The boy-robot should bark! – Children's Impressions of Agent Migration into Diverse Embodiments

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ABSTRACT

This paper presents results from a series of focused group discussions with a sample consisting of approximately 180 children during which views and opinions regarding agents migrating between different embodiments were elicited. The discussions attempted to ground the concept of a *migrating agent* in the children"s own experience of interacting with virtual characters in electronic toys and video games. The results suggest a complex interplay between expectations and appearance, and that disentangling the form of an agent may take from the underlying structures defining the agent's personality may be problematic for potential users.

1 INTRODUCTION

The aims of the LIREC (LIving with Robots and intEractive Companions) project [1] are to investigate the theoretical aspects of artificial companions and embody these aspects into robust and innovative technologies, both in the form of virtual agents as well as physical robots. This will allow for examining the applicability of these theories in actual social environments and facilitating the creation of artificial companions suitable for long-term interactions.

This endeavour includes studying both how a single agent can migrate into different embodiments depending on the tasks that it performs or the preferences of its users, as well as aspects of personalisation and adaptation to the particular idiosyncratic needs and preferences of diverse users.

While a major part of the project is to conceptualise, define and implement technological solutions to facilitate this process, it is also important to consider how prospective users may perceive and understand migration. Key questions for the LIREC project are how the unique underlying agent may be recognisable to the user in these different embodiments, as well as express personalised social behaviour when interacting with its users.

The importance of the use of affective and relational cues when creating and maintaining relationships between an agent and its users has been addressed by Bickmore et al. [2-4] who propose the use of such strategies and demonstrates the impact of their use with anthropomorphic virtual conversational agents.

Kasap et al. [5] propose an emotion engine which allows for emotive communication across different embodiments using a virtual anthropomorphic character and an anthropomorphic robot head. It also allows for episodic memory of previous interactions to be stored, facilitating long-term interactions and the formation of a long-term relationship between the agent and its interactants. While not addressing the topic of migration as such. they suggest that the affective communication ability in combination with the ability to retain memories of previous interactions are key in the development of relationships with artificial agents.

Martin et al. [6] propose an agent capable of migrating into diverse embodiments, and highlights the issue of agent perception in the user, and suggest that the changing nature of an agent's embodiment may degrade the visual cues that may be necessary for recognition and be an impediment to sustaining a continuous relationship. The use of persistent visual or behavioural cues is suggested as a means to counter this impediment. Their findings suggest that the use of visual cues is a powerful tool in aiding recognisability of the individual agent across diverse embodiments. However the use of other cues, as unique behavioural patterns or auditory cues are highlighted as issues that remain open.

2 THE PRESENT STUDY

This study explored children's perceptions of agent migration. Previous work in HRI has addressed how robots are perceived in terms of capabilities and moral agency by children [7, 8] and has indicated that children are capable of quite sophisticated reasoning regarding the nature of artificial entities. As such, insights from such a sample would be beneficial in the design and implementation of relational and affective behaviours as well as for identifying strategies for a migrating artificial agent. While the LIREC project does not focus on children in particular, products such as video games and electronic toys that target this demographic group often incorporate artificial, interactive agents. Therefore, this age-group is likely to have more everyday experience of interacting with such agents than an older population sample.

The topics of interest that were addressed were as follows:

1. Would a sample consisting of 8-10 year old children understand the concept of migration?
2. How would the relationship between the agent and its embodiment be considered?
3. How would this relationship be considered in light of the possibility of migration?

3 PROCEDURE

This study was conducted as part of a larger event in which children from local primary schools visited the Adaptive Systems Research Group at the University of Hertfordshire in

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May 2008. It was conducted as a series of group discussions in which one of the researchers would lead a discussion through which the children's impressions and ideas related to agent migration were elicited. There were a total of around 180 children participating in these discussions, in groups ranging from 3 to 6 children in any given group. While no attempt was made to balance the sample according to gender, all the students were from mixed-gender schools and the composition of the groups reflected this.

The discussion was conducted in a similar manner to a school class, where information was presented in order to facilitate further discussion. While the discussion was divided into stages, the researchers endeavoured to make the topic as responsive to the input of the children as possible, The stages of this discussion are reported below, with the particular questions that the children were encouraged to discuss in italics

1. Introduction to the notion of artificial agents:
    a. Highlighting the difference between characters in interactive media vs. films and books.
    b. Use of characters from video games (see Figure 1) as well as tamagotchis and other interactive toys.
        i. *Are these characters unique, what makes them different from one another?*

2. Introducing the concept of migration:
    a. Transfer of saved computer games to other consoles.
    b. Using electronic pets on websites.
        i. *Is it the same agent, even if it has moved to a different computer?*

3. Introducing the notion of migration into physical embodiment:
    a. Pictures of different robot embodiments, an iCub, a Sony AIBO and a Pioneer robot (see Figures 2-3).
        i. *What robot body would you prefer?*
        ii. *What robot body is the most useful?*

4. Introducing the notion of migration from one physical embodiment to another:
    a. Pictures of iCub and Sony Aibo shown;
        i. *How would you know it was the same agent?*

The above points were deliberately addressed in a loose manner, attempting to let input from the children drive the discussions during each stage as well as the introduction to the next stage.

The picture representing the notion of a migrating agent personality was a character in EA Game's MySims for the Nintendo Wii [9], see Fig. 1. This image was chosen for several reasons. First of all, the Wii console is very popular amongst the demographic that the presentations were given to. As such, the probability of one or more of the children in each group having experience of this game was quite high. Secondly, the notion of a MySims character being recognisable as an individual entity, both in terms of appearance, choice of activities and having a unique interaction history, both with the user as well as other in-game characters, is easily conveyable. The researchers would then use the sharing of experiences by some of the children in each group as a launch point for a discussion around the notion of agent personality. The initial grounding of the concept of an artificial agent, within the sphere of everyday experience of the children, was also intended to allow the children a greater repertoire for reasoning around the ideas that were explored in the discussion sessions.

Figure 1 Screenshot from EA game MySims for the Nintendo Wii used to exemplify a virtual character.

The images representing the robots were chosen in order to explore the large design space available to personal robots [10]. They offer three qualitatively different possible embodiments with three sets of equally different affordances. Having an anthropomorphic and zoomorphic robot as well as a clearly mechanical robot, facilitated exploration of a wide range of scenarios. This was both in terms of activities the participants could envisage the robots performing, as well as the nature of the interactions that would take place using these embodiments. Also, the researchers did not give out any information about the capabilities of these robots, so that any discussion regarding the use of the robots emerged from the capabilities the children projected unto them.

Following the discussion, the researcher demonstrated a form of migration where an agent 'personality' migrated between a Pioneer and a Peoplebot (see Figure 5). For the purposes of this demonstration, the personality was described to the children as being the way it avoided obstacles. The robot embodiments also used voice utterances as the agent migrated from one embodiment to the other.

During the demonstrations, one of the researchers took notes of the discussions and also noted interesting reactions to the

demonstrations. These notes formed the core of the data to be analysed, but also served to highlight themes and issues that could be addressed in subsequent discussions with later groups. The discussions were also videotaped, with the consent of the participating schools as well as the guardians of the chidlren. There was considerable background noise, which made transcription and analysis of the raw video difficult.

4 RESULTS

The results from the discussions are described below. The focus of this analysis was primarily to explore how the children understood the role of an agent in different embodiments as well as migration. As such, the analysis presented is primarily descriptive in nature.

Figure 2 Picture of iCub [11] and SONY AIBO [12] shown during presentation

Artificial Agents

The main themes that emerged from discussing the notion of artificial agents were that of relating this to the children's own experience of video-games and other electronic toys. An interesting point here was that most of the groups explicitly made clear divisions between agents in computer games which are directly controlled by the player, and as such are extensions of the player, and agents that displayed different degrees of autonomy.

This was particularly relevant to how the children discussed the uniqueness of a given instance of a video game character. Most groups initially approached this in terms of the appearance of a character. However, probes from the researchers regarding behaviour were often associated with references to personality.

'Sims like different things, some Sims like to clean while others like playing more'

References to Tamagotchis tended to be linked with the possibility of the death of the agent. This particular feature of these electronic toys was in most groups associated with discussions of the uniqueness of the character emerging from a shared interaction history.

'You can start a new game with a new one…it is not the same. You haven't done anything with the new one…it doesn't know you.'

Migration from one Computer to Another:

The notion of a character in a video game being transferred from one computer/games console to another was not problematic to the sample. All the groups could easily volunteer means of doing so, including email transfer of game data as well as physically moving storage media from one place to the other, before connecting them to the new media. There was a general consensus in all the groups that the character would remain unchanged throughout this process.

Figure 3 Picture of Pioneer shown during presentation [14].

Migration into Physical Embodiment

Discussion centred around the groups' preferences as to what robot body the agent should inhabit. The majority of groups (likely due to having a bias towards game-like characters introduced earlier) focused on the play possibilities of the different embodiments. This led to a preference for the iCub and the Sony AIBO embodiments.

'The dog-robot looks like it can play.'

'The human looking one, because he can play games with me.'

Preferences for the AIBO were often justified in terms of it being dog-like, and reflecting an underlying liking of dogs in general, as well as a clear understanding of the play-possibilities with dogs that could be transferred to interactions with the AIBO embodiment.

'I like the robot dog…no reason, but I really like dogs.'

'I like the robot dog, because I have a dog and I play with it all the time, and we have fun together.'

'I like the robot-dog, it could run after balls and it would be fun.'

Likewise, the iCub was credited with human-like capabilities in terms of speech, as well as intelligence.

'The boy-robot could keep me company…we could talk'

'I would like it [the iCub] *to help me with my homework.'*

On the other hand, groups in which the discussions were led towards other tasks started to have more detailed discussions regarding the possibilities and limitations of each embodiment when executing specific tasks. A common task that was discussed by a large portion of these groups was that of fetching and carrying drinks or snacks. These discussions highlighted apparent affordances based on the images of the robot presented, both in terms of possibilities and limitations:

Figure 4 Group Discussion

'The human one has arms so he can lift things, and walk on his legs to bring you a drink'

'The pioneer-robot could bring you things and drive around.'

'The human one would catch fire if it got water on the wires; maybe it shouldn't use the tap.'

'The one with wheels doesn't have any arms, so it can't pick anything up.

Interestingly, the AIBO embodiment was only considered suitable for particular tasks that the participants considered appropriate for dogs to do:
'It [the AIBO] could get the newspaper.'

'The robot-dog could guard my things.'

Also, some of the groups started considering the possibilities of collaboration between the robot embodiments to better perform tasks. The following quote regarding a fetch and carry task serves to illustrate this:

'The human one[the iCub] *can't walk very fast…maybe it could put the glass on the one with wheels* [the Pioneer] *so it could bring it to you?...I have never seen a fast walking robot'*

Interestingly, some children considered the difficulty for the agent in terms of orienting itself to a new body. This line of reasoning concluded that the humanoid iCub would be the most suitable for the agent, which was represented by the MySims screenshot, due to similarities of form:

'I think the human one, this one has two arms and two legs [points to MySim screenshot]*, and so does the human robot. It doesn't have to learn anything new, so it is easier for it.'*

Migration from one Physical Embodiment to Another
This particular issue raised questions from the children related to how the agent might represent itself across different embodiments. Drawing upon the discussions of the previous sections, the majority of the groups had already considered the notion of a *persistent, unique agent, with a particular interaction history with its users*. Two particular themes emerged as to how the agent could/should signal its identity to an onlooker.

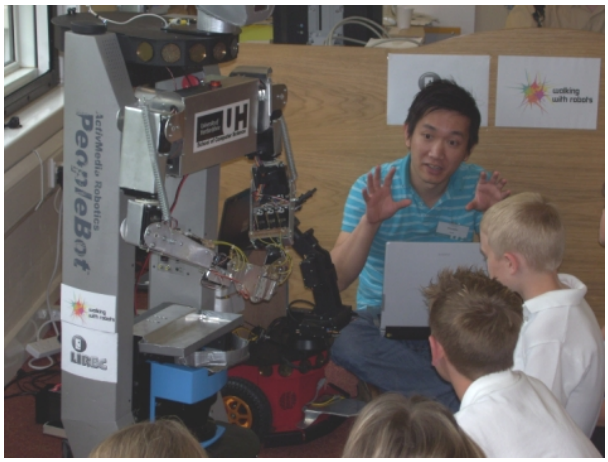

Figure 5 Migration Demonstration.

The first arose through reasoning which posited an original, ideal embodiment for the agent. This particular theme tended to incorporate an implicit assumption that the agent had a form which it spent the majority of its time in, and other embodiments were only adopted at a task-based basis. This led to suggestions of the robot adopting habits and behaviours that were clues to this original form in order to inform the user of its identity:

'If the character was in the dog and then moved to the boy-robot, then maybe the boy-robot should bark?…it would say woof woof!'

'Maybe the dog robot could walk on two legs?'

'When it is in the boy robot it would be very good at rolling over.'

'You would know that it has moved from the human one to the dog, because the dog robot could talk.'

It is interesting to note that participants did not consider such a transfer from the Pioneer embodiment. There was however, some comments that suggested such transfer from the iCub and the AIBO to the Pioneer.

The second theme that emerged followed a line of reasoning in which the group would see the interaction history and personality of the agent as something independent to the embodiments themselves. Following this argument, the groups would argue for analogous behaviours communicating affective behaviour.

'If the character is happy and in the dog it would bark and roll around…if it is in the boy, it could smile and laugh'

'If the character moves into the one with wheels it could spin around really fast if it is happy to see you.'

5 DISCUSSION

The findings from these focused group discussions suggest that children in this age-range are certainly capable of understanding the concept of agent migration into diverse physical embodiments. The use of examples and imagery from the children's everyday experience, through games and electronic toys, was particularly effective in eliciting meaningful responses from the participants.

Many of the responses from the children focused heavily on the play-aspect of such companions. This was to be expected due to initial focus on entertainment applications artificial agents in the slides used in the presentation.. Also, for this age-range most electronics products are intended as vehicles for entertainment. It is important to note that the participants did not have difficulty when prompted to consider applications other than play for the agents in different embodiments. Also, considerations such as engagement across different embodiments is still valid in interactions that are not intended as being solely for entertainment purposes [2].

This study was an exploratory study and the main focus was to gain a wide range of comments and insights into the relationship between how an agent is perceived in terms of its embodiment. Also, our aim was to examine how migration was perceived by the children, rather than examining specific pre-determined relationships between concepts. However, there were some interesting insights from the sample.

One of the most salient themes emerging in the discussions related to how the role of affordances, based on an embodiment, determined the role of the agent. This was in some instances based on the physical capabilities of the embodiment. For example, as in the discussions of whether to use iCub or the Pioneer for the fetch and carry task. However, the iCub and the AIBO embodiments also carried with them a set of expectations. These were not just related to apparent capabilities, but drew on expectations based on the form of the robot, wherein the robot would take on a social role based on what it appeared to be. Thus, fetching the newspaper, running after balls, and guard duty were considered appropriate tasks for the agent in the AIBO embodiment. Likewise, for the iCub, the ability to talk and help with tasks of a more intellectual nature was also considered appropriate

This was also reflected in the views of migration. In those discussions that posited an original form, the agent would retain the social and intellectual aspects of the role afforded to it by the original form. As such, identification of the unique agent would here be accomplished using cues that would hint at these roles, e.g. barking and rolling over if the migration was from the AIBO embodiment, or speaking if the migration was from the iCub.

A similar issue emerged in the statements of those groups who, when considering the best embodiment for the robot to take, decided upon the humanoid form of the iCub. The agent could then apply its knowledge about its virtual embodiment directly to that of the iCub.

These results can be considered in the light of previous work such as Walters et al. [15], which suggests that the behaviour of a robot should be consistent with the expectations created by its particular appearance. However, these results also suggest that adding migration to the mix might create a more complex and dynamic interplay between embodiment and expectations. The discussions suggested that behaviours could clarify an original set of affordances for the agent, *despite* those of its current embodiment.

It should be noted however, that some of the groups focused on the role of the agent as an entity divorced from its embodiment. These groups considered the various embodiments as avenues for interaction which the agent could use to express itself and act upon the world. However, these groups were in the minority and as such, the data on this reasoning is sparser.

6 CONCLUSIONS

This was an exploratory study and these results were not intended to be directly applicable to the implementation of migration processes of agents within the LIREC project. They are however, a source of future avenues of investigation.

The most prominent of these is the issue of how the agent initially should present itself. The power of a perceived 'ideal' embodiment for the agent should not be underestimated, both in terms of framing expectations as to (perceived) intellectual capabilities as well as its social role, As such, when initially presenting itself to the user, the form the agent is introduced in, might impact subsequent perceptions of the agent across different embodiments. This may be a powerful tool in terms of situating the role of the agent within the everyday experience of the user, especially if the social role afforded it by its embodiment is congruent with its capabilities. For instance, a robot intended for fetch and carry as suggested by [16] may benefit from being initially presented as having an original dog-like embodiment. Dogs are trained to perform such tasks for users and thus these affordances would then support the interactions resulting from these tasks. On the other hand, this may prove an obstacle to interactions if the agent is embodied in a form that can use different modalities to communicate than those which the user perceives in its original form. In which case, the user may find these modalities inconsistent with their expectations from the agent.

Therefore, examining the processes of how the perception of the agent's original or ideal embodiment is created by the user,

as well as possible ways of shaping the creation of such a perception, may be useful in future work. Also, ways of utilising these perceptions are also an interesting avenue of investigation.

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REFERENCES

[1] LIREC, http://www.lirec.org, 2008.

[2] T. W. Bickmore, L. Caruso, K. Clough-Gorr, and T. Heeren, "'It's just like you talk to a friend' relational agents for older adults," *Interacting With Computers*, vol. 17, pp. 711-735, 2005.

[3] T. W. Bickmore and J. Cassell, "Relational Agents: A Model and Implementation of Building User Trust," *Proceedings of the SIGCHI conference on Human factors in computing systems*, pp. 396-403, 2001.

[4] T. W. Bickmore and J. Cassell, "Social Dialogue with Embodied Conversational Agents," in *Natural, Intelligent and Effective Interaction with Multimodal Dialogue Systems*, J. v. Kuppevelt, L. Dybkjaer, and N. Bernsen, Eds. New York: Kluwer Academic, 2005, pp. 23-54.

[5] Z. Kasap, B. Moussa, P. Chaudhuri, D. Hanson, and N. Magnenat-Thalmann., "From virtual characters to robots - a novel paradigm for long-term emotional human-robot interaction.," *Submitted to Human-Robot Interaction Conference, 2009.*, Submitted.

[6] A. Martin, G. M.P.O'Hare, B. R. Duffy, B. Schön, and J. F. Bradley, "Maintaining the Identity of Dynamically Embodied Agents," *The Fifth International Working Conference on Intelligent Virtual Agents - IVA 2005 Kos, Greece, September 2005*, 2005.

[7] P. H. Kahn, N. G. Freier, T. Kanda, H. Ishiguro, J. H. Ruckert, R. L. Severson, and S. K. Kane, "Design patterns for sociality in human-robot interaction," in *Proceedings of the 3rd ACM/IEEE international conference on Human robot interaction*. Amsterdam, The Netherlands: ACM, 2008.

[8] S. Turkle, W. Taggart, C. D. Kidd, and O. Dasté, "Relational artifacts with children and elders: the complexities of cybercompanionship," *Connection Science*, vol. 18, pp. 347-361, 2006.

[9] S. Zhu, course materials for CMS.600 / CMS.998 Videogame Theory and Analysis, Fall 2007. *MIT OpenCourseWare (http://ocw.mit.edu/),* Massachusetts Institute of Technology. Downloaded 09-02-2009.

[10] K. Dautenhahn, 'Design spaces and niche spaces of believable social robots', Proceedings of the 11th Annual International Workshop on Robot and Human Interactive Communication (RO-MAN 02), Berlin, Germany, 192-197, (2002).

[12] Sony, "Sony AIBO," *http://support.sony-europe.com/aibo/*, 2009.

[13] RobotCub, *http://www.robotcub.org*, 2009.

[14] Pioneer, "Mobile Robots inc.," *http://www.activrobots.com/ROBOTS/p2dx.html*, 2009.

[15] M. L. Walters, D. S. Syrdal, K. Dautenhahn, R. te Boekhorst, K. L. Koay, 'Avoiding the Uncanny Valley – Robot Appearance, Personality and Consistency of Behavior in an Attention-Seeking Home Scenario for a Robot Companion', *Journal of Autonomous Robot*s, 24(2), 159-178, (2008).

[16] H. Huettenrauch and K. Severinson Eklundh, "Fetch-and-carry with CERO: Observations from a long-term user study with a service robot.," *Proceeding of the 11th IEEE International Workshop on Robot and Human Interactive Interactive Communication(RO-MAN 2001), Berlin, Germany Sept 25-27, 2002*, pp. 158-163, 2002.