Beyond Cardinal Expressions: Can Embarrassment and Confusion Be Perceived in the Faces of Stylized Characters?

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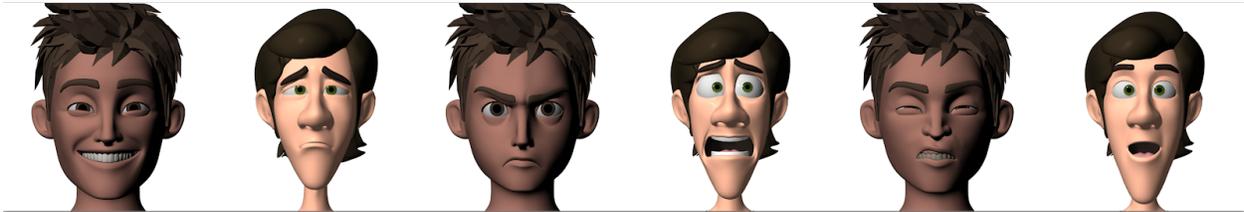
Figure 1: Cardinal Expression Model Images taken from FERG database of the University of Washington (From Left to Right: Joy, Sadness, Anger, Fear, Disgust, and Surprise).

Abstract

Our goal for this project was to accurately model expressions other than the six cardinals - joy, sadness, anger, surprise, disgust, and fear. We used stylized 3D face models to express our proposed emotions - embarrassment and confusion. We were looking to achieve a 60% or greater emotion recognition rate among our user audience, so that we may offer a reference for future studies as others explore non-cardinal emotions or refine models of embarrassment and/or confusion in their own works.

1 Introduction

For nearly half a century, there have only been six emotions reported in psychology resources as consistently recognizable [Haidt and Keltner, 1999]. Those would be the cardinal expressions - joy, sadness, anger, disgust, fear, and surprise. We believe some emotions beyond those six can potentially be reliably recognized, so we decided to explore two other emotions and their expressions - embarrassment and confusion.

By attempting to successfully model these emotions and test user perceivability, we hope to provide a reference for future work. Researchers looking to explore other non-cardinal expressions may look to our methods for reference. Those wanting to present embarrassment and/or confusion in their art or animations may use our models as an example or starting point, as well.

2 Related Works

In previous studies on facial emotion recognition, there has been a greater focus on the perception of expressions of realistic faces. This includes photographs, facial muscle analysis, and realistic drawings [Haidt and Keltner, 1999; Durso et al., 2012; Etcoff and Magee, 1992]. For our project, we decided to translate their realistic recognition findings to stylized 3D model characters to create virtual faces with perceivable emotions.

Other research on facial emotion recognition have also emphasized cross-cultural recognition consistency to find universally perceived emotions [Ekman and Friesen, 1971; Widen et al., 2011]. In Ekman and Friesen's work, they only tested the perception of the six cardinal expressions - joy, sadness, fear, disgust, anger, and surprise [Ekman and Friesen, 1971]. Widen et al. did explore "new" emotions additional to the "old" cardinals - contempt, shame, embarrassment, and compassion - but framed their results to focus on differences in testing methods rather than "old" emotions vs "new" [Widen et al., 2011]. In our study, we worked to expand on the emotions modelled and tested to include embarrassment and confusion. As for the cross-cultural aspect, we see this as a possible future area of study for our proposed expression models, which were tested with a Western audience.

3 Approach

Our first step was finding and reading research papers studying facial cues and expressions associated with our two proposed emotions – embarrassment and confusion.

Then, we designed our 3D face models expressing embarrassment and confusion based on the findings of the facial cue papers and what recognizable characteristics of our emotions they share. Our modelling was done through Maya 2018 by altering online, free-to-use 3D character

models Malcolm, for confusion, and Ray, for embarrassment.

Figure 2: Our Depictions of Embarrassment (Left) and Confusion (Right).

3.1 Embarrassment

In previous research conducted by Dacher Keltner to identify distinctions between embarrassment, amusement, and shame, we found a clear, studied description of how embarrassment is facially expressed [Keltner, 1995]. An embarrassed face consists of an averted gaze, a nervous, shy smile, and tilting of the head forwards or down [Keltner, 1995].

Face touching is also mentioned as a mark of embarrassment, but we decided to leave out that feature [Keltner, 1995]. This is partly due to maintaining a consistent look with the other expression images we were using for our study. Mostly, however, we were influenced in this decision by an observation made by Ekman and Keltner in their Universal Facial Expressions study [Ekman and Keltner, 1997]. They stated that gestures, such as face touching, and facial expressions are different in that gestures are learned socially, whereas facial expressions are more instinctive [Ekman and Keltner, 1997]. Since our focus is on facial expressions, the face touching logically should be excluded.

3.2 Confusion

Besides referencing solely from psychological papers, we wanted to include some research that have scientific backing as well. We found that facial electromyography has been useful to detect multiple emotional statuses. It was also used to detected confusion in the research conducted by Francis Durso. We found in Durso's study that people who undergo a confusing experience tend to have an increase in activity in the left and right corrugator regions, which are the eyebrow areas [Durso, 2011]. In addition, Durso also concluded that confusion involved depressor anguli oris regions, which are in the lower jaw area [Durso, 2011].

Since there were limited studies about the facial cues and facial expression of confusion, we also looked at drawings, portraits, and animated characters as our reference. Based on the information we read and gathered, we decided to include asymmetric eyebrows, unbalanced lifted mouth, and crossed eyes as the elements of our confusion pose.

4 User Study

Once the 3D face models portraying our two emotions were completed, we conducted a user study via SurveyMonkey or Amazon Mechanical Turk. The study consisted of 50 participants who were presented images of 3D models conveying the six cardinal expressions – anger, disgust, fear, sadness, joy, and surprise – along with our two 3D models – embarrassment and confusion – and a neutral expression model. The expression images other than our two were provided by University of Washington from FERG database [Aneja et al., 2016]. Each image was presented one at a time, and the users were instructed to identify the emotion expressed by each model from a multiple-choice list including each of the ten emotions. The list also contained jealousy, contempt, boredom, and an "other" option, in an attempt to alleviate the bias introduced by "forced-choice" studies [Russell, 1994].

According to James A. Russell of the University of British Columbia, the "forced-choice" set-up can skew results as users conform their actual interpretation of the expressions to match one of the given options [Russell, 1994]. However, Jonathan Haidt and Dacher Keltner of the University of Virginia found in their own analysis of perceived emotions that "the free-response method yielded responses that were generally similar to the forced-choice method" [Haidt and Keltner, 1999]. We decided to avoid a completely free-response method due to time constraints for our project which would have made parsing and organizing the responses more difficult and rushed. However, we still provided the "other" fill-in-the-blank option for users to select if they felt inclined to do so.

Figure 3: An Example of a Question on Our Survey with the Neutral Expression.

Table 1: User Study Results in Percentages.

Perceived Emotion	Embarrass-ment	Confusion	Disgust	Anger	Fear	Joy	Neutral	Sadness	Surprise	Jealousy	Boredom	Contempt	Other
Embarrass-ment	42%	6%	2%	2%	4%	28%	4%	6%	0%	2%	2%	2%	0%
Confusion	2%	62%	8%	12%	6%	0%	0%	2%	2%	6%	0%	0%	0%
Disgust	2%	2%	26%	46%	0%	0%	0%	6%	0%	4%	0%	14%	0%
Anger	0%	2%	10%	78%	4%	0%	0%	0%	0%	0%	2%	4%	0%
Fear	0%	4%	2%	4%	82%	0%	0%	4%	0%	2%	0%	2%	0%
Joy	4%	0%	0%	0%	0%	90%	2%	0%	2%	0%	0%	0%	2%
Neutral	4%	6%	4%	4%	0%	2%	60%	6%	2%	0%	12%	0%	0%
Sadness	2%	4%	0%	0%	2%	0%	0%	92%	0%	0%	0%	0%	0%
Surprise	8%	8%	0%	2%	0%	0%	2%	0%	78%	2%	0%	0%	0%

5 Results

In Table 1, we can see that our depiction of confusion was quite successfully perceived at a 62% recognition rate. This means that 31 out of 50 participants interpreted the expression as confusion.

As for embarrassment, our study ended with a 42% recognition rate, or 21 out of 50 participants who responded with the intended interpretation. 28%, or 14 out of 50 participants, perceived our depiction of embarrassment as joy.

We believe the omitting of gestures from the embarrassed expression may have made the facial expression more difficult to recognize than a real expression, as our Western culture closely associates face touching or covering with embarrassment. The shy smile we were going for, too, could have been unintentionally depicted as more genuine than nervous, leading to the participants seeing a more joyous than embarrassed expression. It is also important to consider that us being novices to the Maya 2018 software has very likely influenced the quality of our depictions and therefore our results.

We are quite satisfied with our results, as both 62% and 42% recognition rates are nice starting points for refining and identifying key features of confusion and embarrassment in the future.

6 Future Work

In the future, when others need to represent confusion or embarrassment, they may look back on our work to find base characteristics of the emotions they want to portray in their work. We also hope our project will inspire future research in exploring audience-recognizable characteristics of other non-cardinal emotions.

We also plan to further explore what specific facial features are key to making a stylized expression of confusion and/or embarrassment perceivable. For example, we suspect the eyebrows may play an important role for an audience to identify confusion on a virtual character, but we can not be certain until that itself is tested.

We would also like to conduct a pair of studies outside of the time constraints of this project that would be much like the Haidt and Keltner study [Haidt and Keltner, 1999]. We attempted to provide an optional free response with the "other" option in our survey. However, we believe we could better compare forced-choice responses to free responses and identify and address any existing discrepancies. The ultimate goal would be for confusion and embarrassment to be well perceived through free response without the influence of a multiple-choice list.

It may also be worthwhile, once the stylized expressions are refined, to study cross-cultural recognition of confusion and embarrassment. If expressions of confusion and embarrassment can be more universally recognized, there would be stronger evidence that they should be considered as cardinal expressions.

Conducting studies focusing on separate age-groups would also be interesting, as stylized 3D characters tend to appear in animations aimed at a child audience. If there are differences in perception between ages, we could refine the stylized expressions for confusion and embarrassment, among other emotions, to better match a young age-group's preferences.

7 References

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