University of Sunderland

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Let’s play together: The design and evaluation of a collaborative, pro-social game for preschool children

ABSTRACT

This study designed an interactive game that enables preschool children to play and practise a basic social skill of emotion recognition. We designed 40 age-appropriate cartoon emotion faces based on scientific and aesthetic principles with the aim of encouraging collaborative play and used 20 of the emotion face cards before and after playing the games. We tested 95 preschool children from three schools playing two interactive games: a specially designed emotion game and a control game for a touch screen device. We controlled for the effect of the game by testing one cohort of children with a non-emotion game of similar complexity. The increase in scores in recognizing the emotion faces from pre-test to post-test is significant for girls when playing the emotion game, with especially large increases in scores from girls from the most deprived school. The boys scored higher for collaborative play and also scored significantly higher than girls at recognizing anger but girls were better at recognizing fear.Qualitative analysis using the Talk Taken Down technique showed more egocentric than social dialogue but also more non-verbal expressions of cooperation and enjoyment than verbal interaction with the game. The gameheld their attention well.The study concludes by suggesting seven design considerations for designing prosocial, collaborative games.

Keywords

User-centered design, Web-based communities, emotion recognition, collaborative games, prosocial games

1. INTRODUCTION

When children start preschool they are on the cusp of developing an understanding the mental states of others which is key to the development of empathy and understanding of others. We designed a game that investigated the children’s interactions with their peers while playing the game in mixed sex and single sex pairs. We describe the process of designing appealing, age-appropriate, scientifically-based cartoon emotion faces for an interactive, collaborative game designed for touch screen tablets. After designing, developing and testing this game in the field, we used it as a tool to test its effectiveness as an intervention in teaching the recognition of five of the Ekman’s (1971) basic emotion faces: happiness, sadness, anger, surprise and fear;omitting the sixth basic emotion, disgust. We based this on evidence suggesting that children up to the age of nine confuse the facial expression of disgust with anger and link explanations of this emotion to anger (Widen and Russell, 2010). The aim was to design a collaborative game with emotion recognition as the domain with the premise that children may improve their emotion recognition skills while interacting and playing a fun game. However, even if the children learn these skills, Bandura’s social learning theory (Bandura, 1961) cautions that it will not necessarily result in a change in behaviour. We aimed to design a game that would engage (design for motivation) and keep interest (design for control) using a domain that may help classroom teachers discuss and teach personal and social skills. The contribution of this study is to describe the design and evaluation of a collaborative, prosocial game for preschool children, an analysis of its use as a research tool to analyse collaborative use and the difference in pair-types (girl-girl, boy-girl and boy-boy) and a set of guidelines for designing such games.

Teachers of preschool children in the UK (Kim et. al., 2012) emphasise the development of sharing and social play in school activities so inan increasingly digital world of play it is timely to assess the role of technology in preschool sharing activities. One role for technology is how it can be used in a collaborative context to stimulate dialogue about the shared game. This builds on the sociocultural approach to dialogue and development (Mercer and Littleton, 2007). They suggest that PC screens and keyboards are not conducive for joint use but the wide accessibility to mobile tablets such as the iPad offers opportunities to design for collaborative play. The contribution of this study is to take an interdisciplinary approach to both the design and evaluation of an intuitive, fun game that can be played in pairs by pre-literate, preschool children for fun and to foster emotion recognition skills. Special consideration has been given to the design of appealing, age-appropriate, realistic emotion faces in cartoon form. We combine approaches from interaction design and psychology by reviewing the causes of problems in identifying emotions as part of the broader skills of emotional intelligence. We then describe the process of designing and evaluating an interactive game for preschool children with an emotion domain with the goal of offering a design to appeal to both girls and boys and to help them with the skill of emotion recognition. Evaluation of the interaction between the pairs playing the game was done by observing the dialogue between each player using Piaget's technique of Talk Taken Down (Piaget, 2002).

1.1 The development of social competencies

Children develop a complex set of skills in the first three years of life that enable them to interact socially with, and learn from, others. The development of social skills from infanthood to pre-school begins with the development of the cognitive skills of understanding other's intentions and in time these skills will enable children to understand the perspectives, motives and mental states of others. Selman (1980) described children aged three-six as having undifferentiated perspective taking where although they sometimes understand that the self and others can have differentthoughts and feelings, they frequently confuse the two. This is important for social skills development as perspective taking is thought by developmental researchers as one possible cognitive antecedent of prosocialbehaviour. One of the key developmental skills in interacting socially is to be able to recognise emotions and some preschool children enter school having difficulties recognising the major group of emotions (McClure, 2000). McClure's meta-analysis of the literature on children's ability to recognise faces showed that there are mixed results on whether there is a gender difference in recognising emotions.These social competencies mature over time and lead to the development of emotional intelligence (EI). One scientifically validated, ability-based emotional intelligence model is the Mayor, Salovey, Caruso Emotional Intelligence test (MSCEIT)Mayer, Salovey& Caruso (2000). This ability-based model views emotions as useful sources of information that help one to make sense of and navigate the social environment including using emotions to achieve intended goals Mayer, Salovey& Caruso (2000). The model (validated for adults) is based on four areas: first perceiving or identifying emotions, the ability to perceive and interpret emotions in faces, pictures, voices, and cultural artifacts. They suggest that this ability to perceive emotion is a basic aspect of emotional intelligence that makes all other processing of emotional information possible.

A review of the development of emotional intelligence (EI) in children by Zeidner, Matthews, Roberts and MacCannZeidner, Matthews, Roberts and MacCann (2003) proposed that biological and sociocultural factors interact in a complex way in lower-level competencies that provide a platform for developing skills with an emotion component that become more differentiated over time.A recent neuroscience study in adults using lesion mapping and the MSCEIT, IQ and personality tests (Barbey, 2012) has given an insight into this biological basis by finding interconnections of cognitive and emotional processes that have hitherto been taken as separate constructs. The testing of emotional intelligence on very young children isdifficult because the standard self-report or ability-based EI tests rely on a high level of reading and comprehension and are not suitable for pre-literate children. A critical evaluation of emotional intelligence in adults by Ciarrochi*et. al.* (2000) revealed that EI was not related to IQ but that IQ was related to mood processes, both the ability to manage moods and the ability to prevent moods biasing judgments. Advances in neuroscience have allowed an examination of the interconnections of social and cognitive networks in the brain (Barbey et. al., 2012). Their study investigated whether the neural architecture of emotional and social intelligence are integrated with cognitive intelligence or whether they reside in different brain systems. They found that there is a social knowledge network that provides an integrating architecture for key components of human intelligence. This interconnectedness suggests that social competencies in interacting with peers and teachers are vital for success when starting school.

Developing the social competency skills to take full advantage of the new school environment is important and emotion recognition is an important component of social competency. This not only presents a challenge to the design of preschool technology but also to a design that encourages use by both sexes. The questions that we pose in this study are whether there are any differences in how well the children recognize particular emotion faces in pre- and post-tests of emotion face cards after playing the digital emotion game compared to a digital non-emotion game and whether there are any differences in peer interactions when playing digital games. Both quantitative and qualitative methods are used to answer these questions.

The hypotheses tested are:

H1 –there is a difference in scores in pre- and post-tests of recognizing emotion face cards after playing the digital emotion game.

H2 – there is a difference in single-sex and mixed sex peer interactions with the emotion game.

2 DESIGNING PROSOCIAL GAMES FOR PRESCHOOL CHILDREN

Designing games generally for preschool is challenging as the children arrive at school at an early stage in their cognitive, physical and social development Gelderblom and Kotzé (2009).There are challenges in both the design and the evaluation. They are pre-literate and therefore any interaction instructions must be based on basic ideas and used in an intuitive way. Evaluating the success of an interaction offers challenges as the children lack the metacognitive skills for think-aloud techniques (Edwards and Bendyk ,2007) because of their developmental age. As well as physical and cognitive limitations to the design of games for this age, preschool children in mainstream schools arrive with a range of social skills and some may lack skills to interact socially and may yet be diagnosed with problems with interacting socially, e.g. those with Autism Spectrum Disorder (ASD). An earlier developmental psychology study of analogue games played by five year old children (Orlick, 1981) found that children in a cooperative games programme increased their sharing significantly. In the computer supported collaborative learning (CSCL) literature, collaboration has been defined as “a process by which individuals negotiate and share meanings” and “a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem” (Roschelle, 1995).One of the aims of designing collaborative digital games is to encourage sharing activity and turn-taking.

Many children are already familiar with cartoons and interactive games such as those provided on the cBeebies website Joly (2007)where a multimodal design provides interest and motivation. Designs for children with social problems can benefit from those aimed at children with Autistic Spectrum Disorder. A design approach for children with social problems but developing normally may be adapted from designs for young children with autism spectrum disorders (ASDs) adopting an interdisciplinary methodology for designing interactive multi-modal technologyPorayska-Pomsta et. al. (2011). They believe that using approaches from developmental psychology, the creative arts and artificial intelligence are key to developing technology in this context. In their digital world success can be rewarded using sounds.In a review of the design considerations for children’s games,Keller (1987) suggested thatideally interaction should be achieved via direct manipulation, and game play should also leverage the children’s natural curiosity and provide a level of challenge, control and reward.Gelderblomand Kotzé (2009)gathered studies for design of technology for children aged five to eight and arrived at ten design guidelines in six categories: developmental appropriateness; development of specific skills; design of built-in support; catering for a diversity of users; interaction environments and devices and support for the collaborative use of technology. The recent development of touch screen devices allows children to interact in a less formal way and designers of young children’s technology lessons can learn from the above guidelines and those for mobile interaction devices (McKnight &Fitton, 2010). Another design consideration is the opportunity to use devices such as touch screen tablets that can be used in informal group play settings Humphries and McDonald (2011).Being able to correctly read people is a skill that children need for playing collaboratively and in a study of the quality of peer interaction in analogue games of normally children and children with (ASD) Autistic Spectrum Disorder (Dewey et. al., 1988),the authors described evidence of a link between playing socially and cognitive abilities and also between the qualities of the play material. The need to design digital games for preschool children presents challenges for both physical control and gameplay and also for using the technology itself to enhance social competencies. The goal of the present study was to design an interactive game with an emotion domain for preschool children and to use emotion face cards to test the children’s emotion recognition skills before and after playing the game to test the game’s impact as an intervention.

2.1Experimental design and evaluation of the Emotion Faces game

In an exploratory field study (Humphries and McDonald, 2011) with a prototype designed around matching emotion face parts into a whole face,preschool children enjoyed playing the touch screen game and were able to match facial expression to emotions with some gender differences identified. The girls employed a different approach to game play than boys and the girls achieved a higher success rate but made fewer overall attempts. Both boys and girls showed evidence of enjoyment and engagement with the game and continued playing without adult intervention. This present study builds on this by designing whole emotion faces comprising the five basic emotions of Happiness, Sadness, Anger, Surprise and Fear in a 2D cartoon format based on real children’s faces. We wanted to use simple, full-face 2D representations that are easily recognized by children. Some of the face parts Humphries and McDonald (2011) (particularly the happy eyes) proved difficult for the children to recognise out of context so our aim with a game designed with whole faceswas to test the children’s interactions more on a larger scale and scientifically.We considered different scales of affect such as the Positive and negative Affect Scale (PANAS, Watson, Clark and Tellegen, 1988)but as this schedule is based primarily around adults in a clinical context we believed that the emphasis should lie in single, simple representations of the emotions tested for acceptance with children. We avoided the complexity of clinical affect scales by basing the emotions on Ekman’s examples Ekman and Friesen (2003) adapted for preschool children’s faces.We considered that cartoon depictions of emotion faces to be more acceptable than stock real images to young children who are used to cartoon images in the general media and in games.

To design for real emotion faces we needed to consider some aesthetic and developmental considerations of the perception of faces otherwise the children may react badly to the faces because of the uncanny valley effect. The uncanny valley is a concept from the study of robotics and 3D animation where people react with revulsion if images of people are not realistic Ho and MacDorman (2010).This concept originates from the work of Mori (2012) who described it as the relation between the human likeness of an entity and the perceiver's affinity for it. There is a sense of eeriness existing in a valley of perception where an observer may react positively to a completely alien face and to a realistic face at either end of a spectrum from realistic to unrealistic but negatively to a face in this valley in between the two ends Mori (2012). We considered that computer-generated human face images may fall into this uncanny valley so we decided to make digital images of original, hand-drawn children’s faces. Design elements of the face should be consistent in human realism with facial proportions and texture being designed together if a representative face is to be designed. Children accept cartoon characters but in these the features like the eyes can be exaggerated and skin tones are not overly representative. Aesthetically, to obtain a realistic emotion face our artist first used the proportions of a child’s head. The general proportions of the human head are: the eyes should be half way from the top of the head to the chin and the mouth bisects the latter half from the eyes to the chin. The distance between the eyes is one eye’s width Edwards (2012). Young children have slightly different proportions to adults. The eyes are bigger and the face is lower in proportion to the cranium Foster (2003). Initial sketches based on the real children’s faces (aged 3-4 years) positioned the features in proportion for their age.

The design of the five emotion faces (happiness, sadness, anger, surprise and fear) followed the basic face proportions taking into account the children’s age Ekman’s Ekman and Friesen (2003) guidelines. We decided to use both aesthetic considerations of appropriate proportions of a child’s features and the careful design of emotion expressions based on these collected images of these young children, and in cartoon format so that individual children were not identifiable. The objective of the Emotion Faces game is for children to match faces that represent basic emotional states.

A design challenge was to give guidance to the artist designing the emotion faces to use realistic face proportions and to use a systematic, scientific approach to the generation of the correct expressions. One way was to consider Ekman and Friesen's Facial Action Coding System (FACS). FACS is used to analyse complex movements of the facial muscles that alter expressions. However one of the aims is to simplify complexity so guidance was taken from the more practical descriptions of emotion expressions from Ekman Ekman and Friesen (1978). The design, by an illustration artist, of the faces followed an iterative process where the images were first produced in analogue format then checked for proportions and cartoon likeability and warmth. Two children of the appropriate age selected the most recognisable emotion faces used for the game. The sketches were then checked against Ekman's guidelines for each emotion and the sketches adjusted to incorporate features such as the shape of the lower eyelid in an unforced happy (Duchenne) smile (Figure 1). 40 images (four images for each of the 5 emotions for each sex) were tested on a small number of children of both sexes from this age rang. The children were asked to pick the images from each set of emotions that they thought best matched the emotion. This produced a set of 20 images that were used for the 20 cards for the emotion recognition pre- and post-test. These were then built into digital images using Fireworks software. Figures 1 and 2 show a sample of the completed images.

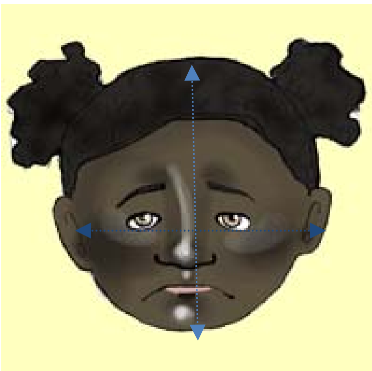

Figure 1 The completed digital sketch of a girl with a Sad face. Notice the proportions of the face mimic a younger child's face because of the slightly larger gap between the cranium and the eyes (in an older child and an adult this is halfway down the face).

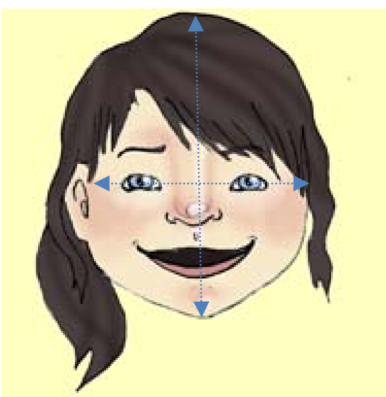

Figure 2 The completed digital sketch of one of the Happy girls' faces. The proportions are of a slightly older child with for example the eyes set slightly further apart than in the sad face. Note the upturned lower eyelid (characteristics of a Duchenne smile).

2.2Designing the high-fidelity prototype.

The software used to develop the interactive game was Microsoft Visual Studio 2007 WPF. This was chosen to support a more unified GUI when using graphics and audio than using Windows forms. We used a Fujitsu Lifebook T series multi-touch tablet computer as it provided a lightweight, robust design with a long battery life suitable for fieldwork in a classroom. The software was chosen with the aim of being able to drag the images if necessary, however some authors (Geldebom and Kotze, 2009) have reported that preschool children lack the physical control to keep hold of the dragged image so this was changed to a drag and drop function. We used C# as a development language as it proved a suitable platform for the quick and easy development of an application to be deployed on a Windows-based machine. The aim was to transfer this concept in the future to a more accessible tablet format such as the iPad but that would require coding using Objective C.This high fidelity prototype was used as a proof of concept and research tool. The game collected performance measures such as number of attempts and percentage of correct selections and time taken. The initial specification was to program the software so that a child or two children will be shown a picture with a choice of five emotion buttons. When the child selects one of the emotions an easel appears with room for four images and 20 random images appear containing only four of the requisite emotion. The child/children touches a face and then this will appear on the easel. For pre-literate children the use of colour was one of the primary mechanisms to give feedback on the correct choice of emotion face. A red background signifies an incorrect choice and the child can touch it again to return it to its original position. If a green background appears, the choice is correct. Emotion sounds were also used as a feedback mechanism as it provided an opportunity to provide feedback on success and prompted children to move the gameplay on to the next emotion. We avoided text instructions and relied on an appropriate sound to signal which emotion was being tested then the sound repeated when success at matching the faces was achieved. We collected real emotion sounds from preschool children from a local primary school during a pre-experiment visit while the children played emotion-related classroom games. The sounds collected were from children's simulated attempts to sound out the emotions. The sounds collected were edited into short, 3 second clips for inclusion into the interactive Emotion Faces game. When all four correct emotion faces are placed on the easel then the emotion sound signifies success and the remaining, unselected emotion buttons appear on the page (Figure 3).

Figure 3The user interface for the Emotion Faces game with the angry button selected.

2.3Research design

Participants

The objectives for taking the emotion cards and high-fidelity prototype into schools was to collect data from a diverse cohort and to get a larger data set than from aninitial exploratory study that was conducted in a small, mainly monocultural school with a low percentage (12.5%), of children receiving free school meals, (Humphries and McDonald, 2011). This is a measure used in UK education as a proxy for the degree of social disadvantage: the higher the proportion of free school meals the higher the level of deprivation. We returned to this school (Mono_LFM). This school is in a relatively affluent, predominantly white area. We selected one other school with the objective for selection being to choose children of the same age but from a more diverse background to investigate whether using the game in a collaborative play context could influence their scores on the social skill of emotion recognition. This second school has a more fluid population comprising children of students from a nearby University and asylum seekers. Many children arrive without speaking English. These two schools selected for testing, Mono_LFM and the second one with an intake of children from diverse backgrounds and some arriving with little English with a high percentage (29%) of children eligible for free school meals (Multi_HFM). The children ranged in age across the whole of the Foundation Stage (nursery and reception classes in the UK, aged 3-5 years). A further 53 child participants from a third, control school (Mono_HFM) were recruited to play a non-emotion iPad game in pairs between the pre- and post-tests of the emotion recognition cards.These children are from a predominantly white area with high unemployment. Data were collected on the between subject variablesof gender, school (3 levels: Mono_LFM, Multi_HFM and Mono_HFM) andtype of intervention (emotion game and a control game). The dependent variable was the change in the score from the pre-test of emotion recognition cards to the post-test of the same cards after the children had played the relevant intervention game. We conducted a second analysis, a repeated measures test on within subjects variable selection of correct emotion faces and between subject variables of collaborative activity (3 levels of pair type) and school (2 levels) was also collected from the 2 experimental schools by video observations of pairs (boy-boy, girl-girl and girl-boy) to assesswhether single-sex or mixed sex pairs differed in their interactions while playing the emotion game.

Procedure

42 Children from the two experimentalschools took part in playing the emotion game in pairs (experimental condition). Each child was tested in a pre-test of their ability to identify 20 emotion faces (10 for each emotion (1 boy's image, 1 girl's image for each) in a Latin Squares' design where the order of emotion faces and gender of faces was alternated between groups of children. This procedure was repeated for the post-test so that memoristion of the order was avoided. In a separate session the children were asked to pair up into dyadic girl-girl pairs,boy-boy pairs and girl-boy pairs to play the game. The children were given the option of choosing who to play with and each emotion play session took place during theirfree play sessions. The children were given basic instructions to get started. They were told to select whichever button they wanted to start and then to select the 4 relevant emotion faces and click to place them on the easel. Success was rewarded by the emotion sound being played and the other buttons reappearing ready for the next selection. At the end of the game all 5 buttons appeared and they could repeat the game if wanted.The gameplay lasted between eight and ten minutes. A Canon 500 EOS digital SLR camera was set up on a stand to videorecord the children playing. The activities took place in their normal classroom and after an initial look at the camera they soon forgot it was there. No child "played up" to the camera. The children were first allowed to play either game with the minimum of intervention. After an initial explanation of how the buttons worked the children were allowed to play on their own. The control game (Duck Duck Moose's "Wheels on the Bus") had the same level of sound and visual feedback and lasts thesame

length of time as the experimental game.

3 RESULTS

3.1The effect of playing the emotion game as an intervention

Two schools tested the emotion game -the monocultural low percentage free meals (Mono_LFM) and the multicultural high percentage free school meals (Multi_HFM) while a control group of children from a third school, monocultural, high percentage free meals (Mono_HFM) played the non-emotion intervention. The goal was to see whether the typeof gameplayed collaboratively influenced the change in scoresbetween pre-test and post-tests of emotion recognition. Before testing the change in scores for emotion recognition using the stimulus cards we conducted a 2-way ANOVA test on the pre-test scores to get a baseline value for children from the different schools. The DV was pre-test score with IVs of gender and school. The aim of the experiment was to collect quantitative and qualitative data for the children's interactions with the game. A test of this was to test the children's emotion recognition scores in a pre-test based on the stimulus emotion face cards, play the emotion face game with a larger set of emotion faces available (40 images), then conduct a post-test of the same emotion faces used in the pre-test. The set of 40 images included the 20 images used in the emotion cards but in a randomised selection to avoid too much memorisation. Scores for both girls and boys increased but girls (N= 26, M= 2.50, SD= 2.760) scored significantly higher than the boys (N=16, M=0.5, SD= 2.098. We conducted a one-way ANOVA analysis of the change in scores from the pre-testto the post-test (dependent variable) with gender as the independent variable. Levene's test was not violated ($p>.05$) and the there was a significant difference in the changes in scores, with girls scoring higher than the boys, $F(1)=6.178$, $p<0.5$ (Figure 4).

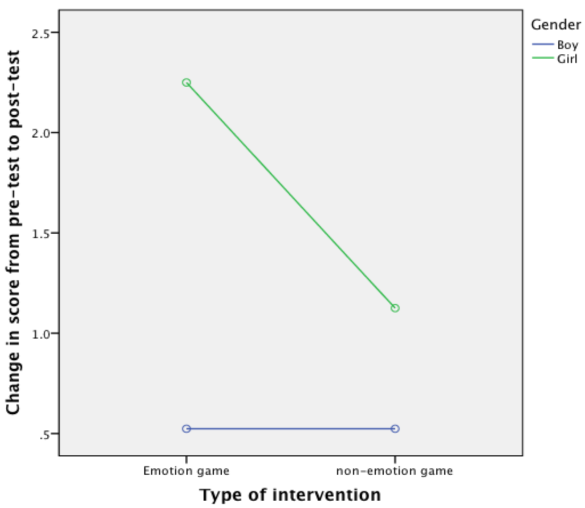

Figure 4 Effect of gender and type of game on improvement in emotion face card scores. The emotion game has a significant effect for girls but not for boys.

When the scores for the quality of play are examined by pair types and school type (Figure 5) the single-sex pairs from the HFM school score the lowest with the biggest difference for the girls, girl-boy pairs score the same but this group is statistically smaller (7 pairs from Mono_LFM, 2 from HFM). There are 6 Girl-girl pairs in the Mono_LFMschool, 14 in the HFM school while there are 4 boy-boy pairs in the Mono_LFM school and 9 in the HFM school. There is no significant difference between the girls and boys in their total play scores (quality of play materials scale). Mean score for boys is M(16) = 32.38, SD=6.888 and girls M(26) = 30.46, SD= 8.760.

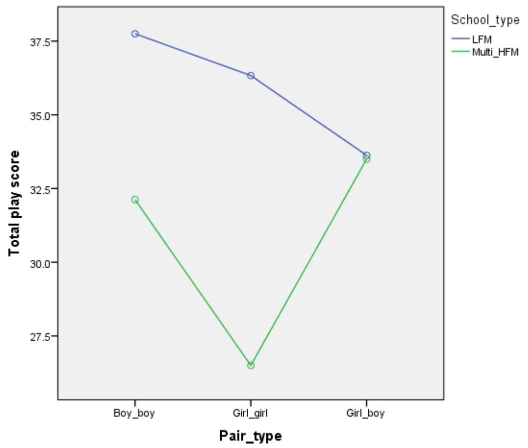

Figure 5 Interactions between pair type and type of school (from the two experimental schools)

Post-hoc analysis of the affect of school type and pair-type on the cooperative total play scores (Dewey et.al. 1988) show differences between single-sex pair scores for both schools and girl-boy pairs with similar scores. Figure 5 shows near-identical scores for the girl-boy pairs from both schools but significant differences between single-sex pairs from the two schools, with children from the MULTI-HFM (more deprived) school showing significantly lower cooperation scores than those from the MONO-LFM school.

3.2 Peer interactions with digital technology

H2 – there is a difference in single-sex and mixed sex peer interactions with digital technology.

There is a marked difference in performance by the girl-boy pairs (Figure 6). All groups score well and in the same range for Surprised but the Frightened scores are very low. This may reflect how recognizable the happy, angry and surprised faces are. Some children found the frightened faces hard to identify and often confused them with sad.

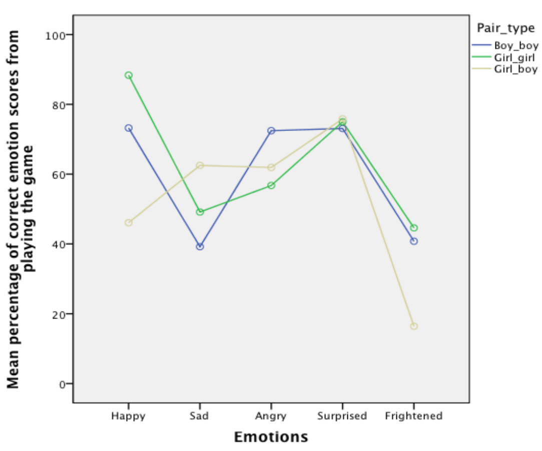

Figure 6 Percentage of correct emotion faces selected during the game by pair types.

Anger and fear have been identified from the literature as causing problems with boys (Peter and Herbon, 2006). This seems an anomalous result as the girls score highest for recognising the faces in the game. To test whether working cooperatively has an effect on the post-test score a correlational analysis was conducted on the post-test scores (recognising emotion faces after playing the game) for correlation between total play score and change in emotion recognition score. The results show there is a negative correlation between change in scores from the pre-test to the post-test and the total play score, $t(42)=-0.316$, $p<.05$. This implies there is an inverse relationship between playing cooperatively and improving the emotion recognition score. It may be that the boys had too much fun to learn from the emotion recognition task or had less skill in recognizing emotions even after practice. The girls gained the most in these tasks but showed less cooperative behaviour with the game, possibly because of lack of confidence.

3.3 Qualitative feedback during game play

In addition to the quantitative log of correct face matches and attempts, notes were taken contemporaneously and from the video data of comments made between the pairs and to other children about the game and also note was taken of their affective responses. There was one girlwho walked away from the game towards the end saying “I want to come out” but the rest stayed for the allocated time and mostly had to persuaded to finish. The girls on the whole were quite serious and did not express overt emotions about enjoying the game except when they matched a face correctly but they did share quiet smiles with female partners, especially when matching the Happy faces. They also helped each other more taking it in turns to select the faces more than the boy-boy pairs. One girl from the Multi_HFM school scored quite a low score (11/20) for the pre-test but was one of the most enthusiastic playing the game and commented (“it’s easy”). She selected all the correct faces first time except for the frightened face where she had an 80% success rate with her partner. She scored 18/20 for the post-test.One boy-boy pair shared smiles and laughter and commented to another child who entered the room “we’re playing an awesome game” . One negative response from several boys from both of the monoculture schools was that they were surprised at the inclusion of the darker-skinned faces as they didn’t know any children in school “like that”.

Another approach to the qualitative analysis of the interaction is to examine the observed verbal exchanges between the children using Piaget’s “Talk Taken Down” framework of the language the children use while playing the game. This comprises three egocentric observations (I repetitive speech, II monologues, III dual/ collective exchange) and socialised interactions (IV child adapts information, V criticism, VI commands, requests and threats, VII Questions to other child, VIII Answers). The results are shown in Table 1.

Table 1Samples of the Talk Taken Down results (non-verbal interactions shown in italics)

Observation		Girl-Girl	Girl-Boy	Boy-Boy
Egocentric	I Repetition	*Smiles when the sounds play.* “Yes” “Yes” “Yes”		
	II Monologue	“I’ve found another one”	“I’ll try this” “there must be one”	
	III Dual/collective	“Yes!” (together when they got it right) “She looks angry”	“we’re doing all of them” “go on” “Oh wait a minute, I’ve got it” “I found one” “We’ve got one wrong” *Boy C and Girl D giggle together* *Boy C points to guide Girl D*	“I want to play again” “There’s one there” “There” (boy A) “That” (boy A) “Yeah, yeah, yeah” (*Boy B, moves the computer towards him to have control).* “It’s a girl” *(Boy A comment about crying sound)*
Social	IV Adaptive	Boy E “That must be one” Girl		

		F “No that’s sad” *Points to suggest a choice (Non-verbal)*		
	V Criticism and derision			
	VI Commands and threats	“Your turn”	“Hey-it’s my turn!” “Now let’s do that one”	“Have a look, see one”
	VII Questions		“How about this?”	
	VIII Answers			

Most interactions are in the egocentric categories monologue and dual/collective. Commands feature commonly. This probably reflects their developmental age. The limitations of this linguistic framework are that it does not capture positive non-verbal interactions while playing the game such as mirroring (showing the same expression), the emotions depicted in the game smiling at each other and giggling and negative (moving the tablet away from the other child). The girl-boy pairs show the most verbal interaction. There is no difference in the pairs in the social interactions. Criticism and direct answers were absent from the interactions.

4DISCUSSION

The hypotheses were H1 – there is a difference in how children learn from the game as an intervention, and H2 – there is a difference in single-sex and mixed sex peer interaction with digital technology. H1 was partially supported in the case of the girls who gained a significant increase in scores between the pre-test and post-test. Boys increased their scores but the increase was not significant. There is a gender difference in the ability to recognise these emotion faces, both in the game and on the emotion cards that supports previous studies McClure (2000), Posamentier and Abdi (2003). Some results confirm findings from the literature with girls being more accurate with identifying emotion faces. The better score for girls in identifying the Frightened emotion faces confirms previous work Ekman (1971), Gelderblomand Kotzé (2009). H1 is thus supported. However, it can be argued that the modality (distancing from reality) of the 2D flat cartoon emotion face images means that one cannot assume that recognizing the cartoon faces reflects a real-life understanding of that emotion (Hodge and Tripp, 1986). The incorporation of real-life emotion sounds adds to the modality. From a semiotic perspective, there are codes within cartoons that have their own message and the context of the emotion depicted in these images has no context (only the face is shown) so while we can say that some children can recognize the images better after playing the gam, it would be a step too far to infer a direct relationship between gains in scores at matching the faces with increased recognition of the emotions in reality.

There is a significant difference in the way girls and boys interact when playing with the technology shown by the superior scores by the boys for quality of play with the digital game so H2 is supported. The fact that the girl-girl pairs performed poorly in the total play score but increased their emotion recognition scores significantly from pre-test to post-test suggests that for girls there is some anxiety whilst using the technology (low quality of play) but they learn more from playing in single sex pairs than the boy pairs or the mixed gender pairs. The analysis of the dialogue indicates that the girl-girl pairs seriously attempt to search for the correct faces and spend less time verbalizing during the game whilst the boy-boy pairs demonstrate a more random search for the correct faces but verbalizing more and enjoying repeating the sounds. This may explain the fact that girls increase their scores more from pre-test to post-test.

The low scores for Frightened confirms that this emotion is difficult to identify by both girls and boys of this age group while girls have the advantage. The ability to identify to identify fear and anger suggested by the fMRI scan research Ho and MacDorman (2010)suggest that that there is a gender difference in the processing of fear and anger with boys with boys showing activation for these two emotions more than girls. This study supports their work for boys in a more deprived school environment recognizing anger. However the evident enjoyment with playing the game and increase in scores when identifying emotions using the emotion face cards suggest that this is a medium that could be usefully used in schools to encourage boys to practice their emotion recognition skills. The gains by the girls from the HFM school in their emotion recognition scores in the post-test suggest that they would benefit as well. Hodge and Tripp report that, with respect to television viewing, there may be a ceiling effect where television enriches otherwise deprived intellectual environment but limits an intellectually rich intellectual environment. They also note that low-IQ girls performed significantly better in reading comprehension if they were heavy TV viewers. Their gains in the scores in this study may be explained by a similar effect in that they start from a low base but if they are used to earning from TV then digital games may also help.

4.1 Limitations

The limitations of the study are that children in the Foundation Stage cannot all be categorized as having attained the same level of cognitive or social development. To what extent IQ mediates the children's performance was not explicitly tested. The results in the present study point to interesting differences in both gender recognition of emotion n faces and the ability to improve their recognition scores after playing the game. The children's success may be due to cognitive differences in ability or the ability to manage their moods and make decisions but the game may serve as a tool to help teachers identify which children have difficulties with emotion recognition. Barbeyet. al. (2000) identify specific tests e.g. the MSCEIT that may be used to assess the functioning of the social knowledge network and in the absence of emotional intelligence tests for pre-literate children, an emotion recognition game may serve as a proxy for emotion perception skills as a precursor to emotional intelligence.

5 CONCLUSIONS AND FUTURE WORK

There may be a role of using the emotion game as an intervention from the finding that when the data from the control school was included, the results of the gain in emotion recognition test from pre-test to post-test show a significant main effect of gender and school, with girls showing a significant increase and boys very little increase. These scores may be still more significant but for the fact that some children missed school and were therefore not included in the analyses. Most of the children from Mono_LFM attended regularly but only 23 out of a class of 30 attended all the sessions for the HFM school in the more deprived area.

The game was a success from the novelty perspective and children had to be persuaded to stop playing. They enjoyed the freedom to play on a tablet without a teacher and enjoyed playing in pairs..Further research is planned with the game and cards with autistic children and contacts have already been established with teachers and local authority personnel from the intervention teams. The design of the game can be improved by making the dark-skins lighter (some children found it difficult to see the emotion clearly in some of these images) and also to use the screen real estate better to be able to enlarge the faces for easier recognition. There is also a version being developed for the iPad (see http://nestor.sunderland.ac.uk/~cs0lhu/interactive_emotions/index.htm) as some parents were interested in obtaining the game but a web-based version may well be more accessible and affordable as many schools in deprived areas may struggle to supply a set of iPad tablets. The contribution of this study to interaction design is in both offering design guidelines for age-appropriate emotion face images for young children as the availability of high quality young children's images is limited.

5 DESIGN CONSIDERATIONS FOR COLLABORATIVE, PROSOCIAL GAMES

Gelderblomand Kotzé (2009)offered ten design lessons from the literature on child development and children's use of technology. The following conclusions can be drawn and suggestions given for the design of collaborative prosocial games based on this study and the literature.

1. **Control to the children**: a move a way from teaching the child to allowing the children to explore and learn intuitively, allowing their own strategies of play and control.
2. **Motivation**: use ARCS Model of Motivational Design (Keller)-attention, relevance, confidence and satisfaction to keep attention. This model was not used explicitly in the design of the emotion game but motivation and satisfaction were considered when moving from the testing mode with a teacher to the game play with pairs of children as during an early field work the children showed less verbal utterances and non-verbal signs of satisfaction (smiling and mirroring) (the children in this study stayed engaged for 10+ minutes before being asked to let more children play); in this case the children related to all of the emotions but found the frightened ones harder to identify. These will need to be redesigned and tested before using in a new version of the game; ensure that the children can gain success and what sort of feedback is provided. In this case the design included no explicit negative feedback only an absence of the positive feedback (emotion sound played); the children were observed setting their own rules of fair play in turn-taking for example and all pair-types demonstrated satisfaction in their verbal and non-verbal interactions.
3. **Developmental appropriateness:** this covers both social and development perspectives. In this case with preschool children there are physical limitations (the extent to which they can drag and drop) and developmental considerations (using icons and buttons rather than text and sound as feedback for pre-literate children).
4. **Specific skills development:** in this context a design to enable a shared experience in identifying emotions. More research is needed to test whether these skills transfer into real life with perhaps closer work such as a longitudinal study with individuals who demonstrate poor recognition of these skills, testing both social collaboration skills (can they be taught to share?) and the development of these skills. There are particular challenges with children on the ASD scale and pilot studies with these groups have already begun.
5. **Design for diverse users:**this study paid particular attention to the age-appropriate design of emotion faces in cartoon form. The images were designed to mimic young face proportions and scientific configurations of features such as the Duchenne smile based on Ekman and Friedman's (2003) guide to facial proportions FACS. One design decision was to include a culturally diverse selection of faces, including African, Asian and Chinese features.

6. **Interaction environments and devices:** collaboration was easier with access to tablets placed on low-lying tables without the impediment of a mouse or keyboard. Schools such as the Mono-HFM school have encased their iPads in protective covers and have purchased one for each of their ASD children with other children having access to shared iPads. These were observed being used in an informal play environment.
7. **Support for collaborative use:** the quantitative and qualitative evidence from this study suggests thatgirls learn more working together but there is more dialogue and social interaction when girls and boys play in pairs. Boys together have great fun but did not learn as much. Boys and girls equally were observed helping weaker peers to play the game. Some girl pairs showed an initial lack of confidence but became more vocal as they realized they could control the game and get success.
8.

7 REFERENCES

Bandura, A. (1969) Social learning theory of identificatory processes. In D.A. Goslin (Ed.), Handbook of socialization theory and research.(pp. 213-262).Chicago: Rand McNally.

Barbey, A. K., Colom R., &Grafman J. (2012). Distributed neural system for emotional intelligence revealed by lesion mapping. Social Cognitive and Affective Neuroscience, 1-8.doi: 10.1093/scan/nss124

Ciarrochi, J. V., Chan, A. Y., Caputi, P., A critical evaluation of the emotional intelligence construct, Personality and Individual Differences, 28(3), 2000, 539-561.

Dewey, Dewey, D., Lord, C. and Magill, J. (1988). Qualitative assessment of the effect of play materials in dyadic peer interactions on children with autism. Canadian Journal of Psychology, 42(2), 242-260.

Edwards, B. 2012.*Drawing on the right side of the brain*. Jeremy P. Tarcher/Penguin: New York.

Edwards, H. and R. Bendyk(2007) A comparison of usability evaluation methods for child participants in a school setting, In *Proceedings of the 2007 conference on Interaction Design and Children,* pp 9-15.

Ekman, P. (1971) Universal and cultural differences in facial expressions of emotion. In J. Cole (Ed.), *Nebraska Symposium on Motivation*, (1971), 207-283. Lincoln: University of Nebraska Press.

Ekman, P. and Friesen, W.(1978)Facial Action Coding System: A Technique for the Measurement of Facial Movement. Consulting Psychologists Press, Palo Alto.

Ekman, P. and Friesen, W. (2003)*Unmasking the face: A Guide to Recognizing Emotions from Facial Clues.*MalorBooks: Los Altos CA, USA.

Foster, W. (2003)*Drawing: Faces*. Walter Foster Publishing inc. Co. USA.

Gelderblom, H, and Kotzé, P. (2009) Ten design lessons from the literature on child development and children's use of technology. *IDC 2009*: 52-60.

Ho, C-C. andMacDorman, K.F. (2010) Revisiting the uncanny valley theory: developing and validating an alternative to the Godspeed indices. Computers in Human Behavior 26 1508-1518 doi:10.1016/j.chb.2010.05.015.

Hodge, B, and Tripp, D. (1986) *Children and Television: A semiotic approach*. (Cambridge: Poility Press.

Humphries, L. and McDonald, S. (2011) Emotion faces:the design and evaluation of a game for preschool children, CHI EA '11

Proceedings of the 2011 annual conference extended abstracts on Human factors in computing systems, ACM, New York, USA.

Joly, A. V. (2007) Design and Evaluation of Interactive Cross-platform Applications for Pre-literate Children, Proceedings: Doctoral Consortium, IDC '07, June 6-8, 2007 Aalborg, Denmark.

Keller, J.M.(1987) Strategies for stimulating the motivation to learn.*Performance and Instruction,* 26,8: 1-7.

Kim, P., Buchner, E., Kim, H., Makany, T., Taleja, N. and Parikh, V. (2012) A comparative analysis of game-based mobile learning

McClure, E. B.(2000) A Meta-Analytic Review of Sex Differences in Facial Expression Processing and Their Development in Infants, Children, and Adolescents, *Psychological Bulletin*, 126, 3: 424-453.

McKnight, L., &Fitton, D. (2010)Touch-screen Technology for Children: Giving the Right Instructions and Getting the Right Responses, IDC 2010, Barcelona, 238-241.

Mayer, J. D., Salovey, P., & Caruso, D. R. (2000)*Models ofEmotional Intelligence*, In R. J. Sternberg (Ed.).Handbook

ofHuman Intelligence (2nd ed). pp 396-420. New York: Cambridge.
Mori, M. (2012)The Uncanny Valley. IEEE Spectrum [http://spectrum.ieee.org/automaton/robotics/humanoids/the-uncanny-valley]five year old children

Mercer, N. and Littleton, K. (2007) *Dialogue and the Development of children's thinking: a sociocultural approach*. Routledge: Oxon.

Orlick, T.D. (1981) Positive socialization via collaborative games, *Developmental Psychology*, 17, (4), 426-429.
Peter, C. &Herbon, A. (2006). Emotion representation and physiology assignments in digital systems.*Interacting with Computers*, *18* 139-170.

Piaget, J. (2002) The Language and Thought of the Child, 3rd Edition. Oxon: Routledge.

Porayska-Pomsta, K., Frauenberger, Pain, C. H., Rajendran, Smith,G.T., Menzies, R., Foster, M.E., Alcorn, A., Wass, S., Bernadini, S., Avramides, K., Keay-Bright, W., Chen, J.,Waller, A., Guldberg, K., Good, J. and Lemon, O. (2012)Developing technology for autism: an interdisciplinary approach,Personal and Ubiquitous Computing, 16:117–127.
Posamentier, M., & H. Abdi(2003) Processing faces and facial expressions. *Neuropsychology Review*, 13(3), 113-144.

Rahman Q, Wilson GD and S. Abrahams (2004) Sex, sexual orientation, and identification of positive and negative facial affect. *Brain Cognition*, 54(3):179-85.

Roschelle, J. and Teasley S. (1995) The construction of shared knowledge in collaborative problem solving. In O'Malley, C. (ed.) Computer-Supported Collaborative Learning, Springer Verlag, Berlin, Germany, 1995, 69-197.
Selman, R. L. (1980). The growth of interpersonal understanding: Developmental and clinical analyses. New York, NY: New York AcademicPress
Vygotsky, L.S. (1987). The collected works of L.S. Vygotsky,Vol. 1 (R.W. Rieber& A.S. Carton, eds.). New York: Plenum Press.

Watson D, Clark LA, Tellegen(1988) Development and validation of brief measures of positive and negative affect: the PANAS scales. *J PersSoc Psychol.* 54(6):1063-70.

Widen, S.C. and Russell, J. A. (2010) The "Disgust Face" conveys anger to children. *Emotion,* 10, 4: 455-466.

Zeidner, M., Matthews, G., Roberts, R. D. and MacCann, C. (2003)Development of Emotional Intelligence:Towards a Multi-Level Investment Model, *HumanDevelopment*, 46:69-96