

EMOTIONAL CONTAGION IN INTERACTIVE ART

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ABSTRACT

The study reported in this paper is part of a larger project, Chameleon, that through a multi-disciplinary collaboration investigates the scientific foundations of emotional contagion, transforming it into an art experience. The aim is to create an emotional bond with the audience and to trigger reflection on emotions. The Chameleon art installation uses facial expression recognition technology to detect the emotional state of the audience and responds using a simple emotional contagion response mechanism and a video portrait selected in real time from a database of emotional video portraits built by the artist. In this paper we evaluate the ability of Chameleon to induce a need for emotional introspection and reflection in the audience. For this aim, an art exhibition was installed with emotional video portraits projected on different walls. The audience was told that the artwork was able to read their emotions and to respond to them while they were walking around the space. Visitors of the exhibition were invited at the exit to participate in the project by being interviewed. Semi-structured interviews were carried out and grounded theory was used to formally analyze the recorded interviews. The results showed that the audience was able to emotionally engage with the expressive portraits often by feeling that an emotional communication loop had emerged. The results also shed light on how this type of technology and the environment in which it is demonstrated could be improved to facilitate the communication loop to take place. The paper provides a detailed discussion of these results.

Keywords: *affective computing, experience evaluation, emotional contagion, facial expression recognition*

1. INTRODUCTION

Emotional contagion is a very basic social mechanism. It forms the basis for understanding each others' feelings and for motivating social support and indirectly becomes a tool for emotional reflection. In the last twenty years, the ability to display and recognize emotions has become critical to creating technology that can interact with us in our social world [1]. The Chameleon project aims to create interactive digital artworks that are able to respond to their viewers' emotional expressions by harnessing emotional contagion mechanisms. Rather than creating artwork that purely mimics or responds to the emotion of its audience, Chameleon wants to create a situation more similar to human-human interaction whereby none of the two partners can control the expressions of the other but each can still affect the other. The study reported in this paper aims to evaluate the use of this type of artwork to induce emotional reflection and introspection in the audience. Emotional introspection and emotional awareness are very important processes that allow people to regulate their emotions and their behavior [2]. In chronic pain for example, a major issue in today's society, low emotion awareness appears to be correlated with slow recovery [3]. Before presenting our study, we briefly report on emotion-aware digital interactive artworks. Then we describe how emotional contagion is understood as well as the importance of emotional awareness.

1.1. Emotion-aware digital interactive artworks

In recent years, art and HCI fields have been collaborating in the creation and study of multimedia art and interactive art installations [4-8]. The emergence of the affective computing field [1] has made it possible to create interactive digital art installations that are able to recognize and hence respond to the emotional states of their audience. These interactive emotion-aware art installations could have a wide variety of applications beyond art per se, e.g., therapy. Various installations of this kind have been proposed with the intent to investigate the way people engage with them.

In [9], the interactive emotion-aware installation takes the form of a tree that recognizes the emotion of a person from voice and facial expressions. The tree grows in a naturalistic manner starting from an initial cluster of small shoots into a larger tree with colored leaves. The user can influence this growth by interacting with the tree and creating a unique tree structure. The experiments showed that participants could strongly engage with the piece of art and were emotionally attached to their creation. However, differently from what the authors expected, the participants did not feel that the emotion expressed through the tree's emerging structure reflected their own emotions. Interestingly, explorative behavior was still observed in the participants and the interaction led to the emergence of a very personal engaging experience. This highlights the fact that mimicry is not necessary to create a bond between the user and technology. The simple realization of having some form of effect on the development of the artwork was sufficient to create a form of engagement.

In [10], the art installation responds to its audience by expressing the audience's emotion using colors, shapes and meaning. The main idea is to invite the audience to emotionally interact with the installation by dynamically presenting them with visual representations of the captured audience's emotion or visual representation of different emotions. The visual representations are created by capturing and automatically recognizing the facial expression

of a person and then combining this expression with colors, shapes and messages selected from a database before projecting the expression back to the person. By realizing that the installation reacts to their expressions, the audience is led to act out different emotional expressions.

Wright et al. [11] exploits the emotional expressions of the audience to investigate the concept of subjectivity through morphing of a real body with a cybernetic one. Their interactive artistic installation, Alter-Ego, creates an alter ego of the person it is interacting with, and displays emotions loosely mirroring those of that person, challenging their perception of identity. The system at times mimics the expression of the participant and at times provides unexpected responses. Even though Alter-Ego technology was not able to perfectly mimic the expressions of the participants, this was not perceived as a limitation but rather as a positive point as it facilitated the emergence of dynamical states. Hence, a question to be asked is how should the boundary of mimicry be set to allow for a dynamical emotional experience to take place, i.e. what minimum and maximum level of mimicry should be achieved?

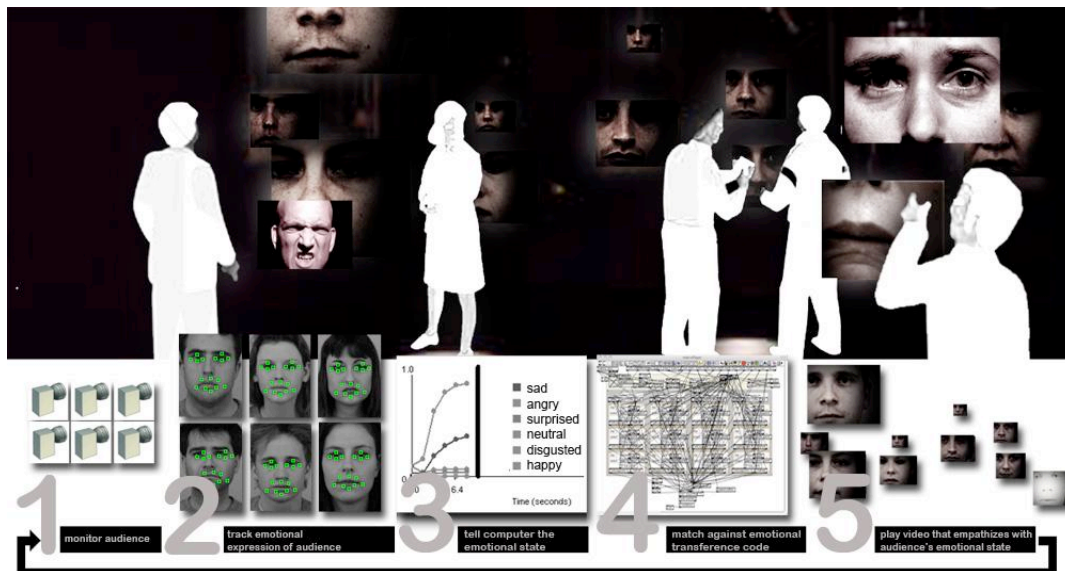


Figure 1: Chameleon system

The Chameleon project [12] explores this question by combining within the art installation an emotion recognition system and a simple emotional contagion response algorithm. The art installation (Figure 1) interacts with its audience by recognizing the audience's emotional expressions and by displaying videos of emotional portraits in response (figure 2). In a previous study [13], by using a Wizard of Oz approach we investigated the patterns of emotional contagion occurring in the observers when looking at videos of emotional displays (Figure 2). The results showed that people tend to respond to the videos or feel the need to respond. It also showed patterns of responses similar to the ones reported in studies on emotional contagion [14]. Mimicry or counter-mimicry expressions appeared to be related to the valence of the videos' emotional portraits and also to the bond the participants created with the art installation. In this paper, we use a qualitative approach to evaluate the experience of the participants when interacting with Chameleon. In particular, we are

interested in exploring if a loose emotional contagion mechanism can trigger emotional reflection and introspection. Before presenting our study, we briefly explain how emotional contagion is currently understood.



Figure 2: Examples of emotional video portrait database

1.2. Emotional contagion

Hatfield et al. [15] defined primitive emotional contagion as “*the tendency to automatically mimic and synchronize facial expressions, vocalization, postures, and movements with those of another person and, consequently, to converge emotionally*”. The transfer of emotions is the product of a complex interaction between several processes, involving simulation of the other person’s sensations and emotions, rationality, instinct, and conditioned reactions [16]. A possible neurological structure at the basis of this phenomenon is the mirror neuron system [17], the system at the basis of imitation.

Various studies have shown that emotional contagion takes place often. In [18], Hess and Blairy investigated whether people showed emotional contagion in response to relatively weak and dynamic facial expressions of emotions of anger, sadness, happiness and disgust. They found evidence on mimicry for each type of emotion. Furthermore, they found evidence of emotional contagion for expressions of happiness and sadness but not for anger and disgust.

However, humans do not always respond to an emotional expression with an exactly equivalent emotional expression. Other evolutionary principles may guide social interaction. An expression of anger may unconsciously trigger an expression of sadness as a form of empathy. Various studies (see [14] for a review) showed that the level of facial mimicry varies as a function of social context and type of emotional expression. In particular, it was found that whereas the mimicry of positive expressions was independent of the relation between observers and expressers, negative expressions were mimicked only when shown by a member of the group. Studies also showed that emotional expressions do not always trigger mimicry. In case of competition counter-mimicry is in fact observed, e.g., an expression of pain could trigger a smile [19].

Various researchers are now investigating the effect of using facial expression on robots. The study presented in [22] showed that the use of dynamic displays favors emotional resonance with the expresser be it a robot or a person. On the other hand static displays facilitate the recognition of the expressed emotion.

In the following sections, we present the empirical study we ran to evaluate Chameleon with the purpose to evaluate and explore the ability of emotion-aware systems embedded

with a simple emotional contagion mechanisms to trigger emotional reflection and introspection in the audience.

2. EMPIRICAL STUDY

2.1. Material

The 7th prototype of the Chameleon system was used for this empirical study. It consists of: 1) a database of dynamic emotional displays (figure 2), 2) an emotion recognition engine [20], 3) an emotional response engine, a projector, a web-cam and a microphone. Three complete systems networked with each other were set up in the room of an art gallery (figure 1). Each system projected videos on one wall of the room. The projections were about 1.5 meters in size diagonally, 1.5 meters off the floor, with the web-cams mounted underneath. The video displays were created by the artist involved in the project. Every day people (also called actors hereafter) participated to create the database. Each shoot was done over a long period. Using elicitation techniques, the actors were led to talk about their emotional experience whilst their expressions were captured by the artist.

2.2. Emotional contagion response algorithm

A response algorithm, inspired by the patterns of emotional contagion, was integrated in Chameleon. The responses of the system are not deterministic but are based on a set of probability rules (table 1) that favor mimicry. The values were at first hypothesized by Frith, and then tuned according to the results of stimulus response patterns we measured in our laboratory experiments [13]. Whilst we do not argue that this table reflects the complexity of emotional contagion phenomena, we explore human reaction to this biased type of response on the Chameleon platform.

Table 1: Probability weight used in the emotional contagion response algorithm

Stimulus	Observers' reactions					
	Happy	Sad	Neutral	Surprised	Disgusted	Angry
Happy	60%	0%	10%	30%	0%	0%
Sad	0%	70%	20%	0%	0%	10%
Neutral	10%	10%	50%	10%	10%	10%
Surprised	15%	15%	5%	50%	5%	0%
Disgusted	0%	0%	0%	25%	60%	15%
Angry	0%	25%	0%	20%	15%	40%

2.3. Participants and procedure

Emotional video portraits were projected on the walls and the audience was told that the artwork was able to read their emotions and respond to them while they were walking around the space. Fifteen of the visitors were interviewed in a semi structured way for 20 to 30 minutes, after interacting with the system for 10 to 20 minutes. Most of the participants had a formal training in arts or at least a keen interest. The general strategy of the semi-structured interviews (see table 2) was to start by asking people what they felt, what they thought of during the experience, and then following the conversation naturally, cover

questions listed below, and following any interesting topic that came up. The interviews were recorded and fully transcribed. A grounded theory approach [21] was used to codify the transcripts and identify emerging themes.

Table 2: Examples of interview questions

Questions
Did you connect with the work? (or feel some emotional bond)
Did you feel like the installation was empathizing with you?
Did you feel the same emotions were shown in the projections?
Do you think it was reading your emotional state?
What were you feeling during the experience?
What were you thinking during the experience?
Did you start reflecting or reminiscing during the experience?
Did you feel more for positive or negative emotions? – are there any particular memories that were triggered?
If you felt you could react but didn't, what prevented you from reacting?
Did you feel a connection with other participants?
Did you notice what other people were doing / feeling?

3. RESULTS AND DISCUSSION

The factors that emerged from the analysis of the interviews can be grouped under three different themes: environment, actor believability, and affective experience. In the following we discuss each issue by reporting extracts from the interviews in table 3, 4 and 5.

Table 3: Extracts from the interviews for the environment theme

Sub-theme	Environment
Collaborating with others	... And when you moved around the space you would see someone else react and get a different response, but then you would see if you could do the same, ...
Competition, control If there was a character was making more noise I was looking at what expressions [the other participants] were making, trying to work out if it was reacting better to them than to me. ... you could control the clip but then they had their own agenda...
Inhibition	At first I felt silly. I felt really self conscious and wasn't quite sure how it all worked. But as I spent more time there I became more relaxed and not worried what was happening around me. And then my experience changed ...
Disturbance In one way, I found having too many voices around me quite distracting ... I could hear some hysterical laughter over my shoulder, and then someone shouting and screaming over there ... so the intimacy of the moment was gone ...

3.1. Environment

The context in which an event takes place always plays an important role on how the event is experienced and develops. The results showed that this was also the case in our study. The environment appeared as a support to the experience through the interaction with the other participants but at times it was also an obstacle to the engagement with Chameleon. Participants discovered and created ways of interacting with the system by observing and collaborating with others, but also through competitive behaviors. Participants reported explorative behavior aimed at better understanding how the system worked. Sometimes, they tried to reproduce the reaction patterns obtained by other members of the audience, leading them into a sort of competition with each other. This is interesting as this kind of behavior is rather unusual in a human-human interaction, and the goal of the artist involved in this

project was to avoid a predictable type of behavioral response where the audience could easily take control over the system reactions. As previously mentioned, the aim of this installation was to embed response mechanisms typical of emotional contagion with the levels of unpredictability that are present in human-human interactions.

Whilst at times the presence of others was a source of inspiration and challenge in understanding how the system worked, it could also prove a source of inhibition. Being aware of others and feeling observed made some of the participants feel embarrassed and inhibited their behavior. However, the feeling of embarrassment diminished as time passed. These effects manifested to a different degree with different members of the audience; some of the people found it easy to focus on their interaction:

Table 4: Extracts from the interview for the Actor Believability theme

Sub-theme	Actor believability
Naturalness	<p>... .. if there is a really big hysterical emotion, it's not giving me much space to figure out what that emotion is about, because it is so overpowering ... But when the emotions were a little less obvious, less dramatic,... it brought out empathy... It made me connect in a different way</p> <p>... Especially the woman she seemed more genuine, so it was easier to feel connected with her. Than the other characters who were quite extreme...</p>
Ambiguity	<p>... Because the guy on the far wall – you couldn't hear what he was saying and I think that worked better....</p>
Inhibition	<p>At first I felt silly. I felt really self conscious and wasn't quite sure how it all worked. But as I spent more time there I became more relaxed and not worried what was happening around me. And then my experience changed ...</p>
Disturbance	<p>... In one way, I found having too many voices around me quite distracting ... I could hear some hysterical laughter over my shoulder, and then someone shouting and screaming over there ... so the intimacy of the moment was gone ...</p>

3.2. Actor believability

Various issues emerged in relation to the behavior of the actors of the video displays. Naturalness in the expression was an issue that emerged often in the interviews. Participants appeared to be able to create an emotional bond with the more natural and more subtle expressions. Apart from these ramifications, just the fact that some of the audience perceived the expressions as being acted was interesting, since most of the emotions expressed by the characters were in a way genuine, given that the artist captured them in long filming sessions where the actors were asked to remember and relive particularly emotional episodes of their lives. It could be that the lack of an appropriate context made the strong expressions to appear as acted even when they were not. Ambiguity and subtle expressions were easier to accept and get involved with because they left space for the audience to associate meaning to them, contextualizing them, and making them more personal to their own experience. Participants imagined responses that were not really there. For example, they identified body movement reactions when the system was in fact not yet able to deal with them.

3.3. Affective experience

This is probably the most important theme for this study as it presents issues related to the type of relations that emerged between the audience and the actors and also the emotional introspection that the experience generated. Feelings of emotional bond and intimacy came up repeatedly in the interviews although they were not explicitly part of the questions. In

many cases the audience was affected by the emotions expressed by the characters, and the constant search for meaning and introduction of context generally followed this. One of the participants thought that the reflections on this experience would be stronger after the exhibition, i.e., when more space more thinking would be available. Participants showed different type of behaviors. Some of them mainly tried to control the system going back to the discussion of expectation people have of technology. On the other hand people let the system drive the emotional story. From the psychological point of view it will be interesting to explore what factors (e.g., personality, technology expectation) affect the type of relations that are formed, and from the design point of view, it will be interesting to find out what factors in the design of the interaction affect the type of relations formed.

Table 5: Extracts from the interview for the Emotional Experience theme

Sub-theme	Affective Experience
Intimacy	<i>... I was close to the character. He was quite up front and in my face. And talking quite low and quite intimately... And he was being quite flirtatious. The feeling I had inside was like having a connection with someone that you had met in a bar or something. We were mimicking each other.</i>
Reminiscence	<i>I was thinking of some sad things that happened to me, when [...the stimulus] was sad for a while, it felt like a long time, and it reminded me of some things.</i>
Post-experience	<i>...it wasn't making me think particularly about how people interact with me but I supposed it is quite an intense experience and I will probably have it more a I am thinking about it later[...] I was aware of the interaction, but I wasn't thinking about it particularly...</i>
Empathy and Introspection	<i>.... I didn't like it when he looked sad and I didn't know why".</i> <i>.... When I was creating these different expressions I had to think back to how I felt to create them, so it did bring up a lot of genuine emotion ...</i>
Control vs. Reaction	<i>...you wanted to sort of push the machine, or push the image to do something, you wanted to provoke the image to do something so you did want to interact all the time...</i> <i>I think when I had eye contact. At certain times they seem to be looking at me. I just responded to them, rather than trying to make them do things, and trying to make them interact with me.</i>

Naturally, technological limitations influenced the experience. A barrier to a complete engagement with the installation was the fact that emotional expressions were projected more than once to the same audience, due to the limited amount of video material in the database. Furthermore, it is possible that a better emotion recognition system could facilitate the emergence of more meaningful emotional dynamics. The size and the position of the projection also played an important role. Some participants felt that the large size of the videos and the high projection were intimidating by giving the audience the impression of someone that wanted to control them. In the most recent installation prototype, the projection is made on three-dimensional structures hanging in the room (rather than on the wall) at audience level creating a more human-human type of interaction.

4. CONCLUSION

The work reported in this paper aimed to evaluate the ability of emotion-aware systems embedded with emotional contagion mechanisms to trigger emotional reflection and introspection in the audience. The analysis of the interviews carried out showed that the interaction with the system created a variety of emotional experience ranging from empathy

and intimacy to reminiscing about past events. The attitude, preconceptions and expectations of the audience towards interaction with technology influenced the way that they interacted with the art and how they judged it. In particular, some of the participants attempted to control the installation's responses. The presence of other people added more richness to the experience as the audience collaborated and competed in finding ways of interacting with the system and eliciting behaviors from it. However, the audience and other noise in the environment could also become at times a source of disturbance and inhibition and hence a barrier to engagement.

Furthermore, the lack of context and the beliefs about how the artwork is built, made some of the audience believe and perceive that the expressions were unauthentic, even through most of the 'actors' responded that the elicited emotion was 'felt' during the shoot. This seemed to have detracted from the participants' capacity to empathize with the characters during the more powerful displays of emotion. However during the more subtle and ambiguous expressions the audience was able to ascribe interpretations that were more in line with the personal experience and enabled them to become more absorbed in the interaction. When the expressions were felt acted, the audience's attention tended to shift to more practical aspects of the system.

In order to ascertain our findings, it could be interesting to run a follow up study based on video observations, that would help overcome some of the subjectivity limitations of the techniques used in the present study. Moreover, it would also be interesting to investigate further the effect of the system on the audience by analyzing post-experience effects, i.e. how the audience re-thinks the installation in subsequent days. It is in fact possible that overpowering videos did not leave enough space for people to think on the spot, but may have seeded reflective processes that take longer to unfold.

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