant was confident about the final shape, an interview in the form of a dynamic conversation was conducted to discuss the thoughts and reasons behind the creation process. During the conversation, the interviewer returned to the defined interview-pillars in order to get comparable data. These pillars are presented below under in *Interview Pillars*.

Stimuli

Both psychologists Paul Ekman and Wallace V. Friesen identified 6 basic emotions from analyzing different facial expressions from participants [14]. These

have also been demonstrated to be common across cultures [15]. However, the current study focus on four of them: Anger, Fear, Happiness, and Sadness. This limitation was made purposefully, as these categories suited the spectrum of affect that the tools was prototyped for. Also, the stimulus purpose was not to communicate a particular emotion but rather to evoke an emotional state.

The stimuli are a set of video clips that have been demonstrated to be attached to different emotions [13]. Precisely, each stimulus matches a particular emotion and consists of three video clips.

Interpreting the ISEI

In this part, a second subject received the ISEI shaped before the first part of the experiment. The purpose of this part was to validate the efficacy of the tool. Thus, the subject was asked to interpret the emotion that the first subject intended to communicate. Later, all four stimuli were presented to the user. The user had to identify the stimulus that better described the emotion conveyed in the ISEI. Finally, a dynamic conversation about the shape's interpretation was held.

Interview Pillars

First participant

- *Can you explain your step-through thinking process? Why did you make the choices you made?*
- *Do you think you convey emotions using this tool?*
- *Describe the experience, what did you feel?*
- *Do you feel like the prototype helps you express anything in particular?*
- *Was the vibration module a helpful expressive tool?*
- *Was the prototype limiting to you in any way?*

Second participant

- *Explain what you believe the prototype communicates, please show and tell.*

- *Did you find the tool expressive?*

Participants

A total of 4 users (2 females and 2 males, all master students in a technical university) participated in the experiment. A variety of cultures is presented among the participants in order to validate the cross-cultural communication using the ISEI. Last, it has to be noted that none of the participants was familiar with neither the device and communicating emotion through an object. All participants were told they would get cookies if they took part in the test.

V. RESULTS

Participants 1 and 2 were tasked with configuring the ISEI and were blindly assigned a random set of stimuli out of four possible. By chance, both stimuli ended up being the same, namely the one meant to convey happiness.

Session 1

Participant 1 shaping the ISEI

The first participant made use of three *bubbly* modules, two *stones* modules, and one *spiky* module (Fig. 8). She stated that the stimuli evoked happiness, which led her to choose mostly *bubbly* and *stone* modules. In one of the three video clips, there is a moment where a dancing man loses his pants. This evoked embarrassment in the participant, which she expressed by choosing *spiky* to one side of the ISEI. The vibration was put up to approximately 60% of full amplitude, meant to strengthen a positive happy feeling. She stated that she shaped the ISEI based on her emotional state, but had a hard time to describe her choices, adding that the ISEI better describes the emotions than she could verbally.

Participant 2 Interpreting Participant 1s ISEI

The second participant interpreted the emotion as mostly positive, attributing this to the *bubbly*, *stone* and vibration modules, but with a little bit of pain because of

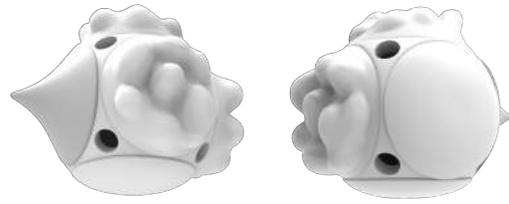


Fig. 8. The ISEI as configured by participant 1 displayed from two different angles

the *spiky* module. The vibration was interpreted as calm, as it was perceived as gentle and not as pronounced. In combination with smoother shapes, the participant expressed that *trust* was communicated. The *spiky* shape introduced some confusion in the process of interpretation, but summarized the overall state to be melancholy.

After being shown the all four categories of stimuli and asked to guess which participant 1 was watching, participant 2 mapped the ISEI incorrectly to *sadness*.

Session 2

Participant 3 shaping the ISEI

The second participant created a representation of the visual stimulus instead of shaping an emotion due to a misunderstanding of the instructions. By chance, all people in the stimuli presented happened to have bald or shaved heads, thus the participant used all *stone* modules (Fig.9) to create a sphere meant to represent round heads (Fig. 10). The vibration was set to a mild amplitude (approx. 50%). The participant did not want to change the shape after correcting the misunderstanding, claiming the ISEI represented happiness to her. When asked what it was in the ISEI that conveyed happiness, the participant referred specifically to the vibration. *Participant 4 Interpreting Participant 3's ISEI*

Participant 4 initially expressed some confusion over decoding emotions from the ISEI. After further exploration, he stated that the vibration communicated *shyness*. When the vibration was turned off, the participant expressed that it felt like something



Fig. 9. The ISEI as configured by participant 3



Fig. 10. The people from stimuli in session 1

was missing or that the object became dead. When asked to play around with the ISEI, participant 4 expressed that it felt *more expressive* when using other shapes, but could not explain more closely what he meant by more expressive. When presented with the stimuli, participant 4 could not find any correlation.

VI. CONCLUSIONS

Participants found it difficult to verbalize the reasoning behind the choices they made during the shaping process. This strengthens the observation made by related studies about the difficulty to translate emotions into language [1]. When comparing interpretations between creating and receiving participants, correlations can be made illustrated in fig. 11. In accordance with the study proposing the SEI, the *bubbly* module was attributed with happiness or similar positive feelings, the *stone* module expressed neutrality or stability to the resulting shape, and the *spiky* module was perceived as anger or negative feelings. In other words, our experiments confirmed earlier findings pertaining to mapping shapes over a valence/arousal spectrum. Regarding vibration, participants interpreted high degrees of vibration as anger. Simultaneously, higher degrees of vibrational amplitude was also interpreted

as bringing *life* to the ISEI, whereas the absence of vibration were described as lifeless. A low degree of vibration was associated with calmness.

All participants report shape forming to be more effective than vibration as to express emotion through the ISEI. From the discussion held at the end of both parts of the experiment, participants declared to feel comfortable using the evaluation tool as means of nonverbal communication of emotional states. All participants asserted the ISEI to be a subjective tool, where interpretation plays the largest part. One participant stated that *Its a very nonverbal way to communicate.*

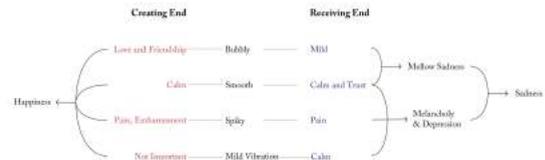


Fig. 11. Visualisation of creating and receiving interpretations of the ISEI

VII. DISCUSSION

The study, though limited in scope, shows with consistency that emotional states can be expressed and interpreted nonverbally through the ISEI toolkit. In the two experiment sessions, several emotional qualities of the configured ISEI was correctly interpreted when given to other participants. However, when asked to map the ISEI configuration to one of the four categories of stimuli, no match was made. It should be noted that since the interpretation of the ISEI was largely correct before being asked to match with stimuli, it is more likely that the mismatching can be attributed to the mapping process rather than to the ISEI.

Participant 4 had a particular hard time interpreting the ISEI, at the same time as self reflection over own emotions were hard to communicate. This could point to that proficiency in interpretation varies between

people of different personalities and/or experiences.

Limitations

Due to the limited scope of the study, only two experiments took place. While they gave interesting results, a larger number of experiments would allow for more conclusive results. It should also be noted that there was no control experiment set up, which leaves the interpretations of the result more vulnerable to subjective conclusions.

VIII. FUTURE WORK

A larger set of experiments would build a more solid validation of the ISEI toolkit. The vibration module used could only be varied in amplitude under constant vibration. Therefore, introducing patterns and/or irregularities to the vibration module in order to make the toolkit more expressive should be evaluated.

Evaluation of people's backgrounds in relation to their proficiency in using the ISEI or SEI would be a helpful addition to better understand the potential and limits of these kind of evaluating toolkits.

In applicational use, the ISEI toolkits modular character lends itself to be used in self-awareness applications. Suggestively, a portable version of ISEI connected wirelessly to an mobile app could allow users to freely self-evaluate their emotional state. Registering and analyzing the different configurations of shapes could then be used to visually present a larger spectrum of the user's emotions over time.

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