“Children like to tell stories, make up games, and build things. In much of our field research, we saw that children are natural-born artists and writers, architects and philosophers. They are sculptors and poets, dancers and musicians. Children are not waiting to become these in the future; they are all of these things right now.” (Druin, Boltman, et al. 1997; Druin and Solomon 1996)
INTRODUCTION

EmaFaces revisits StoryFaces, a storytelling iPad ebook application that enables pre-school children ages 4-5 to explore emotional facial expressions in the form of self-created as well as scripted narratives. Citing research in cognitive and developmental psychology, I propose several features that address the challenges discovered during the user testing phase of StoryFaces, in hopes of improving the socio-emotional development of children ages 4-5.

Motivation

In extending the work on StoryFaces, EmaFaces focus on the exploration of socio-emotional narratives for pre-school children ages 4-5. Developmental psychology literature has shown that for young children, the deliberate enhancement of facial expressions can be crucial to their cognitive, social, and language development. Studies suggest children who are better at identifying fearful facial expressions grow up to be kinder and more generous towards their peers. User study has shown that StoryFaces is very successful with children ages 6-10, where a variety of facial expressions were recorded, and the children collaborated with each other in creating complex stories both scripted and freestyle. They also spent a significant amount of time in the Back Stage. EmaFaces attempts to address the specific challenges faced by children ages 4-5 in order to match the level of success achieved by StoryFaces for children ages 6-10.
**BACKGROUND**

StoryFaces was created with the assumption that “children like to tell stories, make up games, and build things. [They] enjoy many different forms of expression: sound, visuals, movement, and physical appearance.” (Druin, 1998).

**StoryFaces**

StoryFaces is comprised of three components: Video Booth, Story World, and Backstage.

**Video Booth**

The children are invited to make a variety of emotional facial expressions in the video booth. Ema, an animated character, tries to elicit different types of facial expressions from the children. The children do not know at this stage the recorded faces will be used later in the Story World.

**Story World**

Once the children have 3-5 recorded faces, the recorded faces are incorporated into the Story World. There are three scripted stories: “Expressions with an Alien”, “In the Balloon”, and “Walking in the Woods”. Ema narrates the text of the stories.

**Back Stage**

Upon viewing Story World, the children can “go backstage” to edit the story, by changing the order of the recorded faces. They can also record narration for each scene and draw their own backgrounds for each scene in the story.

The children also have the option of creating their own freestyle stories with the recorded faces. The children can draw their own costumes and backgrounds for their recorded faces. In crafting the freestyle story, four scenes are provided for storyboarding. At any point the children can return to the Video Booth to record additional facial expressions. There is also a “Move Character” option for animating the character in a scene.

The app was implemented in ActionScript 3 for Flash. The choice of a touch-based interface such as the iPad with a built-in webcam affords young children intuitive control for basic UI operations such as clicking and dragging movies into storybook illustrations.

**Challenges**

During the user study phase of StoryFaces, it was found children ages 4-5 focused primarily on the making “happy” faces even when Ema prompted them to make a sad or angry face. Their stories contain many smiling characters. Furthermore, they did not make the connection between recorded faces and the final story. While they sometimes narrated stories involving negative emotions, they did not go back to the video booth to re-record corresponding faces.

Ryokai, K., et al, found that children ages 4-5 could not connect distinct scenes of the story as parts of a whole story. Druin, et al, “found children may start a task without finishing it, then start another, and yet another. Then without pause they might go back to the task they started at the beginning and then start something else anew” (Druin, Boltman, et al., 1996). Druin further observed that “when children are given
the chance to use technology in ways they would like, many times they do not have a defined task and their activities are open-ended and exploratory” (Druid, 1996a). Younger children often ended up with shorter but more stories than older children who created stories with more complexity.

Children ages 4-5 did not edit or revise their stories after viewing them. This meant that the only time they were engaged in the Back Stage is the first time, for both the scripted and freestyle stories.

In order to engage younger children to make non-happy facial expressions, StoryFaces proposed making the Video Booth more thematic and dramatic. In addition, Ema could facilitate the recording in a more dramatic but fun way.

The scripted storyboards of “Expressions with an Alien”, “In the Balloon”, and “Walking in the Woods” could be re-constructed such that each scene is both self-contained but also expandable as a whole.

The main challenge that remains is how to best motivate the children to make “non-happy” facial expressions. It has been noted “the best method for motivating children to stick with a computer program may be designing intrinsically rewarding activities in which mastering a challenging problem is rewarding in itself.” (Lepper 1988; Malone 1980) EmaFaces accepts this task in further exploring the challenges faced by StoryFaces.

Ryokai, K., et al, found children ages 4-5 spent time editing the visual aspect of their characters such as how they dressed. This is an important observation as children of this age range respond strongly to visual cues, because “children are sensitive to what they see, much more so than adults would imagine.” (Druid, p. 67) By expanding the pre-made costumes in the Back Stage, children could be motivated to go back to the Video Booth to record the facial expressions they deem as more fitting for the costumes available. While animal outfits can be tricky in terms of children’s different interpretations of the same animal, having the animals be hats with facial expressions that cue non-happy faces could be a prompt for children to make the same faces.
There is a relationship between children’s ability to interpret facial expressions and their ability to produce “non-angry” faces.

Pre-School Children and Non-Happy Emotions

In an early study by Gates (1923), children varying in age from 3 to 14 years were asked to name the emotions shown in face expressions. Gates found “a gradual increase in ability to interpret each picture as we pass from the youngest to oldest children” (1923: 453). Even with liberal scoring, the only expression identified accurately by the majority of three-, four-, and five-year-olds was a happy one. Anger was not labeled correctly by until 7 years, fears until 10 years, and surprise until 11 years of age. (Figure 4.1-1.3, 5.1-2.3) (Bullock, M. & Russell, J. A., 1984)

Rieffe, Meerum Terwogt, and Cowan (2005) asked 4 year olds to explain various emotions. The children referred to desires, not beliefs for “happy”, “anger”, and “sadness”. Five year olds had difficulty identifying the facial expression corresponding to “surprise”. Adults selected Ekman's prototypical surprise expression (Figure A), while five-year-olds selected face B as often as C. A likely explanation could be that children often hear the word surprised in the context of “surprise party”. (Bullock, M. & Russell, J.A., 1984) Four-year-olds produced much the same picture, although they demonstrated slightly broader categories than five-year-olds. Markham and Adams proposed that four-year olds' lower performance for was not due to simple performance difficulties but to the fact their emotion categories were still developing.

Over the preschool years, children move slowly but gradually shift understanding emotions in very broad terms to toward a narrower, adult-like understanding. Emotion categories enter a child's taxonomy in a systematic order. (Figure B). In addition, children use different emotion labels with varying frequencies, which could be attributed to the children experiencing or witnessing some emotions more frequently than others, the following labels were found in order of descending frequency, “happy,” “sad,” “angry,” “scared,” “surprised,” and “disgusted.” (Widen & Russell, 2003, Study 3).

In addressing emotion categories, Widen, S. C. suggests “emotion categories begin broad, including all emotions/faces of the same valence, and then gradually narrow over the preschool years.” Citing Izard's (1971) extensive investigation of over 400 French and American children, where carefully selected photographs of prototypical expressions of basic emotions was used (Figure A), children were presented with two tasks: 1) for each photograph, the children were asked to produce a label; 2) given a label, the children were asked to recognize and select the one “correct” photograph out of three. The children did average over 50% correct on the first task until 9 years old. For the second task, the children did not average over 50% correct until 6 years old. (Widen, S. C. & Russell, J. A.)

Did the Children Really Err?

Widen, S. C. & Russell, J. A. propose that rather than discrete emotions, children's emotional categories are grounded in the concepts of valence and arousal. As shown in Figure C, these two dimensions can be
expanded to four broad categories: pleasure/high arousal, pleasure/low arousal, displeasure/high arousal, and displeasure/low arousal. “Evidence indicates that this dimensional theory dominates the child's thinking about emotion for the second and most of the third years of life.” (Widen, S. C. & Russell, J. A., 2008)

![Emotion Diagram](image)

Widen, S. C. & Russell, J. A. believe the errors children make in labeling and recognizing facial expressions may be systematic, for children are observed to 'mislabel' a face with a label from a similar emotion category than from a different one, with similarity specified by the structural model in Figure C. (Widen & Russell, 2003).

Bullock, M. & Russell, J.A. believe the notions of fuzzy boundaries, structure, and dimensions lend a richer account of the development of the interpretation of emotion ages 4-5. Rather than condemning children as “inaccurate adults”, their behavior is better described within the frameworks presented. (Bullock, M. & Russell, J.A., 1984)

*Are Children Able to Make Non-Happy Facial expressions?*

According to the simulation account (Harris, 1992), emotion understanding begins not with witnessing the emotions of others, but with experiencing them oneself. “In anticipating the others’, one does not rely on a conceptual theory or an innate module, but can simulate the experience in oneself.” If children are correctly able to identify “non-happy emotions” via the framework presented by Widen, S. C. & Russell, J. A., they are fully able to make the same expressions. EmaFaces tackles the challenge in working with children ages 4-5 improve to their socio-emotional growth.
“Designers may approach a product for children with the attitude “I know kids” or “I have kids so I can design for kids,” and they may come up with appealing and age-appropriate graphics and humor. But how to design a game that children can easily figure out how to play may still be elusive.” (Druin, A. p.15)

**Earlier Iterations**

**First Iteration**
The first iteration provided an opportunity for the author of EmaFaces to understand what the next step of EmaFaces prior to research into developmental psychology as well as child-centered interaction. It did not give consideration to developmental psychology (Figure 1.1-1.7). It was the author’s naïve vision of ways in which the new interface would appeal to kids. There is text everywhere, mixed in with audio direction from Ema. The first slide has an option for children ages 4-5 and 6-10, an option that was eliminated in later iterations. While pictures of other children meant to suggest various facial expressions were shown, it was eliminated, for “[the children] don’t want the visual look of things to talk down to them or question their intelligence.” (Druid, A. p. 67)

Figure 1.8 describes a process in which children are asked to put together their recorded faces, as if in a puzzle. Based on these choices, Figure 1.9 then matches the recorded faces to the scripted stories. Design based on labeling and recognition was given serious consideration but eliminated after further understanding of the type of framework children ages 4-5 gravitate in “Did Children Really Err”?

**Second Iteration**
The second iteration emphasized themed backgrounds for the Video Booth (Figures 2.2-2.8). In addition to cues from Ema, themed backgrounds provide additional cue for the children that their facial expressions should match the mood set by the background. With the exception of the happy face, each “non-happy” was prompted at a minimum twice, in addition to Ema’s guidance, accentuated by color cues and symbols. For “angry” (Figure 2.5-2.6) and “sad” (Figure 2.7-2.8), an extra symbol was included for further emphasis. Since children ages 4-5 did not make a connection between the different scenes in the story and the story as a whole and spent a lot of time on the visual aspect (Figure 2.9-2.10), each scene now has the option of going back to the “Dressing Room” for additional costume change. The “Move Character” button was removed since children ages 4-5 were not seen to use it in StoryFaces. This may be because they lack in visual acuity, or “the ability to distinguish details in objects that may be measured in static and dynamic settings.” (Hourcade, J. P., p.294) Similarly, the Video Booth button was removed because the children were observed to not go back to re-record facial expressions.

**Final Iteration**

**Design Principles**
Children will use EmaFaces in a similar fashion to StoryFaces, except spend more time recording their facial expressions via themed backgrounds and more direction from the guiding character, Ema. Ema Faces taps into the observation that children ages 4-5 respond strongly to visual cues, and introduces animal costumes and themed backgrounds intended to cue “non-happy” facial expressions in children ages 4-5.
Wyeth and Purchase [Hourcade, J. P. p.337] emphasized the need to take into account developmental psychology literature when forming concepts for the design of child-centered technologies. Based on Piaget's pre-operational stage (under seven-years old), StoryFaces supports “open-ended and discovery-oriented activities, child-initiated play, active manipulation and transformation of physical items, easy ways to get started, increased challenges for better skills, and the opportunity to create something”. (Hourcade, J. P., p. 355) Ryokai, et al observed that “children of all ages felt strong ownership over the characters made with their own recorded faces.” Piaget would interpret this as “children’s motivations to learn are in great part due to their drive to grow, love and be loved, and assert themselves. (Hourcade, J. P. 2007)

In improving StoryFaces, EmaFaces looks further into developmental psychology for the theoretical framework to address the challenges encountered in StoryFaces. Some researchers have found touchscreens to be well-received by young children, EmaFaces will continue be an iPad application. Druin believes “touch screens remove difficulties children may encounter in operating an external device like a mouse.” (Druin, A., p.319)

**Buttons**

For navigation, EmaFaces will modify the current textual buttons into picture icons. As Druin, A. & Solomon, C. pointed out, “a game for 4-year-old children that requires reading is not age-appropriate.” (Druin, A, p.7) For designing pictorial icons, Juan Pablo Hourcade asserts “The best icons for children are easily recognizable and familiar, representing items in their everyday world.” (Hourcade, J. P. p.19) In so doing, the icons are similar smaller versions of parts of EmaFaces. Unlike in the first and second iterations, where the buttons were small and textual, the buttons in the final iteration are larger for easy navigation.

**Ema**

For the final iteration, Ema will continue to provide on-screen audio instructions. Furthermore, Allison Druin further suggested “[children] can click the characters to hear instructions repeated. Add highlighting or animation of objects that are being referred to in instructions to help direct attention.” (Druin, A., p.18) Ema will also use the phrase “I need your help...” to prompt the child to make “non-happy” facial expressions. This would “empower the child and they in turn would be more excited to share their thoughts.” (Druin, A., p. 36).

Ema could also be animated to make the same expressions, providing contextual clues in his body such as covering his face when sad; and putting his hands on his hips when angry. This draws on Lev Vygotsky’s concept of scaffolding, or the idea that children need help to complete a task before they can complete it on their own, which in this case is the appropriate facial expression. “When children can complete a task with scaffolding, but cannot complete it on their own, they are in the zone of proximal development. Vygotsky thought that good learning occurs when children are in this zone, rather than when they are ready to complete tasks individually. Once children internalize the processes that help them accomplish the tasks, they are able to complete the processes individually.” (Hourcade, J. P., p.287)

**Video Booth**

Gardner and Moran propose that multiple independent yet interacting intelligences lend an effective way for understanding human cognitive abilities. Educators have been inspired to make educational activities that
teach concepts by introducing them through many entry points that leverage children’s multiple intelligences. The more entry points into a concept, the more likely a greater number of children will understand it. (Hourcade, J. P., p.292) StoryFaces enables children ages 4-5 to record their facial expressions, draw and animate their illustrations, act out, narrate, and storyboard and re-edit scripted and freestyle stories. In so doing, the interface provides multiple points of entry for self-guided storytelling.

In the Video Booth, rather than directing the child to make one of each facial expression, Ema will prompt the child to make “non-happy” expression multiple times and only use the last recorded face to be incorporated into the Story World. Themed backgrounds ranging in color as well as symbols provide additional context for the child. For integrating the recorded faces into Story World, only the last recorded face will be used as it may be closer to the desired “non-happy” expression. (Figure 3.2-3.8)

*Story World*

Hourcade, J. P. believes preschoolers are more likely to concentrate on one aspect of a task and neglect others, and in so doing, concentrate on the current state of a task without paying much attention to what happened previously or anticipating what will occur next. (Hourcade, J. P., p. 298) Markopolous, P., et al assert children ages 4-6 have limited attentions spans (Markopolous, P., et al., p.100).

In fact, children ages 4-5 can only hold four or five chunks of information in short-term memory versus seven for adults. This limited working memory capacity translates into reduced complexity in the types of tasks children can handle, for “a smaller working memory limits the amount of information children can keep in mind when problem-solving as well as the relationships children can establish between pieces of information.” (Hourcade, J. P., p.295)

As seen in Story World, children ages 4-5 did not connect the different scenes as one story. To rectify this, starting in Back Stage EmaFaces introduces arrows that provide navigation for the next scene, as well as establish connection between the scenes. The arrows themselves could be animated for additional emphasis. In revising the scripted stories, each scene is now self-contained and independent of the arc of the story. Once the children have made the connection between the scenes, more complexity could be achieved with completing the complete arc of the story.

How effective will this feature be? It should be noted children ages 4-5 have exhibited the ability to relate new situations to previously experiences based on similarities. They have a basic understanding of causality, or that a particular action can trigger a subsequent event. (Hourcade, J. P., p.299) Ema could also explain to the children that the scenes are connected, for “younger children are often unable to track their own progress toward end goals unless they are given frequent reminders and intermittent rewards.” (Druin, A., p.18) Based on these assumptions the children should be successful in connecting the scenes as one complete arc.

Moraveji et al. (Hourcade, J. P., p.217) observed that if children fill in the blanks in comics that have a distinct beginning and an end, they produce more ideas than if they are given blank pages to do so. However, children ages 4-5 are very creative with their self-narrated and crafted freestyle stories, and will continue to add scripted stories as well as the option for freestyle.
**Back Stage**

EmaFaces approaches the Back Stage with the idea that children ages 4-5 are visual in nature, and intrinsically motivated to spend their time backstage. Like with Ema, the tools in both the Background and Dressing Room could be more animated and dynamic. As in “Kid Pix Studio, a unique painting, animation, and slide show product... It has all the typical paint tools (e.g. brushes, geometric shapes, undo), but it has silly sounds, animated erasers, and more. The sounds you can turn off if you choose, but rarely do because it is too much fun to hear. The paint drips, or the eraser blows up, or the letters talk to you.” (Druin, A., & Solomon, C., p.133)

**Animals as Costumes**

In her book “Why the Wild Things Are,” Melson reports that kids see animals in the inkblots of the Rorschach test twice as often as adults do. (MooAllem, J., “A Child’s Wild Kingdom”. The New York Times, May 4, 2013) Likewise, when a Tufts University psychologist asked kids to tell her a story that they’d made up on the spot, ”between 65 and 80 percent of them told her a story about animals.” (MooAllem, J.) The psychologist David Foulkes noted that “61 percent of the dreams that children have between the ages of 3 and 5 years old are about animals”. (MooAllem, J.) According to MooAllem, “young children have been shown to acquire fears of spiders and snakes more quickly than fears of guns and other human-manufactured dangers”. (MooAllem, J.) It is after the age of 4 that fear of big predators like bears and wolves emerge, which coincides with “when the first human children would have begun roaming outside of their camps.” Similarly, fears of lions and sharks peak during preschool. (MooAllem, J.) Therefore, spiders, snakes, bears, wolves, lions and sharks can all be choices for “non-happy” faces. Due to the ambiguity of emotions associated to animals, a result of the types of stories and experiences children were previously exposed to, each animal costume will have an expression of its own, like an animal hat. The Back Stage “Drawing Room” will be populated with 4 such rotating hats (Figure 3.9). Each expression will be represented by the animal closely associated with a “non-happy” expression, as well as making facial expressions themselves in the hat to remove further ambiguity.
EVALUATION

Usability Study
To measure the effectiveness of the features introduced in EmaFaces, the next step is to conduct a usability study. About twice the number of children, 16-20 of an equal number of boys and girls would be recruited for the study. The children should have no known learning disability or obvious sensory or physical handicaps. Parents would be asked to provide optional information on how much previous exposure the children have with iPad ebooks and games alike, in order to accurately interpret the children’s receptiveness to EmaFaces. Since the children from the StoryFaces usability study are outside the age range we are interested in, all children would be exposed to both StoryFaces and EmaFaces for the first time. As with StoryFaces, researchers are to provide basic explanations for how to record facial expressions in the Video Booth. However the fact that the recordings would become part of the storybook would not be disclosed.

The usability study is to test the following three hypotheses:

Hypothesis 1: provided themed backgrounds in the Video Booth, children ages 4-5 will be able to record more “accurate” facial expressions.

Hypothesis 2: children would be able to connect individual scenes as part of the whole story with the help of arrows in the Story World.

Hypothesis 3: children would be motivated to go back and re-record facial expressions in the Video Booth with the help of exciting animal hats in the Back Stage and animated drawing tools.

Since the number of children we may be able to recruit may be limited, a within subjects study will be conducted. Each child will have an opportunity to play with both Story Faces and Ema Faces. An intermittent break between the sessions for each “Faces” ebook due to possible fatigue for children ages 4-5. The order will be randomized such that an equal number of boys and girls will play with Story Faces or Ema Faces first.

Table 1 summarizes the independent and dependent variables of the study:

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Dependent Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Story Faces</td>
<td>Ema Faces</td>
</tr>
<tr>
<td>no themed background</td>
<td>themed background</td>
</tr>
<tr>
<td>no arrow</td>
<td>arrow connecting the scenes within each story</td>
</tr>
<tr>
<td>no animal hats</td>
<td>animal hats in the Back Stage</td>
</tr>
</tbody>
</table>
If carried out simultaneously, the control variable should be such that all iPads used are the same screen size. The random variables may be the time of day the study is carried out as well as the room the study is carried out in.

As proposed StoryFaces, EmaFaces would ideally have a “magic mirror” setup, where the iPad may be propped upright like an easel with markings on the floor to encourage the children to have full body interaction.

**Qualitative Results**
As with StoryFaces, each session would be recorded for qualitative analysis of the difference between the children's experiences with EmaFaces versus StoryFaces. The independent variable arrows could be assessed qualitatively, with the null hypothesis being the arrows have no sway over the children's understanding of the scenes as part of a bigger story.

**Quantitative Results**
The themed background and animal costumes could be tested quantitatively, as metrics are collected to establish differences between EmaFaces and StoryFaces. The null hypothesis in each case is that EmaFaces has no effect on the number of accurate recorded faces/likelihood of returning to the Video Booth. The null hypothesis is assumed to be true unless we are can statistically reject it (or do not reject alternative hypothesis) via the calculation of the p-value. In each case, if $p < 0.05$, there is a less than 5% chance that the null hypothesis is true, or a very small likelihood the results are due to chance.
CONCLUSION

EmaFaces deconstructed StoryFaces, a storytelling iPad ebook application that enables pre-school children ages 4-5 to explore emotional facial expressions in the form of self-created as well as scripted narratives. Citing research in cognitive and developmental psychology, several features were added and the existing interface addressed to improve the socio-emotional development of children ages 4-5. This includes more animation to both Ema and the drawing tools; themed backgrounds to the Video Booth; more guidance in Story World; as well as animal costumes in Back Stage.

Hopefully, EmaFaces will be successful in motivating and engaging children ages 4-5 with storytelling, a variety of facial expressions both happy and “non-happy”, and collaboration. The possibilities are infinite.
First Iteration

Figure 1.1

Figure 1.2

Figure 1.3

Figure 1.4
First Iteration, continued

**StoryFaces**

Go ahead and choose a story you would like, today!

- Expressions with an Alien
- In the Balloon
- Little Red Riding Hood
- Create My Own!

(audio) Remember the colors you'd assigned for the faces you made? The colored icons next to each story shows if and how often each of those types of

---

Figure 1.9
Second Iteration

Figure 2.1

Figure 2.2

Figure 2.3

Figure 2.4
Second Iteration, continued

Figure 2.5

Figure 2.6

Figure 2.7

Figure 2.8
Second Iteration, continued

Figure 2.9

Figure 2.10

Figure 2.11
Final Iteration

Figure 3.1  Figure 3.2

Figure 3.3  Figure 3.4
Final Iteration, continued

Figure 3.5

Figure 3.6

Figure 3.7

Figure 3.8
Final Iteration, continued

Figure 3.9

Figure 3.10

Figure 3.11
Mad Facial Expressions

3 year-olds

Figure 4.1

4 year-olds

Figure 4.2

5 year-olds

Figure 4.3

Sad Facial Expressions

3-year-olds

Figure 5.1

4 year-olds

Figure 5.2

5-year-olds

Figure 5.3

M. Bullock, J.A. Russell / Interpretation of facial expressions

Figure A

Nine facial expressions ordered according to a structural model. Photographs A, C, D, E, F, and G are taken from P. Ekman’s (1976), *Pictures of facial affect* [Palo Alto, CA: Consulting Psychologists Press, Inc.]


