Proceedings of the 2004 IEEE International Workshop on
Robot and Human Interactive Communication
Kurashiki, Okayama Japan September 20-22, 2004

Research Findings from Synthetic Character Research: Possible Implications for Interactive Communication with Robots

Lynne Hall,
School of Computing & Technology,
University of Sunderland,
Sunderland, SR6 0DD, UK
lynne.hall@sunderland.ac.uk

Sarah Woods, Kerstin Dautenhahn
School of Computer Science,
University of Hertfordshire,
Hertfordshire, AL10 9AB, UK
s.n.woods, k.dautenhahn@herts.ac.uk

Abstract

This paper considers findings from synthetic character research using Virtual Learning Environments. Children aged 8-11 years interacted with FearNot, a software package that deals with the social problem of bullying in schools. Following the interaction, children participated in Classroom Discussion Forums, a method we have developed to assist children in verbalizing their views and perspectives. This approach enables the exploration of children's opinions of the software and the potential to derive design implications from a child-centred perspective. The relevance and appropriateness of the research approach taken in the present study for the design and interaction with robots is discussed.

1 Introduction

In designing new interactive environments, such as in human-robot interaction, the needs, abilities and competences of the intended end user must be considered. Recently, there has been increasing interest in using robots for applications aimed at children, for both recreation (e.g. Aibo [1]) and education (e.g. LEGO Mindstorms [2]).

As a user group, children are known to have different needs and expectations compared to adults when designing new interactive applications [3]. These different needs and expectations relate not only to the interactive environment, but also in the manner of gaining user input. Perceived problems in gaining input from children has resulted in the common practice for developers of new technology to ask parents and/or teachers to determine what children's needs are rather than asking the child directly [4, 5]. However, it is essential that children are included in the design and evaluation phase of new technology to ensure that their thoughts, ideas, opinions and behaviour are captured [6, 7].

The views of children and their preferred interaction styles when designing new applications are essential if a product is to be successful for the desired end user group [8]. However, a key issue is how to obtain these needs, views and expectations, with research identifying that directly translating adult design and evaluative techniques for use with children has only limited success [9, 10].

The validity and reliability of children's input towards the design of new products has been the centre-point for many discussions [7, 11]. Findings clearly identify that the use of child-centred methods and techniques improves the quality of children's input and the final artefact.

Whilst some attempts have been made to provide approaches to obtaining children's input in robotics [12, 13], research in the area of children robotic interaction is relatively sparse [8]. Instead studies have generally taken an adult perspective for the design implications of robots for different uses (e.g. [14, 15]). However, social-robotic interaction has similarities with a number of other interactive environments and approaches and findings from these environments may be relevant to the design of child robot interaction.

There are similarities between robots and synthetic characters within virtual environments. Although robots and virtual synthetic characters differ in the nature of their embodiment, they share a number of characteristics including autonomy, tangibility, motion, emotion, interactivity, communication, etc. Similar to a number of robotics environments, such as PETS, a storytelling environment for children [16], Virtual Learning Environments (VLEs) populated with synthetic characters offer children a safe environment where they can explore and learn through experiential activities [17, 18]. Synthetic characters offer a high level of engagement, through their use of expressive and emotional behaviours [19], a goal for many robots.

In this paper we focus on the methods we have developed and the findings we have obtained from synthetic character research within the VICTEC (Virtual ICT with Empathic Characters) project. This project aims to apply synthetic characters and emergent narrative to Personal and Health Social Education (PHSE) for children aged 8-12 through using 3D self-animating characters to

0-7803-8570-5/04/$20.00 ©2004 IEEE

create improvised dramas in a virtual school. FearNot (Fun with Empathic Agents to Achieve Novel Outcomes in Teaching) is an application developed within VICTEC and provides a school-based Virtual Learning Environment (VLE) populated by animated agents representing the various characters in a bullying scenario, see figure 1.

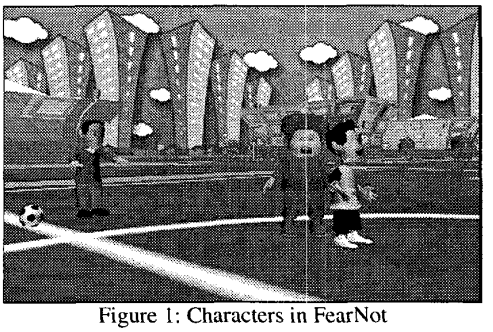

Figure 1: Characters in FearNot

Section 2 presents an overview of our approach to gain children's verbal feedback for the design of FearNot. Section 3 discusses empirical work using our approach and Section 4 provides results. Section 5 considers possible design implications for robotics research and section 6 addresses future work and the conclusion.

2 Classroom Discussion Forum (CDF)

To obtain verbal feedback, we used a method that we have developed, termed Classroom Discussion Forum. Our initial intention had been to use focus groups [20] to elicit views, expectations and needs from children. This approach has been successfully used with children [21] however, classroom logistics make it difficult to implement, with teachers expressing a preference for discussion to follow the normal classroom approach of "Table Time" (small group discussion) followed by "Circle Time" or "on the carpet" (whole class discussion).

Accepting these requirements, we used a Classroom Discussion Forum (CDF) after the children had interacted with FearNot and completed a questionnaire. This forum allows a range of perspectives to be gathered in a short time period in an encouraging and enjoyable way. Similar to focus groups the facilitator can ensure that everyone participates in an informal manner.

3 Method

59 primary school children aged 8-11 years (24 boys and 35 girls) participated. 10 groups of 6 children (all mixed gender) interacted with FearNot depicting a physical bullying scenario. A brief explanation was provided to each group and children then logged into the computers using a unique identification number. Each child interacted individually with FearNot for between 11 and 26 minutes. After the interaction, children completed an Agent Evaluation Questionnaire (see [22]) and participated in a "Table Time" style CDF.

3.1 Physical Bullying Scenario

For this research, FearNot presented the children with a physical bullying scenario with the synthetic characters: Luke (bully), John (victim) and Paul (bystander / defender / narrator). The child's choices, based on a simple dialogue with John (the victim) can affect the storyline and a number of possible "endings" emerge.

The interaction begins with background history about Luke and John followed by a physical bullying incident. This involves Luke knocking over John's possessions and hitting John. The child then sees John going to the library, where he sits down and begins to cry. A dialogue is then initiated with the child, asking for advice from the children and mentioning a number of possible coping strategies. The child is also asked to explain what he thinks will happen as a result of this coping strategy and why. The child then watches another interaction where physical bullying happens again, this time on the football field, see figure 1.

Again, John asks for advice following a similar dialogue. Another scene then occurs, dependant on the children's choices and the emotional states of the agent (for further details, see [22]), a number of different endings are possible. For example, Paul (the bystander) could emerge as a defender and defend John from Luke. Alternatively, Paul (the bystander) could become friends with John (the victim), and could aid him. All of the endings were positive, based on earlier research findings that children did not want to end the FearNot session with a negative outcome. The final scene shows one of a number of educational messages used by VICTEC tailored to the dialogues held with the child. This may reward an appropriate coping strategy, e.g. 'Telling someone you trust is a good way to stop bullying." Or if the child has selected coping strategies that frequently don't work (e.g. fighting back) the message may be more direct: 'don't suffer in silence, tell somebody if you are being bullied.'

3.2 Classroom Discussion Forum

After completing the Agent Evaluation Questionnaire, the children then participated in a 15-minute Table-Time CDF that was led by two trained researchers and included questions relating to their interaction with FearNot:

- Levels of interest and enjoyment that the children experienced from interacting with FearNot
- Interacting with FearNot and the synthetic characters - design, information provision, navigation approaches, interaction style

- Design of characters focusing particularly on emotions and children's emotional responses to the events in the trailer.
- Changes to improve FearNot particularly related to types of advice, endings and educational goals.

4 Results

In these results, we are focusing on the qualitative data provided in the Classroom Discussion Forums. The quantitative data obtained from logging the children's interactions with FearNot and the Agent Evaluation Questionnaire data is currently being analysed.

4.1 Using CDFs to gather Data

Our initial CDFs produced relatively negative data, with the children identifying that they found the story and the interaction uninteresting and confusing: "I didn't really get into it... not very interesting." However, negative results and remarks were almost all seen in the first two CDFs, the remaining eight were positive.

The children were all keen to participate in the CDF and had plenty of comments and ideas, some of which are detailed in the following sections. The teachers found the CDF format appropriate and noted that the method followed caused minimal disruption in the school day.

The notes taken in the CDFs identified that after the fifth group almost no new information was provided by users, with all of the children providing comments similar to those provided in earlier CDFs.

4.2 Interacting with FearNot

No child hesitated or had any difficulty in interacting with FearNot. There was no techno-fear and all of the children had previously used computers. A number of different set ups were available. Children were able to use the mouse, tracker pad and keyboard with high levels of competence, although their typing speeds were very slow. Several children asked if they could use "texting" or "text talk."

When queried about their knowledge and use of computers, many children identified that they used recreational software, ranging from 1st person shooters "I like it when you blow things up, it looks real" and using the web "finding out about stuff with pictures and stories" "I like games where you click on stuff to pick it up."

4.3 Control and Input

Impatience was seen during the interaction and the desire to participate. Children frequently clicked on the screen and tried to control the pace of the interaction: "hurry up that John crying in the library" and "I wanted it to go back so I could read it" [referring to text that disappears too quickly from the screen]. Children preferred interacting with FearNot to Circle Time, again for reasons of controlling the pace: "its better than Circle Time, you don't have to wait to give the answers."

Children also took significantly longer over the dialogue than we had anticipated. They thought long and hard about the advice they would give to the victim, why they would give it and what would happen because of it. The younger children (Year 4: 8-9 years old) found the typing too arduous and wanted more support "a list of things to click on" "already written words." However, the older children (Year 5: 10 years old) liked the possibility to tell John "why he should do what I said" and liked being in control of influencing the progression of the scenario. A number of children asked whether they could use "text talk" and several children worried "whether I'd spelt it right in case he wouldn't understand."

4.4 Enthusiasm and Engagement

All of the children identified that they were pleased to have used FearNot and would have been disappointed not to "have had a turn." Several boys had to play cricket that day and "had come early so that we'd get a go, their [classmates] said it was good."

Children stated that FearNot was "interesting, fun, better than books" and that "You can say what you like, no one else can hear you." All of the groups identified that they would rather use FearNot than a book-based approach and that the privacy provided by FearNot was a great benefit.

The children identified that they would like to use FearNot again "for a different story" and "in John's future."

The children stated that "it was different to other things we've done," "most games are about shooting or jumping, this is more real" and "more fun than reading a book about being bullied." Children noted that "never used anything like that before" and "when can we use it again." They identified that it had helped them think about bullying in a "different way, that poor kid..." and that it "was a better way to learn than watching a video" because with a video you cannot provide advice and see the outcomes.

Children engaged with the characters and stated that they felt "sad for John, Luke is really tight." They were positive about Paul where he was the defender: "best bit was when Paul stood up to him." They found Luke "mean" and "not the sort of person you'd be friends with."

Children were also interested in the past and present of the characters. "you need to know why John's like that, what's happened to him before" and "it'll be problems at home, bullies always have problems with their parents. Did he have problems with his parents?"

4.5 Emotions

Children expressed empathy and had emotional reactions to each of the characters. They were "angry with Luke," "sad for John" and had a number of reactions to Paul who had several roles: "It was great when he helped John," and "He just stood there, why didn't he help" and a lot of children expressed that they "kind of felt sad" after interacting with FearNot because "bullying isn't kind."

4.6 Character Movement and Appearance

A key problem for the children was in remembering which character was which: "bit confused as to who was who" "which one was John again?" The children were not confused by the roles played "Oh, he's the bully, no didn't like him" but had problems associating the role with the name. When children asked "which one was John?" other children in the group always responded with the bullying role rather than with a distinctive physical feature, even though the characters were distinctive in terms of hair colour, clothes and body shape. One child suggested an approach, that other members of her group endorsed: "Why don't you put their names on their tops?"

The children did not find the embodiment of characters and objects in FearNot to be of a high standard: "too slow" "balls don't move like that" "John waddled." One child stated "the graphics were so bad it made me laugh."

5 Discussion / Design Implications

5.1 Using CDFs to gather Data

The negative data obtained from the first two CDFs can be explained as experimenter bias. This was the first experimental trial of FearNot in a school-based setting. Further, a number of practical issues were resolved during the initial interaction session. By session three, the experimentation was working well and the researchers were significantly calmer and the environment less chaotic. This emphasizes the importance of practise runs before the "real" experiment.

Within the usability literature, there is support for using very few users for product evaluation. With so few users each evaluation must not be plagued by new software, crashes and technical problems. Achieving stable artefacts is difficult in emergent research areas, such as synthetic characters and robotics. It can be suggested that where the interactive experience to be evaluated is based on the use of complex, diverse technologies with potential technical problems that a greater number of users is necessary.

When aggregated the data provided by the CDFs provides a considerable amount of quality information that can be fed directly into FearNot design. Translating CDF comments into FearNot design specifications is a rapid process, applying basic content analysis techniques.

The use of the small Table-Time CDFs was highly effective and could possibly be an equally appropriate approach to robotic research. This approach fits well into a classroom situation, mirroring the techniques used by teachers for small group discussion. Further, whilst clearly more than a handful of users are needed for evaluation, a point is quickly reached when very little new information can emerge. From our results 5 small CDFs of 5 children were sufficient to obtain a significant amount of high quality data. This is roughly equivalent to a single class in many schools. Our results also highlight the need for all children within a class to be involved in the design process and their strong interest in all "having a go."

Obtaining design input from children can be achieved in a range of settings, however, there is considerable support for the classroom setting, both within the research literature [23] and from our own findings. The logistical difficulties of testing within a school are surmountable and testing in school is preferred by staff, parents and pupils.

A benefit of the use of CDFs is the speed with which the results of a CDF can be translated into design recommendations. This enables it to contribute quickly to the design process of novel interactive systems, such as synthetic characters and possibly robots. Being able to produce design recommendations quickly, strongly assists the design team in identifying priorities for improvement. In each CDF we have used, we have been able to report back design priorities and issues within a week. Typically in VICTEC we seek children's input as an informant, informing us about design decisions. When an informant approach is used, it is crucial that the design decisions can be presented quickly to the design team to permit further refinement. The success of this approach within VICTEC suggests that a similar approach might be suitable for the development of other interactive systems, in an emergent, research-based area, such as robotics.

5.2 Interacting with FearNot - Implications

Children found FearNot usable for their tasks and all children had no problems interacting with FearNot, even though the interface requires substantial modification. The ability of children to interact with a novel application and their levels of competence revealed a high degree of computer use. However, the low typing speeds coupled with regular clicking on the screen, suggested that most interaction is achieved through point and click. Thus, children whilst as competent as many adults in interaction are not competent at adult tasks like typing text. It might be interesting to investigate to what extent this finding also applies to human-robot interfaces.

The ease with which children used peripherals and their interest in point and click style interactions implies that in the development of interfaces for robots, that specialized console style devices may be more appropriate, coupled with minimal input through typing text. A number of children referred to the use of texting and it may be that the most appropriate input device for robots could be based on the mobile phone.

5.3 Control and Input

As in other fieldwork we have performed, children clearly wanted to control the interaction, trying to influence the pace at which actions and events happened. This may have relevance for robotics research in terms of the level of control that should be afforded to child users. Many children mentioned this issue and most could be seen

trying to affect the interaction using mouse clicks on the screen.

The thoughtfulness of the children in relation to the dialogues was unexpected and added a significant amount of time onto the interaction. Children were clearly immersed in the scenario and with providing advice to John. They also expressed a desire to know more about the characters and understand the storyline in more detail.

5.4 Enthusiasm and Engagement

Our results showed that children wanted to interact with unusual interactive experiences. Children were positive about the use of FearNot and would like to use it again. This is positive for any team developing innovative interactive systems as it shows that children are interested and enthusiastic about the development and use of novel applications. The lack of similarity between FearNot and other applications that children have used was noted. However, children viewed this positively, identifying that it was useful to try new, alternative approaches to learning. This may have positive implications for robotics, identifying that children are prepared to engage with new forms of interaction and that they view such novelty positively.

The high levels of engagement and enthusiasm elicited by the children for FearNot has potential educational implications for both software and robotic designers in terms of novel and innovative techniques to engage children with often sensitive classroom and school-based problems. All the children expressed a preference for using FearNot rather than a teacher-led session in the classroom to explore the different issues surrounding bullying. Children frequently said "If I was being bullied I wouldn't talk in a classroom session but I would try out different things on a computer session because nobody can see what I'm putting and it's private." Possibly robots could serve a role in addressing sensitive emotional issues also.

5.5 Emotions

Despite the somewhat negative responses from the children towards the character movement and appearance in FearNot, high levels of empathic engagement were displayed, sadness for John the victim and anger towards Luke the bully. This has possible design implications for robotic design as some researchers have paid particular attention to refining the facial expressions and emotional reactions of robots to resemble humans as closely as possible [24, 25]. The results suggest that precise emotional expressions and perfect movement are not necessarily prerequisites for children to experience believable and enjoyable interactions.

A related concern is that if robots and agents resemble humans too closely there is the danger of falling in the Uncanny Valley and for the user to experience discomfort from the interaction. The Uncanny Valley proposed by Mori suggests that as a robot/agent increases in humanness there is point when the robot is not 100% similar to humans and the balance between humanness and robotness becomes uncomfortable [26]. Woods et al. [27] have found supporting evidence for the uncanny valley in a study investigating children's attitudes towards robots.

Children did not express strong preferences for particular emotions that the characters should be able to express again indicating that agents' emotional expressions are not an underlying design requirement for children to experience believable interactions, and this could apply to robotics research. This finding could mean that the children in the current study did not have the cognitive capabilities to recognize and understand emotions fully. However, this is unlikely as they all expressed empathy towards the characters. A more likely explanation is that children were able to impose a level of their own imagination for the characters feelings and personality as the characters did not resemble perfect humans.

5.6 Character Movement and Appearance

The confusion between the various characters only relates to their names. The characters appear to be associated in terms of their roles rather than their names.

Children did not seem to use physical distinctiveness as a distinguishing characteristic focusing on role. This finding may have implications for robotics research where multiple robots are used. It could be suggested that clear, artificial naming (via a textual label) could be beneficial, rather than relying on physical distinctiveness of the robots.

The animation used in FearNot was found to be impoverished, all children were critical about the appearance. However, this poor movement did not seem to affect the engagement, enjoyment and enthusiasm of the children. This finding is one that we have seen in other fieldwork and is also seen in [28]. This could be relevant to the field of robotics, identifying that engagement and the evocation of empathic reactions can be achieved despite poor movement and appearance.

6 Conclusion

The research approach taken in the present study to explore children's opinions of the synthetic characters in FearNot has elicited useful design implications from a child-centred perspective. CDFs are well suited for use with primary school aged children as they are informal, engaging and fun and also offer the opportunity to gather significant amounts of data. CDFs provide a useful research tool to explore children's attitudes and opinions in a social context.

The results have highlighted that children are essential in the design phase of synthetic characters rather than relying on adult perspectives as it is clear that children have different cognitive and social expectations and

capabilities. The results from this study may have some useful implications for robotics research using children, as they have shown that the form, movement and emotional expressions of synthetic characters do not have to be perfect for children to experience believable and engaging interactions. Future research needs to investigate in more detail how our results with virtual characters apply to robot-human interaction.

Acknowledgements

Partially supported by the VICTEC project carried out with the support of the European Community in the Framework V Programme.

References

[1] Sony, "Aibo," www.aibo-europe.com 2004.

[2] Lego, "Mindstorms," www.legomindstorms.com 2004.

[3] A. Druin, "The role of children in the design of new technology," Behaviour and Information Technology, vol. 21, pp. 1-25, 2002.

[4] A. Druin, et al., "Children as our technology design partners," in The design of children's technology, A. Druin, Ed. San Francisco: CA: Morgan Kaufmann, 1999, pp. 51-72.

[5] A. Druin, "A place called childhood," Interactions, vol. 3, pp. 17-22, 1996.

[6] M. D. Brouwer-Janse, et al., "User interfaces for Young and Old," Interactions, vol. 4, pp. 34-46, 1997.

[7] M. Scaife and Y. Rogers, "Kids as informants: telling us what we didn't know or confirming what we knew already.," in The Design of Children's Technology, A. Druin, Ed. San Francisco, CA.: Morgan Kaufmann, 1999.

[8] D. S. Acuff and R. H. Reiher, What Kids Buy and Why: The Psychology of Marketing to Kids. New York: Free Press, 1997.

[9] L. Hanna, K. Risden, and K. Alexander, "Guidelines for Usability Testing with Children,"Interactions, vol. 4, pp. 9-14, 1997.

[10] A. Bruckman & A. Bandlow, "HCI for Kids," in Human–Computer Interaction Handbook, J. Jacko and A. Sears, Eds. Hillsdale, NJ: Lawrence Erlbaum, 2003, pp. 428–440.

[11] A. Druin, "Cooperative inquiry: Developing new technologies for children with children," presented at CHI '99, 1999.

[12] A. Druin and J. Hendler, Robots: Exploring new technologies for learning for kids. San Diego: Academic Press, 2000.

[13] T. Ito, "Analysis on Children's Images of Robots in terms of Clinical Psychology: How Children Perceive Robots Changes in Children's Images of Robots after their Interaction with Robots," presented at Robo Festa, Yokohama, 2001.

[14] Z. Khan, "Attitude towards intelligent service robots," NADA KTH, Stockholm 1998.

[15] M. Scopelliti, M. V. Giuliani, A. M. D'Amico, and F. Fornara, "If I had a robot at home.... Peoples' representation of domestic robots," in Designing a more inclusive world, S. Keates et al., Eds. Cambridge, UK: Springer, 2004, pp. 257-266.

[16] A. Druin, "Designing PETS: A personal Electronic Teller of Stories," presented at CHI99, 1999.

[17] R. Moreno et al., "The Case for Social Agency in Computer-Based Teaching: Do Students Learn More Deeply When They Interact With Animated Pedagogical Agents," Cognition and Instruction, vol. 19, pp. 177-213, 2001.

[18] D. P. Pertaub, M. Slater, and C. Barker, "An Experiment on Public Speaking Anxiety in Response to Three Different Types of Virtual Audience," Presence: Teleoperators & Virtual Environments,, vol. 11, pp. 68-78, 2001.

[19] C. Nass, K. Isbister, and E. Lee, Truth is beauty: researching embodied conversational agents. Cambridge, MA: MIT Press, 2001.

[20] G. E. Gorman and P. Clayton, Qualitative Research for the Information Professional: a practical handbook. London: Library Association Publishing, 1997.

[21] G. de Vries, "Involvement of School-aged Children in the Design Process," Interactions, vol. 4, pp. 41-2, 1997.

[22] L. Hall, et al., "Designing Empathic Agents: Adults vs. Kids," presented at ITS 2004, Maceio, Brazil, 2004.

[23] J. A. Rode, et al., "Curriculum-Focused Design," presented at IDC 2003, 2003.

[24] C. L. Breazeal, Designing sociable robots. Massachusetts: The MIT Press, 2002.

[25] L. Cañamero, "Playing the emotion game with Feelix: What can a LEGO robot tell us about emotion?," in Socially intelligent agents: Creating relationships with computers and robots, K. Dautenhahn, A. Bond, L. Canamero, and B. Edmonds, Eds. Massachusetts, USA: Kluwer Academic Publishers, 2002, pp. 69-76.

[26] K. Dautenhahn, "Design spaces and niche spaces of believable social robots," proceedings of IEEE Int. Workshop on Robots and Human Interactive Communication; RoMan, Berlin, Germany, 2002.

[27] S. Woods, K. Dautenhahn, & J. Schulz, "The design space of robots: Investigating children's views," To appear in proceedings of IEEE Int. Workshop on Robots and Human Interactive Communication; RoMan, Kurashiki, Japan, 2004.

[28] S. Marsella, W. L. Johnson, and C. LaBore, "Interactive Pedagogical Drama for Health Interventions," presented at 11th Int. Conference on AI in Education, Sydney, Australia, 2003.