

# THE DEVELOPMENT PROCESS OF A PSYCHOTHERAPEUTIC GAME FOR FACIAL EXPRESSION RECOGNITION IN PATIENTS WITH SCHIZOPHRENIA: A PILOT STUDY

R. P. Gonzalez<sup>1</sup>, F. Alpiste<sup>1</sup>, S. Ochoa<sup>2</sup>, J. Fernandez<sup>1</sup>, I. Tortades<sup>2</sup>, J. Torner<sup>1</sup>, M. Garcia-Franco<sup>2</sup>, J. Ramon Martín<sup>2</sup>, S. Vilamala<sup>2</sup>, M. J. Escandell<sup>2</sup>, E. Casas-Anguera<sup>2</sup>

<sup>1</sup> *Universidad Politècnica de Catalunya (SPAIN)*

<sup>2</sup> *Parc Sanitari Sant Joan de Déu (SPAIN)*

## Abstract

This work presents the design and development process of 'Feeling Master', a new psychotherapeutic interactive game for facial emotion recognition. Feeling Master is conceived as a tool to measure facial emotion recognition in schizophrenic patients. A unique feature of this new psychotherapeutic interactive game is the use of cartoon stimuli. It is widely recognized that utilizing stimuli with relatively reduced complexity, like cartoons, to teach emotion recognition to children and adolescents is a beneficial therapeutic option. Designed as a modular game, the patient is asked to correctly answer the questions posed or, depending on the activity, simply match an emotion with the corresponding face. Feeling Master was fully designed with an iterative user-centered approach, which places an emphasis on users' needs and stresses the importance of designing products that are functional, applicable, and usable for a broad range of people. The goal of this study is to describe the design and development process of Feeling Master and to demonstrate the benefits of using user-centered design (UCD) as the framework for a psychotherapeutic interactive game design process.

Keywords: Facial, emotion, recognition, user-centered design, schizophrenia, game, design, development process, psychotherapeutic, facial expressions, cartoons.

## 1 INTRODUCTION

Emotive facial expressions are the foundation of social interaction and the ability to identify them is an important social skill. Indeed, nonverbal cues are often more important than verbal content in conveying emotional information that is crucial for developing successful relationships [1]. Expressing and experiencing emotions lie at the core of being human and it is critical for the psychological well-being of individuals to be able to express these emotions [2]. Though emotion is an abstract concept, developing children as young as three years old who have exposure and practice are able to infer basic emotions from facial expressions [3]. At three years of age, typically developing children start to acquire the ability to conceptualize and name different emotions [4].

It is widely agreed that schizophrenic patients show a reduced ability to perceive and express facial emotions. A deficit in emotion recognition has been found to be a characteristic feature of this pathology [5–11]. Evidence for this comes from numerous studies that have used facial expressions of emotion as stimuli [12–15]. Controversy exists, however, regarding the nature of such a deficit in schizophrenia. Some investigators believe that the deficit is emotion-specific. This supposition is based on the fact that schizophrenic patients are impaired in the recognition of emotions, especially negative emotions [16–20].

Most developmental studies concerned with the perception and identification of facial emotions have used some adaptation of Matsumoto and Ekman's picture set, which consists of prototypical, intense displays of basic emotions (e.g., [21], [22]). The number of facial emotions has usually ranged from four (fear, sadness, anger, and joy) to seven (adding disgust, surprise, and contempt). Other studies have used even more stylized stimuli, such as cartoon faces (e.g., [23], [24]). It is recognized that cartoons have a strong advantage in expressing emotions and feelings. Previous findings suggest that utilizing stimuli with relatively reduced complexity, like cartoons, to teach emotions to children and adolescents is a beneficial therapeutic option. Moreover, training studies have suggested that children with autism show greater improvements in facial emotion recognition when programs utilize cartoons rather than photographs of real faces [25].

A range of social cognitive deficits have been reported for both autism and schizophrenia [26–28], particularly in the theory of mind [29–31], the perception of social cues [15], [32] and facial affect recognition [33], [34]. Both autism and schizophrenia are characterized in part by pervasive social dysfunction that impairs the ability to initiate and maintain reciprocal interaction [35]. Notwithstanding, no study to date has attempted to explore the performance in emotion recognition of individuals with schizophrenia when interactive applications include cartoons rather than photographs of real faces.

## 2 GAME DESCRIPTION

Feeling Master is a psychotherapeutic interactive game for facial emotion recognition with three levels of difficulty (see Fig. 1). The game was developed as a tool to investigate the deficit in facial expression recognition in patients with schizophrenia. There is a maximum time allowance for solving all questions that may differ from level to level, and it is the practitioner who customizes the game for each patient. Designed as a modular game, once the level has been chosen, the patient will be prompted to correctly guess the answers to the questions posed or, depending on the activity, simply match an emotion to the corresponding face.

According to Ekman [36], there are six basic facial expressions of emotion, and it is these emotions that were selected for use in the application: happiness, sadness, anger, surprise, disgust, and fear. In addition, therapists will have the ability to manage information regarding patients' data, see patients' performance, and configure future sessions and activities within the application. Taking into account the type of patient, the therapist may choose an easier or more complex activity, with more or less time dedicated to each activity. A distinctive feature of Feeling Master is the use of cartoon stimuli instead of the prototypical picture set of the basic emotions.



Fig. 1 Three levels of difficulty in Feeling Master.

## 3 DESIGN METHODOLOGY

The overall design of Feeling Master was created with an iterative user-centered approach, which places an emphasis on users' needs and stresses the importance of designing products that are functional, applicable, and usable for a broad range of people [37], [38]. The name of this methodology is user-centered design (UCD). Iteration is fundamental to this design process, and occurs by cycling through the overall process multiple times, and also by reiterations within a step—for example, by the creation of multiple versions of the same facial expression. In this process, user/expert testing connects each major iteration. In the progression from the early concept to the final prototype, feedback from users and experts helps validate all major design decisions. The design and development process of the game includes four major phases: 1) facial expressions design, 2) application design and development, 3) design evaluation with users through protocol analysis or the think-aloud method, 4) usability assessment through a pilot study with schizophrenia patients and healthy control volunteers.

### 3.1 Facial expressions design

The precise detection of the position of the face and prominent facial features such as the eyes, eyebrows and mouth is the most important step towards automatic recognition of facial expressions

[39]. In this study, facial expressions are emphasized using cartoon techniques. It is widely acknowledged that cartoons have a strong advantage in expressing emotions and feelings [40]. To simplify the development process of our cartoon characters, we used the famous LEGO Minifigures illustrations. The face of the Minifigure was of particular importance, since it gives the strongest indicator of the emotional state of the character.

In order to generate expressive cartoons for each of the six basic emotions defined by Ekman [36], we adopted the following ground rules to customize the character's facial expressions. These rules were summarized and simplified from Parke and Waters' book [41].

- Happiness: The mouth is wide with the corners pulled up toward the ears and the eyebrows are relaxed.
- Sadness: The mouth is relaxed and the inner portions of the eyebrows are piled up above the upper eyelid.
- Fear: The mouth is dropped slightly open. The eyebrows are raised, pulled together, and curved upward.
- Surprise: The mouth is dropped open, the eyebrows are raised, and the upper eyelids are open.
- Disgust: The mouth is slightly open with the upper lip squared off and the middle eyebrows are pulled upward.
- Anger: The mouth is closed with the upper lip slightly compressed or squared off. The eyebrows are pulled downward and together.

The customization process of the character's facial expressions began with a small number of hand-drawn pencil sketches for each of the six basic facial expressions. An illustrator modified the facial expression (eyes, eyebrows, and mouth) of the original character illustrations based on the rules we defined for each emotion. An example of these sketches is shown in Fig. 2a. Once we completed the pencil sketches for each facial expression, we applied these changes to the original vector illustrations (see Fig. 2b.). Then we added the upper torso and arms to the illustration, as shown in Fig 2c. During the customization process of the character's facial expressions, we used the same character to illustrate the six different emotions. At this point, we were ready to start the first round of user testing (Fig 2c). The users' feedback was noted and analyzed, and then the illustrations were refined. The user testing cycle for the facial expressions was repeated five times until the representation of each emotion was ready to be applied to more characters. Throughout the illustration phase, we mainly focused our effort on two emotions: disgust and anger.

During the testing process, user feedback made us realize that these two emotions (disgust and anger) were the most challenging to illustrate in comparison to the other four basic emotions (happiness, sadness, fear, and surprise). Between each iteration, the illustrator adjusted the facial features—such as the eyes, eyebrows, and mouth—that defined each emotion. Once each emotion was thoroughly tested, the detail of each illustration increased with further rounds of testing and iteration until each emotion illustration was finalized.

Once the majority of users had successfully recognized the six different facial expressions using the same character, we started expanding the amount of cartoon characters for the game. To extend the family of characters, we applied the same synthesis of the facial features (eyes, eyebrows, and mouth) on new Minifigures with diverse features and accessories (hats, helmets, beards, moustaches, hair, scarves, bows, shirts, uniforms, dresses, and capes). Finally, we combined the head and the body accessories with two different skin colors (yellow and dark brown) to develop the final eighty characters needed for the game. Subsequently, we applied the six basic facial expressions to each of the eighty characters of the game.

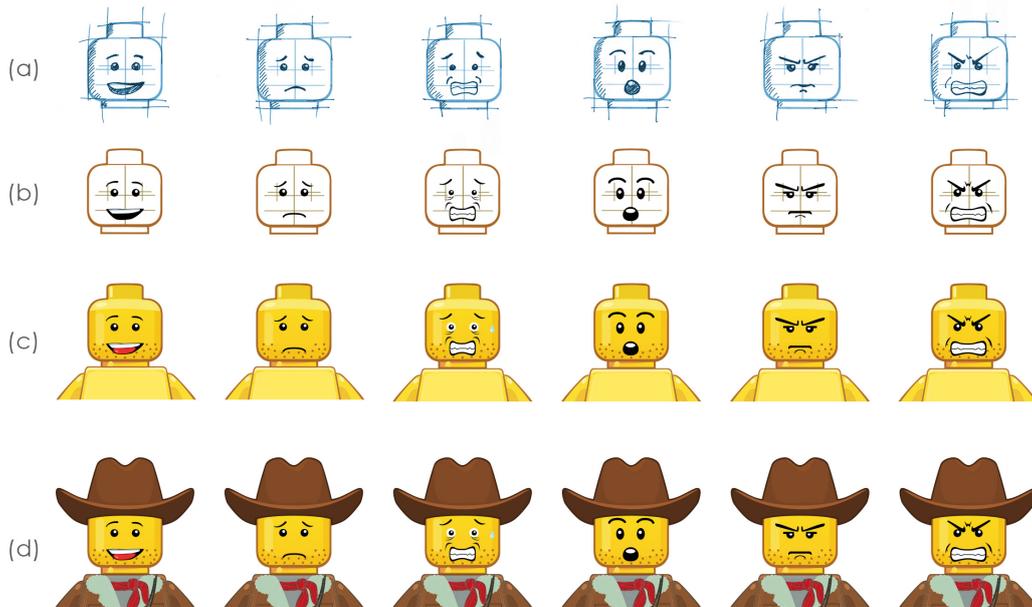


Fig 2. Facial expressions design process: happiness, sadness, fear, surprise, disgust, and anger. (a) Facial expressions: pencil sketches. (b) Facial expressions: vector illustrations. (c) Minifigures for user testing. (d) Final Minifigures with accessories.

### 3.2 Application design and development

Throughout the game design process, interviews with game designers were held. Their considerations were taken into account particularly in regard to external appearance (i.e. aesthetic and sensory appeal), since, according to the designers, this is of primary importance in enabling users to feel engaged with an application. Some other aspects of engagement such as challenge, control, novelty, customization, motivation, and how to hold a users' interest in the game were discussed. Equally important, marketing professionals and UI analysts were asked for their personal opinions of the application based on their professional and technical knowledge. Medical staff, mainly psychologists and therapists, was also interviewed. It was extremely important to include medical professionals in the entire process and take their ideas and professional remarks into consideration.

During the first stage of the application design process, we developed several low-fidelity sketches of the game interface. These sketches were paper-based and do not allow any user interaction. Low-fidelity sketches were faster to create and modify. Utilizing low-fidelity sketches was helpful in facilitating early visualization of alternative design solutions. An additional benefit of this methodology is that when using rough sketches, users may feel more comfortable proposing changes. Once we defined the basic layout of the interface, we started using computer-based tools (Adobe Photoshop and Illustrator) to increase the fidelity of the mockups. Creating wireframes and user interface elements with these tools took more time and effort, but looked more realistic and refined. At this stage, we asked the experts (game designers, marketing professionals, and medical staff) to focus on the visual design, including the look and feel of color, fonts, layout, and images.

The next step was to develop a number of partially functioning computer prototypes that simulated the basic game interaction. These prototypes were developed in order to explore the functionality, interactivity, and degree of difficulty of the game. The design of these prototypes was kept quite simple so they could be easily modified and adapted to the requirements of the users without demanding enormous programming and extraneous work. In general, developing a final application in one go is never advisable since no matter how fine-grained a design model may be, there will always be emergent design problems. It was crucial during this stage to design and test the customization of the

game's interface with medical staff. Within this interface, therapists can manage information regarding patients' data, see patients' performance, and configure the complexity of the game.

The observations made during the above stages were used as guidelines for the design of the final interactive graphical interface and for its final implementation. Some useful conclusions were drawn during the design of the prototypes about the simplicity of the interface and the level of interaction needed for the game. It was decided that the graphical interface must be kept simple so users would be able to play the game without considerable training. Furthermore, the degree of enjoyment and surprise resulting from the interaction with the interface was very important. Finally, we documented the preferences of the experts regarding game mechanics, color, and contrast choices for the visualization of the graphical interface, and their enthusiastic reaction to the introduction of sounds.

### **3.3 Design evaluation with users: protocol analysis or the think-aloud method**

Despite the problems identified in the evaluations of the experts, the final design evaluation of Feeling Master fell to the users. For this purpose, we utilized a systematic qualitative technique known as protocol analysis or the think-aloud method. This technique requires users to express their feelings, thoughts, and opinions during the test. One objective of this approach is to enable designers to get a better understanding of the users' mental model during their interaction with the application. Importantly, protocol analyses of digital interfaces are based on the direct observation of a real interaction between the user and the application. In each protocol analysis session, the user is asked to perform a specific task using the system and to verbalize his/her thoughts concurrently by "thinking aloud." Users are asked to give a continuous explanation on what they are attempting to do, what problems they are confronting, and other task-related thoughts [42].

These techniques demand a usability expert and a minimum of four participants who are to be observed; the more users that can be observed, the better the outcomes [43]. For our analysis, six users participated in the think-aloud test. Before the assessment, the purpose of the research and think-aloud test was explained to the participants and they were given information about the scenario. During the testing, the participants were asked to think aloud while using the game and the usability expert wrote down their comments. After the think-aloud test, the data obtained from the participants was used for the analysis of the game and the final adjustments to the application were then made.

In general, all users found the application easy to use and entertaining. They commented favorably on the look and feel of the application and on the overall game mechanics. However, some participants experienced serious difficulties recognizing the disgust emotion illustration. After being reminded to verbalize their thoughts about the disgust illustration, they said that the disgust illustration was unclear and confusing. On the other hand, most of the participants did not perceive any difficulty in recognizing all of the other emotions (happiness, sadness, fear, surprise, and anger). A possible explanation of the increased difficulty in recognizing the disgust emotion in this evaluation, when compared to the evaluation of the facial expressions in the design phase, is that the users in this assessment had a limited amount of time (8 seconds) to recognize the emotions. Previously, during the facial expressions design phase, we gave users an unlimited amount of time for recognizing each emotion. The results were likely influenced by the "ceiling effect." The ceiling effect appears when a high value in scores is achieved for a high number of participants. Generally, this situation is favored by using long stimulus exposure times that range from 500 milliseconds [44] to 15 seconds [45].

Results suggest that using protocol analysis or the think-aloud method was extremely helpful to define the usability problems at the end of the development process before we utilized the Feeling Master prototype in a pilot study with schizophrenia patients and healthy control volunteers at a psychiatric rehabilitation center.

### **3.4 Usability assessment: pilot study with schizophrenia patients and healthy control volunteers**

The usability assessment consisted in a pilot study conducted to evaluate the effectiveness of the psychotherapeutic interactive gaming tool prototype. The study was conducted among patients with schizophrenia in five rehabilitation psychiatric units from Parc Sanitari Sant Joan de Déu (PSSJD) in Barcelona, Catalonia, Spain. A total of 24 patients with schizophrenia (SF) participated in the study, and 17 healthy control (HC) subjects were recruited to match the patient cohort at a group level in terms of age, gender, and education.

In the patients' first individual sessions with the psychiatrists, inclusion and exclusion criteria were reviewed. These sessions dealt mainly with the standard psychiatric interview of the DSM-IV diagnostic criteria and the Personal and Situational Attribution Questionnaire (IPSAQ). The study and treatment information were provided to the patients, and they signed a consent release form to participate in the study. Once the application was installed and tested on the tablet, the practitioner customized the number of questions for each of the three levels (seven questions), the maximum amount of time per question (12 seconds), and chose the emotions needed for the study (happiness, sadness, anger, fear, and surprise). For this assessment, we decided not to use the facial expression for disgust based upon the poor performance of this emotion during the previous evaluation with users. The total number of questions for each game was 21 (Fig.3).

The study took place across two "one-on-one" sessions, conducted on different days within a one-week period. The patients were tested in a quiet area, away from the other patients in their rehabilitation psychiatric unit. Each session, which took about 10 to 15 minutes to complete, was administered by a psychiatrist and the application designer. Throughout each session, patients interacted with the application two times (two games, with randomly selected emotions for the overall session). By the end of the study, each patient used the psychotherapeutic interactive gaming tool prototype a total of four times.

For each game, the system automatically recorded all of the patient's answers (right and wrong), the patient's profile, the system configuration, response times for each question, and the score for each game.

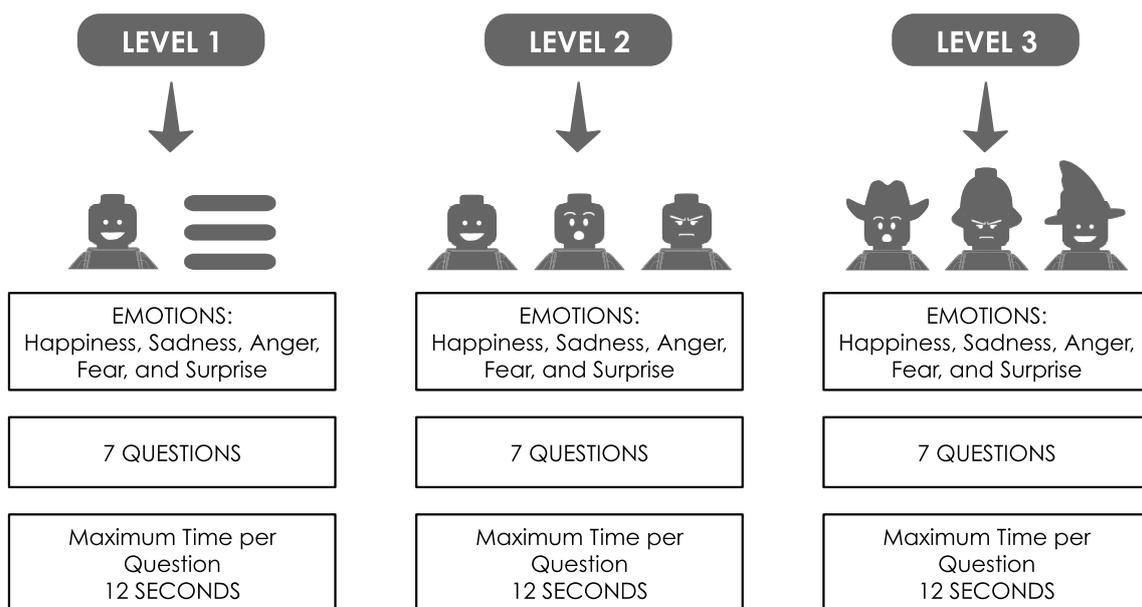


Fig. 3 Interactive Feeling Master tool: Summary of Levels

The effectiveness of Feeling Master is based on the emotional recognition of cartoon faces. The design ensures that participants can effectively play the game. As can be seen in the results, high levels of accuracy (i.e., correct answers in emotion recognition) are reached in both the HC and SF groups (Table 1.). Considering all emotions, the percentage of hits fluctuates between 81,10 to 94,10 in the HC group in the first session, and between 67,00 to 88,50 in the SF group.

These results are consistent with previous studies about the difficulties in emotion recognition associated with schizophrenia patients. Additionally, the game shows marked differences between the ability of HC and SF participants to successfully recognize emotions, specifically fear.

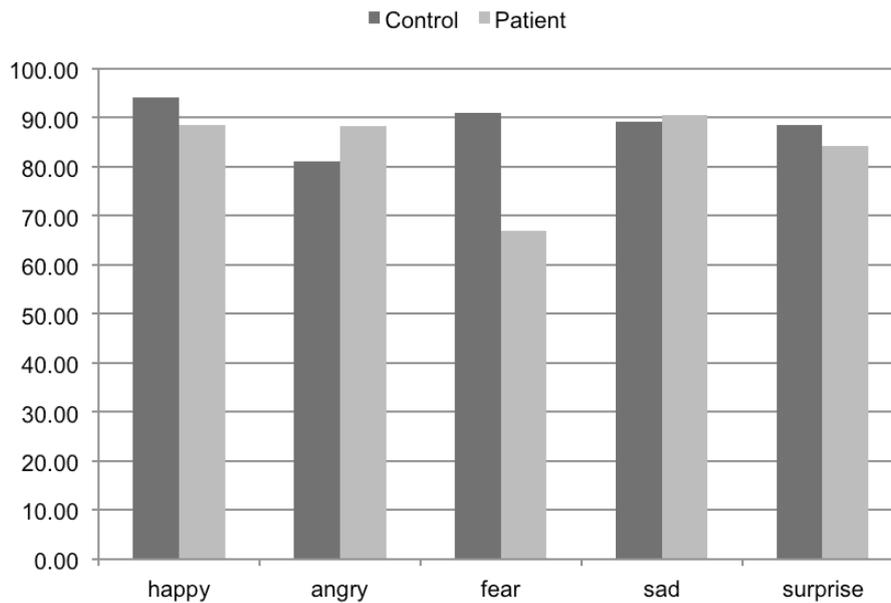


Table 1. Percentage of correct answers in emotion recognition by patient and control groups in the first session

## 4 CONCLUSION

To our knowledge, there are no previous instances of an interactive tool being used for the assessment of emotional recognition designed with the UCD methodology. This study attempted to demonstrate the advantages of using UCD as the framework for a psychotherapeutic interactive game design process. Key to this study, and definitive of the approach, was the fact that UCD gathered consensus from the medical community throughout the design process. This, in turn, allowed the design and development to move forward smoothly. Furthermore, the patients and therapists helped to convey a positive message regarding the improved interface, which resulted in a boost in the users' initial acceptance of the product.

In summary, applying the UCD process to design a psychotherapeutic interactive game was very successful. At present, a clinical study is being carried out using Feeling Master among patients with schizophrenia in numerous rehabilitation psychiatric units in Barcelona, Catalonia, Spain. Preliminary results using Feeling Master have already shown consistency with the idea that difficulties in emotion recognition are associated with key cognitive deficits in schizophrenia, specifically in the recognition of fearful facial expressions. These findings are consistent with previous studies carried out with different tools for the assessment of emotional recognition.

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