Testing the Media Equation with Children

Sonia Chiasson and Carl Gutwin
Computer Science Department, University of Saskatchewan
110 Science Place, Saskatoon, SK, S7N 5C9, Canada
sonia.chiasson, carl.gutwin @usask.ca

ABSTRACT

Designers of children's technology are often more interested in user motivation than those who design systems for adults. Since children's technology often has aims such as education or practice, keeping the user engaged and interested is an important objective. The *Media Equation* – the idea that people respond socially to computers – shows potential for improving engagement and motivation. Studies have shown that people are more positive about both themselves and the computer when software exhibits certain social characteristics. To explore the possible value of the Media Equation as a design concept for children's software, we replicated two of the original Media Equation studies, concerning the effects of praise and team formation. Our results, however, were contrary to our expectations: we did not find evidence that children were significantly affected by social characteristics in software, and adults were influenced in only a few cases. These results raise questions about using the Media Equation as a design principle for children's software.

Author Keywords

Media Equation, CASA, children's technology.

ACM Classification Keywords

H.5. Information interfaces and presentation: User interfaces (*Interaction styles, screen design*)

INTRODUCTION

Children are becoming primary users of software and technology, and more attention is being paid to the specifics of how to design for children. There are several ways in which designing children's technology is different from designing for adults (e.g. [7,12]). One difference in particular is the focus on ways to improve engagement and motivation for younger users.

Designers of children's technology are often more concerned about user motivation than are those who design systems for adults. Utility and usability for a particular work task are primary objectives for mainstream software, but children's technology often has different aims, such as teaching school subjects or providing practice with particular skills [6]. Since the value provided by these systems is only obtained if the child actually spends time with the application, motivating a child to continue is an important design issue. One commonly used motivation is entertainment: by making a computer system fun, it is likely that children will remain on task longer. However, entertainment is not appropriate for all applications, and it would be valuable to have other means to engage and motivate users. One possible means is the Media Equation.

The Media Equation is a hypothesis suggesting that people respond to computers and other forms of media in the same ways that they respond to real people (e.g., [3,10,16,17,18]). Several studies, primarily by Nass and Reeves, have shown that people apply to computers the social rules and conventions that are usually reserved for other humans – that is, when presented with even minimal social cues, people automatically respond in a social manner. One finding of this work is that when computer software exhibits certain qualities of human behaviour (such as praising the user or acting like a teammate), the users of the software are significantly more positive about the computer system and about their own experience [20]. For example, the computer is seen as friendlier, more helpful, and more intelligent; users also feel that they are happier, more comfortable, and more in control, when the software exhibits human qualities.

The effect of the Media Equation has been reported in a wide variety of situations, with both experienced and novice computer users. If the Media Equation really is a basic fact of human interaction with computers, then it provides a potential opportunity for improving motivation in children's technology. If we can build software that naturally makes children feel better about themselves and the computer system, they are more likely to stay at the computer longer, more likely to listen to the system's instructions, and more likely to return to the software later.

However, virtually all of Nass and Reeves' Media Equation studies were done with adults. Our research therefore considers two questions: does the Media Equation apply to children; and, if an effect exists, is it stronger or weaker than it is with adults? To explore these questions, we replicated two of the original Media Equation tasks with children aged ten to twelve, and also tested adults aged eighteen to thirty as a comparison group. Our study looked

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at the effects of praise and team formation; we looked at whether people in either age group changed their responses when the computer system showed these human behaviours. We also considered whether males or females in either group were affected more strongly.

Our expectation was that children would respond more strongly to the Media Equation than adults, because children are often more willing to anthropomorphize objects and more willing to accept imaginary things as real [21,24,26]. However, our results did not match these expectations. The addition of social characteristics to the systems produced few significant effects, and the effect was weaker in children than it was in adults. Although these results are early, our findings raise questions for the use of the Media Equation as a means of improving motivation.

In the following sections, we briefly review research into the design of computer systems for children, and summarize previous work on the Media Equation. We then report on the study, and consider the implications of our findings for the design of children's technology.

THE DESIGN OF CHILDREN'S TECHNOLOGY

The majority of research on interface and interaction design has been done for software and systems intended for adult users. It is assumed in most cases that adults have basic computer skills and that the computer is a tool to help complete a particular task [6]. In contrast, children primarily use computers for education, entertainment, and social activities; in addition, they may not have all of the skills that mainstream software takes for granted, such as reading, fine motor control, or typing ability [12].

A number of principles and approaches have been proposed for the design of children's systems. Some examples:

- Children have varying literacy levels, so interfaces should be primarily visual, and text materials should be presented in an age-appropriate format [8,12];
- Children's fine motor skills are not fully developed, so mouse interactions such as selection, targeting, and dragging should be simplified [8,14];
- Children collaborate differently than adults do: multi-user interfaces should help children stay aware of their collaborators, and should help mediate conflicts over control of shared resources [5,13].
- Boys and girls are different: different interaction styles can seen with pairings of the two sexes [23], and designs can take these differences into account [13];
- Intrinsic motivation may be reduced, so systems should be interesting, challenging, and entertaining, with age-appropriate reward structures [12,15,19, 25];

The last point is most relevant to our work. While research has been done into means of making software more engaging, less work has been done into motivation by designing software to encourage particular social responses in children. This is the realm of the Media Equation.

THE MEDIA EQUATION AND CASA

The Media Equation claims that "media experiences equal human experiences" [20, p. 251]. People's responses to media are natural, social, and the same as responses to real-world experiences with other people. The Media Equation includes media such as television, but some modes of interaction are specific to computers. These lead to a particular set of social responses where the computer is actually considered as a separate social actor in the interaction. The interaction differs from those using avatars by considering the computer itself as an actor. This area of research is called Computers As Social Actors (CASA).

Nass and Reeves have tested their CASA hypothesis with studies based on accepted social psychology research about how human-human interaction unfolds, but where one of the humans in the situation is replaced with a computer. They found that people consistently respond in the same manner regardless of whether they are interacting with a second human or with a computer (e.g., [10,17,18,20]).

The Media Equation exists because human social responses are natural and subconscious; for thousands of years, anything that engaged us socially really was human and deserving of our social responses [1]. It is only recently that we have been interacting with machines, and the hypothesis suggests that the evolutionary responses still take hold. Treating the computer as a social actor falls in this category of behaviour; it engages us, so we respond socially [20]. Critics of CASA have suggested that only those people who are inexperienced with computers are likely to respond in this manner, or that people are really thinking of the human programmer 'behind' the software [2]. However, CASA studies have been carried out to show that neither of these criticisms are valid (e.g. [18,20]).

Other research also points towards the development of a social relationship between humans and computers. Strommen and Alexander [24] speak of a progression where computers were once mere tools, but now the level of emotional engagement with computers has risen to a point where we can speak of a partnership between humans and computers. Another study determined that most people also attribute aspects of agency (decision-making capability and the capacity for intentions) to computers [9]. In everyday use, computers are often blamed when things go wrong and often given some of the credit when things go right [9,16].

The majority of CASA studies have used adult participants, and for the most part this work has not been extended to children. However, a few pieces of research are relevant to our research questions. First, one study investigated whether children aged eight to ten respond to praise from a computer as positively as when the same praise is given by a teacher [3]. Her results show that children do respond to praise from the computer, although only four hypotheses of ten reached a significance level of $p<0.10$. Second, Turkle [26] suggests that recent generations of children, who have always had computers as part of their lives, have different attitudes towards technology than do earlier generations. Turkle also suggests that children have different ideas than adults about whether something is alive, and that their computers often fall nearer to the 'alive' marker. Children are also more comfortable than adults attributing psychological characteristics to machines [26, 27].

STUDY METHODOLOGY

We carried out a study to test two of the earlier CASA findings (the effects of praise and the effects of team formation) with children aged ten to twelve. We also tested a group of adult participants for comparison, to see whether the Media Equation affected children and adults differently. Our methods followed the original Nass and Reeves studies (e.g., [10,17]) as much as possible, with some modifications to make the materials more appropriate for children.

Participants

Thirty-nine children (20 boys and 19 girls) from a local school, and thirty-three adults (18 women and 15 men) from a local university participated in the study. The children were ten to twelve years old and in grades five and six. The adults were students majoring in either Computer Science or Psychology; their median age was 22 years.

All participants were familiar with computers and mouse-and-windows software. All the adults used desktop systems more than 20 hours per week. Ninety percent of children said they used a computer at home and most reported using it on a weekly basis. Three quarters of the children said they used a computer at school, although much less frequently than at home. The most common activities carried out on the computer were playing games and web browsing, with over 90% of children spending time on these activities.

Apparatus

Participants carried out two different tasks on two different computer systems during the session; these were set up at different locations in the room and participants moved from one station to another as instructed by the experimenter. Another area of the room was used for answering the paper questionnaires after each task.

Custom test applications were developed using Visual Basic 6.0. The software ran on PII Windows PCs with 1024x768 screens, keyboards, and mice. The interfaces for the tasks were simple Visual Basic forms containing textboxes, buttons, and radio buttons (see Figure 1). The interfaces were closely modeled on the systems used in the original studies [10,17].

Tasks

Two different tasks (Guessing Game and Desert Survival) were used to test different aspects of the Media Equation.

Guessing Game (Praise)

To test the effects of praise from the computer, participants played several rounds of a question-and-answer guessing game (Figure 1). This was the same task used in previous experiments by Fogg and Nass [10]. It was felt that children would understand the simple game without modification. The children enjoyed the game, and several returned to ask whether they could play again or take the game home.

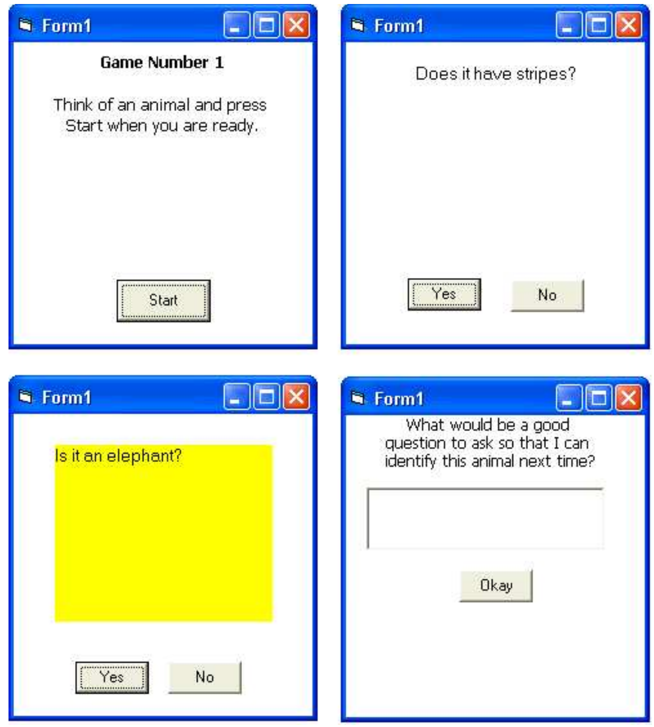

Figure 1. Basic screens for Guessing Game

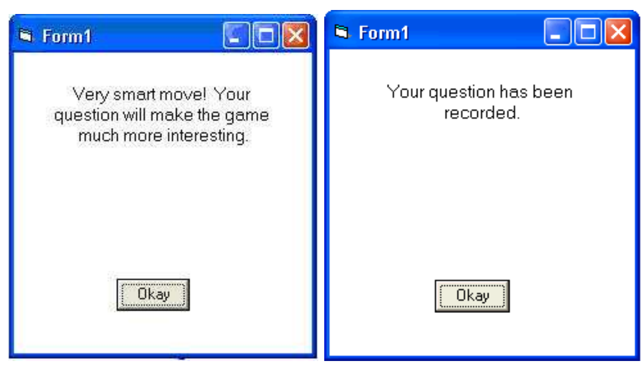

Figure 2. Examples of praise (left) and non-praise (right) feedback in the Guessing Game.

Participants were first asked to think of an animal. The computer then asked a series of yes/no questions and finally tried to guess the animal. The computer was programmed to guess incorrectly most of the time. When this happened, the participant was asked to add to the game by suggesting a question that would help identify this animal in the future. The computer then displayed feedback about the suggestion and moved on to the next round. This feedback varied according to experimental conditions. Half of the participants received positive feedback (praise) from the computer after each question entered, telling them that their suggestion was very good. The other half received only neutral feedback informing them that they were moving on to the next round of play. There were several different feedback messages, and participants received a different message with each round. Figure 2 shows examples of the feedback provided in the praise and non-praise conditions.

Each participant played seven rounds of the guessing game. As they played, they saw their suggested questions from previous rounds being incorporated into the game. After seven rounds, participants answered a paper questionnaire about their experience with the computer. The questionnaire asked about their perception of their own performance, their perception of the computer's performance, their overall perception of the computer, and their opinion of themselves.

Desert Survival (Team Formation)

The Desert Survival Problem was used to examine whether computers that act as the user's teammate are treated differently than systems that make no mention of teams. In this task, participants were asked to imagine that they were stranded on a deserted island. They were given a list of several items that might help them survive on the island, and their task was to choose the most important items for survival and then provide reasons for their choices. The original studies [17] also used this task, but in a longer form that was deemed too time-consuming for children. To make the task age-appropriate, our version used a shorter explanation of the situation, and had participants select five items out of eight rather than rank twelve items. Pilot tests with children helped adjust the task to a suitable format.

Participants completed the first portion of the task (reading the scenario and making their initial choices) away from the computer. During this phase, the experimenter introduced the concept of teammates (see below) according to the experimental condition. Participants then moved to the computer to enter their choices in a dialogue with the computer (see Figure 3): they compared their choices with those made by the computer, and entered a justification of each choice. Once they had discussed all of the items, participants wrote down a final set of selections, possibly altering their initial decisions.

Two computers were used for this task, following the original studies [17]. Participants were either assigned to a team or told that they were working as individuals. All participants were asked to wear blue wristbands at the start of the task. Half the participants were told that they were members of the Blue Team and would be interacting with their teammate, the Blue Computer (which showed a blue background), to complete the task. The second half was told that they were Blue Individuals who would be interacting with the Green Computer (showing a green background) to complete the task. Instructions given to participants in the team condition made several references to "your team's choices" and "your teammate;" no mention of the word team was made in the individual condition.

The computer was programmed to consistently choose three items that were different from the participant's choices. A consistent script of reasons for and against each item was used by the computer, but since the computer's choices depended on the participant's initial selections, the reasons varied across participants.

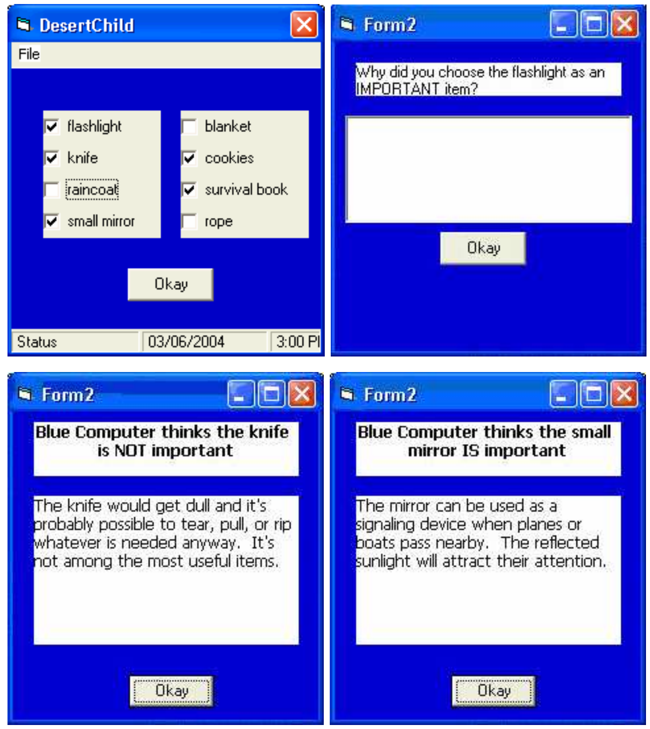

Figure 3. Screens from Desert Survival task. Top left: entering initial choices. Top right: entering justification for each choice. Bottom: comparing to the computer's choices.

Participants completed a paper questionnaire at the end of the session asking about their experience with the computer (see Table 1). We also recorded the number of changes that participants made to their initial rankings after interacting with the computer and their rationale for each item.

Data Collection

The primary measure used in the study was a questionnaire completed after each of the two tasks. Questions were *a priori* grouped into several sets that considered different aspects of the interaction. There were approximately ten questions in each group. The two main groupings, used in both tasks, dealt with the participant's opinions about the computer's characteristics, and the participant's feelings about themselves during the interaction. Other groupings of questions that were more specific to each task were also used. If the Media Equation had an effect on participants, it should result in more positive responses on the questionnaires.

For each question, participants circled their answer among five choices ranging from strongly positive to strongly negative. Half of the questions were inverted to avoid bias. Previous Media Equation studies used ten choices, and much longer questionnaires; however, pilot tests showed that children could not complete the full survey in a reasonable time, and that they were more comfortable choosing from among five items rather than ten. Questions were selected from the Nass and Reeves questionnaires to give a reasonable representation of the range of the original studies, and that involved concepts children would understand. Example questions from the seven different question groups are shown in Table 1.

In the team formation task, one further measure was taken: the number of items that a participant changed on their final rankings sheet to match the computer's choices.

Set A: Opinion of computer (used in both tasks)
Questions about whether the computer was: friendly, helpful, polite, likeable, interesting.
Set B: Feelings about self (used in both tasks)
Questions about whether the participant felt: busy, happy, comfortable, in control, calm, pleasant.
Set C: Opinion of tutoring session (Guessing Game)
Questions about whether the tutoring session was: fun, interesting, helpful, easy, quick.
Set D: Opinion of feedback (Guessing Game)
Questions about whether the feedback from the computer was: accurate, fair, interesting, generous, positive, friendly.
Set E: Perception of computer as partner (Desert Survival)
How much did you cooperate with this computer? How much did you think of yourself as part of a group?
Set F: Perception of similarity to computer (Desert Survival)
How similar were the computer's suggestions to yours? How much did you agree with the computer's reasons?
Set G: Trust and confidence in the computer (Desert Survival)
How much did you trust the information from the computer? How helpful were the computer's suggestions?

Table 1. Question types for each question group (5-point scales). Full questionnaires can be seen in [4].

Study Design

The study used a 2x2x2 mixed factorial designs for each task (guessing game or desert survival), with a number of planned comparisons. Some comparisons analysed adults and children separately, and others considered them together. There were three between-participants factors:

- Treatment (social characteristics present or absent)
- Age group (children or adults)
- Sex (male or female).

All participants completed both tasks; order was balanced so each task was seen in the same position the same number of times. Adults and children were evenly divided between the experimental condition; within age groups, there were also an equal number of females and males.

RESULTS

Analyses were carried out separately for the two different aspects of the Media Equation (praise in the guessing game task, and team formation in the desert survival task). Results are organized below by these two aspects.

Effects of Praise

Four question sets were analysed:

- **Set A**: the participant's opinion of the computer,
- **Set B**: their feelings about themselves,
- **Set C**: their opinion of the computer's feedback,
- **Set D**: their opinion of their own performance,

From these variables, several comparisons were made:

- Overall differences in responses between adults and children (main effect of age)
- Whether praise changes responses for either adults or children (main effects of treatment)
- Whether praise affects adults or children more strongly (interaction between treatment and age)
- Whether praise affects males or females more strongly (interaction between treatment and sex)

Overall differences between children and adults

Considering all data, children and adults' responses were significantly different (see Figure 4 and Table 2), with children responding more positively overall, regardless of whether or not they received praise. The difference was about one-half point on the 1-5 scale of the questionnaire.

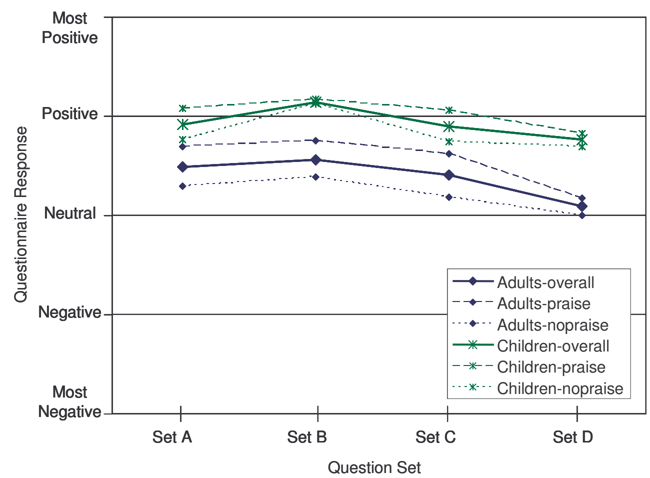

Figure 4. All data: mean responses, by age and treatment.

	Set A	Set B	Set C	Set D
Age	**$F_{1,71}$=11.55, p<0.001**	**$F_{1,71}$=31.24, p<0.001**	**$F_{1,71}$=15.59, p<0.001**	**$F_{1,71}$=20.04, p<0.001**

Table 2. All data: main effects of age on each question set.

Does praise affect either adults or children?

Adults and children were considered separately for this analysis. In both cases, mean responses were slightly higher in the treatment condition. However, ANOVA showed significant effects of praise on some question sets only for adults (see Tables 3 and 4). For questions about the computer, themselves, and the computer's feedback, adults answered more positively when they were praised. No effect was found for questions about their own performance. For children, no significant effects of praise were found for any question set.

	Set A	Set B	Set C	Set D
Treatment	$F_{1,38}$=3.17, p=0.09	$F_{1,38}$=0.10, p=0.75	$F_{1,38}$=3.00, p=0.09	$F_{1,38}$=0.60, p=0.44

Table 3. Children: effects of praise (treatment).

	Set A	Set B	Set C	Set D
Treatment	**$F_{1,32}$=5.88, p<0.05**	**$F_{1,32}$=6.48, p<0.05**	**$F_{1,32}$=7.34, p<0.05**	$F_{1,32}$=0.54, p=0.47

Table 4. Adults: effects of praise (treatment).

Does praise affect adults and children differently?
Analysis of variance did not show a significant interaction between treatment and age (see Figure 4 and Table 5), even though adults showed significant treatment effects and children did not.

	Set A	Set B	Set C	Set D
Treatment x Age	$F_{1,71}$=0.09, p=0.76	$F_{1,71}$=2.37, p=0.13	$F_{1,71}$=0.24, p=0.63	$F_{1,71}$=0.02, p=0.88

Table 5. All data: interaction between treatment and age.

Does praise affect males and females differently?
Adults and children were considered separately for this analysis. Analysis of variance did not show any main effect of sex for children; that is, boys and girls answered similarly overall. In addition, although there were slightly larger differences for girls on some questions (see Figure 5), no interaction effect between treatment and sex was found. Tables 6 and 7 show the ANOVA results.

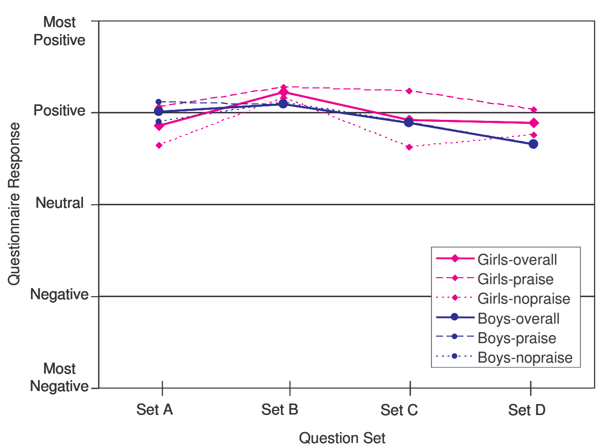

Figure 5. Children: mean responses, by sex and treatment.

	Set A	Set B	Set C	Set D
Sex	$F_{1,38}$=0.84, p=0.37	$F_{1,38}$=0.77, p=0.39	$F_{1,38}$=0.04, p=0.85	$F_{1,38}$=1.96, p=0.17
Treatment x Sex	$F_{1,38}$=0.36, p=0.55	$F_{1,38}$=0.29, p=0.59	$F_{1,38}$=2.89, p=0.10	$F_{1,38}$=0.60, p=0.20

Table 6. Children: main effects of sex, and interaction between treatment and sex.

For adults, significant overall differences were found between men and women for questions about the computer and questions about the computer's feedback (see Figure 6). However, no interaction was found between treatment and sex (see Table 7).

	Set A	Set B	Set C	Set D
Sex	**$F_{1,32}$=5.40, p<0.05**	$F_{1,32}$=1.10, p=0.31	**$F_{1,32}$=4.48, p<0.05**	$F_{1,32}$=1.71, p=0.47
Treatment x Sex	$F_{1,32}$=0.04, p=0.85	$F_{1,32}$=0.01, p=0.96	$F_{1,32}$=0.06, p=0.81	$F_{1,32}$=0.06, p=0.82

Table 7. Adults: effects of sex, interaction with treatment.

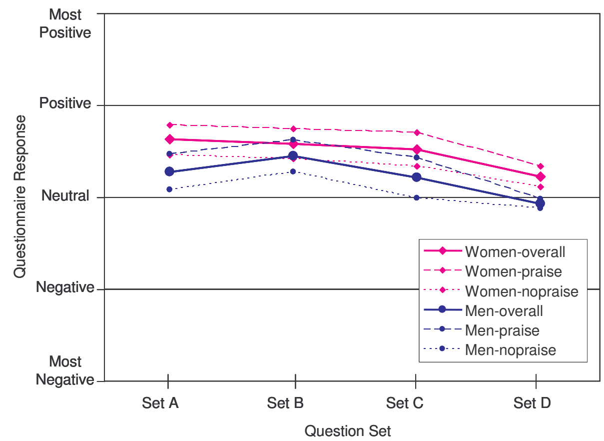

Figure 6. Adults: mean responses, by sex and treatment.

Effects of Team Formation

From the desert survival task, five question sets and one behaviour variable were analyzed:

- **Set A**: the participant's opinion of the computer,
- **Set B**: their feelings about themselves,
- **Set E**: their perception of computer as a partner,
- **Set F**: their perceived similarity with the computer,
- **Set G**: their confidence and trust in the computer,
- The number of items that participants changed.

Again, several comparisons were planned, and again, some used the entire data set and some analysed children and adults separately. The comparisons were:

- Overall differences in responses between adults and children (main effect of age)
- Whether team formation changes responses for either adults or children (main effects of treatment)
- Whether team formation affects adults or children more strongly (interaction between treatment and age)
- Whether team formation affects males or females more strongly (interaction between treatment and sex)

Overall differences between children and adults
Once again, children and adults' questionnaire responses were significantly different (see Figure 8 and Table 8), with children again responding more positively overall. The difference was approximately 0.5 points on the 1-5 scale of the questionnaire. However, there was no difference in the number of items changed to match the computer's suggestions ($F_{1,71}$=2.80, p=0.10) (Figure 7).

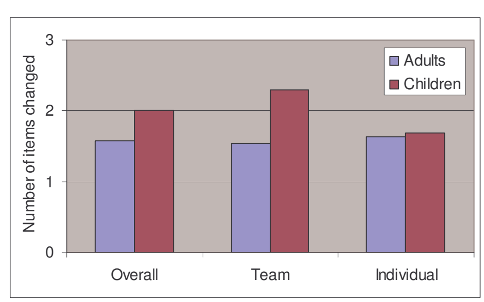

Figure 7. All data: mean number of items changed (maximum of three), by age and treatment.

	Set A	Set B	Set E	Set F	Set G
Age	**$F_{1,71}$=10.8, p<0.005**	**$F_{1,71}$=27.1, p<0.001**	**$F_{1,71}$=13.3, p<0.005**	$F_{1,71}$=0.9, p=0.34	**$F_{1,71}$=6.7, p<0.05**

Table 8. All data: main effects of age.

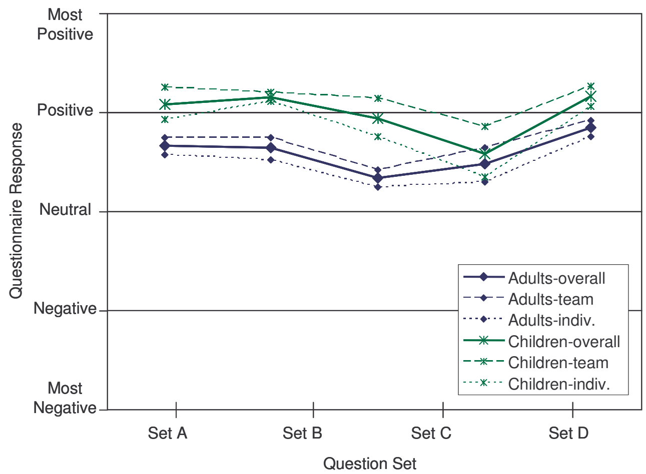

Figure 8. All data: mean responses, by age and treatment.

Does team formation affect either adults or children?

Adults and children were considered separately. Once again, responses in both cases were more positive in the team condition than in the individual condition (see Figure 7). Analysis of variance showed significant effects of team formation on only one question set for adults, and no effects at all for children (see Tables 9 and 10). The question set that did show an effect for adults was set B (feelings about themselves); adults answered these questions significantly more positively when they were in the team condition.

	Set A	Set B	Set E	Set F	Set G
Treat.	$F_{1,38}$=2.59, p=0.12	$F_{1,38}$=0.08, p=0.78	$F_{1,38}$=3.04, p=0.09	$F_{1,38}$=4.02, p=0.05	$F_{1,38}$=1.71, p=0.20

Table 9. Children: main effects of team formation

	Set A	Set B	Set E	Set F	Set G
Treat.	$F_{1,32}$=2.12, p=0.16	**$F_{1,32}$=4.73, p<0.05**	$F_{1,32}$=0.86, p=0.36	$F_{1,32}$=3.33, p=0.08	$F_{1,32}$=0.83, p=0.37

Table 10. Adults: main effects of team formation.

The opposite situation (children more affected than adults) was found in the items changed to match the computer. Children changed 0.7 more items in the team condition than they did in the individual condition; adults were basically the same in both conditions (see Figure 7). For children, ANOVA showed a significant effect of team formation on the number of items changed ($F_{1,38}$=7.63, p<0.05). No effect was found for adults ($F_{1,32}$=0.23, p=0.64).

Does team formation affect adults and children differently?

For questionnaire responses, analysis of variance did not show significant interaction between treatment and age for any question set (see Figure 8 and Table 11).

	Set A	Set B	Set E	Set F	Set G
Treat. x Age	$F_{1,71}$=0.15, p=0.70	$F_{1,71}$=1.61, p=0.21	$F_{1,71}$=0.17, p=0.68	$F_{1,71}$=0.19, p=0.66	$F_{1,71}$=0.01, p=0.92

Table 11. All data: interaction between treatment and age.

The number of items changed, however, did show a significant interaction between treatment and age ($F_{1,71}$=4.37, p<0.05). As can be seen in Figure 8, children's behaviour was more affected by the team condition than was the adults'.

Does team formation affect males and females differently?

Adults and children were considered separately for this analysis. For children, analysis of variance showed a main effect for only one question set (feelings about themselves). Although there were some larger differences for boys on some question sets (the opposite of what was seen in the praise analysis), no interaction effect between treatment and sex was found. Figure 9 and Table 12 show these results.

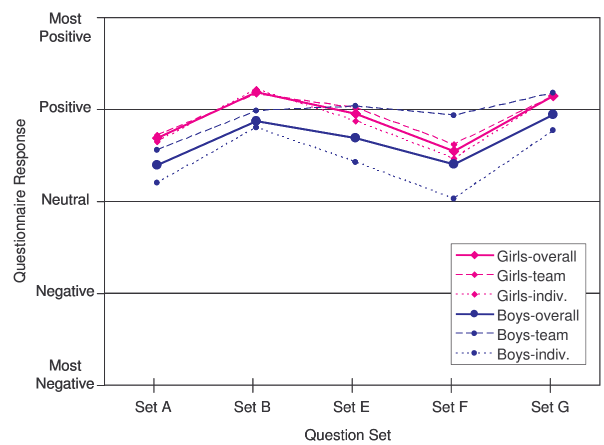

Figure 9. Children: mean responses, by sex and treatment.

	Set A	Set B	Set E	Set F	Set G
Sex	$F_{1,38}$=1.80, p=0.19	**$F_{1,38}$=6.55, p<0.05**	$F_{1,38}$=2.05, p=0.16	$F_{1,38}$=0.04, p=0.83	$F_{1,38}$=1.20, p=0.28
Sex x Treat.	$F_{1,38}$=0.22, p=0.65	$F_{1,38}$=0.45, p=0.51	$F_{1,38}$=1.01, p=0.32	$F_{1,38}$=2.13, p=0.16	$F_{1,38}$=1.20, p=0.28

Table 12. Children: main effects of sex, and interactions with treatment.

For adults, one question set (Set F - perceived similarity with the computer) also showed a significant main effect of sex (see Figure 10 and Table 14). No interaction effects between sex and treatment were found.

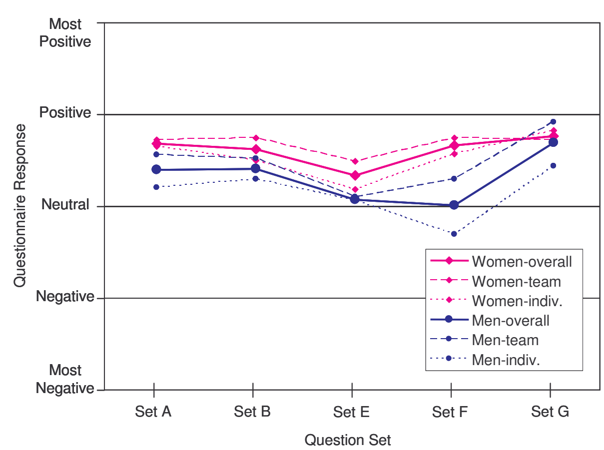

Figure 10. Adults: mean responses, by sex and treatment

	Set A	Set B	Set E	Set F	Set G
Sex	$F_{1,32}$=4.01, p=0.06	$F_{1,32}$=3.33, p=0.08	$F_{1,32}$=0.47, p=0.50	**$F_{1,32}$=7.75, p<0.05**	$F_{1,32}$=0.06, p=0.81
Sex x Treat.	$F_{1,32}$=1.02, p=0.32	$F_{1,32}$=0.14, p=0.72	$F_{1,32}$=0.08, p=0.78	$F_{1,32}$=1.17, p=0.29	$F_{1,32}$=2.10, p=0.16

Table 14. Adults: ANOVA results for main effects of sex and interactions with treatment.

For children, there was no main effect of sex on the number of items changed ($F_{1,38}$=1.64, p=0.21), nor was there an interaction with treatment ($F_{1,38}$=1.64, p=0.57). The analysis for adults was similar: we found no main effect ($F_{1,32}$=0.89, p=0.36) or interaction with treatment ($F_{1,32}$=0.05, p=0.83) .

DISCUSSION

Our study did not find evidence that children are affected by the addition of social characteristics to software. In summary:

- some effects were found for adults – they answered significantly more positively for three of four question groups in the praise task, and for one of five groups in the team formation task;
- no effects of adding social characteristics were found for children in either task, for any question group;
- males and females were in most cases not significantly different either in their overall responses, or in the way they responded to the addition of social characteristics.

Our study raises several questions about the effects of the Media Equation. In the following sections we consider possible explanations for our results and issues that are raised by the findings.

Children and the Media Equation

Our results were unexpected given Nass and Reeves' previous studies. We consider three possible explanations: that the Media Equation does not strongly affect children, that the effect is so strong it overwhelmed any differences between the experimental conditions, and that the children's overall positive responses hid the effect.

If the effect of adding social characteristics is limited for children, why would this be so? The children we studied have grown up with computers, where adult participants have not. It is possible that the children have been so exposed to software that they are not "fooled" into responding socially. Attitudes towards different types of technology can certainly vary by generation: for example, Turkle [26] saw different perspectives from children who have always had computers as part of their lives than from those who have had computers introduced later in life. This hypothesis could be tested in future by replicating our study with children who have differing amounts of experience with computers.

There are arguments against this view, however. First, our adult participants had a median age of 22 years; therefore, most of them were born later than 1980, and so would also have had considerable experience with computers and software. Second, children often behave socially towards many kinds of objects that they have grown up with (stuffed toys, for example), suggesting that simple exposure is not enough to preclude a social response. Our observations of the children during the study also suggest that at least some of them were anthropomorphizing the systems, referring to the computer as "he" or commenting that they didn't want to hurt the computer's feelings.

These opposing points lead us to the second possibility – one that embraces the idea of children's willingness to treat objects socially. It is possible that children are in fact strongly affected by the Media Equation, so strongly that they respond to social cues that adults overlook. Younger children will often behave socially towards the simplest of objects (wooden spoons, shoes, bread rolls), naming the objects and carrying on imaginary conversations with them. This willingness to believe is perhaps beginning to wear off by the time a child reaches twelve years old, but it may still affect their behaviour. Thus, the 'non-social' computer systems that we tested may have seemed very social indeed to the children – after all, even the most basic computer systems exhibits social characteristics such as interacting with the user, carrying out the user's commands, and providing feedback in natural language. If the systems already seemed social to the children, it is possible that the addition of praise or team formation characteristics did not change their views substantially. The fact that children responded more positively overall may provide some evidence for this point of view. To follow up this alternate hypothesis, we would have to construct a computer system that behaves in ways that are as unlike a human as possible, and then examine the effects of adding the most basic interactive characteristics.

Finally, it is also possible that the more positive outlook displayed by children overall simply hid an actual Media Equation effect. If a child's baseline is already near the top of the questionnaire, there is less room for them to show a dramatic change in their responses. It is interesting to note that in both tasks, the children's responses were usually higher (and never lower) in the treatment condition. Although the differences were not large enough to show a significant difference, it is possible that an effect could be shown with a larger sample.

Text-based praise

In our study, children responded similarly whether they were praised or not. Many types of children's software with educational or motivational goals offer praise as a means of encouraging children. Our results suggest that such praise may be of limited value. However, this conclusion must be limited to praise that is given in text, since the presentation of the praise may have been a factor in our results.

First, it was clear that children spent less time reading the computer's feedback as the guessing game went on. They were enthusiastic about playing the game, and they soon realized that the feedback messages were not essential to moving forward. Several participants only glanced at the message and then pressed the 'OK' button to go to the next question. It is possible that children did not get the full effect of the positive messages in these cases. Adults, on the other hand, were more likely to be able to read the messages at a glance and pick up the tone of the text.

Second, children may not find text-based praise especially rewarding when compared to the multimedia feedback they typically receive when playing computer games. Adults, on the other hand, may have been just as unimpressed by the feedback but may have recognized the significance of positive assessment in any form.

Further study is required to determine whether presenting the praise in other formats or otherwise bringing attention to it would provide more beneficial results. However, it seems clear that if the praise is contained in non-essential feedback, and is not distinguished from other interface features, it may not provide the expected positive effects.

Team formation

Although the formation of a team with the computer had no impact on the children's responses, it did significantly influence the number of items changed to match the computer's suggestions. Although this result should be replicated in other situations, it appears that team formation can be a useful tool if the goal of a software program is to influence children's actions. When on a team, children took the computer's advice and suggestions seriously and modified their behaviour accordingly.

The lack of results from the team-formation questionnaires is in line with another recent study of the Desert Survival problem. Shechtman and Horowitz [22] showed that adult participants were significantly less likely to engage in relationship-building behaviors when they knew they were interacting with the computer as opposed to when they believed they were conversing with another person. This work suggests that people are less willing to emotionally invest in a relationship when they are aware that their partner is a computer.

Gender-specific design

Much research has been done to determine how to create user interfaces for children that take into account the different interaction styles of boys and girls (e.g., [13,23]). However, the results of our study show few significant differences in the ways that boys and girls felt about themselves, about their performance on the task, or about the computer. It was interesting to note that there was a larger means difference for girls in the praise task, and a larger difference for boys in the team-building task. We plan to look more closely at sex differences in future studies, but to date we have not seen any evidence that different designs for different genders will have much effect on feelings about self or about the computer.

Finding Media Equation effects

We were surprised at the weakness of the Media Effect in our study, given the many previous experiments that have shown clear results. There are several potential reasons for this. It is possible that the Media Equation is transitional in nature and is diminishing with further exposure to computers. However, it is unlikely that a strong effect could simply disappear. It is possible that if anything has changed since the initial studies were conducted, it is the type of manipulations needed to draw it out. With animated agents, avatars in video games, and other humanlike characteristics in many current systems, minor changes such as praise or team formation may no longer be enough to show an effect. Other recent studies using simple manipulations have also showed reduced effects or no effects at all [11, 22].

However, if it is more difficult now to elicit predictable social responses from users, using the Media Equation as a design principle becomes a moving target. People, children included, may respond socially to the computer, but not necessarily on cue or in the expected manner. This is problematic for designers since it makes it difficult to know what social elements to incorporate into their designs, or how to present these characteristics.

Finally, even if differences had proven to be significant in our study, it is unclear whether the Media Equation effect is large enough in real-world terms to be a useful design principle. A slightly more positive response to the computer or feeling about the child's own performance may not be a bad thing, but it is also unlikely to have any dramatic effects on the motivational issues introduced earlier.

FUTURE WORK

This study has raised a number of questions, and further work is needed in several directions to adequately determine how the Media Equation affects children.

First, it is still unclear whether children are not affected by social characteristics or are affected so strongly that minor manipulations show no difference. In our study, methods and tasks followed the original Nass and Reeves studies as closely as possible. In future studies, we will depart from these models and explore other tasks and software designs that may make the Media Equation effect appear. We plan to investigate interfaces that more closely reflect the multimedia interfaces that children use every day. Human social interaction engages many of our senses and is enriched by this multi-sensory experience; human-computer relationships may also be enhanced with multimedia, making the Media Equation more apparent. In addition, we plan to replicate more recent studies that used different systems and different tasks.

Second, we will look at the issue of children's overall positive responses by finding tasks where the children's baseline is lower. One reason for studying the Media Equation in the first place is to try and help motivate children to engage in activities that they would not otherwise choose to do. Although the two tasks in our study were not particularly exciting, they may have been more fun to carry out than multiplication or spelling drills. Therefore, our studies could be replicated with software about which children are not so positive, to try and lower the baseline response.

CONCLUSION

The Media Equation is a potential tool to improve engagement and motivation in children's software and technology. We carried out a study to determine whether children are affected by the addition of social characteristics to software, and whether the effects in children are stronger or weaker than in adults. Our study did not find strong evidence for the Media Equation, and suggests that these effects are not as easy to create or detect as previously indicated. Children were not significantly affected by praise or team formation and adults were influenced only in some cases. These results emphasize the need to re-examine the Media Equation to determine its applicability in interface design.

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