Team ProApps

Discover-E-Motion

DESIGNING A SOCIO-DEVELOPMENT GAME FOR STUDENTS WITH AUTISM

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ENGR 110/210

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INTRODUCTION

Autism and autism spectrum disorder (ASD) are general terms for a group of neurodevelopment disorders that typically are characterized by impairments in social and communication skills. The disorder appears within the first 3 years of life and in addition to the affected development skills, autism also causes a decreased response to sensory information. According to statistics from the U.S. Centers for Disease Control and Prevention (CDC), the disorder affects around 1 in 88 children in the United States, and the number of diagnoses has been increasing yearly[1]. Many people may be unaware of the extent to which autism affects a large population of the United States; it may be surprising to note that more children are diagnosed with autism each year than with juvenile diabetes, AIDS or cancer, combined.

Given the prevalence of autism in the juvenile population, many parents, caregivers, and therapists seek out educational tools that cater to the needs of a child or student with autism. Unfortunately, many of the tools available to consumers today focus on distinct aspects of the disorder, often neglecting other aspects outright. This is important when one considers the basic social processing steps that an individual goes through in any given interaction. These steps involve the recognition of emotion, the internalization of that emotion, and the appropriate response to the emotion. The problem that these existing educational tools fail to address is the attention given to multiple steps at once, and in particular, the transition between those steps. These observations are

1 http://www.autismspeaks.org/what-autism

especially important given the fact that many studies show that early assistance with social processing has positive effects on the behavioral development of children with autism[2].

OBJECTIVES

The main objective for our project is to create an iPad application that assists students with autism in one of the areas affected by the disorder. We chose the iPad as the platform for our project because the App Store makes for convenient and inexpensive (or free) distribution of the software and we wanted to make our application as freely accessible as possible. We also found through our interviews and research that the iPad is becoming a more common platform for developing applications targeted for use in the autism community[3]. The common use of iPads means that the students and aids will likely be familiar with the device, making it easier for them to learn how to use the application. In addition, using the iPad as the platform for our application removes any stigma that might be associated with a specialized device specifically linked to a disability.

Our specific objectives for our application were derived from the interviews that we conducted. These interviews and the motivation they provided in our chosen objectives is discussed in further detail in the Design Criteria section as well as at the beginning of the Methods section.

We chose to primarily address the difficulty that students with autism face in recognizing emotions in facial expressions. To help students learn how to recognize facial cues for different emotions, we decided to create a game that would use repetitive picture matching to help students identify the facial cues associated with basic emotions. One of our main objectives in the creation of this game is to make it fun and intuitive to use so that it is appealing to the students. In particular, we want the game to appeal to a young audience given the fact that early practice in recognizing socio-emotional cues for children with autism can improve social skills[4].

We also want to expand our game to address more than just the first step of emotional processing. While a picture matching game can help students practice recognizing emotions on different faces, we also brainstormed features of the game that would help individual students apply

2 http://www.cdc.gov/ncbddd/autism/treatment.html

3 http://mashable.com/2013/02/01/innovative-autism-community-ipad/?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+Mashable+%28Mashable%29

4 http://www.autismspeaks.org/about-us/press-releases/early-intervention-improves-social-skills-brain-activity-autism

the skills they learn in the game to their everyday lives. We want to help them connect the process of recognizing the emotion in someone's face to internalizing that emotion and understanding the feeling associated with it. The first method for connecting our game to real life situations is to add in familiar faces to the pictures being displayed in the game. The game will have the option to take photos and save them so that the students can take pictures of people they interact with on a regular occasion and have them appear as some of the faces in the game. The addition of familiar faces should increase the student's ability to recognize the emotional cues that their parents or caregivers are displaying. We also hope that the addition of these familiar faces will help the students translate the skills they learn in our game into their everyday lives which will in turn help provide a context for the emotions that they encounter. Another method for connecting emotional recognition to the other steps of social processing would be to merge our game with the existing Emotionary app. Emotionary is an emotional journal for the iPad that allows students to create entries based on the emotion that they are feeling at a given time. Each entry is tied to an emotion and the student records the context in which they are feeling that emotion. Integrating our game with Emotionary would allow students to look up entries for a certain emotion that they are practicing recognizing in order to provide a context for a time that they experienced that emotion.

Another objective of our project was to add in customizable features to our application. We conducted some initial interviews at the Pacific Center for Autism Education (PACE) to discuss our application idea and to collect information about design considerations for our product. In talking with speech and occupational therapists and aids at PACE, they stressed the variety of individualized needs that their students have. They suggested a number of customizable features that would be helpful in tailoring our game to different students' needs. While our timeline for this project is not sufficient to add in all of the customizable features that were mentioned, we would like to add in as many customizable features as possible to increase the number of students who could use our application in the future.

Throughout our project we intend to keep meeting with the students and therapists at PACE. This will provide us with feedback on the usability of our application and the appeal that it holds for the students. This will also give us regular feedback on how intuitive the game is to use and ease at which the settings can be changed to customize it for different users.

DESIGN CRITERIA

Much of the early background research conducted by our project team involved processing the work that past students and researchers have completed on the topic. We were very lucky to have two predecessors to the same field of work, former students of ENGR110/210, who happily

brought us up to speed on the scope of the work they had left upon graduating from Stanford, as well as the future direction they saw for the project. Coincidentally, these two former students also represented the first group that we interviewed to commence Discover-E-motion. Anna Ly and Hain-Lee Hsueh had originally created two different programs for their masters project, another for the quarter-long project in ENGR110/210. These two programs included an iPad app called Emotionary, which served as a journal or diary for users and allowed them to document different situations in which they felt a variety of emotions by taking pictures, keeping written logs, or recording voice memos. In addition, Anna and Hain-Lee created a series of mini-games for the Xbox Kinect system, which involved a more physical aspect of social development for students with autism. The games provided the students with a way to practice waving skills (a lesson in personal space and proper greetings) as well as emotion recognition.

The interview provided us with many valuable notes about the future of our project, one of which would become the base upon which we chose to model our final project. The pair emphasized the need to add a sense of realism to our eventual application, saying that students would respond better to more realistic facial expressions and emotions, and that doing so would allow their practice to be more transferrable to the real world application of these skills. In addition, they stressed the importance of developing a solid feedback system. One of the problems they encountered with Emotionary was that students would often press random buttons on the screen in the hopes of receiving some sort of feedback. Even if the feedback was negative (e.g. a pop-up message displaying "Wrong Answer"), the students would continue to press the button in order to see any sort of action on the screen. In creating our application it will be important to limit our feedback system to only include positive feedback for correct answers.

Among other key points, Anna and Hain-Lee also mentioned the idea of integrating our eventual iPad app to their existing Emotionary app. This connection would allow students not only to practice their social and emotion recognition skills, but it would also give them some real world context to the emotions that they encounter.

Shortly after our meeting with Anna and Hain-Lee, our team met with the project suggestor, Kurt Ohlfs, director of the Pacific Autism Center for Education (PACE). Kurt had many suggestions for the direction we could take with our new project, and was very enthusiastic about helping us find the best fit for the time period we were constrained by. An important fact we took from our meeting was that the majority of the applications that Kurt had encountered focused on developing communication skills in students with autism less verbal students, as opposed to developing the more basic skill of emotion recognition. This was an important point in our design process, as it led us to research some existing solutions and discover exactly what was lacking from these programs. Kurt also mentioned that the need for a simple way to track and output data for each user was very important, as it would allow therapists and caregivers to tailor their lessons and interactions with the

students according to the feedback they received from the app as well as generally tracking the students' progress throughout the game.

This meeting with Kurt spurred many ideas for the direction we could take our app. Both during the meeting and in subsequent brainstorm sessions as a team, we managed to develop a few compelling ideas that would directly address the socio-emotional development concerns for students with autism. Among these ideas, we discussed the feasibility and impact of programs such as an application that would help students improve their skills with organizing and planning their days, a more detailed calendar application that assists students in moving from task to task on a daily basis, a matching game that would help with the recognition of emotion based on facial expressions. We also considered directly expanding on Emotionary itself. In the end, we felt that we identified most with the idea of an emotion recognition game, and we were excited to continue with this path as it seemed to be more novel, with very few existing applications on the market. We were also enthused about the possibility of interacting our game with the existing Emotionary app, something Anna and Hain-Lee had mentioned, as it would add more depth to the learning process. This potential integration with Emotionary also led us to choose the emotion recognition game as it was the best complement to the Emotionary app in terms of helping students further develop their socio-emotional skills.

Once we decided on the creation of an emotion recognition game, we continued to brainstorm and develop more details regarding what we would eventually include in our final app. Some of these ideas included the use of video scenarios being played for students, who would have to select the correct emotion based on the context in the scenario, as well as a game that involved the selection of a facial expression based on the emotion as a written word. Ultimately, we decided to create a game that did indeed involve selecting the correct facial expression from photos based on a given emotion, but also included the key aspects of matching real faces to real faces. Again, this choice came directly from our interview with Anna and Hain-Lee, who both mentioned the importance of adding a sense of realism to the game. With this goal in mind, we set out to create a prototype of the application.

METHODS

In talking with Kurt and the other therapists at PACE, we determined that one of the most important objectives for our application is adding in customizable features to make it usable for a wider group of students with autism. As part of the customization of the game, we also wanted to add a sense of familiarity and realism to the game in order to make the skills acquired through the game easily translatable to real life. This need for customization and familiarity in our application also lent itself to creating a picture matching game because it seemed most applicable to social processing for

students with autism and it also seemed that could be most easily customized to different user's specific needs.

Because we understood the importance of making our application as realistic as possible, we determined that we wanted to use photographs of people making the emotional faces rather than using icons of faces for each emotion. We started with the basic concept of having two different pictures to choose from so the student would tap whichever picture was displaying the prompted emotion. We started taking pictures of ourselves making faces for different emotions and discussing which pictures were clearer and which were more difficult to determine the emotion. In discussing the common facial signals between pictures of different people expressing the same emotion, we came up with the idea of having an example picture in the upper right hand corner demonstrating the prompted emotion so the students could use it to recognize similar facial cues in the pictures that they are choosing between. Our prototype is shown below (Figure 1). The emotion that the student is finding is written in the upper left hand corner. The picture in the upper right hand corner always matches the written emotion and can be used as an example of a person expressing that emotion. The student then chooses from the bottom two photographs which person is expressing the displayed emotion.

Figure 1: Paper Prototype

After determining the basic structure for our game described above, we recruited 10 of our friends and took pictures of each of them making the six emotions. We made sure the pictures had similar white backgrounds that were as blank as possible to avoid distracting stimuli. We then constructed a display prototype using foam core. The prototype consisted of a piece of foam core with slots for each stack of photos and the emotion words. We organized rounds and ordered the photos so that as the students were working with the prototype we would flip over the photos and words to display the next round. We then added small lights around the edge of the board so that we could manually make the lights flash when the student got a correct answer as a method of positive feedback.

After taking the prototype to PACE and getting some feedback on the design from the students and therapists there (see Results section for further discussion of prototype feedback), we started coding application. First we drafted some preliminary sketches of the views within the application and the screen flow process. We then discussed the algorithm that would choose the pictures for each round and the screen flow layout of the game. Below in Figure 2 and Figure 3 are some sketches from our design process.

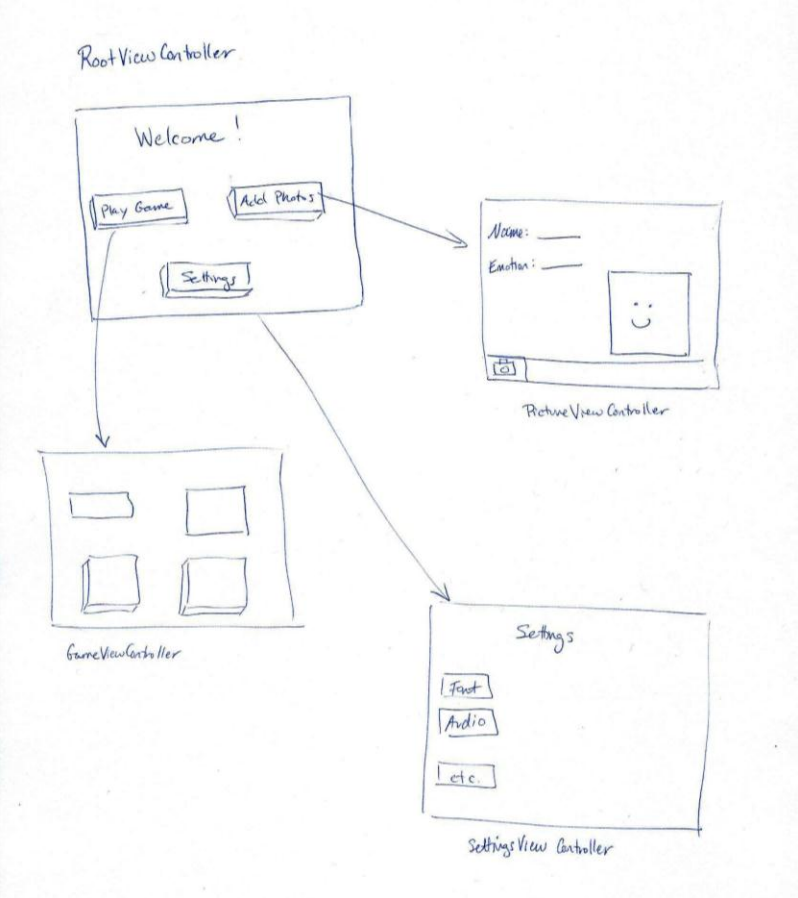

Figure 2: ViewController Schematic

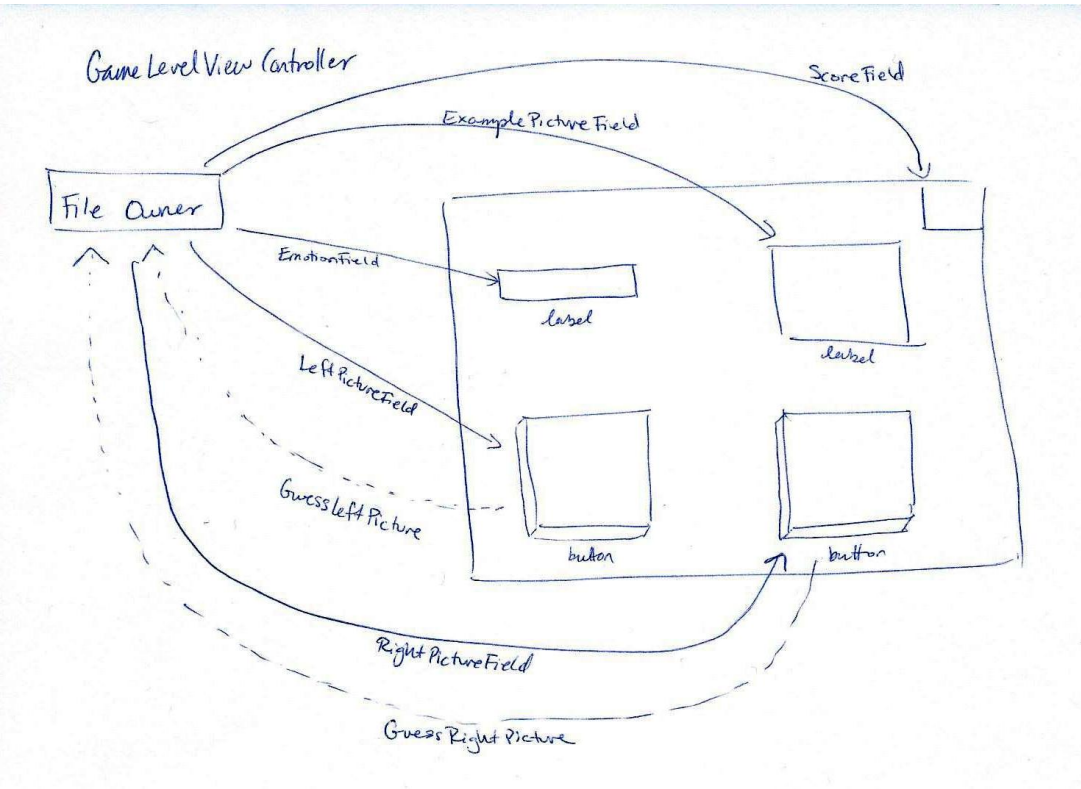

Figure 3: Game Screen Schematic

The following is a description of the final application that we created.We created two icons for our application, one for the standard iPad model and a higher resolution image for the new retina display iPads. These icons will eventually be the outward display of the application in the App Store if we chose to release the product through the App Store. When the code for the application is manually loaded onto an iPad for testing, the icon appears in the iPad's home screen of app icons.

Figure 4: App Icon

Clicking the icon brings up the main load screen of the application. This screen has two buttons: "Play Game" which takes the user into a level of the game, and "Add Pictures" which allows the user to take their own photographs to add into the game. The screen also contains the ProApps logo and the DiscoverEmotion logo.

Figure 5: Load Screen

Clicking on “Play Game” brings the user into the picture matching game. The format of the game closely resembles the prototype that we initially created. The word for the emotion is written in the upper left corner and the upper right photo is an example picture that always corresponds to the emotion word. The student then choses from the lower two pictures to find the picture where the person is making a face corresponding to the written emotion. The student selects his or her guess by tapping the photo. If the student chooses the correct answer, the correct photo spins around and three new photos and a new emotion words are displayed for the next round. There is a tally of the score (presented as correct answers out of total rounds) displayed in the upper right hand corner.

Figure 6: Game Screen

Currently, the application is set up such that there is no maximum on the number of rounds in the game. The main load screen/menu can be accessed at any time by tapping the "Back" button in the upper left corner. This simplified set up was ideal for testing with different students at PACE, allowing them to play for different lengths of time and transitioning quickly between students as well as for demonstrating the game. Modifying the code such that a level would have a set number of rounds would be easy.

The algorithm generating each round for the game chooses two random emotions from the list of six emotions, one for the correct emotion and one for the incorrect emotion. It then chooses 3 random people from the list of people whose photos have been added into the game, one for each of the photos on the game screen. The side on which the correct picture will be displayed is also chosen at random. Once the correct emotion, the incorrect emotion, the correct picture location, and the actors for the example picture, the correct picture and the incorrect picture have been chosen, the program loads all of the correct images and displays them on the screen. The program is designed such that each round is generated at random, and there is no limit on the number of people whose

pictures can be added to the game (the minimum number is three so that each picture can be a different person).

To add new pictures to the game, the user selects “Add Pictures” from the main load screen of the game (see figure 5). Selecting that button brings up a table of all of the actors (people whose photos are included) currently in the game (see Figure 1). From this menu, the user can add or delete actors from the table. To add photos for an actor or edit the existing photos for an actor, the user selects that actor’s name from the table, which brings them to the details view for that actor.

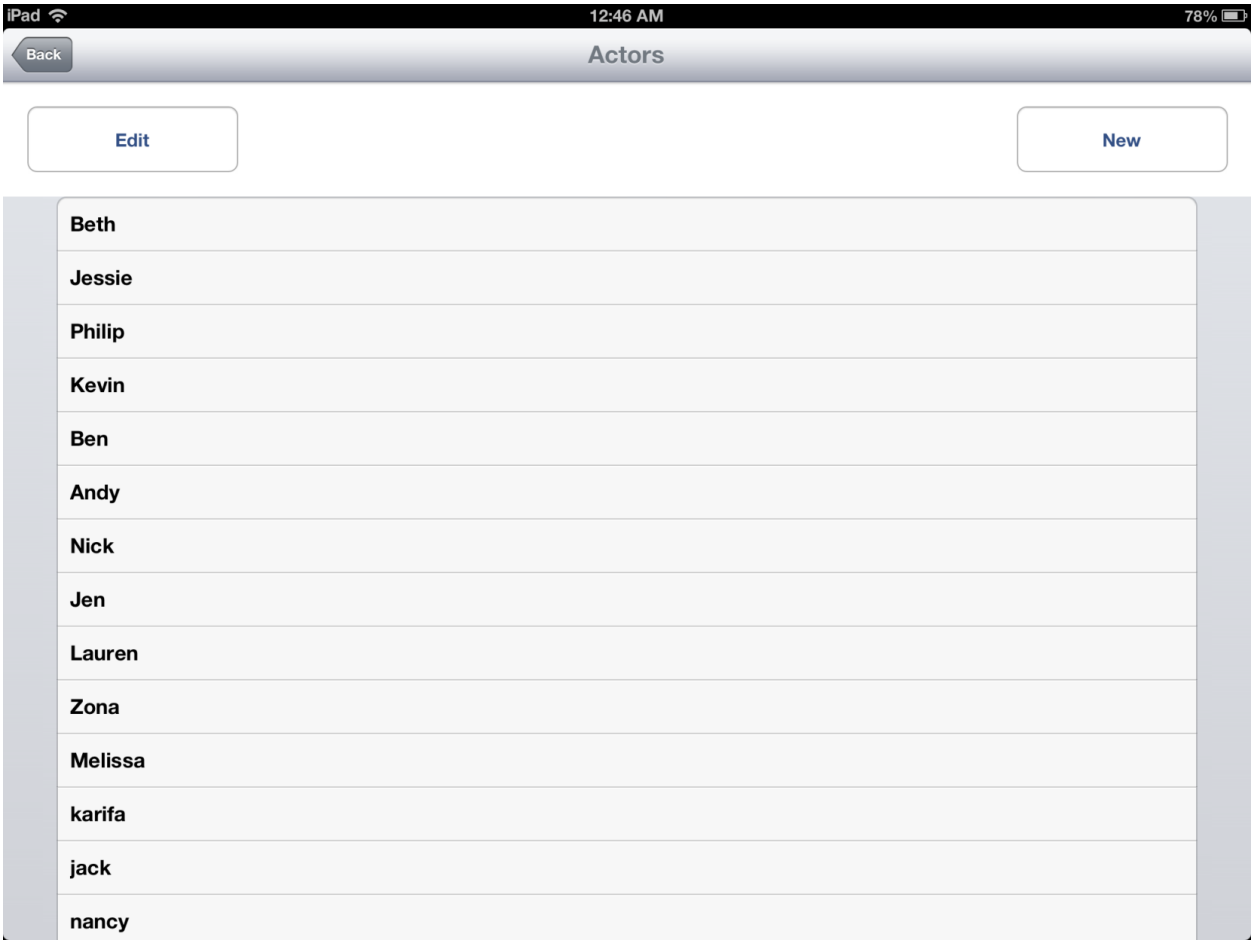

Figure 7: List of Actors Screen

On the details view for each actor, there is a field for their name (a keyboard pops up to type in the name) and six buttons, one for each emotion included in the game. Pressing on each button brings the user to a new page for that emotion picture (see Figure 8).

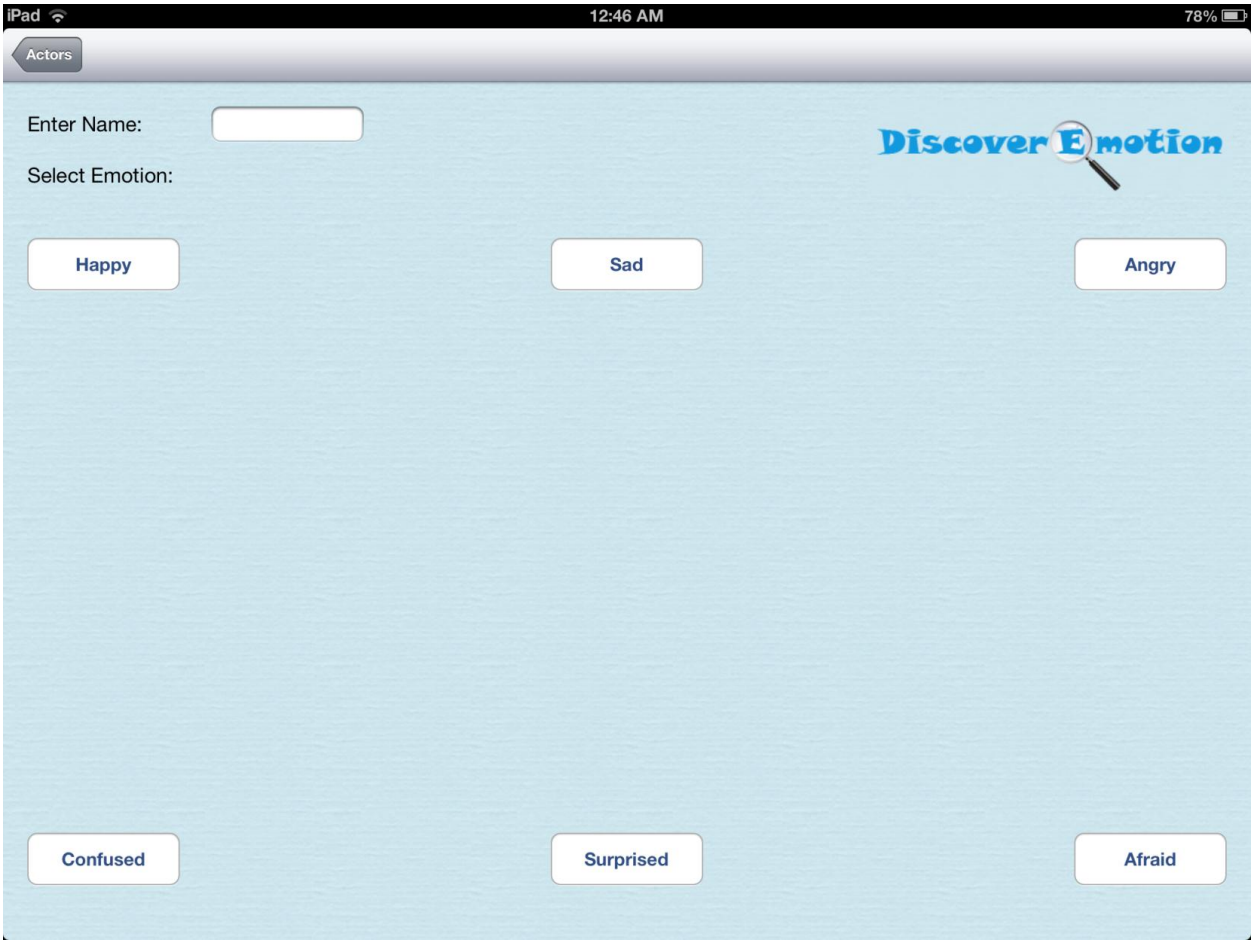

Figure 8: Actor Details Screen

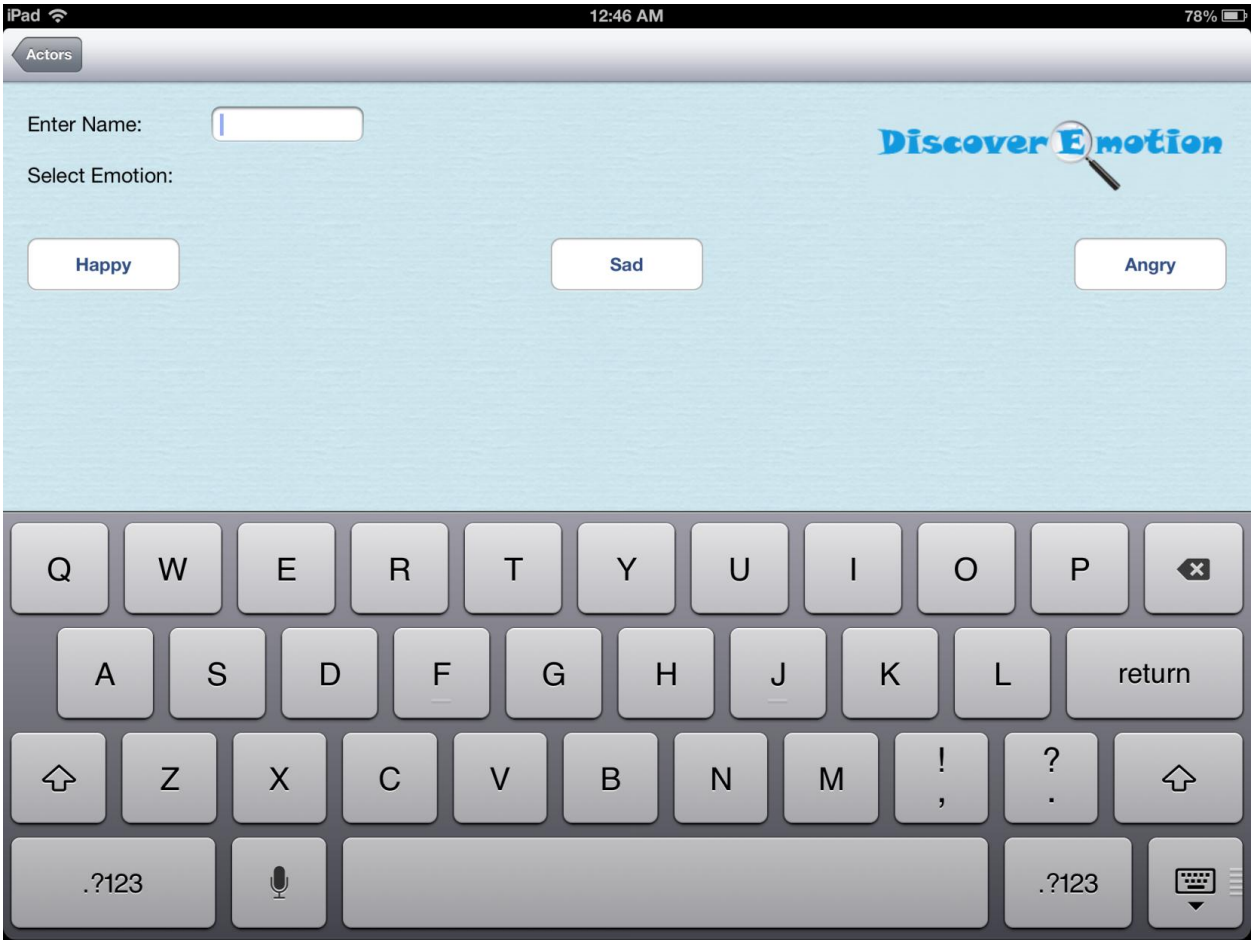

Figure 9: Actor Details Screen with Keyboard

Once on the screen for a given emotion (Figure 10), there is a camera button in the lower left corner of the page. To take a new photo or replace the existing photo, the user selects the camera button and then the iPad's built in camera opens so the user can take a photo. The user can then back track through the menus and add other photos using the "Back" buttons in the upper left.

Figure 10: Happy Picture Screen

After creating the iteration of the application described above, we loaded two iPads with the game and took them to PACE for a day of testing with the students there. We had preloaded the applications with pictures of Stanford students. When we first got to the center, we played the game with two of the students who used the original prototype from one of our previous trips to the center. These students quickly learned how to use the game, and played with it for approximately fifteen minutes. We were then able to take some photographs of the PACE staff to incorporate into the game. After loading in these photos of staff members that the students were familiar with, four students, including the original two, played with the game.

We observed that the two students who had used the prototype previously and used the app earlier in the day were significantly more engaged with the game as they started to recognize some of the people in the photos in the game. All of the students who played the game after adding photos of the PACE staff commented on the people that they knew in the pictures and seemed to be enjoying recognizing the staff making the different emotions in the game. We also noticed that some of the students were prone to repeatedly tapping the picture that they were guessing. Because the game was programmed to respond to each tap, a double tap would skip through rounds quickly as it would

count the double tap as two guesses for two different rounds. Finally, it took some students a couple rounds to understand that the picture in the upper right was an example of the emotion rather than one of the options that they could guess. Although, when we discussed the game with students, some said that they found the example picture helpful in determining the correct emotion to choose so it seems that the example picture is helpful but it could be more clearly distinguished from the options that the student is choosing between. This problem could be addressed by changing the background of the lower images to make it clearer that they were buttons, or framing the example picture in a more distinct way. Having an screen with instructions for the game that appeared at the beginning of each round would also be helpful in explaining the difference between the example picture and the lower two pictures.

In addition to these observations, we received some direct feedback from the students. We asked all of the students whether they enjoyed that the photos rotated when they selected a correct answer. Most of the students enjoyed the positive feedback, although some commented that it could be made more exciting. One of the students also commented that the wording for the score ("Score:" and "Out of:") wasn't clear and that "Right:" and "Wrong:" would be easier to understand. Finally, one of the students commented that he wished that he could play the game with others. We discussed some of the other apps that these students have used on the iPad that they like so we could research them to get ideas for improving our application. This student noted that he has played Words with Friends® and other similar games that have the option to play against other users and that was the format he was envisioning for adding a social component to our game.

We also spoke with some of the therapists and other staff members at PACE for additional feedback on our application. The therapists discussed the variations in motor skills that their students have (including repeated tapping and prolonged holds) so that we could get a sense of the different use scenarios that our application should be robust to. The staff also mentioned that our simple interface was good and that moving forward we should avoid adding too many other visual elements around the screen that weren't necessary for the game as they can be distracting to students. Finally, the staff expressed a desire to see output metrics from the students playing the game. In particular, they said that having information about which emotions were easier and more difficult for students to recognize would be especially helpful for some of their non-verbal students.

RESULTS

After the creation of our prototype, we returned to PACE to interact with a few of the students and gather feedback on our initial design. The four students we worked with on that visit represented a large difference on the spectrum of autism, which allowed us to gather valuable feedback on our

attempts to make a product that is customizable to many users. The younger students (about kindergarten age) were nonverbal and had much difficulty focusing on the task of the game. Neither of the two students we interacted with managed to complete the task once and seemed to be very distracted by the novelty of the prototype, as they repeatedly touched and fiddled with the various features on the board. On the other hand, the older students, who were on the less severe end of the spectrum, were able to give us much more direct feedback. These students demonstrated that they understood the objective of the game, to recognize and match emotions, and the only difficulty encountered in these interactions stemmed from the ambiguity between similar facial expressions (e.g. confused and afraid). An interesting quote we took from these interactions came from a student with Asperger's syndrome, who was suggesting other potential names for our application by saying that the game was not necessarily "how do I feel right now," but rather "what does it look like to feel [the emotions]". This was indicative of the fact that students have trouble with the internalization of emotions, and thus also have difficulty with the transition between social processing steps. In this respect, we feel that an eventual link between our app and the existing Emotionary app will allow for a deeper level of learning and understanding to occur.

After working with the students, we talked briefly with the therapists at PACE to gather feedback from professionals who work with the students on a daily basis. This discussion yielded many suggestions for our final product, and gave us a long list of customizable features that the therapist team thought would be helpful to include. Although we very much appreciated their input, we had to keep our limited timetable in mind when selecting some of these features to implement in our final iteration. Nonetheless, given all of the information gleaned from each interview and especially given the valuable feedback we gathered from our interaction with the students, we were able to come up with a model upon which we could base our final product. This model included the use of large buttons, simple menus, and easy pathways to enhance the usability of the app, a feedback system that provides a controlled response for correct answers, as well as a scoring system, and the customizable features discussed below.

DISCUSSION AND FUTURE WORK

At the conclusion of our quarter-long project, we sat down to gather our thoughts on its development as a whole and evaluate the large amount of feedback we received from the students and staff at PACE. A similar debriefing period also took place at the midway point of the quarter, where we discussed the future direction of the app given the testing we had done at the time. One of the major things we realized was that the long list of suggestions for customizable features given to us by the staff, whether it be the addition of audio or the ability to change font characteristics, was far too extensive for us to implement in the short amount of time remaining. Thus, we focused our

attention on the customizable features that we considered to be the most important to expanding on social processing, then adding what additional features that time allowed. The main feature we focused on while developing and coding the app was the inclusion of familiar faces. While we discussed this in depth even before creating the paper prototype, it became evident that this feature would be the detail that set us apart from existing apps and interactive DVDs that address emotion recognition. Therefore we kept this in mind during the actual coding of the app, and the result was an entire screen dedicated to the user addition of familiar faces (see Methods section above).

While this was indeed more engaging for the students, the feature did have some drawbacks that came to light during testing. The most prevalent of these was the difficulty encountered by users attempting to make the facial expressions of the six emotions given to them. It was rather difficult to find a balance between an overly exaggerated expression and one that was simply not expressive enough to distinguish between the others. Thus, for future consideration, we would like to include a set of instructions, user guide, or even an array of sample pictures that would assist the user in making more recognizable facial expressions for each emotion. For example, a tester of our product suggested having the user watch a series of videos that were designed to elicit specific emotions, then have the app take screen shots throughout the video. The opportunities to expand on this feature are numerous, and we hope that future developers will consider spending time perfecting an easy and efficient method.

Another drawback to the familiarity feature we considered for future use was the user would have to add an extensive library of pictures to the app in order for the student to take advantage of it right away. Thus if the student did not have many people readily available to add photos, the game would not be as effective. This presents a great opportunity for future work, as having a preloaded set of pictures that included a variety of people of different demographics would truly allow for a more extensive experience for the student.

Finally, there is a huge opportunity for having the app output the metrics for a given session in a way that is concise and easily understandable for therapists and parents alike. This was also a feature that we considered in our initial brainstorming session, however we quickly realized that it was outside the scope of this course due to time constraints. Nonetheless, we discussed the potential impact of allowing therapists to further customize students' learning experiences by being able to view which emotions are giving a specific student trouble, or which emotions they find particularly easy. We feel that this feature, in conjunction with the addition of our familiarity feature, could catapult DiscoverEmotion to the ranks of the most helpful educational tools available to students with autism.

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