You make me happy

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You Make Me Happy: Using an Adaptive Affective Interface to Investigate the Effect of Social Presence on Positive Emotion Induction

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Abstract

Affective user interfaces are usually characterized as interfaces that try to recognize, interpret and respond to human emotions. In this paper, we take a different perspective and investigate if and how a digital, interactive adaptive mirror, which is a game-like affective interface, can induce *positive emotions in participants and how the social presence of a friend affects the emotion induction. Results show that participants systematically feel more positive after an affective mirror session and co-presence of a friend is shown to boost this effect.*

1. Introduction

Emotions are a fundamental ingredient of our daily life and govern our everyday interactions. Research on emotions has matured substantially in the last two decades, which has resulted in new theories and methodologies, and in many valuable findings. This research has been done in many fields and from many different perspectives (evolutionary, psycho-physiological, neurological, psychodynamic, etc) [1]. The field of human-computer interaction (HCI) is no exception, where the role of emotion in user interfaces is investigated both for designing better interactive systems [2] and for evaluating their usefulness with users [3].

The traditional concept of computers as emotion-less machines has actually set the road towards instilling computers with emotions [4]. This infusion of emotions in everyday user interfaces has given birth to a new generation of user interfaces known as 'affective user interfaces'. These interfaces are usually characterized as interfaces that try to recognize, interpret and respond to human emotions [5]. In this paper we take a somewhat different albeit related perspective, and study to what extent interfaces can *induce* emotions in human users, where we focus on positive emotions [6]. For this purpose, a new, multimodal interface concept has been developed: the Affective Mirror (AM), which tries to induce positive emotions in users by showing a distorted ("funny") representation of their face. It integrates automatic emotion detection from both face and voice, and uses the fused, perceived emotional state of the user as a "trigger" for selecting different audiovisual effects.

Evaluating affective interfaces is a complex issue and requires more than the "standard" usability evaluations [7]. In this paper, we not only aim to test the effectiveness of the AM in inducing positive emotions but also try to gain insight into the extent to which social factors have an impact on this emotion induction. Although many researchers believe that emotions are a fundamental medium of social communication and that social context shapes the expression of emotion [8], not much is known about possible social factors that may have an influence on the expression of emotion [9]. Past experiments in this field were conducted with single participants, even when though there are indications that the mere presence of another person may have an effect on the extent to which people show their emotions.

In this paper we describe an experiment, where we ask participant to sit in front of the Affective Mirror either individually or with one of their friends and we look at the effects of physical co-presence of a friend on the emotion induction and effectiveness of the AM. In this experiment, we collect different kinds of data of participants interacting with the AM, including personality information, biophysical measurements, overall user experience measurements and self-reported emotion scores.

2. The Affective Mirror

The Affective Mirror (AM) is an affective multimodal interface that adapts itself to the user's perceived affective state [10]. The purpose of the AM is to try and make people laugh and thereby induce positive emotions in them. This is done by creating an interactive 'production-perception-adaptation' loop. The basic idea is simple: the AM detects the state of the user and then provides audiovisual feedback by distorting the user's face in the mirror, just like a traditional carnival mirror. A crucial difference with such a traditional mirror is that the amount and type of face distortions produced by the AM depend on the detected levels of laughter and smiling. The more participant laugh, the more they progress in different levels of distortions, resulting in a truly dynamic and interactive experience.

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2.1. Functionality and Architecture

The AM senses the user's state by interpreting observational user data. The affect sensing system is based on a visual subsystem and a vocal subsystem that detect smiles and laughter. The affect recognition system captures laughter and affective verbal expressions in the voice, and facial expressions from the frontal video stream. Fusion of the recognition subsystems results in monitoring the overall user experience and adapts the AM to the current user state.

. In this study we focus on the use and experimental evaluation of the AM. Although the AM[1] is in a stable state, new features have been added for this study, in particular to improve the sensing system. In addition, we added new visual effects which were synchronized with new audio effects. The dynamic customization of the user interface was also improved, giving the AM a more game-like look.

The AM consists of number of software modules and hardware components. The most important ones are Eye Catcher [11], Face Reader [12] and Laughter Recognition in Speech (LARS) [13]. Even though both FaceReader and LARS sometimes make incorrect predictions about the user's emotional state, this does not damage the interaction. The recognized emotional state merely acts as a trigger of new visual distortions, and is never communicated directly to the user. Below, we briefly explain these key components and for details of other components and of the general architecture of the system we refer to [10].

2.2. Eye Catcher

To capture participants' live video stream and for displaying their video stream on the screen after appropriate facial distortions, we used the Eye Catcher. The Eye Catcher is a videophone that provides real time eye contact between two video call participants. A high-resolution camera is installed behind the screen of the Eye catcher that is invisible to the participants sitting in front of it. The camera captures the live video of the participants and then displays it on the eye catcher's display after appropriate transformations.

2.3. FaceReader

To analyze facial expressions and smiles, we used the FaceReader. This software is provided by Noldus and automatically analyzes a person's facial expressions and gives an estimate of the person's emotional state. FaceReader is trained with a database of frontal facial photographs for six basic emotions. A live video stream from the eye catcher's camera is transmitted to the FaceReader which then analyzes it frame by frame and stores the assessment of the person's emotions in a text file. For the AM, only the detection of positive and negative affect by the FaceReader was used.

[1] The AM was developed in the MultimediaN project.

2.4. Laughter Recognizer in Speech

The vocal laughter recognizer (LARS) was developed at TNO after modifying some of the existing software and technologies. It detects laughter from speech by first differentiating silence from speech and laughter and then performing a voice activity detection to filter out non-speech and non-laughter sounds.

Figure 1. Behind the scenes look at the setting of the AM

2.5. Working Scenario

This section presents a brief interaction scenario between a user and the AM. The user sits in front of the mirror when the session starts. The mirror captures the user's face, and displays a distorted version of the face to the user together with a corresponding funny sound. Typical manipulations are effects where eyes are blown up, or the mouth corners of the user are raised in an extreme fashion, or the face appears in a swirl mode. Such visual distortions tend to generate surprise effects in the user's face, or make the users laugh. These facial expressions are in turn detected by the system, after which the user is confronted with a more extremely distorted version of his/her face.

3. Experiment: Effect of Physical Presence

The aim of this study is to find out whether users indeed feel more positive after a session with the AM, and whether there is an effect of physical co-presence on the effectiveness of the AM. For this we compared single participants (who sat in front of the AM alone) with participants who sat in front of the AM in the presence of a friend. We compare a "natural" condition with a control condition in which participants are asked to suppress their laughter. We added a suppress condition to check whether that participants would not "fake" their laughter in the normal condition (in other words, the suppress condition offers a check for so-called "demand effects"). If participants would not be able to suppress their laughter completely and feel positive after the AM session, this would offer a compelling argument for the effectiveness of the AM.

3.1. Participants

Participants were 94 (55 females) Dutch undergraduate students (M = 21 years, SD = 2.4). Of these, 54 participated in self-selected pairs, consisting of friends and 40 participated individually. Pairs and individuals were randomly assigned to either the suppress or the natural condition. Male and female participants were equally distributed over the conditions. All participants were recruited during a cognitive psychology class, and received partial course credit for participating in the experiment.

3.2. Procedure

The experiment was conducted in one of the labs of Tilburg University. The procedure for both conditions (individuals or pairs) was essentially the same.

Upon arrival in the experimental lab, the participant was seated in a comfortable chair facing the Affective Mirror. In the case of pairs of participants, it was first decided which participant would sit in front of the AM first. The other participant sat on the left side of the participant in front of the AM, such that the friends face and the distortions of the affective mirror could be seen.

Figure 2. Individual participant (Right) and pair of participants (Left)

The Eye Catcher component of the AM was placed on a small table. Two microphones, the experiment task booklet and physiological sensing equipment were also placed on the same table. At this point the mirror was not active. After seating adjustments, the experimenter introduced himself and briefly described the purpose of the experiment, after which the participant was asked to fill an informed consent form. All participants gave a written consent to record and use audiovisual data for research purposes. After this, the participant filled in a self-report emotion questionnaire ("At this moment, I feel…") derived from [14], consisting of six 7-point bipolar semantic differential scales with positive and negative adjectives (happy/sad, pleasant/unpleasant, satisfied/unsatisfied, content/discontent, cheerful/sullen, high spirits/low-spirited). The order of the adjectives was randomized; for processing negative adjectives were mapped to 1 and positive ones to 7.

Following this, electrodes for measuring galvanic skin response (GSR) and heart rate were attached to the participant and this was followed by a rest period of 5-7 minutes for recording the baseline physiological measurements of the participant. The participant was also fitted with a tie clip microphone for recording the audio required for the AM. After the pre-session measurements, the experimenter started the actual AM session and left the room. In the "suppress laughter" condition, participants were instructed not to laugh during their interaction with the AM. In the natural, "show laughter" condition, participants received no further instructions except that they simply had to watch into the Affective Mirror. Each session lasted 3-5 minutes depending on the amount of detected laughter. As soon as the final level was over, the experimenter entered the room, removed the electrodes and gave the participant the same emotion questionnaire as before. Participants also received a token of appreciation, which consisted of a printed Score Card showing the perceived laughter statistics (amount and duration of recognized laugher from face and voice) together with a funny picture of the participant (Figure 3).

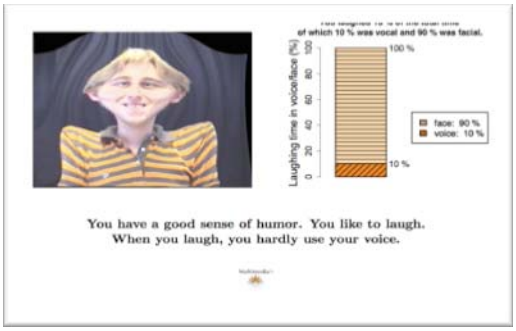

Figure 3. Scorecard as a token of appreciation

Finally, the participant was asked to fill in additional questionnaires about the overall user experience and fun of the AM experience, marking the end of the first part. The user experience questionnaire was derived from [15, 16], consisting of eighteen 5-point Likert scale items. These eighteen items were divided into five distinct but related categories: *Naturalness of the AM* ("The AM was rather artificial…"), *enjoyment* ("It was fun to sit in-front of the mirror..."), *feeling of time* ("Time passed quickly/I found it a waste of time…"), *play again* ("I would like to play again / playing again would be boring…"), and *induce laughter* ("The mirror stimulated amusement..."). Positive and negative questions were randomly combined in the questionnaire. For data-processing purposes, negative questions were recoded such that 1 always represents very negative and 5 represents very positive. Furthermore, the Funometer from Janet Read's fun toolkit [17] was used for measuring fun.

In the case of pairs of participants, both participants sat in front of the AM after each other. After the first member of the pair had participated, where the procedure ran exactly as described above (including measurements and questionnaires), the two participants switched positions, and another session with the AM

was initiated in exactly the same way. During both sessions, the second participant (i.e., the one who was not sitting in front of the AM) did not receive any particular instruction and he/she was told to sit together with his/her friend naturally. When both participants had been in front of the AM, they were debriefed and thanked for their participation with a scorecard for each.

Figure 4. Examples of visual distortions created by the AM.

3.3. Statistical Analysis and Design

The internal consistency of the self-reported emotion questionnaire was measured using Cronbach's alpha and was very good ($.82 < \alpha < .93$) for both individuals and pairs. Two separate analyses were run. First we analysed the data from the pairs in a mixed between-within design, with Time of emotion measurement (2 levels: pre and post) as within-variable and Condition (2 levels: suppress laughter, show laughter) and Turn (2 levels: first, second) as between variables. Next we compared the data from individuals and pairs in a comparable mixed between-within design, with Time of emotion measurement as within-variable, and Co-presence (2 levels: alone or together) as between-variables and the self-reported emotion scores as the dependent variables. Checks for statistical significance were performed with repeated measures analyses of variance (RMANOVAs) in the case of the self-report emotion scores.

The internal consistency of the UX questionnaires was measured using Cronbach's alpha. For individuals, it was very good ($.77 < \alpha < .85$) for all five categories. For pairs, it was also very good ($.80 < \alpha < .88$) for four categories, but with an exception of $\alpha = .69$ for the 'Naturalness of the AM' category. Due to the high Cronbach's alpha values, all items belonging to a particular category were merged for each condition for both individuals and pairs and the averages of each category are discussed in the results section. For the fun question, the data from the 'funometer' free scale was mapped on the 1-10 scale where 1 represented no fun at all and 10 represented a lot of fun. Checks for statistical significance on the questionnaire data were performed using independent sample t-tests.

3.4. Results

3.4.1 Self-report emotion questionnaire

Analysis of the individual's data revealed that participants indeed reported more positive feelings after sitting in front of the AM than before (pre-emotion (1): $M = 4.18$, post-emotion (2): $M = 5.63$). Furthermore, participants' self reported emotion scores were not influenced by Condition, $F<1$. Thus, participants report the same emotional state, irrespective of whether they were in the "suppress laughter" or in the "natural" condition.

Analysis of the pairs' data revealed that there was no significant effect of Condition nor of Turn (both $F<1$). These two factors do not interact with any of the other factors. In other words, for the self-reported emotion scores it does not matter whether participants from pairs sat in front of the mirror first or second. In addition, similar to individuals' results, it does not matter whether participants were asked to suppress their laughter or not. Based on these results, we aggregated the data of all participants across Condition and Turn for further analysis. Figure 6 summarizes the results for the comparison between pairs and individuals. It can clearly be seen that participants report overall more positive scores *after* their session with the AM ($M = 6.36$) than before ($M = 4.29$), $F\ (1,92) = 957.170$, $p < .001$, $\eta^2 = .912$). Interestingly, this effect is stronger for participants who participated with a friend than for single participants, cf. the significant interaction between Time of the emotion measurement and co-presence, $F\ (1,92) = 29.249$, $p < .001$, $\eta^2 = .241$.

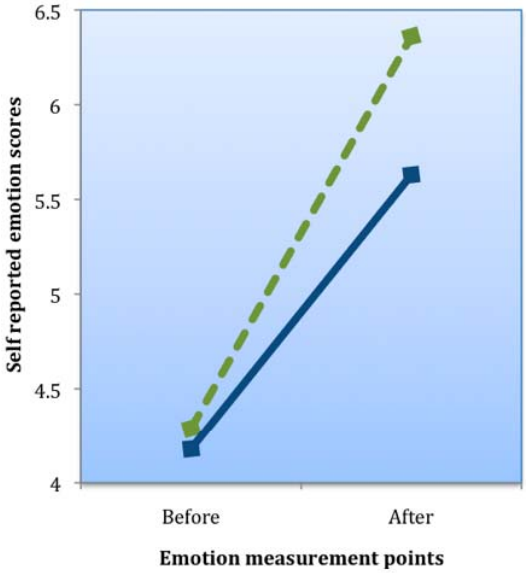

Figure 5. Comparison of the changes in self-reported emotional state scores for pairs (green dotted line) and individuals (blue straight line). The x-axis represents the two emotion measurement points Before and After the AM session and the y-axis represents the average self-reported emotion scores on a 7-point scale ranging from 1 (very negative) to 7 (very positive)

3.4.2 User experience and fun questionnaire

Table 1 summarizes the results of the user experience questionnaire for both pairs and individuals. It can be seen that participants scored above neutral for all constructs, irrespective of condition. This shows that

Category	Condition	Pairs	Individuals
		Mean (Std. Dev.)	Mean (Std. Dev.)
Laughter Induction	Laugh	4.29 (.460)	3.85 (.489)
	Suppress	4.04 (.720)	3.70 (.544)
Play Again	Laugh	4.39 (.629)	4.05 (.510)
	Suppress	4.00 (.693)	3.80 (.616)
Feeling of Time	Laugh	4.11 (.497)	4.10 (.541)
	Suppress	4.23 (.765)	4.15 (.489)
Naturalness of AM	Laugh	3.75 (.645)	3.90 (.641)
	Suppress	3.69 (.618)	3.65 (.933)
Enjoyment	Laugh	4.50 (.509)	4.35 (.489)
	Suppress	4.12 (.516)	3.90 (.618)

Table 1. Mean of five UX questionnaire categories on a 5-point scale (1=very negative, 5=very positive)

participants were positive about the interaction with the AM and the overall user experience. It can also be seen that the mean scores of all categories are higher for pairs than for individuals.

In the case of individuals, no effect of condition was found for any of the categories, with the exception of the Enjoyment category where participants enjoyed the experience more in the natural, Laugh condition, $t(38) = 2.316$, $p < .05$. But apart from this, it was found that the user experience was very similar in the Laugh and the Suppress condition. Finally, it was found that participants in the Laugh condition had more fun ($M = 8.45$, $SD = 1.09$) than participants in the Suppress condition ($M = 7.50$, $SD = 1.19$), $t(38) = 2.52$, $p < .01$).

For pairs, no significant effect of Turn was found for any category of the UX questionnaire. Based on this result, we aggregated the data of all participants across Turn for further analysis. It can be seen that participants scored fairly above neutral for all constructs, irrespective of condition. This shows that participants were positive about the interaction with the AM and the overall user experience. A t-test revealed a significant effect of the condition for the 'enjoyment' ($t(52) = 2.756$, $p < .01$) and 'feeling of time' category ($t(38) = 2.184$, $p < .05$). No effect of condition was found for the other three categories. Finally, it was found that participants in the Laugh condition had more fun ($M = 8.96$, $SD = .90$) than participants in the Suppress condition ($M = 8.15$, $SD = 1.02$), $t(52) = 2.966$, $p < .01$.

4. Conclusion and discussion

The Affective Mirror is a novel interface concept for inducing emotions in users in an ethical way. The AM creates a game-like experience and adapts itself intelligently based on the user's perceived current affective state. In this paper we investigated if and to what extent the AM induces positive emotions in participants and how the co-presence of a friend affects the emotion induction.

In general, results revealed that the Affective Mirror as an affective game-like interface worked very well in inducing emotions and that participants indeed felt more positive after their AM session. Interestingly, for both individuals and pairs, the results revealed that the Affective Mirror succeeds in inducing positive emotions in participants and for the reported emotions it did not matter whether participants were instructed to suppress their laughter or not.

In addition, results showed that the induced effect is stronger for people who participate with the AM with a friend present, suggesting that social factors strengthen the effectiveness the AM. These results are consistent with the results found by [18, 19]: doing an activity together with a friend results in feeling better than doing an activity alone. These results also strengthen the results of other studies [20, 21] where the effect of the social presence on game players was investigated and it was revealed that the game experience and emotional response increases in the physical presence of a friend.

The analysis of the UX and fun questionnaire revealed that participants had a very good experience while interacting with the AM. These results are also quite consistent with the self-report emotion questionnaire. First, participants not only felt better after the AM session but they also indicated that they had fun while interacting with the AM and overall reported a good user experience. Participants appreciated the naturalness of the Affective Mirror, reported that the time passed very quickly during the affective mirror session, showed a big interest in playing again or sitting in-front of the mirror again, and reported that the AM was indeed hilarious and induced laughter, irrespective

of whether they were in the natural or in the suppress condition. For the enjoyment category, results showed that the participants in the natural condition enjoyed the experience more than the participants in the suppress condition. This result it is in line with the results of the fun question where participants reported having more fun in the natural condition compared to the suppress condition. These findings are corroborated by the qualitative data collected in the interview afterwards, where one participant explained the reason of having less fun in the suppress condition in this manner "The AM was funny and it was fun to play with it but if I had a chance to play with it or move my body/face with it then that would have been more fun." Another participant reported: "Suppressing was more or less like a task to do. I did not do funny things in response to the AM's transformations because I thought it could break my suppression anytime. It was already difficult to control my laughter and I did not want to disturb my task by doing some funny things, which I actually wanted to do." They showed an interest in freely interacting with the AM as this so called "task free interaction" induced more laughter and gave a more engaging experience in their opinion.

Furthermore, in the case of pairs, participants were overall more positive about the AM and scored higher on all items of fun and UX questionnaire, which is again in line with previous studies [21]. Participants had mixed feelings about sitting first or second in front of the AM. Some of them said it did not matter whether their turn is first or second but almost half of them said that going first is much more fun.

Currently we are further analyzing the collected data, where we are looking for correlations with biophysical and personality data with the self-reported emotion scores reported in this paper. We also aim to strengthen the AM's affect recognition system where it would be interesting to feed the biophysical data into the AM feedback loop. Furthermore, we will use the collected video-clips for perception studies (analyzing participants' facial expressions) where we are particularly interested in differences between the "suppress" and the "natural" condition. Finally, we are running more studies under the social dimension, to investigate how the presence of a stranger or of a person with incongruent behaviour effects the expression of emotions.

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