

University of Technology, Sydney

Faculty of Engineering and Information Technology

Crowdsourcing facial expressions using popular gameplay

by

Hemanta Sapkota

Student Number: 11329366

Project Number: 2013S-9

Supervisor: Dr Chek Tien Tan

**A 6 Credit Point Project submitted in partial fulfilment of the requirement for
the Master of Information Technology**

Spring Semester 2013

ORIGINALITY STATEMENT

I hereby declare that this submission is my own work and to the best of my knowledge it contains no materials previously published or written by another person, or substantial proportions of material which have been accepted for the award of any other degree or diploma at UTS or any other educational institution, except where due acknowledgement is made in the thesis. Any contribution made to the research by others, with whom I have worked at UTS or elsewhere, is explicitly acknowledged in the thesis. I also declare that the intellectual content of this thesis is the product of my own work, except to the extent that assistance from others in the project's design and conception or in style, presentation and linguistic expression is acknowledged.

Signed

Date

ABSTRACT
CROWDSOURCING FACIAL EXPRESSIONS USING POPULAR GAMEPLAY
HEMANTA SAPKOTA

SPRING SEMSTER 2013

Abstract

The performance of affective computing systems often depend on the quality of the image databases they are trained on. However, creating good quality training databases is a laborious activity. In this paper, we evaluate BeFaced, a tile matching casual tablet game that enables massive crowdsourcing of facial expressions for the purpose of advancing facial expression analysis. The core aspect of BeFaced is game quality, as increased enjoyment and engagement translates to an increased quantity of varied facial expressions obtained. Hence a pilot user study was performed on 18 university students whereby observational and interview data were obtained during playtests. We found that most users enjoyed the game and were intrigued by the novelty in interacting with the facial expression gameplay mechanic, but also uncovered problems with feedback provision and the dynamic difficulty adjustment mechanism. These findings hence provide invaluable insights for the development of BeFaced. Also, based on the findings several improvements were made to the game.

Author Keywords

Games with a purpose; crowdsourcing; facial expression analysis

ACKNOWLEDGEMENT

This research project is made possible through the help and support from everyone, including: parents, teachers, family, and friends.

First and foremost, I would like to thank Dr. Chek Tien Tan for his continuous support and encouragement throughout the duration of the project. His mentorship has been very valuable not only for this project but also for my own professional development.

Second, I would like to thank Daniel Rosser and Jose Vasquez for their support in all matters related to the development BeFaced. Without them, this project wouldn't have been possible at all.

Third, I would like to thank all the participants that took part in the playtest study. Without your support, the study would not have been possible.

Finally, sincere thanks to Aniva, my wife, for putting up with my antics during the whole semester.

TABLE OF CONTENTS

Introduction.....	1
Literature Review.....	2
Chapter 1: BeFaced.....	3
1.1 Motivations.....	3
1.2 Introduction to BeFaced.....	3
1.3 Dynamic Facial Expression Classifier.....	4
1.4 Implementation of Facial Expressions Tracking.....	5
1.5 Implementation of BeFaced.....	5
Chapter 2: Methodology.....	6
2.1 Conducting the Playtest Study.....	6
2.2 Data Analysis.....	7
2.3 Data Interpretation.....	7
2.3.1 Enjoyment and Novelty.....	8
2.3.2 Game Challenge.....	8
2.3.3 Perceived Face Tracker Performance.....	9
Chapter 3: Conclusions from the pilot study.....	10
Chapter 4: Improvements to BeFaced.....	10
4.1 Devising an Improvement Plan.....	10
4.2 Implementing Core Mechanics Tutorial Level.....	11
4.3 Implementing Feedback for Repositioning the iPad.....	12
4.4 Implementing Facial Expression Animations When Tapped.....	13
Chapter 5: Conclusions and Future work.....	13
References.....	14

LIST OF FIGURES

- Figure 1: BeFaced gameplay flow.....3
- Figure 2: Six basic facial expressions.....5
- Figure 3: Player matching the tiles and making the face to clear them up.....5
- Figure 4: A sequence of images showing the tutorial levels implemented for BeFaced..... 11
- Figure 5: Feedback mechanism to let the player know when to reposition the iPad..... 12
- Figure 6: Animation for the fear face.....13

NOMENCLATURE

- BeFaced: A casual tablet game developed by UTS Games Studio
- Dynamic Difficulty Adjustment: The process of automatically changing parameters, scenarios, and behaviours in a video game in real-time, based on the player's ability, in order to avoid them becoming bored (if the game is too easy) or frustrated (if it is too hard).
- Bejewelled: A tile-matching puzzle video game by PopCap Games, first developed for browsers in 2001.

Introduction

Affective computing deals with accurately recognising, understanding and responding to human emotions (Picard 1997). It employs novel machine learning algorithms to deal with the data generated by sensor devices, ex. cameras. Facial expression analysis is a mature domain in affective computing. It involves a user making faces like anger, happy, sad, etc while interacting with a device and then using machine learning algorithms to make inferences as to what expressions were made. Facial expression analysis, despite showing high level of accuracy and robustness (Tan et al. 2012), is still an open problem that relies heavily on empirical data i.e. good quality of face images. Good performance of facial expression tracker usually depends on having sample images of large variability. Some variables include posture, illumination and other individual facial features.

Unfortunately, systematic collection of high variability facial image database is a time consuming and costly endeavour. Crowdsourcing could be a viable method for collecting these images (Tan et al. 2012). To this end, UTS Games Studio has developed BeFaced, a casual tile matching game that aims to generate database of such images through crowdsourcing.

The purposes of this project are: 1) **Conduct a pilot study to validate the core gameplay of BeFaced**, and 2) **Improve BeFaced based on the results of the study**.

The rationale for conducting a pilot study relates to the game quality, which is the core aspect of BeFaced. Better game quality means increased enjoyment and engagement, which translates to better collection of images for the database.

Chapter 1:BeFaced discusses motivations behind developing BeFaced followed by a general introduction of how it works. Important components like *dynamic difficulty adjustment (DDA)* and *facial expression recogniser* are briefly touched followed by a description of how it is implemented.

Chapter 2:Methodology talks about the procedures for conducting the playtest study. A precise treatment is given to how the study is conducted; the data collected and how interpretations are formed.

Chapter 3:Conclusions from the pilot study derives several insights from the study and presents a roadmap for improving it.

Chapter 4:Improvements to BeFaced discusses the work undertaken by the researcher to iteratively improve BeFaced based on the conclusions from the pilot study

Chapter 5:Conclusions and Future work provides roadmap for the future of BeFaced.

Literature Review

Public datasets play a crucial role in objectively comparing algorithms for producing common benchmarks. Because of this, such datasets are central in advancing the state-of-the-art in computer vision research. Cohn Kanade database (Lucey et al. 2010) and MMI database (Pantic et al. 2005) are some of the relevant datasets used in affective computing (Zeng et al. 2007). Although, these databases have seen widespread use (Bartlett et al. 2006), they are mostly laboratorial and limited in the number of unique participants. Part of the reasons for this can be attributed to the methodology of the actual data collection which is mostly manual and time-consuming. Extension and development of such public datasets also do not have any roadmap, rather depend on the creators' plans. For example, the extended version of Cohn-Kanade (CK) dataset, CK+, was released after 10 years.

Crowdsourcing refers to “obtaining input to a particular task by enlisting the services of number of people, either paid or unpaid, typically via the Internet” (Google 2013). In a related study (McDuff et al. 2012), employed crowdsourcing to generate the Forbes dataset. Arbitrary viewers' facial expressions were recorded by asking them to view media over the internet. More than 3000 videos were collected in about two months. Variability of facial expressions in the videos were shown to be higher than the traditional datasets. Despite demonstrating much potential for crowdsourcing facial videos, two issues were visible in the study. Firstly, the approach for acquiring facial videos required the participants to be willing to watch commercial videos which offered no interactivity whatsoever. Moreover, such a participation usually requires some form of incentives. Secondly, the acquired expressions were limited to happy expressions. Achieving variability with such an approach requires constructing or acquiring videos for all the standard facial expressions: anger, surprise, disgust, fear and sadness. Clearly, it would be a laborious activity. To add to the woes, media over the internet do not have clear copyright boundaries. To use them, somebody has to sort out the copyright issues, which sounds like a lot of hassle.

Crowdsourcing has seen some clever applications in the field of gaming. FoldIt is a crowdsourced game where players are required to decipher the protein model of an AIDS causing virus (Khatib et al. 2011). FoldIt demonstrated that a well crafted game provided enough intrinsic motivation to drive engagement to solve a problem. In this case, the particular problem, could not be solved by scientists for over 15 years. The players were able to do it in 10 days.

Chapter 1: BeFaced

1.1 Motivations

The problems highlighted in the previous section are the motivations behind BeFaced. BeFaced aims to alleviate the shortcomings by utilising popular gameplay to enable intrinsic motivation, as well as use an extensible design approach to continuously solicit a growing number of different expressions. Moreover, it allows the option of simply sending facial feature locations instead of the actual facial images (Tan et al. 2013)

1.2 Introduction to BeFaced

BeFaced (Tan et al. 2013) is a tablet game that strongly follows tile matching mechanics of the popular game – Bejewelled (PopCap 2013). Figure 1 depicts the core gameplay of BeFaced.

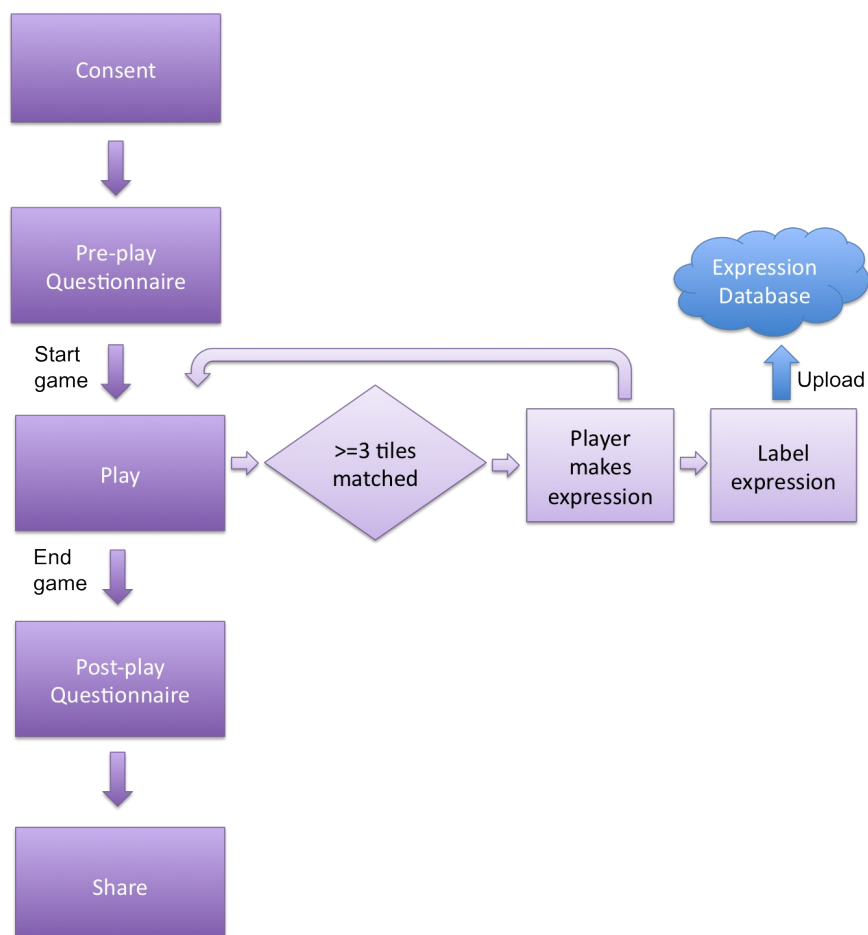


Figure 1: BeFaced gameplay flow (Tan et al. 2013)

The player starts with a consent followed by a one-time pre-play questionnaire. During the play, whenever three tiles or more are aligned, the game presents a three second window during the which the player has to make the expression shown on the tiles. Matched expression are cleared up, points are scored and new tiles are generated in order to advance in the game. As a part of the game evaluation process, the player can optionally participate in a post-game questionnaire. The aligning of three or more tiles was used as the core mechanic due to its popularity (Popcap 2013). Popular gameplay mechanics can help obtain large database of natural and varied facial expressions. The game has been implemented in Apple's IOS platform and uses iPad's front camera as the sensor device for capturing facial images.

Upon successfully matching the expression, the face data is automatically captured and uploaded to a remote database. Based on the *principle of least privilege*, the system, by default, uploads bare-minimum tracked feature points, that are anonymous. If the player had explicitly indicated consent for full image disclosure, the system will upload images of faces, that would identify real people.

1.3 Dynamic Facial Expression Classifier

The captured expression are fed through the dynamic expression classifier. The computed probability for the captured expression, if greater than a certain threshold, would clear the tiles. Dynamic Difficulty Adjustment (DDA) (Hunicke and Chapman 2003) is also employed, which enables dynamic tweaking of the difficulty based on player's success in matching facial expressions. Some of the harder faces like Disgust might not cross over the threshold boundary for the first two times despite being a valid expression. The DDA system at this point lowers the threshold in order to let the player succeed in the third try. Once the player starts getting better at making the expression, the DDA increases the threshold. There's an inherent tradeoff between accuracy and player engagement with respect to lowering of the threshold. Continued lower threshold means that the classified images may not be of the best quality. Despite this, the game favours reducing accuracy for a broader goal of keeping the player engaged as this translates to more varied records in the dataset.

The accuracy of the dataset can be reevaluated by a human operator manually. The face-data upload mechanism we talked about in the previous section supports this feature. Facial data points or images in combination with the associated information uploaded by the system allows the manual operator to correctly classify or throw away records from the database.

1.4 Implementation of Facial Expression Tracking

The facial expression tracking feature is based on deformable model fitting (Saragih et al. 2010).

The model learns independent image patches centred on landmarks on the face. Deformable model fitting requires no training and no user intervention through the tracking process. This avoid clunky setup processes for players (Tan et al. 2013).

The implementation of the facial expressions recogniser was built on top of ofxFaceTracker (McDonald 2011), an add-on in the openFrameworks c++ toolkit with the openCV library for the computer vision functions (Tan et al. 2013).

1.5 Implementation of BeFaced

BeFaced itself is implemented as a mobile game for the Apple's IOS platform. Six basic facial expressions (Ekman 1993) have been implemented with the possibility to expanding them in the future. Figure 2 is a representation of the six basic facial expressions (Ekman 1993) viz. Anger, Disgust, Surprise, Joy, Sad and Shock.

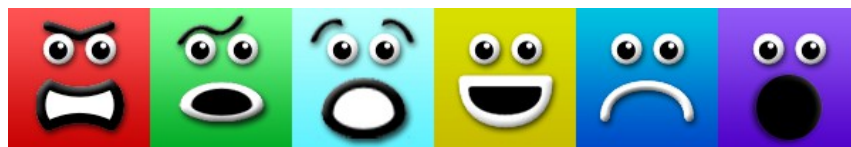


Figure 2: Six basic facial expressions

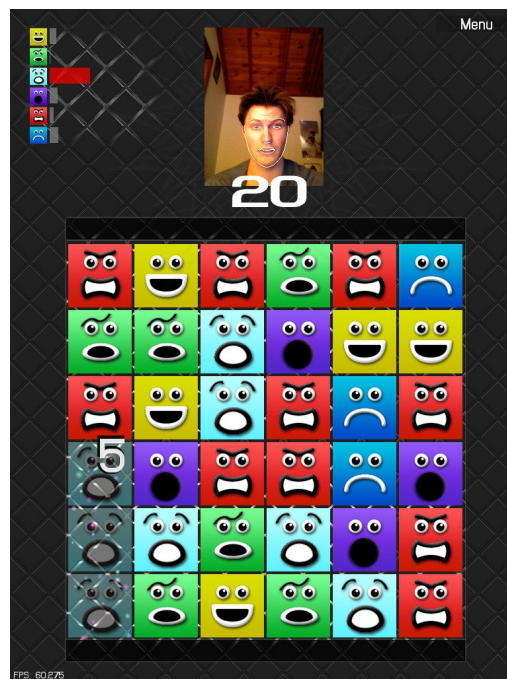


Figure 3: Player matching the tiles and making the face to clear them up.

Chapter 2: Methodology

2.1 Conducting the Playtest Study

The study involved soliciting 18 participants from students and staff in UTS with a mix of experiences and interests in playing games. An ethics application was filed with the UTS ethics application committee for approval. See Appendix I – Ethics application. Participants were required to play the game in a 15 minutes session. A video of the participant was recorded for the entire play session. A pre-play questionnaire was required to filled up to evaluate their experience and interest in general games. After completing the play session, a follow up interview was conducted to assess the overall impression of the game and evaluate the perceptions on its effectiveness for collecting facial expressions. Data collection included recorded gameplay videos of the participants, observations made by the researched during the play, and post-play interviews. Players were not asked to verbalise their experiences whilst playing, as it would hinder the interactivity in the game i.e. interruptions in the facial tracking caused by the player by speaking aloud.

Participants were recruited via undergraduate and postgraduate university mailing lists. 18 male participants (P1-P18) took part in the study and were aged between 19 and 36 ($M = 24.2$, $SD = 4$). Most participants were familiar with a tablet device as 12 indicated they own an iPad, two indicate they own an Android-based tablet and four do not own any tablets. The participants were primarily casual players where two participants indicated they play games for more than 20 hours per week, two participants between 10 to 20 hours, seven participants less than 5 hours per week, and six participants less than 1 hour. One indicated he/she did not play games at all. Also, 13 participants indicated they have played a version of the Bejewelled (Popcap 2013) game whilst five participants indicated they have not. See Appendix II – Pre-play questionnaire.

The experimental procedure consisted of three parts. (1) After signing a consent form, participants filled in a pre-play questionnaire to determine player demographics including age, sex, gaming interests, gaming habits, and the type of tablet they have as well as whether they have played Bejeweled games (resulting in the data as presented above). Participants were briefed on the structure of the experiment before proceeding. (2) They were then given an iPad (third generation) and proceeded to play BeFaced until they felt like stopping. (3) After finishing play, the researcher conducted a semi-structured interview whereby planned question categories included whether they learned the game quickly, whether they felt joy and whether there were anything they disliked. A high definition webcam was used to record video and audio of the play sessions and interviews. Each session took around 15 minutes in total and no compensations were given after the session.

Data reduction involved transcribing the post-game interview videos and thereby iteratively recording themes by analysing each transcript in succession.

2.2 Data Analysis

The first step in the data analysis was to transcribe information from all the videos (2GB+). Videos were grouped into two categories: 1) Playtest session 2) Interview session. The contents of all the interviews were manually transcribed and aggregated into a single document. See Appendix III – Interview transcript. This document served the basis for further interview analysis.

The next step was to categorise all the participant responses. The following categories were used: *Gameplay, Expressions, Difficulty, Scenario, Target Group, Facial Recognition, and UI*. See Appendix IV – Response categorization.

Third step was to conduct occurrence analysis. Categories had to be consolidated into broader groups: *GamePlay, Interface, Facial Tracker, and Other Comments*. Each of the broader categories had sub-categories – *Interesting, Interactive, Awesome, Novel, Good/Cool, Fun, Difficulty, Variety, Weird, Similarity, Eyebrows, Familiarity, Confusing, Intuitive, Colour Contrasts, Detection Problems, Self-playing, and Social playing*. Finally, the occurrences of sub-categories were counted and were further categorised into either *positive* or *negative*. See Appendix V - Occurrence analysis.

Next, the playtest session data were quantified by recording individual time spent on the play and interview sessions. See Appendix VI – Playtime analysis.

2.3 Data Interpretation

The average time taken to play BeFaced was 3m22s (SD = 1m18s). The longest play time was 6m02s (P12) whilst the shortest was 25s (P15) which correlates to their gaming habits of 10-20 hours of games per week (P12) and less than 1 hour of games per week (P15) respectively. This provides a brief notion that BeFaced was perceived as a normal game.

The coded transcriptions of the post-game interviews are the primary data used for this analysis and will be augmented with the observational data. Three broad themes emerged from the data, which is described as follows.

2.3.1 Enjoyment and Novelty

Nearly all participants (17/18) made explicit positive comments on their overall impression on the game. The remaining participant (P1) said that it felt like Bejewelled. Most of them thought the game was interesting and were intrigued by the novelty of the core gameplay mechanic. Descriptive terms like “interesting” (P3, P4, P6, P10, P12, P16, P17 and P18), “awesome” (P5) and “Cool” (P11) were used. For example:

“I think it’s quite interesting. Like it’s a different approach for gaming because it makes you use your face but it’s also a strategy game. So I think it’s quite interactive.” (P10)

“Um.. it’s pretty new. Something different. When you compared to other ones like bejewelled, candy crush. This one’s like pretty different.” (P13)

Some participants also expressed enjoyment during play, using terms like “fun” (P10, P11, P12, P13 and P18) and “interactive” (P7 and P10). For example:

“I think the game was interesting. It’s fun to play actually.” (P12)

The interface also appeared to have contributed to the enjoyment.

“It’s lovely how you have the feature that show lines come up on your face.” (P15)

These responses show that even with a single-level, the core mechanic did manage to establish an obvious psychological draw to users. Firstly, the novelty factor of the facial expression mechanic to clear tiles was attractive enough for players to want to pick it up and play. Secondly, players did express that this core mechanic was fun.

There were also some opinions on optimal play situations. Two participants (P3 and P9) expressed that they would like to play with friends on social networks whilst one (P4) mentioned that it might be embarrassing to play in public.

2.3.2 Game Challenge

13/18 participants expressed making some of the facial expressions were challenging. For example:

“Some faces were really hard to make. Especially sad ones.” (P5)

“I was choosing expressions that were easier to make.” (P6)

On first look, this might seem like an undesirable experience. However, a well-designed game is not about providing easy gameplay, with many well-known games that are fun but extremely challenging. This notion also seemed to be expressed by one participant:

“Yeah. It’s fun. It’s really fun. Especially when you cannot make those faces if you don’t do the right faces.” (P18)

The current single-level BeFaced game immediately presents a typical level with six expressions to be made, but the eventual game would consist of many preceding levels that have a gradually increasing challenge. For example, the first few levels might only involve a single happy expression, and then happy and sad for the next few levels, and so on. Nevertheless, these findings will not be overlooked and the challenge aspects will be re-evaluated when the prior levels are in place, in order to properly balance the challenge progression.

2.3.3 Perceived Face Tracker Performance

6/18 participants felt that their expressions were not detected properly. For example:

“Sometimes the facial recognition wouldn’t work. I tilted the display to make it work.” (P6)

“Sometimes it doesn’t recognise the confused face.” (P12)

Via observations from the gameplay videos, it can also be seen for some participants (P12, P13 and P18) that the face tracker often lost track of the face in the midst of play. During this time, they still continued to make expressions possibly resulting in a notion that the face tracker was faulty when there were no feedback from the game. This was due to a combination of large pose and lighting changes on the face, a common issue in many face tracking algorithms. However, this problem was not frequent in other participants. Nevertheless this implies that an obvious feedback mechanism needs to be incorporated that informs and instructs the player how to reposition the iPad in order for the tracker to re-establish a lock on the face.

The other observation was that the DDA system might have reduced the difficulty by too much too quickly. Currently, the dynamic classifier is set to definitely accepting an expression (and adding it as a learning sample to the classifier) after two unsuccessful tries, a design decision that was thought to be able to alleviate overly challenging experiences for some. This might have also attributed to the notion of a faulty face tracker. The DDA system hence needs a much more granular and player-specific adjustment mechanism.

Chapter 3: Conclusions from the pilot study

From the pilot study performed, we found that the first playable prototype of BeFaced already establishes potential for crowdsourcing facial expressions as participants found it enticing and fun to play. However, several crucial issues have also emerged that will serve as guidelines for the next iteration, namely:

1. Providing timely and specific feedback to let the player know how to reposition the iPad.
2. Providing a tutorial level that teaches the player about the core mechanics of the game without receiving any help from other players
3. Providing a more granular and player-specific DDA system, and
4. Designing progressive levels to evaluate and balance challenge progression.

Chapter 4: Improvements to BeFaced

As with any software that's being actively developed, there are always plenty of bugs, features and enhancements that can be made. BeFaced, being no exceptions, had many features and enhancements on the issues list. The conclusion of the study also presented some additional tasks.

4.1 Devising an Improvement Plan

Based on the conclusions of the study and existing issues with BeFaced, the following plan was devised for its improvement.

Phase I

1. Implementing core mechanics tutorial level
2. Implementing feedback to let the player know how to reposition the iPad
3. Implement face animations to be shown when tapped
4. Bug Fixing / Enhancements
 1. Slide to Shift Bug
 2. Improved automated hinting

Phase II

1. Multiple game levels with themes
2. Varied gameplay objectives

For the purposes of this project, only Phase I was implemented. Phase II is left for the future.

4.2 Implementing Core Mechanics Tutorial Level

The purpose of having a tutorial is to teach the core mechanics of BeFaced to the players. The gameplay style is unusual and requires some form of training. The following illustration shows the precise sequences of tutorial that was implemented.



Figure 4: A sequence of images showing the tutorial levels implemented for BeFaced

4.3 Implementing Feedback for Repositioning the iPad

As pointed out in the conclusion of the study, it was desirable to have a feature that would let the player know when to reposition the iPad when focus is lost. The illustration below shows this feature.

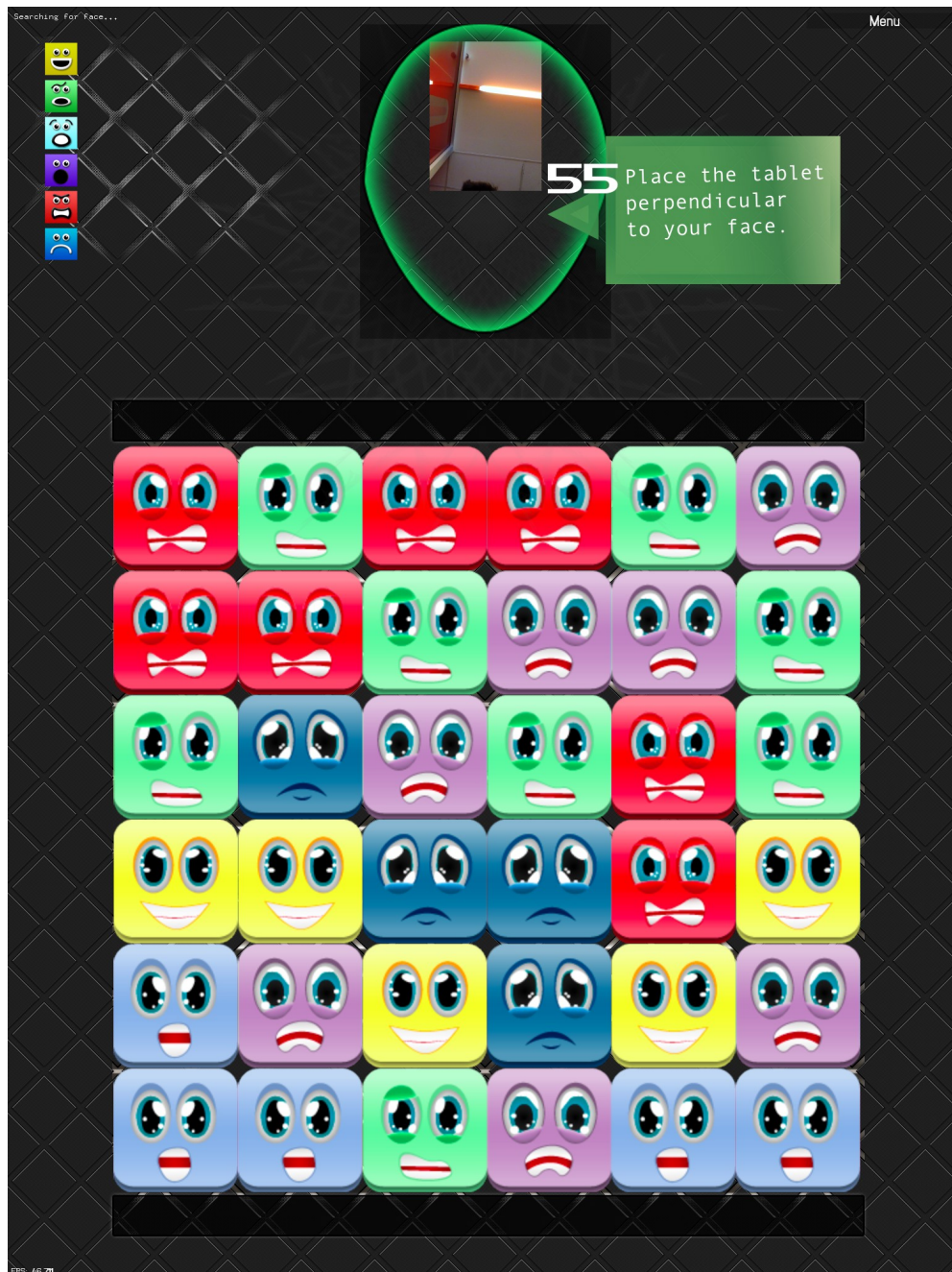


Figure 5: Feedback mechanism to let the player know when to reposition the iPad

4.4 Implementing Facial Expression Animations When Tapped

In order to provide better feedback to the players on how make the faces, each of the six basic faces are to be animated. One of the six faces, the feature has been implemented for the *Fear* face. The following sequence of animation has been used.



Figure 6: Animation for the Fear face

Chapter 5: Conclusions and Future work

BeFaced demonstrates a viable crowdsourcing platform that can be used for advancing computer vision algorithms. This might trigger discussions of applications beyond just facial expressions, for example applying the BeFaced concept to crowdsource dance gestures using popular games (e.g., using Kinect dance games). Secondly, it portrays the design of a game-with-a-purpose to enable massive crowdsourcing. The notion of using popularised gameplay mechanics (i.e., tile matching in our case) to increase engagement in these games might be an area for discussion. Thirdly, it uses a novel facial expression input interface on the iPad to control gameplay. To the best of our knowledge, BeFaced is the first tablet game to have realtime facial expression tracking and classification as part of the core gameplay mechanic. This can provide inspirations for other forms of affective interface design.

Hands-on interaction with BeFaced will therefore provide first-hand experiences with the novel interaction interface as well as the potential for massive crowdsourcing. This can generate valuable insights and triggers for the discussion and exploration of the designs behind BeFaced. Crowdsourcing, game design and novel affective interfaces have been major topics of interest in CHI over the last few years, and BeFaced provides a platform to explore these topics further.

After the next development iteration, the subsequent evaluation step is to release the BeFaced app onto the Apple App Store coupled with an in-game questionnaire to evaluate player experiences on a larger scale with high external validity. Improving the game quality is of utmost importance as a better game means a higher quality dataset for advancing facial expression analysis research. The release will also serve to investigate its feasibility in collecting a high quality facial expression database and comparing it to current popular datasets.

References

1. Picard, R.W. 1997. *Affective Computing*, MIT Press.
2. Tan, C. T., et al. (2012). A feasibility study in using facial expressions analysis to evaluate player experiences. *Proceedings of The 8th Australasian Conference on Interactive Entertainment: Playing the System*. Auckland, New Zealand, ACM: 1-10.
3. Tan, C. T., et al. (2013). Crowdsourcing facial expressions using popular gameplay. *SIGGRAPH Asia 2013 Technical Briefs*. Hong Kong, Hong Kong, ACM: 1-4.
4. Lucey, P., Cohn, J., and Kanade, T. The extended Cohn-Kanade dataset (CK+): A complete dataset for action unit and emotion-specified expression. In *Proc. IEEE CVPRW*, no. July, IEEE Compute. Soc. Press (2010), 94–101.
5. Pantic, M., Valstar, M., Rademaker, R., and Maat, L. Web-Based Database for Facial Expression Analysis. In *Proc. IEEE ICME 2005*, IEEE Compute. Soc. Press (2005), 317–321.
6. Zeng, Z., Pantic, M., Roisman, G. I., and Huang, T. S. A survey of affect recognition methods: audio, visual, and spontaneous expressions. *IEEE Trans. PAMI* 31, 1 (2007), 39–58.
7. McDuff, D., Kaliouby, R. E., and Picard, R. Crowdsourcing facial responses to online videos. *IEEE Trans. on Affective Computing* 6, 1 (2012), 1–14.
8. Bernstein, M. Crowdsourcing and Human Computation: Systems, Studies and Platforms. In *Proc. CHI 2011 Ext. Abstracts*, ACM (2011), 53–56.
9. Hunicke, R., and Chapman, V. 2003. AI for Dynamic Difficulty Adjustment in Games. *Assessment*, 91–96.
10. Google, Crowdsourcing. Viewed 1st Dec 2013, <https://www.google.com.au/search?q=define+crowdsourcing&oq=define+crowdsourcing&aqs=chrome..69i57.4982j0j7&sourceid=chrome&espv=210&es_sm=119&ie=UTF-8>
11. PopCap. 2013, Viewed 1st Dec 2013, <<http://bejeweled.popcap.com/html5/0.9.12.9490/html5/Bejeweled.html>>
12. SARAGIH, J. M., LUCEY, S., AND COHN, J. F. 2010. Deformable Model Fitting by Regularized Landmark Mean-Shift. *International Journal of Computer Vision* 91, 2 (Sept.), 200–215.
13. McDonald, K. 2011, ofxFaceTracker. Viewed 1st Dec, 2013, <<https://github.com/kylemcdonald/ofxFaceTracker>>
14. Ekman, P. 1993. Facial expression and emotion. *American Psychologist* 48, 4, 376–379.

Appendix I: Ethics Application

UTS: IT: Creativity & cognition Studios

CROWDSOURCING FACIAL EXPRESSIONS USING POPULAR GAMEPLAY
UTS HREC 2013000136 2013-4CROWDSOURCING FACIAL EXPRESSIONS USING POPULAR GAMEPLAY,
HREC 2013000136 2013-4*

I _____ (participant's name) agree to participate in the research project *Crowdsourcing facial expressions using popular gameplay (HREC 2013000136 2013-4)* being conducted by *Chek Tien Tan* at the University of Technology, Sydney. *Hemanta Sapkota* will be the Masters student helping to conduct the experiments.

I understand that my participation in this research will require approximately 35 minutes of my time. The research involves me being video recorded while playing the BeFaced tablet game. I will be required to complete 1 questionnaire to access my gaming experiences and interests, as well as interviewed on my experiences whilst playing. In addition, I will be asked to perform think aloud, which means verbalizing my experiences whilst playing.

I understand that the purpose of this research is to understand whether the BeFaced game is effective in collecting facial expressions by keeping the player engaged in the game.

I understand that the data collected and analyzed from the video, questionnaires and retrospective think aloud responses may be quoted in academic publications. If this occurs, I understand that they will be published in a form that does not identify me.

I also understand that Chek Tien Tan or Hemanta Sapkota might contact me for further consent in the case that he wishes to show snippets of the video during academic presentations.

I am aware that I can contact Chek Tien Tan (chektien.tan@uts.edu.au / 02 9514 4828) or the University of Technology Sydney Human Research Ethics Committee (see note below) if I have any concerns about the research. I also understand that I am free to withdraw my participation from this research project at any time I wish and without giving a reason.

I agree that Chek Tien Tan and/or Hemanta Sapkota have/has answered all my questions fully and clearly.

Signed by

____/____/____

Witnessed by

____/____/____

NOTE:

This study has been approved by the University of Technology, Sydney, Human Research Ethics Committee.

If you have any complaints or reservations about any aspect of your participation in this research that you cannot resolve with the researcher, you may contact the UTS Ethics Committee through the Research Ethics Officer at UTS Broadway, Building 1, Level 14; or 9514 9681; or Research.Ethics@uts.edu.au. Please quote the UTS HREC reference number.

Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

* Number obtained from CCS Ethics Administrator

UTS Creativity and Cognition Studios 2-page Ethics Approval Application

**From: Chek Tien Tan
HREC 2013000136 2013-4***

1. Title

Crowdsourcing Facial Expressions Through Popular Gameplay

2. Aims

A study on the effectiveness of using popular gameplay for collecting facial expressions data to improve affective computing algorithms.

3. Methodology

The following methods will be applied:

- Video Analysis
 - Participants are required to play the BeFaced tablet game in a 15 minutes session.
 - A video of the participant will be recorded for the entire play session.
- Questionnaires
 - A pre-play questionnaire will be given to evaluate the player's experience and interest in games.
- Interviews
 - Asked several questions to assess the overall impression of the game and evaluate the perceptions on its effectiveness for collecting facial expressions.
- Think Aloud
 - Players will be asked to verbalize their experiences whilst playing.

4. Significance

Results from this study represent an investigation of how effective popular gameplay can be used to collect useful facial expression data for improving affective computing algorithms.

5. Number of participants and justification of numbers

Up to 20.

A fairly small size is chosen as it is an initial stage to verify the viability of this research direction.

6. Selection/exclusion criteria

Participants will be students and staff in UTS, with a mix of experiences and interests in playing games.

7. Children under 18 years of age will participate in the evaluation.

No.

8. Procedures

Participants will be:

1. contacted and briefed on the nature of the study;
2. asked to sign a consent sheet upon agreement (see 11.);
3. asked to play a tablet game;
4. video recorded during the entire play session;
5. asked to perform think aloud during play;
6. asked to fill in 1 questionnaires.
7. Interviewed face-to-face

9. Time commitment for participants

The entire session will take about 35 minutes.

- 15 minutes of gameplay and think aloud
- 10 minutes for the questionnaire.
- 10 minutes for interview

10. Location of research

UTS Games Studio and staff offices.

11. Consent procedures

Signed consent sheet(s) (see attached)

12. Additional Risks (additional to those noted in the CCS Generic Approval)

N/A

13. Strategies to cope with risks mentioned in 12.

N/A

14. Other issues

No other issues perceived as being problematic.

*Number obtained from CCS Ethics Administrator

UTS: IT: Creativity & cognition Studios

CROWDSOURCING FACIAL EXPRESSIONS USING POPULAR GAMEPLAY
UTS HREC 2013000136 2013-4

*CROWDSOURCING FACIAL EXPRESSIONS USING POPULAR GAMEPLAY,
HREC 2013000136 2013-4**

GENERAL INFORMATION

WHO IS DOING THE RESEARCH?

Chek Tien Tan – An academic at UTS.
Hemanta Sapkota – A Masters student at UTS.

WHAT IS THIS RESEARCH ABOUT?

This research is to find out about the effectiveness of using popular gameplay for collecting facial expressions data to improve affective computing algorithms.

IF I SAY YES, WHAT WILL IT INVOLVE?

I will ask you to play a tablet game that involves making facial expressions while being video recorded during the entire play session. I will also ask you to fill in 1 questionnaire, and talk about your experiences during gameplay.

ARE THERE ANY RISKS?

You might be inconvenienced by the time required to be involved in the activity. It is also possible that you might feel uncomfortable being recorded on video. However, you are free to opt out at any stage of the research.

WHY HAVE I BEEN ASKED?

You are able to give me the information I need to find out about player experiences because you are willing to play games.

DO I HAVE TO SAY YES?

You don't have to say yes.

WHAT WILL HAPPEN IF I SAY NO?

Nothing. I will thank you for your time so far and won't contact you about this research again.

IF I SAY YES, CAN I CHANGE MY MIND LATER?

You can change your mind at any time and you don't have to say why. I will thank you for your time so far and won't contact you about this research again.

WHAT IF I HAVE CONCERNS OR A COMPLAINT?

If you have concerns about the research that you think I can help you with, please feel free to contact me on 02 9514 4828 or at chektien.tan@uts.edu.au.

This study has been approved by the University of Technology, Sydney, Human Research Ethics Committee.

If you have any complaints or reservations about any aspect of your participation in this research that you cannot resolve with the researcher, you may contact the UTS Ethics Committee through the Research Ethics Officer at UTS Broadway, Building 1, Level 14; or 9514 9681; or Research.Ethics@uts.edu.au. Please quote the UTS HREC reference number.

Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

* Number obtained from CCS Ethics Administrator

Appendix II: Preplay Questionnaire

18

responses

Summary [See complete responses](#)

What is your age?

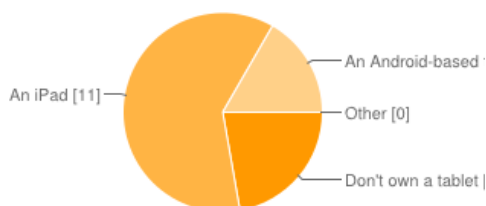
26 24 25 25 19 19 36 21 24 24 26 31 25 24 21 23 24 22

What is your gender?



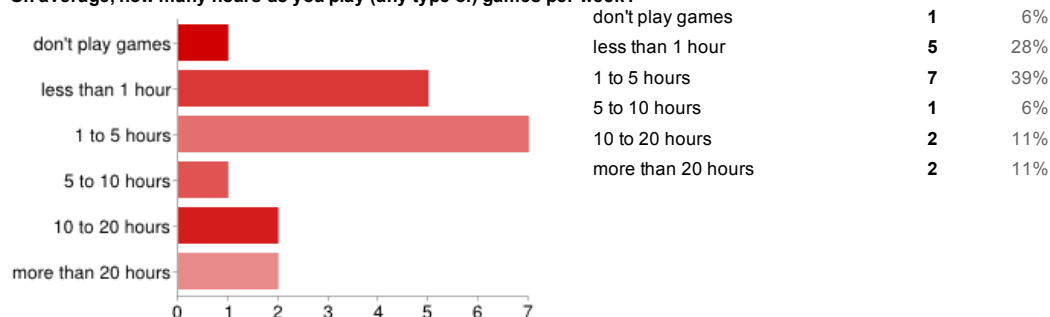
Male	18	100%
Female	0	0%

What type of tablet computer do you own?



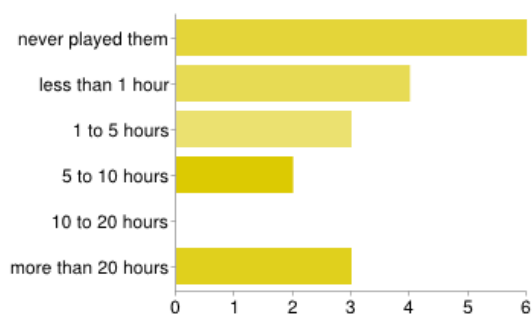
Don't own a tablet	4	22%
An iPad	11	61%
An Android-based tablet	3	17%
Other	0	0%

On average, how many hours do you play (any type of) games per week?



On average, how many hours have you played the Bejeweled game?

never played them	6	33%
less than 1 hour	4	22%
1 to 5 hours	3	17%
5 to 10 hours	2	11%
10 to 20 hours	0	0%
more than 20 hours	3	17%



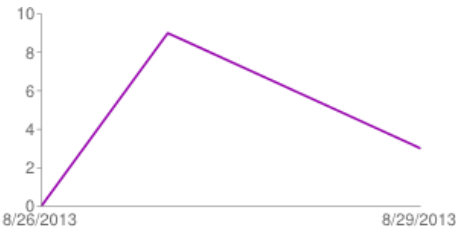
What types of games do you enjoy playing?



First-person Shooters (Counterstrike, Left4Dead, etc)	11	61
Strategy (Starcraft, Company of Heroes, TowerMadness, etc)	9	50
Role-playing (World of Warcraft, Diablo, Oblivion, etc)	12	67
Simulations (The Sims, Simcity, Railroad Tycoon, etc)	5	28
Puzzle (Bejeweled, Brain Teaser, Portal, etc)	8	44
Word & Trivia (Words with Friends, DrawSomething, etc)	3	17
Chance-based (Poker, Mahjong, etc)	5	28
Social (Farmville, Mob Wars, The Sims Social, etc)	1	6
Sports (Wii Sports, FIFA, Need for Speed, etc)	8	44
Physical Board Games (Chess, Scrabble, Settlers of Catan, etc)	5	28
Real-life Sports (Soccer, Basketball, Swimming, etc)	6	33
Other	1	6

People may select more than one checkbox, so percentages may add up to more than 100%.

Number of daily responses



Appendix III: Interview Transcript

Interview Transcript

Peng Fang / Anxishg

What do you think about the game?

Anxishg: I think it arranges from Bejewelled.

How can we improve the game?

Peng Fang: The facial recognition can be more accurate. Because you need to wait until you can clear all the blocks. It makes the game more fluent.

Anxishg: Better UI.

Yue Ma

What do you think about the game?

Yeah, it's quite interesting. But personally, I won't play this.

Why wouldn't you play this game ? Would you play with your friends?

Yeah, maybe I can play with my friends in social games platform. When i'm on my own, it'd be quite weird doing a lot of expressions.

So by social do you mean playing games with your friends in Facebook where your friend would make the face and you could copy it?

Yep.

Did you have fun while playing the game?

Yeah, it was quite interesting.

Was there anything confusing?

No.

Is there any suggestions on how can improve the game?

Let me see, I think it's pretty interesting.

Xinchen

What do you think about the game?

I think the game is very interesting. How can you attract the people to play this game? I think most of the people will play the game in trains. But if other people see you make the expressions...

People might think you are crazy?

Yeah (laughing)

Did you find anything difficult while playing the game?

I think it is very easy if you're familiar with the game. I think most people get familiar with the game within 2 – 3 minutes.

At the start of the game did you have any problems understanding what you should be doing?

I think there's no problem.

How would you describe this game to someone who's never played it before?

I would tell other people, if you want to practice your face, play the game!

Raounak

What do you think about the game?

It's awesome. Amazing.

Did you have fun while playing the game?

Yeah, absolutely.

Was there anything confusing?

Some faces were really hard to make. Especially the sad ones.

Do you have any suggestion on how we can improve the game?

You can actually add more levels. Make it a bit complicated. And it works pretty well for kids and others as well like me.

Paul

What do you think about the game?

It was interesting. I understood the concepts.. I noticed that sometimes my facial recognition would't work. But I sort of tilted the display and it recognised more easier

Did you have fun while playing the game?

Yeah, it's interesting. I guess you could add more interactivity as opposed to just touching with hands.

Was there anything confusing?

Maybe, I guess, wasn't recognising my face. Maybe if there was more feedback when that occurs. It was kind of confusing. The tile went back to its original position so I kind of understood that I had to redo it to get it to work.

Do you have any suggestion on how we can improve the game?

Uh... I guess, I didn't understand why there's a tracker on the top left. Is there an objective to that ?

(Interviewer: yeah well that basically tells you what sort of expression you make. There's six different expression (happy, sad, etc, etc). It basically sort of indicates that these are the expressions that closely match to what you just made)

I guess like maybe, it would be interesting to do more variety of expressions. I found that I was choosing some that were kind of easy, I guess.

Ngoc Dang Khao Ngyugen

What do you think about the game?

Umm.. It's quite good to having like you face recognising interactive game.

Did you have fun while playing the game?

Umm.. Yes.

Was there anything confusing?

Yes. There's two animation confusing me. This type face (**Sad**) and this type of face (**Surprise**), they are quite similar. But the rest is like, they're quite unique. Like the Fear, Disgust and Happy, they're not really different. The sad face and angry face are different. This (Happy face) is pretty easy.

Do you have any suggestion on how we can improve the game?

Yeah, use different face types. Because I noticed that most expressions were based on the mouth. You can do tongue out, close one eye. (*Pointing to the facial tracker*) This is just for debug right ?

The animation like how you're moving it (*swiping of tiles*), it's kind of hard. Like it should be more smoothly. I had to tap. Yeah, but besides that, should be good.

It should have more levels. More animations. Like you know, a facial animation that is more funny. Or you could do like a bonus level where you make a series of face. You do smile, then tongue out, and blink, like a series.

Naif

What do you think about the game?

Uh.. I like it.

Did you have fun while playing the game?

Yeah.

Was there anything confusing? I noticed you're having difficulty making faces ...

Yeah, some face you cannot make it. But others I can do.

Do you have any suggestion on how we can improve the game?

I don't have any idea in my head.

MingJay Chen

What do you think about the game?

Umm.. I think it first time for me to play a game that use my face to make all kinds of expressions..... If you can put it in the market it may have a hit.

Did you have fun while playing the game?

Yeah. I think because when I put the face and I feel very relaxed and yeah you know the features are very interesting and when I make the right face and I got very happy. So I think it's a good game.

So what do you think is the objective of the game? (Shouldn't have asked this question considering he already answered it in first and second questions).

First you need to make sure about what the face is and then you just need to do it.

Was there anything confusing?

Yeah, I think sometimes the red once (Angry) and green one (Disgust) were very difficult to make and you know the shape of the mouse is just like this one (*indicating circular shape*) and I think is a little difficult.

Is there anything that you did not like in the game?

So I'm not quite familiar with the game so I don't know if it has a lot of levels

(Interviewer: right now it just has one level)

You know recently there are a lot of games that are related to Facebook/Twitter and maybe if there is a connection to Facebook and friends, play together, it may get better.

Kenny Xu

What do you think about the game?

I think it's quite interesting. Like it's a different approach for gaming because it makes you use your face but it's also a strategy game. So I think it's quite interactive.

Did you have fun while playing the game?

Yeah. It was pretty fun. But I had some difficulties making the correct gestures.

Was there anything confusing (besides what you just mentioned)?

I think it's pretty straightforward because the facial expression were on the iPad so you already know what you have to do. I think it's pretty clear.

Do you have any suggestion on how we can improve the game?

I think the only suggestions would be the facial recognition.. just the way the app responds to your face. Because sometimes I felt it couldn't really like detect the gestures you're trying to do.

Julien Retif

What do you think about the game?

I think it's pretty cool actually.

Did you have fun while playing the game?

Yeah, with the faces that I could get.. but... yeah it was good. Was different.

What is the objective of the game?

To match the faces... like I'm not sure exactly how to word it... You try to match the faces

Now that you've played the game, is there any information you've received beforehand that would have helped you in playing the game?

No I don't think so. I think it's fairly straightforward.

Was there anything confusing?

No not really.

Johnny Yip

What do you think about the game?

I think the game was interesting. It's fun to play actually.

What is the objective of the game?

The objective would be to match 3 or more rows and then you have to match the emotion/face using the camera to like unlock it or destroy it.

Was there anything confusing?

Trying to match emotion that's asked of you was a bit hard. Sometimes it doesn't recognise like the confused face (Disgust)

How would you improve the game?

I think I noticed I had to move my eyebrows a bit to match the (was that the purple tile?) the purple tile and the green one. I had to move my eyebrows to distinguish from that one to the other one. But like I was trying to do the purple face. I mean the purple tile's face but I had to move my eyebrows. So I guess you have to make a little bit better.

What do you think about the tiles? Do they convey the meaning of said expression?

The purple tile again, I don't know what emotion that was. Was it surprised?

(Interviewer: I guess that's Fear)

Irtiza Zabin

What do you think about the game?

Um.. it's pretty new. Something different. When you compared to other ones like bejewelled/candy crush. This one's like pretty different.

Did you have fun while playing the game?

Well, I did. Because you have to go for a lot of face movements to achieve what you want to do.

Was there anything confusing?

Well, few of the expressions were. Because like some of them had round mouth and if you wanted to do something else with it might recognise the other one (*Indicating to the face tracker*) and just really difficult in that matter. But yeah, other than that, it's cool.

Do you have any suggestion on how we can improve the game?

Well, I mean if you had more expressions I mean, because the difficulty I had was with the round mouth where you had your lips to look like an O but there are some other icons which look the same as well. So probably have different reactions like how you can change that. So yeah.

Fahad

What do you think about the game?

Yeah, the game's pretty good. Interface is pretty good. Colors are good.

Did you have fun while playing the game?

Yeah. At the start was bit challenging but got hang of it in the end.

Was there anything confusing?

Yeah, in terms of like matching the shapes coz. The faces tend to look similar. But the color contrast was good.

Do you have any suggestion on how we can improve the game?

Maybe like add more facial expressions may differentiating a bit more. Other than that it's pretty good.

David

What do you think about the game?

Well, I think it was very nice. Very nice. I love the interaction. I love the responsiveness. It's lovely how you got that features that lines come up on your face and you got the outline of all the features. One thing I would say that the actual tiling business is a little bit hard to get into but it is intuitive. Perhaps you could just make it more detailed to the user. And also the objective of the game, not quite sure when I start playing it, if there's any end result i'm looking for. But it looks great and it works really well. I guess it's got great potential.

Was there anything confusing?

Not confusing as such, it's hard to really figure out what... hard to move the tiles around but it's a nice idea. I thought it was fun. I looked good.

Did you have fun while playing the game?

Yes, tactile wise. But strategy wise, I think should probably put more.. figure out how to actually.. or maybe there could like some sort of point system to add more feedback kind of stuff.

Do you have any suggestion on how we can improve the game?

See above.

Chenshi

What do you think about the game?

Quite interesting. Very hard to make some expressions.

Did you have fun while playing the game?

Yes. Sometimes.

So when you started with the game, did you know what to do?

Yeah.

What about those expression tiles? By looking at them were you able to tell that that's the face you have to make?

Yeah, but sometimes it's hard to identify what expression it is.

Is there something that you did not like about the game?

No.

Was there anything confusing?

Yeah. For example, confusing is I don't know what expression is like, how to express it. If there's something that tells me how to make the expression then it would be good. If there's an expression that I can't copy then I recommend better....

Do you have any suggestion on how we can improve the game?

See above.

Cheng Zhong Zhang

What do you think about the game?

Well, this game is quite interesting. Because you use different kind of emotions to play the game and using the picture to match. It's quite interesting. It's a good idea to design a game. And but it is quite difficult to match because some emotions are quite similar and also i'm quite confused with different kind of rules/face will have different kind of emotions. Same emotions has different kind of face. So yeah, that's my point.

Did you have fun while playing the game/Were you bored while playing the game?

Yeah, good.

What do you think is the objective of the game?

Actually, this is quite like candy crush.

Charlie

What do you think about the game?

It's interesting. You have to do the faces. But the difficult thing is to do the different faces like the Angry, Happy. Sometimes when I smile.. umm. I do smile face and then it would recognise as Angry. Sometimes you cannot understand that.

Did you have fun while playing the game/Were you bored while playing the game?

Yeah. It's fun. It's really fun. Especially when you cannot make those faces if you don't do the right faces. But um.. maybe the game has some bugs now but I think if you fix it, it would be really good.

Was there anything confusing?

Um.. I think nothing confusing. It's easy to understand. You just do the faces.

Do you have any suggestion on how we can improve the game?

Basically, you have to improve the quality to recognise the face. Just as I said I do the smile faces but it recognises as angry.

Appendix IV - Response Categorization

ID	Playtester	Gameplay	Expressions	Difficulty	Scenario	Target Group	Facial Recognition	UI
P1	Peng Fang	Need to wait before you can clear the blocks					High accuracy recogniser leads to a fluent game	Could be better
P2	Anxishg	Like Bejewelled.						
P3	Yue Ma	Quite Interesting.	Making expressions on my own would be weird		Wouldn't play on my own Would play with friends through social networks			
P4	Xinchen	Very Interesting.		Easy to get familiar within 2 – 3 minutes.	Most people will play on trains. They might look silly.			
P5	Raounak	Awsome game. Make it a bit more complicated.	Some faces were really hard to make. Especially Sad ones.			Works well for Kids and others like me.		
P6	Paul	Interesting. Could add more interactivity as opposed to just touching with hands.	More variety of expressions would be good I was choosing expressions that were easier to make	Understood the concepts. Tiles went back to original position.			Sometimes facial recognition wouldn't work. Tilted the display to make it work.	More feedback when facial recogniser isn't working. Didn't understand why there's tracker on the top-left ?
P7	Ngoc	Interactive face recognising game. Should have more levels/animations. Bonus levels.	Sad and Surprise face were quite similar. Fear, Disgust, Happy not really different Happy face is pretty easy. New expressions like Tongue out and Blink.					Swiping of tiles should be more smooth.
P8	Naif	I like it.	Some face I cannot make but others I can.					

P9	Mingyay Chen	First game that lets me use my face to make all kinds of expression.	When I put the face I feel very relaxed. When I made the right face, I was very happy.	Angry and Disgust were very difficult to make. Shape of the mouth is circular.	Playing together with friends in Facebook will make it better.			
P10	Kenny Xu	Quite Interesting. Different approach for gaming. Makes you use your face, but it is also a strategy game. Quite interactive.		Fun but had some difficulties making the correct gestures.		Sometimes I feel it couldn't really detect the gestures you're trying to do.		
P11	Julien Reif	Pretty cool actually.		Had fun playing with the faces I				
P12	Johnny Yip	Interesting. Fun to play actually.	I had to move my eyebrows a bit to match the purple tile and green one. I had to move eyebrows to distinguish from that one to the other. I don't know what emotion purple tile was conveying.	qqqqggggkkaach emotion that's asked of you was a bit hard.		Sometimes it doesn't recognise the confused face (Disgust).		
P13	Iritza	Pretty New. Something different compared to Bejewelled/ Candy crush.	Few of the expressions were confusing. Add more expressions.	Had fun because had to make a lot of faces. The mouth of the faces were shaped like O. Had difficulty making a happy		Facial tracker wasn't recognising correctly		

P14	Fahad	Pretty good.	Faces tend to look similar.	Confusion in terms of matching the faces. At the start was bit challenging but got the hang of it.				Interface is good. Colour contrasts were good.
P15	David	I love the interaction/responsiveness. Not sure about the objective of the game. It looks great and works really well. Add points system.	It's lovely how you have the feature that show lines come up on your face.	Tiling business is a little bit hard to get, but is intuitive.				Hard to move tiles around. Add more feedback.
P16	Chenshi	Quite interesting.	If there's something that tells me how to make the expression then it would be better.	Very hard to make some expressions				
P17	Cheng Zhong Zhang	Quite interesting. Like Candy Crush.		Quite difficult to match some emotions Same emotions have different kinds of face.				
P18	Charlie	It's interesting. You have to do the faces. The game has some bugs now.	Really fun when you cannot make those faces.	Difficult to do faces like Angry and Happy.			Improve the quality of facial recogniser Just as I said I do the smile faces but it recognises as Angry.	

Appendix V: Occurrence Analysis

Text

Occurrence Analysis

Category	Sub-category	No. of comments	
		Positive	Negative
Gameplay	Interesting	7	
	Interactive	5	
	Awesome	1	
	Novel	1	
	Good/Cool	2	
	Fun	4	
	Difficulty		13
Interface	Variety		3
	Weird		1
	Emotion		0
	Similarity		1
	Eyebrows		1
	Familiarity	1	
	Confusing		2
	Intuitive	1	
	Color contrasts	1	
Facial Tracker	Detection Problems		6
Other comments	Self-Playing	2	
	Social Playing	1	
Total		23	21

Appendix VI: Playtime Analysis

Playtime					
	Playtest	Interview			
Anxishg	03:28:00.00	00:25:00		208	
Charlie	05:40:00.00	01:38:00		340	
Cheng	04:13:00.00	01:33:00		253	
Chensi	04:02:00.00	02:19:00		242	
David	01:58:00.00	01:31:00		118	
Fahad	03:38:00.00	00:47:00		218	
Irtiza	02:29:00.00	01:11:00		149	
Johnny	03:42:00.00	01:38:00		222	
Julien	01:50:00.00	00:44:00		110	
Kenny	02:18:00.00	01:03:00		138	
Mingjay	03:45:00.00	02:40:00		225	
Naif	06:02:00.00	00:43:00		362	
Ngoc	01:23:00.00	02:55:00		83	
Paul	02:30:00.00	01:42:00		150	
PengFang	02:40:00.00	00:25:00		160	
Raounak	04:26:00.00	00:37:00		266	
Xinchen	04:35:00.00	01:38:00		275	
YueMa	02:20:00.00	01:02:00		140	
Average	03:23:16.67			203.2777778	3.387962963
STD	0.0544100686			78.35049875	1.305841646
					22.8
					18