Introducing EVG: An Emotion Evoking Game

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Abstract. A dungeon role playing game intended to induce emotions such as boredom, surprise, joy, anger and disappointment is introduced. From the preliminary study, facial expressions indicating boredom and anger were observed. Individual differences were found on appraisal and facial expression of surprise, joy and disappointment.

Keywords: emotion, game, facial expression

1 Introduction

This paper introduces the Emotion Evoking Game (EVG), an open-source computer game that can evoke emotions from users. EVG is designed to assist development and evaluation of new techniques for recognizing emotions and generating facial expressions. At a basic level, this tool allows researchers to more systematically explore the factors that elicit emotion and to carry out facial expression study. Specifically, EVG benefits research in embodied virtual agents in several ways. It allows researchers to closely study and capture the features and dynamics of real human emotional expression, a critical precursor to building more expressive virtual human bodies [1]. It also provides a tool that can help evaluate computational models of emotion [10].

EVG is built on the ideas first realized in the Geneva Appraisal Manipulation Environment (GAME) [12] – a Pac-Man like game running under DOS created by Geneva Emotion Research Group from the University of Geneva. In GAME, events representing different values of appraisal dimensions are used to induce emotions in players. Traditionally, researchers have employed a wide range of stimuli to evoke emotions. These include displaying images or videos with emotional impact [13] [15], imagining emotional events [21] [8] [14], interacting with a human confederate [20], etc. The use of computer video games promises several benefits over these traditional approaches. While playing a video game, the subject is involved in a task, so a range of task-related emotions such as frustration can potentially be evoked. Further, there can be other human players or AI-driven characters feigning to be human in the game. Thus a range of social emotions can be evoked such as guilt, or anger due to betrayal of a teammate. In contrast, using the display of static images, the subject is more a

passive observer. The social and task contexts are minimal and hard to manipulate freely. As a consequence, certain emotions, such as frustration and guilt, can be hard to induce. Additionally, the emotions evoked are often indirect, sympathetic of the people and events depicted in the image. Also, computer games, by giving researchers control over the environment in the game, offer a sophisticated and systematic way to manipulate appraisal dimensions through game events.

EVG is built on a modern operating system. It's generally available to the community for use in research on recognition and synthesis of emotions. In this paper, we discuss EVG and an initial, formative evaluation of EVG. For the current study, we set up EVG so that players would experience a sequence of events that aim to induce boredom, followed by surprise, joy, anger and disappointment. Preliminary findings are presented.

2 Related Work

The facial expression of emotion has been one of the more heavily studied topics in emotion research and has become increasingly important in work on intelligent virtual agents. There is a large body of research that addresses questions concerning the structure of facial expressions, the relation of facial expressions to underlying emotions, the role of facial expressions as a signal that mediates social interaction, whether facial expressions are culturally universal, etc. Here, we touch on a small portion of the research relevant to the current discussion.

Research by Ekman [6] shows that facial expression is a pattern of activities across the face. Ekman & Friesen [7] listed action units (AUs) of Facial Action Coding System (FACS) that correspond to different facial expressions. On the other hand, the component-based approach to facial expression argues that certain appraisal checks induce certain facial features, that individual component of facial expressions, such as lowering the eyebrows into a frown, themselves carry meaning [19] [18].

Another research question concerns the degree to which facial expressions are universal or culturally/individually dependent. Ekman's research [6] argues that there are six facial expressions – happiness, surprise, anger, sadness, fear and disgust – that are culturally universal but whose display can be managed by culturally determined display rules. Smith and Scott's summarization [19] of Darwin [4], Frois-Wittmann [9], Izard [11] and Ekman & Friesen [7]'s work on common features of widely recognized expressions shows agreements such as raised lower eyelids, raised lip corners and open mouth are expressions of joy; eyebrow frown and raised upper and lower eyelids are display of anger; eyebrow frown, raised eyebrows and lowering of lip corners are associated with sadness. Surprise, as Darwin pointed out, is a biologically determined facial display consisting of eyebrow raise, widening of the eyes, and opening of the mouth/jaw drop. However, research has shown that facial expressions of emotion are more often partial than complete [2] [16]. Furthermore, strong evidences of stable individual differences in facial expressions in both

individual and interpersonal context were found [3]. Further, studies by Reisenzein [17] find that surprise doesn't correspond to the three component display proposed by Darwin. Self-reports and behavioral measures indicated the presence of surprise in most of the subjects' expressions. But surprise expressions were observed only in 4-25%, and most displays consisted of eyebrows raised only. Further frontalis EMG measurement failed to detect notably more brow raisings in the subjects.

EVG, as a platform for conduction facial expression experiments, provides us with the opportunity to study these different theories.

3 Emotion Evoking Game

EVG is adapted from an open source game called Egoboo [5]. Compared to off-the-shelf games, EVG, as an open-source game, gives researchers access to the code that allows precise control over game events. It offers systematic ways to manipulate game events based on appraisal dimensions. With control over timing of events, it provides us with opportunities to study issues such as interactions between emotions. Access to the code also allows us to incorporate hooks into EVG to log the game events and synchronize them with other data sources such as experiment videos, physiological signals, etc.

Fig. 1. Screenshot of Emotion Evoking Game

In the present study, EVG is implemented as a role-playing dungeon adventure game, in which the player (subject) completes missions in an underground palace accompanied by a non-player character (NPC) teammate. The current setup includes events targeted to evoke five different emotions: boredom, surprise, joy, anger and disappointment. The events are designed based on the appraisal dimensions described

in [10]. Events are timed in certain sequence so that these five emotions are evoked in the same order. The story used in the current study is that the player, accompanied by a teammate, starts out in an underground palace with the goal to collect 2000 units of gold. Towards the end, player defeats the boss enemy and successfully collects 2000 units of gold. Then the teammate betrays the player by killing him and stealing the victory. The five main emotion evoking phrases are discussed below.

Collection: First, the player goes about the dungeon to collect gold by opening up chests placed in separate chambers. Each chamber is connected by hall ways but separated by one-direction shutter doors so that player can't walk back to the previous chamber. The map of the dungeon is also designed in a way that there's only one path through following the direction the shutter opens. This setup reduces the cognitive load for path finding and filters out possible noise in emotions caused by such cognitive load, such as confusion and frustration. We call this stage the Collection Stage. During this stage, there's no enemy presence. There're 10 chests contain a total of 1750 units of gold in the dungeon. We hypothesis that events in this stage have the following characteristics and are intended to evoke boredom.

Table 1. Hypothesis on appraisal dimensions of events during Collection Stage

Appraisal Dimension	Value
Goal contingency	Assist Goal
Coping potential: Controllability	High
Coping potential: Changeability	Low
Causal attribution: Agency	Self/Game Designer
Causal attribution: Blame/credit	Credit
Unexpectedness	Low
Urgency:	Low

Shock-and-Awe: The next stage happens towards the end of the game. The stage starts when player walks into the last chamber and finds the boss enemy accompanied by several other powerful enemies suddenly falling from the ceiling. The relative power of the enemy is controlled by enemy's life points, attack speed, damage per strike, size and appearance. We name this stage the Shock-and-Awe Stage. Player is holding a weapon in hand. The weapon can be operated by pressing a button on the game controller. The weapon is not very powerful judging by the size, appearance and damage per strike. Before this point, player has never faced with any enemy, let alone out-numbered by enemies much more powerful than the player. We hypothesis that events at this stage have the following characteristics and are intended to evoke surprise:

Table 2. Hypothesis on appraisal dimensions of events during Shock-and-Awe Stage

Appraisal Dimension	Value
Goal contingency	Block Goal
Coping potential: Controllability	Low
Coping potential: Changeability	High
Causal attribution: Agency	Others/Game Developer

Causal attribution: Blame/credit	Blame
Unexpectedness	High
Urgency:	High

Victory: After battling with the enemies, player defeats all the enemies and the boss enemy drops 1000 units of gold. Each subject has collected less than 2000 units of gold at this point. The gold left behind by the boss enemy can be collected and help player achieve his goal. In addition, none of the chests placed in the previous chambers has contained more than 500 units of gold. We named the death of the boss enemy the Victory Stage. Events at this stage are hypothesized to have the following characteristics and are intended to evoke joy.

Table 3. Hypothesis on appraisal dimensions of events during Victory Stage

Appraisal Dimension	Value
Goal contingency	Assist Goal
Coping potential: Controllability	High
Coping potential: Changeability	Medium
Causal attribution: Agency	Self
Causal attribution: Blame/credit	Credit
Unexpectedness	High
Urgency:	Low

Betrayal: While player is going around collecting the gold left behind by the boss enemy, the teammate betrays the player by attacking the player. We named this stage the Betrayal Stage. Before this stage, the teammate simply follows the player around the dungeon, watching the player collecting gold along the way. During player's battle with the enemies, the teammate attacks the enemies but doesn't draw out any weapon until this stage, nor is he injured. Our hypothesis is that events at this stage have the following characteristics and are intended to evoke anger.

Table 4. Hypothesis on appraisal dimensions of events during Betrayal Stage

Appraisal Dimension	Value
Goal contingency	Block Goal
Coping potential: Controllability	High
Coping potential: Changeability	High
Causal attribution: Agency	Others/Game designer
Causal attribution: Blame/credit	Blame
Unexpectedness	High
Urgency:	High

Loss: Eventually the teammate kills the player and claims victory. Player loses all the gold collected along the way. We name this stage the Loss Stage. Events at this stage are hypothesized to have the following characteristics and are targeted to evoke disappointment.

Table 5. Hypothesis on appraisal dimensions of events during Loss Stage

Appraisal Dimension	Value
Goal contingency	Block Goal
Coping potential: Controllability	Medium
Coping potential: Changeability	Medium
Causal attribution: Agency	Others/Game designer
Causal attribution: Blame/credit	Blame
Unexpectedness	Low
Urgency:	Low

4 Preliminary Assessment

To investigate whether EVG could be a platform for emotion and facial expression study, a preliminary assessment was carried out to test the effectiveness of EVG.

Subjects:
Six volunteers participated in the study. Among them, one subject participated in the pilot study to test the experiment setup. One subject didn't complete the experiment. And one subject experienced technical difficulties at stage five.

Apparatus:
The game used in the experiment runs on a Dell Dimension 8400 PC connected to a 19 in LCD. A Logitech Pro 4000 webcam is placed on top of the monitor for facial expression capturing. The webcam also has a microphone built in. Camtasia Studio 3 is running at background on the same machine that runs EVG to do screen capture of the game and recording of the facial expression. A Saitek P2500 Rumble game controller, as well as 2 speakers are connected to the Dell PC.

Material:
A questionnaire consists of questions on subject's game experience was used before the test. Another questionnaire, modified from Geneva Appraisal Questionnaire (GAO) was used to report appraisal of emotion evoking events after the test.

Procedure
1. Subject fills out the pre-test questionnaire.
2. Subject sits down in front of the experiment computer.
3. Experimenter explains how to use the game controller.
4. Training level begins. The training level shares the same layout and appearance of the test level. But there're no enemies at this level and there's only one chest to open for training subject how to use the game controller to collect gold. Experimenter also explains to the subject where the number of units of gold collected and the health level are displayed on the screen.

5. Subject acknowledges that he/she understands how to use the controller and displays adequate skills to operate the game controller.
6. Subject reads descriptions of the test level. Test level and recording starts. Experimenter leaves the room.
7. Subject completes the test level. Experimenter re-enters the room and subject fills out the post-test questionnaire.

Result:
The screen capture of the game and video of facial expressions are synchronized using Camtasia Studio 3. Facial expressions at stage 1 to 5 are shown from top to bottom in Fig. 2.

Pictures from the top row are facial expressions from stage 1 – the Collection Stage. During this stage, we observed facial expression with lips closed and eye lids half-closed. We interpret this facial expression as indication of boredom. From the self-reports, all subjects reported that they felt this stage was boring. But nevertheless, subjects still maintained certain level of engagement, trying to keep track of how much gold has been collected.

At stage 2, we designed events to evoke surprise. However no obvious facial muscle movements that correspond to the 3-component theory of surprise expression were observed. Mostly subjects changed their facial expression from boredom to an expression that suggested increased engagement, with their eyes open wider compared to previous stage. But on the post-test questionnaire, subjects reported experiencing surprise at this stage. Contrary to the name of the stage – Shock-and-Awe, some subjects actually reported feeling joy as the secondary emotion accompanying surprise. They also reported that they felt joy because when the enemy appeared, they were happy that after feeling boredom at Collection stage, they finally had something to bash. These subjects have a relatively rich video game experience. Taking the game experience into account, the coping potential of these events should be considered high instead of low. So, it's reasonable that upon seeing the enemy, joy was accompanied with surprise. But some subjects also reported anxiety while actually engaging in battle with the enemy. They reported saying they were afraid that they might die.

At stage 3, the Victory Stage, we didn't observe much facial expression change except with one subject. Other subjects seemed to maintain their facial expression since the battle with the enemies. On the post-questionnaire, there was no self-report on experiencing joy at this stage. Possible explanation is that the events are not strong enough to evoke joy and possibly only significant enough to evoke relief.

At the Betrayal Stage, clear patterns of facial activities, such as tight, pressed lips, were observed as an indication of anger expression. On the post-test questionnaire, all subjects reported feeling anger. During this stage, we also observed that some subjects eventually smiled, perhaps to mask the anger or perhaps as self-directed amusement.

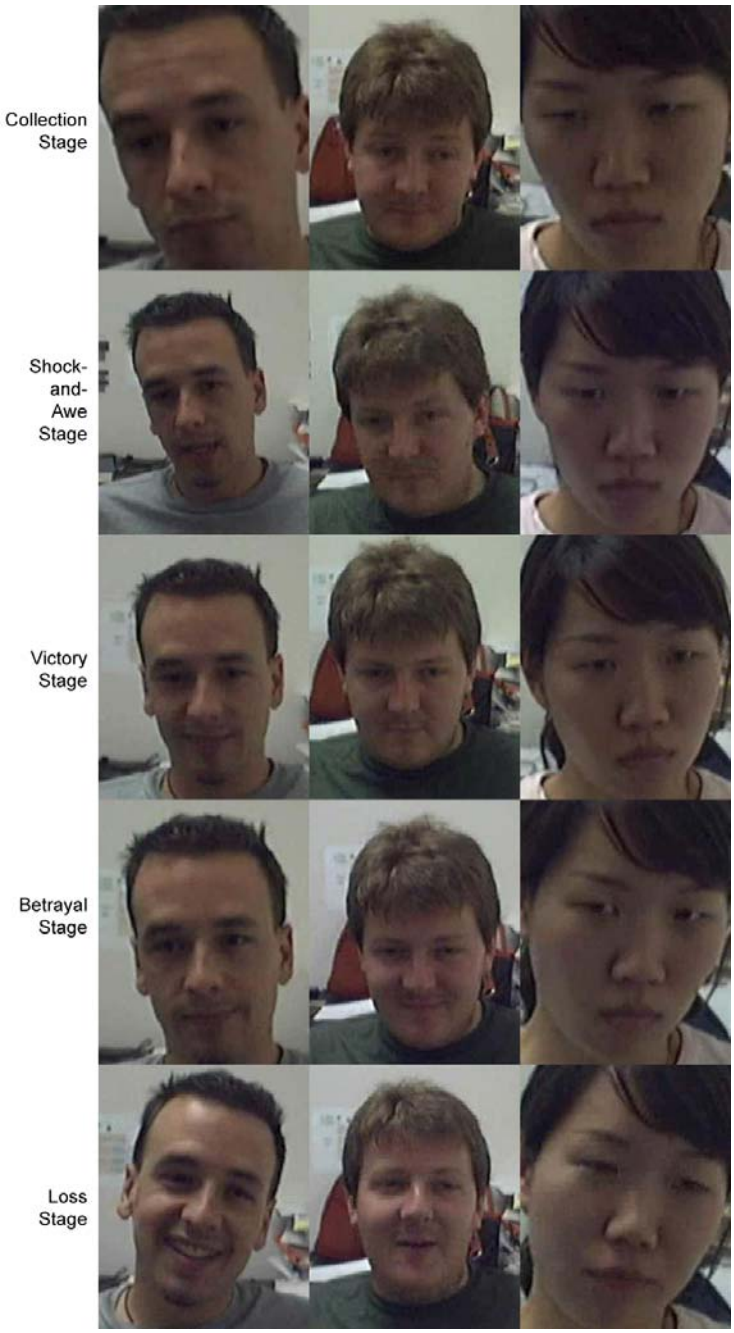

Fig. 2. Facial expressions from different stages of the game

The last stage is the Loss Stage during which a player is defeated by the teammate and newly acquired bounty is stolen. At this stage, we observed diversity in facial expressions. One subject started to laugh possibly due to relief. One subject cried out because of great disappointment. One subject with firmly pressed lips and briefly closed her eyes while head tilted to one side suggesting disappointment mixed with anger.

5 Discussion and Future Work

The ultimate goal of the Emotion Evoking Game is to provide a platform that facilitates research into the design of better algorithms for computationally modeling emotions, recognizing emotions and for generating emotional expressions of embodied conversational agents. The work presented here is a very preliminary study to evaluate EVG. From the study, we successfully evoked boredom and anger, according to the self-report and display of facial expression. We created a sequence of game events to evoke a sequence of emotions. Influence of early emotional experience on later emotional interpretations was observed. For example, boredom could alter the appraisal of stimuli at Shock-and-Awe stage from surprise accompanied by fear to surprise accompanied by joy. We also observed the influence of individual differences on appraisal of emotion evoking events. For example, gaming experience could shift appraisal of supposedly fearsome events from aversive to appetitive. Individual, cultural and gender differences could also have been affecting display of facial expressions. Of course, the current study is a formative evaluation, and any full study of such phenomena would have to address a range of issues. Most notably, a full study using EVG would require multiple coders to encode facial expressions to insure the cross-coder reliability of the classification of the emotional displays.

Going forward, EVG provides an opportunity to study a range of dynamic phenomena. In particular, studies could be carried out to explore emotional trends and sequences such as the impact of prior emotional states on subsequent emotional reactions. Replacing the webcam with a high speed camera will allow us also to explore how expressions evolve. With such a capability, we could evaluate and study the component hypotheses of facial expression [18] [19]. Finally, by using confederates to play against or observing the subject, the game could also allow us to explore the role of social context on emotions and the display of facial expressions.

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