The Effects of the Media Equation on Children

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Abstract

Computers play an increasingly large part in children's daily lives, yet most interface design research has focused on adult users. One area of research that has informed adult interface design is the Media Equation, which explains how people respond to media in a fundamentally social manner and how they treat computers as social actors in interactions. To date, it was unknown whether these findings apply to children as well. This thesis investigates the effects of the Media Equation on children in three specific areas: praise, team formation, and politeness. It also examines whether varying the form of the computer affects the Media Equation in any way and whether there are any gender differences in how children respond to the Media Equation.

Little evidence was found to support the existence of Media Equation effects on children. Children responded positively regardless of whether any Media Equation elements were incorporated into the interfaces. These results raise doubts on whether there is any added value to including Media Equation principles into the design of children's interfaces. The results do, however, shed some light on children-computer interaction and lead to a set of guidelines for designers of children's technology.

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Table of Contents

List of Figures

List of Tables

1. Introduction

Children's software does not fully meet the needs and expectations of its users (Druin, 1996; 1999; National Public Radio et al., 2000) and there are few guidelines or design principles in place to help improve it. Most human-computer interaction research has been focused on adults' interaction with computers and it has been assumed that everyone behaves in the same manner. Since children behave differently than adults in most everyday situations, it is likely that their needs for computer interfaces are quite different than those of adults.

One phenomenon that has been used as a basis for the design of adult's technology is that people respond socially to computers. Conventional wisdom predicts that since computers are machines, people will treat them like other inanimate objects, without concern for their "feelings" and without taking into account their "opinions". Surprisingly however, people behave in much the same manner when interacting with computers as they do when interacting with other people. This phenomenon is known as the Media Equation (Reeves and Nass, 1996). The Media Equation states that *media equals real life*. "Individuals' interactions with computers, television, and new media are *fundamentally social and natural,* just like interactions in real life. […] Everyone expects media to obey a wide range of social and natural rules" (Reeves and Nass, 1996, p.5).

Studies in social psychology explain how people interact with each other, while studies in Human-Computer Interaction explain how people interact with computers. Research in Human-Computer Interaction has shown that adults apply to computers the social rules and conventions that they usually reserve for people. It appears that this behaviour is subconscious; when faced with something that gives even minimal social cues, people automatically respond in a social manner. This application of the Media Equation has led to a range of studies in the area of Computers As Social Actors (CASA) where social psychology experiments with well-known outcomes are modified to include a computer as one of the social actors, giving remarkably similar results to the original studies.

Most of these studies have involved adult participants and it is not known whether their results are due to some characteristic of the adult population. For example, perhaps the results are due to the fact that most adults were introduced to computers later in life and are not used to interacting with such a "smart" machine. What happens when one grows up with computers as part of everyday life? Would this early introduction lead to weaker or stronger social interactions with computers? This thesis investigates children and computers as social actors, in order to shed light on the social relationship between children and computers and to find design guidelines that can improve children's technology.

There are few studies examining how children interact with computers as social actors. While there exist some design guidelines for developing children's software, few deal with social interaction between children and computers. The knowledge gathered from this study of how children respond to computers will be used to develop design guidelines for children's software. If children do strongly treat computers as social actors, then developing computers that follow the expected rules of social interaction will lead to more satisfying and successful experiences. If children do not treat computers as social actors, then it is not worthwhile to spend extra time and effort in making computers follow social rules of interaction.

1.1. The Problem

There are few existing design principles guiding whether children's software should conform to social rules of interactions or how interfaces for children could be improved to take into account social behaviour. This lack of design guidelines leads to children's technology that follows social norms only by chance and that may present an internally inconsistent character, which may be unsettling and frustrating to users (Reeves and Nass, 1996).

The specific problem investigated in this thesis is that it was unknown how children respond to CASA and thus unclear whether children's technology would benefit from following Media Equation principles. While it was impractical to test every social psychology hypothesis to see whether the same holds for human-computer interactions, I investigated a few that seemed especially relevant to children. Three areas where children seemed likely to demonstrate social responses towards a computer were politeness, team formation, and praise. It has already been shown that adults respond politely to computers, treat computers as teammates, and respond positively to praise from computers (Fogg and Nass, 1997; Nass, Fogg, and Moon, 1996; Nass, Moon, Carney, 1999) but it remained unknown whether children respond in the same manner.

Girls and boys form very different social relationships and have different ways of interacting with each other. These differences may carry over to their interactions with computers as well. In fact, research has already shown that girls interact differently than boys when using a computer (Inkpen et al., 1995; Stienstra, 2003). It was deemed important to explore whether gender differences were apparent with respect to the Media Equation as well.

A third dimension to this investigation examined whether different design guidelines are needed when the form of computer is altered. Children use technology in different forms every day, from desktop computers, to handheld video games, to stuffed toys with embedded computers, to mini electronic organizers and diaries. Previous CASA studies assumed that the computer was a desktop computer with monitor, keyboard, and mouse. Since day-to-day human-computer interaction is no longer limited to desktop computers, it seemed fitting to investigate whether changing the form affected the Media Equation. Different forms of computers afford different types of interactions and may bring forth different social responses. To date, little research has been done to investigate whether varying the form of computer affects the Media Equation for adults or for children.

Specifically, the following questions were addressed:

- Did children respond to the Media Equation in the same manner as adults?
- Were there any gender differences in social interaction with computers?
- Did the form factor (the computer's form) influence children's interactions?

1.2. Motivation

A study released in 2003 by the US Department of Education reveals that about 90% of children aged 5 to 17 use computers and that 59% use the internet. These rates are even higher than those for adults. The study also shows that girls use computers as much as boys do, having eliminated the gender gap visible only a decade ago. Children most frequently use computers for playing games, working on assignments, email, and surfing the internet (Debell and Chapman, 2003). Obviously, computers are a part of everyday life for today's children.

A second survey asked children how they felt about computers. The results showed that while they like using computers and feel it is important to be technologically savvy, all is not perfect. More precisely, 83% of children were annoyed by programs that were difficult to use, 89% were irritated by not being able to find the information they wanted, and 89% were frustrated by how long some things take to work (National Public Radio et al., 2000). These results indicate that children's technology is not meeting the expectations of its audience.

It was worth testing the Media Equation with children because it may be a valuable principle for guiding the design of children's technology. Since children use computers for entertainment, education, and communication, there is potential for significant impact on their lives. Despite the considerable influence of these technologies, there has been very little research into the consequences of their design. Children's experiences with these technologies could be improved if we knew what type of interaction is most effective and engaging. These products impact children's lives; we need to know what type of influence they have, learn how to design them properly, and learn whether badly designed products can negatively affect children. There are currently few guidelines in place to address these issues.

1.3. Solution

The solution was to carry out experiments to determine how the Media Equation affected children and to derive design guidelines based on analysis of the findings. Three areas of child-computer interaction were investigated to determine what design principles best fit child-computer interaction: (1) Did children respond to the Media Equation in the same manner as adults? (2) Were there any gender differences in social interaction with computers? and (3) Did the form factor (the computer's form) influence children's interactions?

1.3.1. Age Differences

Previous research has shown how the Media Equation affects adults; I investigated whether children respond similarly. It was unknown whether their life-long interaction with computers strengthened or weakened the effects of the Media Equation. These children are accustomed to computers and have developed a mental model where it is not strange to think of these machines simultaneously as “sort of alive” and as “just a machine” (Turkle, 1984; 1995). Reeves and Nass (1996) speak of how our reaction to media is natural and automatic, since historically, anything that elicited such responses was in fact alive and deserving of our social attention. With technology now so prevalent in children’s lives, perhaps they have developed different interaction styles than adults. The studies were done with children and repeated with adults to investigate whether there were differences between the two groups.

1.3.2. Gender Differences

Boys and girls now use computers in equal numbers. While the type of activities they engage in varies somewhat, with girls slightly more likely to use computers for email, word processing, and school assignments (Debell and Chapman, 2003), it is clear that technology is no longer viewed as “only for boys”. Boys and girls are using computers, but it remained unknown whether there were gender differences in how children respond to the Media Equation and whether different design guidelines should be devised to account for different interaction styles. The studies were conducted with an equal number of boys and girls to test whether there were any gender differences with respect to responses to the Media Equation.

1.3.3. Form Factor

The type of computer affords different types of interaction. It was unknown whether the form factor influences social interaction and whether Media Equation effects are stronger for some types of computers. Since children are likely to use many types of computers in their daily life, it is important to know whether any design guidelines derived apply across all form factors. The form factor was investigated by having the children interact with both desktop and handheld computers during the Media Equation experiments.

1.3.4. The Experiments

To investigate these factors, I conducted three different experiments to gather data about children and the Media Equation.

These experiments tested aspects of social interaction with a computer by looking at praise, team formation, and politeness. These particular topics were selected because of their potential for having a large influence on children's interaction. Since children's technology often has the goal of teaching children, it is important to know whether praise from the computer has the same positive effect as when it is given by a person. Secondly, being part of a team has a significant impact on individual behaviour and attitudes. It is important to know whether children view computers as teammates. It is also important to understand how interfaces can encourage or diminish such social interaction. Lastly, children often modify their behaviour to seek approval from others and so are likely to modify their responses when interacting with a computer as well. This type of behaviour falls under politeness norms where someone tries to present themselves in the best possible light.

Having gathered information about children and computers, design guidelines for children's interfaces were derived. Lessons for practitioners, gleaned from my experiences with testing social effects of computers with children, are also presented.

1.4. Study Overview

This section describes the steps required to gain knowledge about children and the Media Equation and then reach a set of design guidelines for children's technology. The main steps were to conduct studies testing aspects of the Media Equation with children, analyze the results, consider the implications with respect to designing children's technologies, and derive a set of guidelines and lessons for practitioners.

I collected data to supply an empirical basis for devising design guidelines by running the three studies investigating the Media Equation; one for each of politeness, team formation, and praise. The children who participated in these studies ranged in age from 10 to 12 years old.

The first study looked at the effect of praise given by the computer. Children played several rounds of a guessing game where they were asked to help improve the game by suggesting new questions for the computer to use within the guessing game. The computer provided either positive (praise) feedback or neutral (generic) feedback about their suggestions. Social psychology suggested that the children would feel better about themselves and have a more positive opinion of the computer that praised them than of the computer that only provided neutral feedback.

Secondly, the Desert Survival Problem was used to examine whether children respond to computers as teammates. In this task, they interacted with the computer and ranked a set of items in order of importance. While the computer suggested its own ranking and provided reasons for its decision, the children could take the computer's advice or choose their own ranking. Social psychology indicated that when children were made to feel part of a team, they were more likely to listen to the computer's suggestions, think the computer is more helpful, and feel better about their own performance.

The last study looked at whether children apply social rules for politeness to computers. Nass and Reeves used a tutorial task to test this aspect of social interaction in the original studies with adults (Nass, Moon, and Carney, 1999). The same task was used with children although the content of the tutorial was made appropriate for the age level. Using the computer, participants were asked to read a short tutorial about various facts and answer some questions about the facts presented. The children then completed a questionnaire evaluating the computer's performance. Half the children completed the questionnaire on the same computer that just gave them the tutorial, the other half moved away from the computer and completed a paper version of the questionnaire. If children apply rules of politeness to computers, the answers to the questionnaires would be more positive when answered on the computer than if the questionnaires were answered on paper.

To test for form factor, participants completed some tasks on a desktop computer and some using a handheld computer. Efforts were made to ensure an even distribution of boys and girls across the different conditions so that gender differences could be examined.

The tasks used in these studies varied slightly from the original Media Equation studies, having been adjusted for use by children rather than adults. To assure that the differences between children and adults could be properly assessed, all of these new studies were repeated with an equal number of adult participants.

The next step was to analyze the data and find whether the Media Equation worked as predicted in these cases. After analysis, it was possible to consider the implications of the results with respect to the design of children's technology and determine the usefulness of using the Media Equation with children. A set of guidelines and lessons for practitioners were derived and presented based on these findings.

1.5. Contributions

The main contribution stemming from this project is an understanding of a design factor in child-computer interaction; namely that the Media Equation is not as useful for design, nor as easy to implement, as previously thought. The results of these studies question whether there is a Media Equation effect on children and suggest that its inclusion in the design of children's interfaces has few added benefits.

Minor contributions include:

- an understanding of gender differences and similarities in the social relationships children form with the computer with respect to praise, politeness, and teammates,
- evidence that varying the form of the computer has little effect on child-computer interaction with respect to the Media Equation,
- an understanding of how children differ from adults in terms of treating computers as social actors on the basis of praise, politeness, and teammates
- evidence that varying the form factor does not affect how adults respond to computers,
- evidence that adults do not respond to the Media Equation as strongly as previously reported.

1.6. *Thesis Outline*

The remainder of the thesis is organized as follows:

- Chapter 2 covers a literature review of relevant topics, including CASA, designing for children, and social psychology.
- Chapter 3 describes the methodology used for the studies, discussing the procedure, participants, software, and data collection tools.
- Chapter 4 presents the detailed analysis and results for each study.
- Chapter 5 includes a discussion of the results and offers possible explanations for these unexpected results. It also presents some design guidelines and lessons for practitioners based on the results and experience of running the studies.
- Chapter 6 gives a summary of the research and contributions of this thesis. It also discusses areas where further work could help clarify the importance of the Media Equation on children's technology.

2. Literature Review

The proposed research draws from several areas of study. This chapter gives relevant background information about each of these areas. The chapter begins with an overview of design guidelines already suggested for children's technologies and the studies which led to the development of these guidelines. In the next section, previous work addressing form factors is discussed, especially children's experiences with handheld computers. In section 2.3, the Media Equation is explored in detail, with emphasis on Computers as Social Actors, previous studies involving children and the Media Equation, as well as the original Media Equation studies on teammates, politeness, and praise done with adults. Lastly, social psychology and education literature provide insight on how teams, politeness, and praise affect human-human interaction and provides a background for determining the expected social responses to the Media Equation.

2.1. Design Principles for Children's Technology

Until recently, little thought has been put into designing technology specifically for children. Over the last few years, efforts have been made to include children in the design process to try and learn what leads to good children's products. This section summarizes what has been discovered to date about designing for children, including design guidelines stemming from the process of including children as design partners.

Designers long assumed that taking an interface that works for adults, adding a few animations and bright colours, automatically makes it work for children (Druin, 1999). When designing other specialty products, designers often involve the area experts in the process but rarely are children directly involved in products designed for kids. It is assumed that the teachers, parents, or other adults in the children's lives know more about what children like and want than the children themselves. If children are brought in, it is usually for evaluation of already designed products (Druin, 1999).

Existing user interface guidelines for children's computer products include instructions such as "present instructions in age-appropriate format" and "design activities to be inherently interesting and challenging so children will want to do them for their own sake" (Hanna et al., 1999), but little is said about the type of interaction that children expect. Children do not want to spend time learning how to use technology; it should be intuitive enough that they can just jump in and do it. They also want things that look good and respect who they are, does not talk down to them, and does not question their intelligence (Druin, 1999). These observations point to the need for interfaces that are aware of social expectations and that behave according to social conventions. Traditional human-human interaction is what children have the most experience with and so it would make sense that this is the type of interaction that is most comfortable and intuitive for them.

Children are not miniature adults (Druin, 1996). They have their own needs and goals which cannot necessarily be met by adult tools. This section examines several characteristics of children that distinguish them from their adult counterparts. Each characteristic is followed by existing design principles for children's technology that address these differences.

2.1.1. Children have varying literacy levels

Most adult user-interfaces assume that users are proficient readers with fairly extensive vocabularies. Children have not reached this proficiency level. Young children may not even know the alphabet yet, while older children may not fully understand text-based instructions. Children can also be very creative spellers, making it difficult for an interface to recognize text input (Druin et al., 2001). Most conventional interfaces include menus and help functions that are text-based, making them inappropriate for young users. Since reading levels vary significantly, children's interfaces must be designed with a narrow age-group in mind to adequately meet the needs of its users. The following paragraphs describe a few research projects that have addressed literacy in children's interfaces.

In their research about digital libraries for children, Druin et al. (2001) discovered that typical text-based interfaces were insufficient to meet the needs of young users. They developed SearchKids, a graphical interface for a digital library offering querying, browsing, and reviewing of search results through graphical means. It uses content-specific metaphors such as a zoo for navigating information about animals and allows children to form queries by dragging representative icons. With SearchKids, children could successfully navigate a large information space that was previously inaccessible to them.

Steiner and Moher (1992) found that using a graphical interface resembling a storybook helped children infer the purpose and operation of their storytelling software. Children could create images in the top portion of the storybook page and write the corresponding story in the lower half. The familiar storybook layout helped children learn to use the software quickly.

Hanna et al. (1999) present several interface design guidelines for children's technology based on years of experience with developing children's software. To deal with varying literacy levels, they suggest presenting instructions in an age-appropriate format and including the option of having text instructions read aloud as most children are not accustomed to reading on a screen. They also suggest that instructions should be easy to remember and should avoid making use of concepts unfamiliar to children (for example, referring to left and right portions of the screen for young children). Having on-screen characters speak instructions with corresponding animations is also useful because it directs attention and helps in understanding.

Table 2.1 summarizes the design principles discussed in this section:

Table 2.1: Design principles addressing literacy levels

Design Principles
Interfaces should be very visual, avoiding use of text as much as possible and reducing cognitive load. (Druin et al., 2001)
Content-specific metaphors are useful in helping children navigate interfaces (Druin et al., 2001; Steiner and Moher, 1992)
Present instructions in an age-appropriate format (Hanna et al., 1999)
Instructions should be easy to comprehend and remember (Hanna et al., 1999)

2.1.2. Children's motor skills are not fully developed.

Children's fine motor control skills continue to develop as they get older. Until fully developed, they may have difficulty controlling the mouse and targeting small areas on the screen. Secondly, tasks requiring them to hold down mouse buttons while moving the mouse or for extended periods of time are tiring and difficult for them to accomplish (Steiner and Moher, 1992; Hannah et al., 1999; Inkpen, 2001). These actions are common requirements in adult user interfaces but are inappropriate for younger users. Typing can also be an obstacle for children as their usual strategy is hunt-and-peck, turning even simple sentences into tedious, time-consuming tasks.

Children can learn to use a mouse as an input device, but a simplified interface is easier for them to operate. For example, one-click interfaces are simpler than those requiring double-clicking or dragging. Furthermore, children may confuse the mouse buttons, so children's interfaces should have the same functionality for each mouse button (Druin et al., 2001). Alternatives to dragging, such as clicking to attach an object to the cursor then clicking to drop the object in the desired location (also known as sticky-drag-and-drop) requires less manual dexterity on the part of the children (Steiner and Mohen, 1992; Hannah et al., 1999; Inkpen, 2001). Strommen further discovered that continuous motion is easier for children to control when they can click once to start the motion then click again once they want to stop, rather than having to continuously move the mouse or hold down a mouse button (Strommen, 1994). The impact of having simplified mouse interactions is considerable. Inkpen (2001) found that while playing the same game, children were more motivated and solved significantly more puzzles using a point-and-click interface versus one that used drag-and-drop. For young children whose coordination is not yet fully developed, using a touch screen offers a simple alternative to using a mouse as an input device (Druin et al., 2001).

Children's developing motor skills may not provide them with the fine-motor control needed to target small items such as icons and regular buttons used in traditional interfaces. Interfaces for children should include on-screen items large enough to compensate for some inaccuracy in targeting (Steiner and Moher, 1992; Druin et al., 2001).

Most children's interfaces avoid the notion of a selected set of objects on the screen, such as having to highlight several items at once to perform some action. One reason is because it is difficult for children to use traditional means of selection such as clicking to select one corner of an invisible rectangle then dragging the cursor to its opposite corner. The major difficulty is in picking an appropriate starting point so that all desired objects are surrounded. Berkovitz (1994) proposed an alternative where users initially click on a selection tool, then click the area where they want to start the selection. A selection rectangle appears; users can then "push out" the edges of the rectangle until all desired objects fall within the rectangle. His studies show that this is a much more intuitive interaction for both children and adult users even with the extra step of clicking on the selection tool.

The design principles addressing children's motor skills are summarized in Table 2.2:

Table 2.2: Design principles addressing motor skills

Design Principles
Make mouse interactions as simple as possible. One-click interfaces are easier than dragging or double clicking (Druin et al., 2001).
Make all mouse buttons have the same functionality (Druin et al., 2001).
Touch screens are good for young children who have difficulty using a mouse (Druin et al., 2001).
Young children have difficulty targeting small objects on the screen. Items should be large enough to compensate for some inaccuracy in targeting (Steiner and Moher, 1992; Druin et al., 2001).
Dragging movements are difficult for young children. Dragging should be accomplished by clicking on the object to attach it to the pointer, then clicking again to drop it in the desired location (Steiner and Moher, 1992; Hannah et al., 1999; Inkpen, 2001).
Interfaces should not require children to hold down mouse buttons for extended periods of time, especially if simultaneous mouse movement is necessary, as it leads to unacceptable physical demands of too much finger pressure (Strommen, 1994).
Using a mouse, continuous unidirectional motion on the screen is easiest for children when a "click-go-click-stop" interface is used, where children click the mouse to start the motion and click again once they want to stop (Strommen, 1994).
Marquee selection should be accomplished by drawing an initial selection area on the screen then allowing users to shape it to the desired size by "pushing out" the edges of the area, rather than the traditional method of choosing one corner of the rectangle and dragging to its opposite corner (Berkovitz, 1994).

2.1.3. Children use technology for education, entertainment, and socialisation

Adult interfaces usually try to help users be as efficient and productive as possible. It is assumed that they have basic computer skills and that they have a task in mind where the computer is a tool to complete this task (Druin and Inkpen, 2001). Children, on the other hand, use technology for education, social, and entertainment purposes. Their main goal is to have fun. If a product is engaging, motivating, and interesting, they will continue to use it; otherwise, they will turn to other pursuits. In order to be successful, a product needs to keep their interest and attention. This may mean sacrificing efficiency or turning away from adult design principles that advocate lean, simple interfaces.

Children's worlds are usually guided and controlled by the adults in their lives. While this is arguably important for children's safety and development, it leaves children desiring the opportunity to be in charge. This empowerment can be found when children play computer games or interact in virtual environments (Druin and Inkpen, 2001). They are in control of their world and can make all the decisions; learning about social interaction and consequences of their actions.

Social interaction is an important part of children's lives. With today's technology, the interaction opportunities are increasingly diverse. Whereas children were previously limited to playing with other children in their neighbourhood, they can now easily interact with people from around the world to play, share, explore, and experience new ideas (Druin and Inkpen, 2001). Technology also gives children the chance to interact in ways that are less intimidating than face-to-face, opening new opportunities for those who are shy, self-conscious, or unable to interact through traditional means (Druin and Inkpen, 2001). Children's technology should encourage and facilitate this social interaction.

Keeping children engaged and motivated are central goals of many children's interfaces. One concrete way previous researchers have found to motivate children is through the use of entertainment click-ons (also known as "hotspots"). These are active regions on the screen that reward users who click on them by displaying an animation, sound effect, or other multimedia response. Their main function is for entertainment and diversion. Children spend a significant amount of time finding and revisiting click-ons, usually as a break from other tasks. Super et al. (1996) studied the success of entertainment click-ons in an educational mathematics game called Counting on Frank. They found that children used the click-ons most after periods of math-focused activity and that click-ons offering multiple responses, humour, and multimedia were most enjoyable and popular. They also determined that screen position and type of on-screen object affected the likelihood of finding the click-ons.

Another motivational tool for children's software is an on-screen animated character. Lester et al. (1997) investigated the use of animated pedagogical agents by including such an agent in an educational product teaching children about plants. Five different versions of Herman-the-Bug were used, ranging from a muted agent to a fully expressive one. They found that simply having an animated character on the screen while children worked on an educational task positively affected children's experiences and encouraged them to use the software more frequently. Benefits increased when the character was expressive and offered domain-specific advice and explanations, including increased learning and positive affect. Hannah et al. (1999) adds that on-screen characters should not be intrusive; their comments should be appropriately timed to complement current activities or to prime children for what is about to happen.

Through their work in developing multimedia environments for children, Hannah et al. (1999) derived several design guidelines applicable to children's technology. They found that successful interfaces give children control over the environment and let them set the pace of the interaction. Tasks should resemble real-life tasks which are familiar and interesting to children and should be comprised of simple steps that are intuitive and easy to remember. They add that activities should start out very simple, increasing in complexity and difficulty as the child masters the required skills. Feedback is also very important and should guide children through learning new concepts. Sedighian and Klawe (1996) found that gradually removing feedback and supportive cues in an educational game encouraged children to assume increasing cognitive responsibilities and stimulated engagement with the underlying formal mathematical concepts. They used a version of their Super Tangrams game where children learn about geometric concepts such as rotation, translation, and reflection. The initial levels of the game provided many visual cues to help predict the outcome of the shape manipulations and then cues were gradually removed as the children advanced through the game, requiring them to think about the concepts and predict the results themselves. This proved a successful strategy for engaging children in reflective thinking.

Another key factor in successful children's applications is the use of extrinsic rewards (Hannah et al., 1999). While designing tasks that offer intrinsic rewards is ideal, where solving a problem or learning a new skill is reward in itself, often this motivation is not enough to sustain most children's interest and encourage them to try less enjoyable activities. In children's technologies, extrinsic rewards often come in the form of multimedia messages, points or scoring systems, and bonus activities. These rewards should be consistent and available even if children repeat the same problem or activity levels, as they will often fail at more advanced levels and need to re-experience success to gain confidence for moving forward.

Pausch, Vogtle, and Conway (1992) also uncovered the importance of having extrinsic rewards such as a scoring system in children's games. The focus of their study examined the effectiveness of alternative input devices; children played a version of the well-known Pong game that originally did not display a score on the screen as it was not deemed important to the task. They found that the children demanded a score and in its absence started keeping score themselves by counting. The scoring mechanism was later added to keep children focused on the task at hand.

The design principles from this section are summarized in the following table (Table 2.3):

Table 2.3: Design principles addressing motivation and entertainment

Design Principles
Children like having control of their world. Technologies should provide much freedom for children to define their experiences (Druin and Inkpen, 2001).
Children are social beings. Technology should help them engage in various social experiences (Druin and Inkpen, 2001).
Entertainment click-ons are an effective tool for engaging children. Multiple response click-ons are most popular while humorous and multimedia click-ons are most enjoyable. The probability of finding click-ons is determined by position on the screen, and type of on-screen object (Super et al., 1996).
Providing occasional entertaining diversions (such as click-ons) keep children engaged and motivated during learning tasks (Super et al., 1996).
Animated pedagogical agents are useful for learning environments, even those who do not provide any advice or interaction are perceived positively (Lester et al., 1997).
Expressive, domain-specific agents are useful due to pedagogical benefits and positive affective impact (Lester et al., 1997).
On-screen character interventions should be supportive rather than distracting (Hannah et al., 1999).
Design activities to be inherently interesting and challenging so children will want to do them for their own sake (Hannah et al., 1999).
Activities should allow for expanding complexity and support children as they move from one level to the

next in use of the product (Hannah et al., 1999; Sedighian and Klawe, 1996).
Design supportive reward structures that take children's developmental level and context of use into account (Hannah et al., 1999; Pausch, Vogtle, and Conway, 1992).

2.1.4. Children need feedback and guidance

Children expect to see the results of their actions immediately. If it appears that nothing has happened, they will repeat the action until something does occur. Of course, by this point, they may have set off a chain of events that are quite unexpected and unwanted. While constant auditory and visual feedback can be annoying for adult users, children users need and expect it. Intuitiveness is very important for children's interfaces. Children cannot be expected to read a manual to learn how to use a product; the product must either be entirely intuitive or provide some way of guiding them through the tasks. Using an on-screen character is a popular method of providing this guidance. Besides leading children through tasks, an on-screen guide is also useful to keep children focused and motivated on the task at hand.

Steiner and Moher's work on the Graphic StoryWriter (Steiner and Moher, 1992) demonstrates the need for immediate feedback. Their initial system had no visual or audio feedback to signal that an object was properly selected. As a result, children repeated the selection action in hopes that something would happen. They also often clicked on buttons multiple times since there was no feedback signalling that the click had been registered, leading to unexpected results when the series of commands executed. Subsequent versions which included feedback were much easier for children to use.

On-screen icons need to represent familiar items and be intuitive for children. For example, using a stop-sign for stopping activities and making buttons have a 3-D appearance so they appear clickable help children recognize the purpose of icons (Hanna et al., 1999). Visual or audio feedback should be present when children move their mouse over clickable portions of the screen to indicate what is clickable and what is not. For audio feedback, it is desirable to have a short delay so that children can deliberately activate it by holding their mouse over certain areas; otherwise they tend to hear random audio after their cursor is already somewhere else and fail to make the connection. It should also be clear when the computer is busy processing requests so that children know to wait for something to happen. This can be achieved through on-screen icons or audio feedback but should be easy for children to understand. Conversely, if the computer has been waiting for input for an extended period of time, it should also indicate this with some feedback (such as humming or toe-tapping) (Hannah et al., 1999).

Using a prototype system that simulated a walk through the woods, Strommen (1994) discovered that children explore interfaces in a non-systematic way and often do not recognize places they have previously visited. Children explored the virtual environment by walking along a set of paths and looking for animals. At junctions, the children rarely looked at all of possible paths nor were they able to distinguish which paths they had previously followed. If it is important for children to track their movement through a virtual environment or for them to explore the environment in its entirety, then the system should provide a means of tracking and displaying this information.

Children may forget how to accomplish tasks requiring several steps or even simple tasks that are done infrequently. Danesh et al. (2001) point to the need for scaffolding, which means helping and supporting children through the necessary steps. For example, in their development of Geney, they found that children would forget how to beam information between handheld devices and needed to be reminded to point the devices towards each other. They used a wizard-like interface to successfully guide children through the process.

Table 2.4 provides a summary of the design principles addressing issues of feedback and guidance.

Table 2.4: Design principles addressing feedback and guidance

Design Principles
Children are impatient and need immediate feedback showing that their action have had some effect, otherwise they will repeat the action until some outcome is perceived (Steiner and Moher, 1992)
Interfaces should track and display children's exploration of environments if it is important for them to remember where they have previously visited (Strommen, 1994)
Design icons to be visually meaningful to children (Hannah et al., 1999)
Use cursor design to help communicate functionality (Hannah et al., 1999)
Use rollover audio, animation, and highlighting to indicate where to find functionality (Hannah et al., 1999)

Interfaces should provide scaffolding and guidance to help children remember how to accomplish tasks (Danesh et al., 2001)

2.1.5. Children's mental development has not reached maturity

Younger children have difficulty with abstract concepts. They also may not have the in-depth content knowledge required for navigating complex interfaces. Their usual approach is trial-and-error; once they find a method that works, they are unlikely to look into finding a more efficient way or to look for advanced options.

Druin et al.'s (2001) work with SearchKids highlights how children think of information spaces and how they mentally organize such information. While they may not be able to think of appropriate search terms for a query, they do understand icons representing what animals eat, where they live, and their appearance. By using a visual representation of animal characteristics, children are able to create complex queries and successfully navigate a large information space.

Children learn the laws of cause and effect early in childhood. They expect their actions to have a direct effect on their environment. For this reason, input devices should have direct mappings to the actions on the screen. Johnson et al. (1999) investigated the use of a stuffed toy as an input device for controlling an on-screen character. Moving the stuffed toy resulted in corresponding actions from the on-screen character. When a direct mapping was used, the children quickly grasped the idea and had no problems understanding how to control the on-screen character. Problems arose however, because the motion of the on-screen character appeared jerky and unnatural since it required the children to have very fine control over how they moved the stuffed toy. An alternative called intentional control was implemented. With intentional control, the software interpreted the motion of the stuffed toy and mapped this to a context-appropriate action on the screen. For example, moving the toy's feet made the on-screen character walk. While resulting in smoother on-screen motion, the children needed training to learn how to control the character and some were unable to grasp the abstraction. While useful, intentional control or other abstractions need to be used with care as they are not intuitive for most children.

Plaisant et al. (2000) also discovered the need for direct correspondence between body motion and motion of a controlled robot. In their experiment, children wore various sensor controls, mapping their motion to the actions of a robot. When arbitrary mappings were used, the children found it difficult and confusing to control the robot but when they adjusted the location of the sensors so that a more direct mapping applied, the children easily learned to control the robot.

The following table (Table 2.5) summarizes the design principles addressing children's varying levels of mental development.

Table 2.5: Design principles addressing level of mental development

Design Principles
Children's interfaces need to take into account the fact that children may not yet understand abstract concepts (Druin et al., 2001).
Children's interfaces should not make use of extensive menus and sub-menus as children may not yet have the ability to categorize or have the content knowledge required to navigate efficiently (Druin et al., 2001).
Children are accustomed to direct manipulation interfaces, their actions should map directly to the actions on the screen. If other styles are used, expect that most users will require training and that some will not be able to grasp how the interaction works (Johnson et al., 1999; Plaisant et al., 2000).

2.1.6. Children are good at make-believe

Children are very good at playing make-believe and most will readily immerse themselves in pretend situations, acting as if they were presented with the situation in real-life (Strommen, 1994). Strommen's "Woods Visit" software enabled children to explore a virtual forest from a first-person point-of-view. He found that the children would physically duck their heads when passing under low-hanging branches on-screen. One child even stopped playing and sat quietly in her chair; when questioned, she explained that she was being quiet to see if any animals would come out. They accept on-screen characters, such as these animals, as social actors and will interact with them in a social manner without hesitation.

When metaphors are used, children expect the on-screen objects to behave as they would in real-life. Rader, Brand, and Clayton (1997) explored children's understanding in a visual programming environment. The children could create objects then assign rules to control their behaviour. They discovered that while children understood that rules controlled behaviour, they also expected their objects to have the properties of their real-life counterparts. For example, when the object was a raindrop, the children expected that it would fall towards the ground, even though the corresponding rule dictated that it would move sideways.

Danesh et al. (2001) successfully used a pond metaphor in their design of Geney, a collaborative game where children use handheld computers to learn about genetics. The goal was to mate fish with different characteristics to produce off-springs whose genetic makeup matched a specified target. Children easily grasped the metaphor; helping them navigate the system and understand the process.

Table 2.6 provides a summary of the design principle discussed in this section:

Table 2.6: Design principle addressing tendency to make-believe

Design Principles
Care should be taken when using metaphors for interfaces as children readily immerse themselves in the environment. While this leads to more intuitive interactions; it may also lead to expectations that exceed the bounds of the interface (Strommen, 1994; Rader, et al., 1997; Danesh et al., 2001).

2.1.7. Children like playing with physical objects

Children enjoy playing with stuffed toys and using them in make-believe situations due to their perceived friendliness and cuddliness. Merging this play with computer interfaces leads to interesting input and output devices. The toy can be used as an input device to control on-screen characters or can be used as an output device to autonomously perform movements as described by the child or computer.

Active participation in a task is important for children's learning and enjoyment. Direct manipulatives enhance traditional children's toys by adding computational power. These new toys encourage learning of concepts usually reserved for older children and help explore scientific phenomena through active participation (Resnick et al., 1998; Mikhak et al., 1999). Resnick et al. (1998) built a wide variety of direct manipulatives, including programmable building blocks that can be used to build smart robotic creatures, programmable beads to teach children about dynamic patterns, and badges that communicate with each other and change their appearance based on those communications to teach about topics such as the spread of epidemics.

Alternative input devices such as pressure mats and video-tracked props encourage children to physically interact with their environment and become more involved in the interaction (Stanton et al., 2001). Stanton et al. (2001) extended KidPad so that it could be controlled through sensors embedded in floor mats (a magic carpet) and physical props such as large cardboard shapes. They found that children collaborated more and were more engaged using the magic carpet and the props as input devices. It also made the interaction more interesting for a larger audience to observe. However, the physical devices required more involvement and work on the part of the user and slowed down the interaction. These trade-offs were deemed acceptable and even beneficial to the types of tasks undertaken by the children. Surprisingly, small changes in the appearance of the magic carpet and the props led to significant changes in the way children interacted with the devices. For example, when squares were used to indicate the position of the carpet sensors, the children jumped vigorously on them, but when arrows were used, they carefully placed a foot on the arrow. Lastly, they found that to be useful in a classroom environment, these systems needed to be quick to set up and easy to store as space and time are at a premium.

A third research project resulted in the creation of Curlybots, small robots whose motion is programmed through physically moving it and recording the given motion. It can loop through recorded segments, resulting in complex patterns of motion. Frei et al. (2000) found that Curlybots succeed in engaging even young children in exploring advanced mathematical and computational concepts that would traditionally only be learned at a later age and with the use of a traditional computer. Having a physical, smart device to play and experiment with helped children build their mathematical intuition in ways unsupported by conventional toys or computers.

Table 2.7 lists the design principles addressing children's preference for physical objects.

Table 2.7: Design principles addressing preference for physical objects

Design Principles
Children like tangible interfaces because they enjoy touching objects and having physical interactions (Johnson et al., 1999, Resnick et al., 1998; Frei et al., 2000; Druin, 1999).
Physical props and having physically large input devices encourages collaboration (Stanton et al., 2001).
Be aware of how superficial changes to the design can produce very different physical interactions. Different interfaces emphasize different actions (Stanton et al., 2001).

Physical devices should be easy to setup and store as they are often used in classrooms or other locations where space must be multi-purpose (Stanton et al., 2001).

2.1.8. Children collaborate differently than adults.

Even when they have their own computers, children naturally group around one machine to work together. They enjoy playing together and like to share their experiences with friends and family (Druin and Inkpen, 2001). They are often more successful as a result of this collaboration (Danesh et al., 2001).

Typical desktop computer configurations lead to inefficient collaboration as children struggle for control of the input devices and try to be active participants in the interaction (Strommen, 1994). Passive participants often point to the screen and issue directives, but soon become disinterested due to lack of control over the interaction. One branch of HCI research addresses these issues through the creation of Single-Display Groupware, where several users share an output screen, but each has their own input devices. Single-Display Groupware systems lead to greater user satisfaction, enhanced collaboration, and allow users to work side-by-side independently as well as together on a task (Inkpen et al., 1995; Stewart et al., 1998, 1999).

Immaturity in group dynamics and negotiation leads to collaboration problems among children as each child struggles for control of the situation. With adult systems, including awareness information of what others are doing helps resolve some of these issues. However, with children at times even awareness is not enough to resolve conflict as neither will give up control of the item in question even though they know this would resolve the issue (Cockburn and Greenberg, 1996).

Gender differences are also apparent in interaction styles when children work together. Girls take turns by "giving" control to the other player, while boys "take" control from the other player when they feel it is their turn (Inkpen, 1995).

The design principles addressing the different collaboration styles of children are summarized in the following table (Table 2.8):

Table 2.8: Design principles addressing collaboration styles

Design Principles
Giving children each their own mouse when collaborating encourages participation and cooperation. It also leads to greater user satisfaction (Inkpen, 1995; Strommen, 1994; Stewart et al., 1998, 1999).
Groupware interfaces should provide mutual awareness at all times (Cockburn and Greenberg, 1996).
Interfaces should support both “give” and “take” transfers of control to accommodate different interaction styles (Inkpen, 1995).
Single-Display Groupware is useful for children’s co-located collaboration as they naturally group to one computer even when they have the opportunity to use separate machines (Inkpen, 1995; Stewart et al., 1999).

2.1.9. Summary of Design Principles

The common theme through the design principles presented in this section is the need to adapt interfaces to how children naturally behave, to accommodate for children’s developing skills and knowledge, and to make products that are enjoyable from a child’s point of view. It is obvious that design principles for adults do not necessarily apply for children’s interfaces and that it is necessary to look at this user population closely to determine what best meets their needs.

2.2. Form Factor - Handheld computers

Computers are no longer restricted to traditional desktop stations; portable devices are becoming increasingly popular. Handheld computers offer a flexibility that children enjoy. They want to be able to use technology in the places where they spend their time – in the school yard, at a friend’s house, in the car, or in their bedroom (Inkpen, 1999). They already have experience with handheld technologies since most of them have used hi-tech toys such as Nintendo’s Gameboy or Sega’s GameGear. For many children, one of these game devices constitutes their first personal computer.

Another handheld electronic device that children have experienced is the Tamagotchi cyberpet and other similar cyberpets. Here, the children are responsible for the virtual caring, feeding, and nurturing of their electronic pet (Danesh et al., 2001; Fogg, 2002). This type of cyberpet encourages social interaction with the device; in fact, a lack of social interaction “kills” the pet.

Even without the obvious social relationship directly encouraged by some of these toys, handheld devices may still encourage social interaction merely due to their size and portability. The personal nature of handheld devices leads us to think that reaction to them would be more intense and likely more social.

Many schools have brought handheld computers into the classroom in recent years. Since the cost of these machines is a fraction of the cost of desktop or laptop computers, they offer a viable alternative where each child can have their own device. Preliminary reports show that handheld computers can be successfully incorporated into the classroom and offer many benefits to students (Soloway et al., 2001; Roschelle, 2003).

Handheld computers are typically construed as personal, individual devices, but systems such as Geney demonstrate their use in a collaborative, classroom setting (Mandryk et al., 2000; Danesh et al., 2001). Children could learn about genetics using textbooks and traditional teaching methods, but adding handheld computers encourages interaction and helps students understand through their own experiments and investigations. These projects point to the usefulness of handheld computers in encouraging social interaction among students.

A second research study by Moher et al. (2003) used handheld computers in the classroom to help students discover the need for control of variables in experimental settings. This concept is typically difficult for even college students to successfully grasp, yet third graders were successful at gaining an understanding of the concept within an hour of discovery and play. Each student was given a handheld computer that controlled one circle on a shared display screen, but they were not told which circle mapped to their device. They could toggle the color of their circle from blue to orange. Their task was to change the color of all circles to blue in the least amount of time. In the first session, the class took a little over half an hour to complete the task. Remarkably, it took them less than 4 minutes to complete the task the second time, showing that they had learned the value of changing only one variable at a time. While they may have been taught this concept in more traditional ways, using the handheld devices enabled them to learn the concept on their own through active participation.

2.3. The Media Equation

The Media Equation claims that "media experiences equal human experiences" (Reeves and Nass, 1996). People's responses to media are natural, social, and the same as responses to real-world experiences. Here, media consists of not only computers, but also television and other forms of multimedia. The Media Equation includes social responses to all of these forms of media. However, some modes of interaction are specific to computers and these lead to a particular set of social responses where the computer is actually considered as a separate social actor in the interaction. This sub-category of the Media Equation is known as CASA: Computers As Social Actors. Since the proposed research involves computers, the following section describes CASA in detail and gives specific information about CASA and children. Also included are summaries of all existing research studies about the Media Equation and detailed descriptions of the three studies used as a basis for the present research.

2.3.1. Computers As Social Actors (CASA)

People respond socially to computers. Over the last decade, Nass and Reeves have tested their CASA hypothesis by developing studies that test various aspects of the human-computer relationship. Each of these studies is based on proven social psychology research; in each case we know how the human-human interaction unfolds. They replicated the social psychology experiments, replacing one of the humans with a computer and found that people consistently respond in the same manner regardless of whether they are interacting with a second human or with a computer (Nass, Steuer, and Tauber, 1994; Nass, Fogg, and Moon, 1996; Reeves and Nass, 1996; Fogg and Nass, 1997; Nass, Moon, Carney, 1999). This section describes why CASA occurs, provides some of the arguments against the existence of CASA, and presents evidence for CASA by other researchers.

Social responses are natural and subconscious; for thousands of years, anything that engaged us socially really was human, or at least alive and deserving of our social responses (Barkow, Cosmides, and Tooby, 1992). We are programmed to react automatically to stimuli. Most of our daily reactions are automatic and natural, requiring little scrutiny on our part (Bargh et al., 1992). When people stop and analyze the situation, they can avoid these social responses for the moment, but the cost of consciously scrutinizing every action and reaction makes it impossible to do so continuously. It is only in recent years that we interact with machines, watch other-realities on movie and television screens, and take part in virtual environments (Turkle, 1995). All of these invoke our subconscious reactions: we feel sad, excited, scared, and happy even though the stimulus is not "real". If we stop to think, we can convince ourselves to suppress the reactions; however our initial reactions are still automatic and social. Treating the computer as a social actor falls in this category of behaviour; it engages us so we respond socially (Reeves and Nass, 1996).

Previous researchers and critics of CASA imply that only those deficient in their understanding of computers would respond socially when interacting with a computer. They state that people who are inexperienced or ignorant may respond socially to computers due to their lack of understanding about their counterpart but that an educated person of average intelligence should treat the computer as a tool and machine. (Bench-Capon and McEnery, 1989; Campanella, 2000; Searle, 1981). However, CASA studies have all been performed with participants who are knowledgeable about computers and have extensive experience using computers. They show that educated, intelligent persons do treat computers as social actors.

A second argument states that the computer is a proxy in the interaction and that people are thinking of the computer's programmer or the person behind the computer, and thus responding to the human, not the computer. In this argument, any social response is aimed at the human rather than directed towards the computer (Searle, 1981). Nass and Reeves dismiss this argument because their studies show that participants were not thinking of the programmer behind the computer. When questioned, participants say they gave no thought to the programmer. In instances where different computers were treated as separate social actors, participants later revealed they thought the same programmer had programmed both computers. If the programmer was the social actor, participants would have treated the computers as one rather than as individual social actors (Nass, Steuer, and Tauber, 1994; Reeves and Nass, 1996).

Other research also points towards the development of a social relationship between humans and computers. Strommen and Alexander (1999) speak of a progression where computers were once tools in the sense that drills or telephones are 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. Computers do elicit behavioural and affective responses that mimic the social responses towards humans (Maes, 1997; Strommen and Alexander, 1999). Another study determined that most people also attribute aspects of agency – either decision-making and/or intentions - to computers (Friedman, 1995). The computer bares some level of blame when things go wrong and some of the credit when things go right (Friedman, 1995; Moon and Nass, 1998).

Laurel (1990; 1991) discusses how computer agents need to have a recognizable personality and behave in a manner consistent with that personality. The need for this coherent personality comes from our social expectations for interactions and our experience with human-human interaction. Moreover, Brennan (1990) speaks of this human-computer conversation in all interfaces, not necessarily only those explicitly seen as agents. She claims that humans are accustomed to adjusting their conversational manner for different partners and that they naturally adjust while interacting with the computer as well. While humans are aware that they are interacting with a computer as opposed to another human, the interaction is still fundamentally social.

2.3.2. CASA with Children

The majority of Nass and Reeves's CASA studies used adult participants. For the most part, the work has not been extended to test children and children's computer interfaces. This section looks at existing research that leads us to believe that children will follow the Media Equation and treat computers as social actors.

A study by Campanella-Bracken (2000) looks at CASA and children from a psychological and educational point of view. She investigates whether children aged 8-10 respond to praise from a computer as positively as when the same praise is given by a teacher. Her results show that children do respond to praise from the computer in a manner consistent with when praise is received from a person. Participants were asked to read a story then answer some multiple choice questions about it. The computer either praised their efforts or provided neutral feedback between each question. Results show that the children praised by the computer liked the computer more than those children who worked with a neutral computer and they felt their own ability to complete a task was greater than children who received neutral feedback. These reactions are similar to when praise is given by a person. She also found that the children praised by the computer had higher recognition and recall scores for the task compared to those working with the neutral computer. So her study supports the idea that children treat computers as social actors with respect to praise.

Turkle (1984; 1995) has studied our relationship with computers for the last two decades, focusing much of her work on children. She sees a very different perspective from this generation of children who have always had computers as part of their lives when compared to those who have had computers introduced later in life. While she does not use the same terms as Nass and Reeves for her findings, it is clear that she finds a social component to their interactions with computers.

Piaget states that children learn about their environment by interacting with it; they figure out what is alive and what is not through this constant investigation (Piaget, 1960). While children have been taught that computers are machines and not alive, there is a lingering conflict in their minds about these things that appear to think, move, feel, and live. To resolve the issue, they seem to develop a new, parallel definition of "alive" to encompass these new beings that do not fit into traditional categories. They are comfortable speaking about living beings in their Sim-like environments, about their Furbies having feelings, and about their computer being smart or having a temperament (Turkle, 1995; 1998).

Whereas autonomous motion used to be a defining factor for children to determine whether something was alive, they now speak in terms of psychology and their computers often fall somewhere very near the "alive" marker. To make matters even more complicated, children are accustomed to seeing computers "morph" into humans and vice versa through television shows and toys like Power Rangers and Transformers. They come to an understanding that biological life and technological life are somewhat different, but the distinction is not as clear as it might have been a few decades ago. Children are comfortable attributing psychological characteristics to machines, making them fitting partners for dialogue and relationships (Turkle, 1995;

1998). If children attribute a level of emotion, thinking, and intention to computers, it is likely that they respond socially to computers as well.

Scaife and Duuren (1995) also found that children believe computers and robots have brains, although they recognize that it was not the same "kind" of brain as humans. In contrast, few children attributed a "heart" to the computers and robots, suggesting that they do not see them as animate in the usual sense. They conclude that children use a continuum anchored by inanimate at one end and fully animate at the other – and that computers and robots fall somewhere in the middle (Dolgen and Behrend, 1984; Scaife and Duuren, 1995).

Many children's toys now have embedded computers, allowing stuffed toys to talk, sing, and play games with the child. This is an obvious application of CASA principles since often the characters represented are familiar to children through television and books; they already have expected personality traits and behaviours. One such toy is ActiMates Arthur, the loveable aardvark. The developers of Arthur have incorporated three specific social traits into its interaction: praise, humour, and affection. They found that the character does in fact elicit the expected and appropriate emotional responses from children. They further state that this social interaction is a healthy way for children to practice and develop their social skills (Strommen, and Alexander, 1999). In another study investigating interaction with an AIBO pet dog, researchers raise questions about the appropriateness of toys that behave in such a social manner because there are few consequences to negative behaviour towards the toy. They feel that children may fail to develop the moral responsibilities that real, reciprocal companionship involves (Friedman, Kahn, and Hagman, 2003). However, it is clear that they do believe that social interaction is taking place between the children and the computerized toys.

2.3.3. Summary of Media Equation Studies

Reeves and Nass, along with their colleagues, have conducted thirty-five studies testing various facets of the Media Equation. This section summarizes their findings. They categorize their work into five major categories. These categories will be used here to group their findings as well (Reeves and Nass, 1996). Unless otherwise stated, the studies were done with adult participants who were experienced computer users or familiar with the type of media used.

Two basic experiments were used several times to test various components of the Media Equation. The first was a tutoring task where participants completed a three-part tutorial, first reading facts, then answering questions, and finally receiving an evaluation of their performance and the computer's own performance as a tutor. The second task was called the Desert Survival Problem. Participants ranked a set of twelve items in order of importance for survival on a deserted island. Next, they discussed the items with the computer, each giving reasons why the item was or was not important for survival. Finally, participants completed a final ranking of the items.

The following tables (Table 2.9 to Table 2.13) summarize the Media Equation studies (Reeves and Nass, 1996):

Table 2.9: Media and Manners, Media Equation studies (Reeves and Nass, 1996)

Media and Manners	
Politeness	When someone asks about their own performance, the polite response is to tell them that they did well. If a third party asks about the same performance, it is acceptable to give a more honest (and possibly negative) response. This study investigated whether people are polite to computers. Participants completed the tutorial task. In each case the computer said that the participant had done a good job and that it had performed well as a tutor. Next, participants answered a questionnaire evaluating the computer's performance as a tutor. Those who answered the questionnaire on the same computer that provided the tutorial gave more positive and homogeneous responses than those who answered the questionnaire on paper or on a second computer. This follows social rules of being polite when someone asks about their own performance. The findings were consistent when using both a text-based interface and a voice interface.
Interpersonal Distance	People react when someone invades their personal space. It is natural to become alert and pay closer attention when someone comes too close. This study investigated whether the concept of personal space extends to those present on a screen. Participants watched a series of images of human faces using several combinations of screen size, shot size, and viewing distance. Faces that appeared close were evaluated more intensely, consistent with reaction when one's personal space is invaded even though there was no real physical threat. Participants paid more attention to closer faces and recognized them better as well, just as when people are near in real life.

Media and Manners	
Flattery	Social psychology shows that people like being praised, even if it is unwarranted. It also shows that people will try to dismiss criticism if possible. Secondly, the source of the praise or criticism is judged based on its comments. Experimenters tested the effects of praise and criticism given by a computer. Participants played a guessing game where they were asked to help improve the system by suggesting questions at different points in the game. The computer provided praise, flattery, neutral feedback, or criticism about their input. When participants received praise or flattery, they liked the computer more and felt better about their own performance. When criticized, they dismissed the comments when told the comments were random and not contingent on their performance, but felt worse about themselves and the computer when they believed the criticism was warranted. These reactions are consistent with when praise, flattery, or criticism is received from another human.
Judging Others and Ourselves	Self-praise is often met with suspicion, while someone who self-criticizes is viewed as more likeable and intelligent. The reverse is true for those who praise and criticize others. These social psychology observations were tested with the computer delivering the praise or criticism. Participants completed the tutorial task. The computer's evaluation either praised or criticized the participant's performance and its own performance. Results revealed that people react the same when the computer praises and criticizes as they do when it is done by another human. A second study examined what happened when a third party provided the evaluations. The tutoring computer was liked significantly more when a second computer praised it, and was thought less intelligent and less likeable when criticized; this reaction is consistent with human-human behaviour.

Table 2.10: Media and Personality, Media Equation studies (Reeves and Nass, 1996)

Media and Personality	
Personality of Characters	Psychologists maintain that the two main personality dimensions are dominance and friendliness. This study investigated whether people categorize fictional characters along the same dimensions. Participants were third, fifth, and seventh grade children. They were asked to describe several television characters using any descriptors they wished. Analysis of the results showed that participants readily identified dominant/submissive traits followed by the friendliness of the characters. A second study asked participants to rate characters given a set of attributes; the same two dimensions were prominent. A third study showed novel, simple, hand-drawn non-human characters to adults and asked them to rate the similarity of the characters. Again, they found dominance and friendliness to be important dimensions. Even if the way in which fictional character personalities are portrayed can vary significantly from real life (a dominant cartoon character may be ferocious giant, while a submissive one may be a small, shy-looking cartoon turtle), apparently personality dimensions are applied to fictional characters with even minimal cues.

Media and Personality	
Personality of Interfaces	This study extended the idea of personalities by investigating whether a computer interface (without an agent or character) would also be attributed a personality. They created two text-based interfaces, one dominant and one submissive, to test their hypothesis. The dominant computer always initiated interaction, expressed itself assertively, displayed a high level of confidence in comments (a number from 1 to 10), and was named "Max". The submissive computer was named "Linus", always went second in conversation, expressed comments in the form of suggestions, and displayed a lower level of confidence. Participants were initially tested to find out whether they had dominant or submissive personalities. They were then asked to work on the Desert Survival Problem. Results showed that people liked the computer best and thought it was most helpful when its personality matched their own. They were also able to determine the personality of the computer; ranking the dominant computer as more aggressive and confident while the submissive computer was described as shy and reserved.
Imitating Personality	Social psychology shows that people like being imitated; it is flattering to have someone change their own behaviour to match yours. This study tested whether the same positive reaction occurred when the computer imitated the user's personality. Participants were initially tested to assess whether they had dominant or submissive personalities. They then completed the Desert Survival Problem. This time, they interacted with the computer about half of the items, took a break, and then returned to discuss the rest of the items. For one group, the computer started out dominant then became submissive after the break, or started out submissive then became dominant. For the second group, the computer kept a consistent personality throughout. Participants liked the computer best and thought it was most useful when it changed its personality to match their own. Surprisingly, they also gave the computer credit for changing, even if it proved in the wrong direction.

Table 2.11: Media and Emotion, Media Equation studies (Reeves and Nass, 1996)

Media and Emotion	
Good versus Bad	The human brain reacts differently to good and bad stimulus, the left hemisphere being more active for material that is evaluated as good and the right hemisphere responding to bad. The reaction is immediate; our brain classifies things as good or bad as soon as it receives the stimulus. This study examined whether these reactions occur when the stimulus is simply an image on the screen. Participants were asked to watch scenes on television while an EEG (electroencephalogram) recorded brain activity. The EEG showed that media has the same immediate effect on the brain as real-life stimulus.
Negativity	Psychology literature explains that negative experiences are more intense and remembered better than positive ones, even though they are disliked. Moreover, events immediately following a negative event are remembered better while memory is impeded for events immediately preceding a negative experience. The study investigated whether simply seeing negative media had the same effects as when negative experiences occurred in real life. Participants watched several television ads that were categorized into three groups: explicitly negative, explicitly positive, and mixed. The ads were embedded into regular television programs. Results showed that participants liked negative ads much less but remembered their details much better. A second study looked at recall of events just prior and immediately after negative and positive ads. Again, the predictions from psychology held true, participants forgot details immediately before negative content and remembered what came immediately afterwards.

Media and Emotion	
Arousal	Arousal measures the intensity of an experience, good or bad. Higher states of arousal increases vigilance and attention to the world. This experiment tested whether arousal was relevant when people watched media rather than real-world events. Participants viewed video segments and rated them according to arousal and valence (good or bad) using pictorial scales. They were then tested on how many segments they could recall. The more arousing the scene, the better it was remembered, even after two weeks. Arousal is a relevant factor even when the events occur only on the screen.

Table 2.12: Media and Social Roles, Media Equation studies (Reeves and Nass, 1996)

Media and Social Roles	
Specialists	People respect experts and the products associated with them. The exact same product presented by a generalist is viewed as inferior compared to when it is presented by an expert. This label of "expert" does not even need to be confirmed for the effect to be seen. Experimenters told half the participants that they were watching an ordinary television that showed both news and entertainment programs. The other half were told they were watching special televisions, one used only for news shows and one used for entertainment programs only. To emphasize the specialty televisions, signs identified them as "News television" and "Entertainment television" respectively. Identical news and entertainment segments were shown to all participants. Those who watched the specialty televisions thought the news segments were of higher quality, more informative and serious, and more interesting. The same occurred for the specialty entertainment segments. They were perceived as funnier and as more relaxing than those viewed on the generalist television. Apparently, labelling media as "expert" has the same impact as when people are labelled.
Teammates	Being part of a group affects individuals' behaviour and attitudes. It makes little difference whether these groups are formed on the basis of some common characteristic or just randomly assigned. People think fellow group members are more similar to themselves, cooperate more with group members, and admire them. This study investigated whether computers can be teammates. Participants completed the Desert Survival Problem. They were asked to wear blue wristbands and told that they were members of the Blue Team. Half the participants interacted with a Blue Computer while the other half worked with the Green Computer. To test another dimension of team formation, some participants were told that their final rankings would be evaluated individually, while others were told that they would be evaluated as part of a team. Results showed that participants thought the Blue Computer was more intelligent and more similar to them. They also cooperated more with the Blue Computer. Those who thought their performance was contingent on team behaviour were again more likely to cooperate and think that the computer's suggestions were valuable. Their behaviour was consistent with when team members are human.

Media and Social Roles	
Gender	Social psychology has well documented the influence of gender-stereotypes. Praise from males is taken more seriously, women supposedly know more about love and relationships, while men are supposedly more apt at technical subjects. Even the most minimal cues suggest gender and engage stereotypes. This study used a variation of the Tutorial task where the information was presented by male or female voices. The tutorial topics included love and relationships, mass media, and computers. Participants answered questions about the topics on a second computer. A third computer evaluated their performance and the performance of the tutoring computer. This third computer used a male or female voice. Participants were more influenced by praise from the male-voiced computer; they believed the praise and thought the tutoring computer had done a better job. They also thought the male-voice evaluator was friendlier. As for the tutoring computer, they thought the female-voice was a better teacher for love and relationships and a worse teacher for computers. A second study manipulated voices from taped segments of six women to make their voice more "feminine" (higher frequency and softer) or more "masculine" (lower frequency and louder). After watching the modified video segments, participants rated the women with "masculine" voices as having more drive, willpower, reasoning-skills and learning capability than those with "feminine" voices. A slight modification in voice was enough to trigger gender stereotypes even though the segments all had women speakers. Obviously, even minimal cues from a computer are enough to engage gender stereotypes.
Voices	Different voices normally mean that separate people are present. Each voice is attributed to a different social actor. Experimenters tested whether different voices on the same computer would be attributed to separate social actors and whether the same voice on different computers would be attributed to the same actor. The tutorial task was used. Participants completed the tutorial on one computer, listening to one male voice. Next they completed a questionnaire rating the tutorial, using the same computer. Half the participants heard the same voice ask the questions while the other half heard a second voice. The results showed that participants viewed different voices on the same computer as separate social actors. They evaluated the tutorial more positively when the same voice asked the questions than when a second voice conducted the post-task interview. A second study examined whether praise from a different voice affected participants' opinion of the tutorial. With male voices, participants thought the tutorial was significantly better when a second voice praise the tutorial than when the same voice praised itself. However, when the voices were female, the opposite occurred. Participants thought the tutorial was worse when it was praised by a second female voice. A third study investigated whether the same voice on different computers was considered as one social actor or two. Participants heard the evaluation of the tutorial on a second computer. Half the participants heard the same voice praise the tutorial while the other half heard a different voice praise the tutorial's performance. The results showed that using different computers had no effect on the results, the same voice was considered as one social actor and two voices were considered as separate social actors. As in real-life, different voices signify separate social actors.

Media and Social Roles	
Source Orientation	The messenger of a message is often more important than its original source. People automatically attribute a message to its closest and most obvious source, even when they know better. This study investigates whether computers are considered the source of messages rather than programmers. Participants completed two separate tutorial tasks. In one tutorial, the evaluation told participants that they did well and in the second, they were told that they performed poorly. Half of the participants were asked to think of the programmers while they completed the tutorials and evaluations as each programmer had a different tutoring style. The other half were told the same thing except the word "computer" replaced the word "programmer". Results revealed that participants who did not have to think of the programmer thought the computer was friendlier, more effective, and more similar to themselves than those who had to think of the programmer. Participants could think of the programmer if asked to do so, but it required extra effort and lead to more negative experiences. People think of the computer as the social actor by default, not the programmer.

Table 2.13: Media and Form, Media Equation studies (Reeves and Nass, 1996)

Media and Form	
Image Size	In real life, size is one of the most primitive cues people have about what is happening in their environment. People generally like big things and arousal levels are usually higher for larger items. Big things are consequential, either as a threat or as an opportunity. If media invokes the same reactions as real life, then the same content viewed on a larger screen should be more arousing and memorable. Participants watched sixty video segments; half viewed the segments on a 22-inch screen and the others used a 90-inch screen. The larger screen elicited much more arousal than the smaller screen. A week later, participants also remembered the segments from the large screen better. A related study showed that movie scenes viewed on the larger screen were liked much more. These results show that larger media invokes the same basic reactions as larger items in real life.
Fidelity	Most of what we see does not rely on perfect visual fidelity; peripheral vision is blurry and ill-defined and we regularly deal with poorly-lit environments. However, we adapt to this visual compromise quite easily and extrapolate the information we need to get a clear picture in our mind. Experimenters explored whether lower-fidelity images would be evaluated the same as higher-fidelity versions. Participants watched sixteen video segments from popular movies. Some saw a very high-quality version of the videos, while others saw a fuzzy picture with blurry edges, poor contrast, and visible scan lines. Tests measured memory, attention, and evaluation of the videos. Results showed no difference between conditions. Participants reacted the same to the low-fidelity images as to the high-fidelity ones.

Media and Form	
Synchrony	Timing is significant in human interaction. A slight pause or puzzled silence and people know something is wrong, even if the words say otherwise. Media often violates the rules of timing, for example by having jerky movement in video conferencing, or out-of-sync lips and audio. Experimenters predicted that audio-video asynchrony would result in negative evaluations of the speaker. Participants viewed eight video clips. For each participant, half of the segments were shown with asynchrony. When interviewed, very few participants said they noticed the asynchrony at all. However, the speakers who were viewed in asynchrony were evaluated as less interesting, less influential, and less successful in their delivery. This occurred even when the participants did not perceive the asynchrony problem. In media, as in real life, unnatural timing is viewed negatively.
Motion	Motion alerts people to pay attention. When people are exposed to sudden motion, they stop all unnecessary action and focus on the source of the motion. This response is called visual orienting. It is a natural response that allows people to assess threats and react accordingly. This study considered whether motion on the screen caused the same visual orienting. Participants watched a situational comedy with commercial breaks while an EEG machine measured brain activity. The EEG data showed that attention was closely related to movement. Pictures appearing immediately after sudden motion were remembered much better. Even though the motion occurred on the screen, the reactions were the same as for real-life motion.
Scene Changes	One of the most unnatural events in media is the visual cut that changes from one scene to the next. There is no equivalent real-life experience. Experimenters predicted that visual cuts will cause visual orienting as does other motion on the screen. Participants watched a thirty-minute video program while attached to an EEG machine to monitor their brain activity. Results showed that visual cuts demanded attention, brain activity peaked one second after each cut. Visual cuts, like sudden motion in real-life, elicit automatic responses from humans. A second study investigated whether the type of cut affected human response. They found that cuts between related scenes demanded less attention than those between unrelated scenes. A third study examined whether it was possible to overload people with too many cuts by showing them different commercials, some with no cuts and others with frequent cuts. Results showed that participants paid less attention to the commercials with many cuts than the ones without cuts. Apparently there is an upper limit to the effectiveness of visual cuts to get attention, too much motion causes people to tune out. A fourth study looked at whether visually dynamic messages will receive more favourable evaluations than static ones. Participants watched several campaign ads, some where the candidate was in a visually static environment (no cuts or camera movement) and others that were visually dynamic (the candidate was shown in different settings and multiple cuts). Participants liked the candidates better, thought they were more honest, intelligent, and trust-worthy when they were shown in a visually dynamic environment. The visual motion encouraged attention and encouraged favourable evaluations.

Media and Form	
Subliminal Images	Psychologists have long studied the area of "semantic activation without subjective awareness", which translates into "people can think about things without knowing why". Things that we are unaware of can influence our thoughts. Experimenters tested whether images in television messages that people cannot consciously identify influence judgements people make about media. Participants were asked to watch some video segments and evaluate the emotional state of the people in the videos. Before each segment, a smiling or sad face was flashed on the screen, too quickly for it to be consciously recognized by the participants. Results showed that when the smiling face was shown first, participants rated the person in the video segment as happier. The reverse occurred when a sad face was shown. Even with media, unconscious events influence the thoughts of individuals.

2.3.4. Details of relevant studies with adults

Research into the Media Equation has taken place over the last decade, with several dozen studies examining its various components as summarized in the previous section. This section details the three studies relevant to the current research, namely the studies on praise, teammates, and politeness.

Praise study

Flattery is defined as communicating positive things about another person without regard to that person's true qualities or abilities. Social psychology tells us that people respond favourably to flattery from humans; they tend to believe that the flatterer is being sincere, they feel better about themselves after being flattered, and they have more favourable opinions of those who flatter them. The effects of flattery are similar to those of true praise (Berscheid and Walster, 1978; Cialdini, 1993; Jones, 1964, 1990; Stengel, 2000). For this reason, I will use the term praise to denote the positive feedback given by the computer in these experiments regardless of whether it is warranted.

To test whether people respond to praise from a computer in the same way as when it comes from a human, Fogg and Nass (1997) designed a study were participants received praise as feedback from a computer. Forty-one undergraduate students were recruited to participate in the "Animal Game". All participants were computer literate. They were placed into one of three experimental conditions: sincere praise, flattery (unwarranted praise), or generic feedback.

Participants played twelve rounds of the guessing game where they secretly thought of an animal and the computer tried to gain information about the animal through a series of yes/no questions. At some point, the computer tried to guess which animal the participant had chosen. The computer guessed incorrectly most of the time. After each wrong guess, the computer asked the participant to suggest a question to help identify the particular animal next time. After entering a question, participants were given feedback and moved on to the next round. The feedback reflected the three experimental conditions: they received positive feedback in the praise and flattery conditions, but were simply asked to begin the next round in the generic feedback condition. The only difference between the praise and flattery conditions was that praise participants were told several times beforehand that any feedback they receive was based on comparisons with hundreds of other participants, while flattery participants were told that the feedback was random and had nothing to do with their input.

After playing twelve rounds of the guessing game, participants answered a questionnaire that measured their feelings during the interaction, their perception of the interaction, and their perception of the computer. The questions gave adjectives and asked participants to rank how well it described their experience on a 10-point Likert scale. A Likert-scale is commonly used in social research to measure participants' level of agreement with a statement. Participants are asked to choose a point on the scale that matches their degree of agreement.

The results show that people respond positively to computers that flatter and praise, in much the same way as they do to humans. People who were praised/flattered reported a higher level of power and felt that they performed better than those receiving generic feedback. They also thought that the interaction was more enjoyable and were more willing to continue working with the computer. (Fogg and Nass, 1997)

Teammates Study

Nass and Reeves have shown that people treat computers as teammates when certain factors are present; namely, identity and interdependence. These are the same factors needed to induce team behaviour among human-only groups (Nass, Fogg, Moon, 1996).

To manipulate identity, researchers must convince participants that they are part of a team by labelling them as such. Nass and Reeves accomplished this by telling participants that they were part of the "Blue Team" and giving them blue wristbands to wear. The computer had a blue or green border and was labelled "Blue Computer" or "Green Computer". Participants should believe that the Blue Computer was a teammate while the Green Computer was an outsider.

The second factor of team formation, interdependence, involved telling participants that their performance would be rated as an individual or as a team, taking into account both the computer's and their own performance. The hypothesis stated that those who thought their evaluation was contingent on both the computer and their own performance would be much more likely to cooperate and find the computer's suggestions helpful.

The study used undergraduate students with extensive computer experience as participants. Half the participants were male and half were female. Two different experimental manipulations were performed on the participants, affecting identity and interdependence. These manipulations are consistent with those normally done in social psychology research. Several studies were done, manipulating identity and interdependence individually, as well in combination, to test which affected team formation the most.

The identity manipulation was done by telling half the participants that they were on the Blue Team and would be interacting with the Blue Computer. The non-identity participants were told that they were Blue Individuals, working with the Green Computer. Non-identity participants were also told that even though they would be interacting with a computer, they were working as individuals and not part of a team.

Interdependence participants were told they would receive the same evaluation as their teammate, the Blue Computer. The non-interdependent individuals were told that although they were interacting with a computer, the evaluation was based on their work alone.

Participants were asked to complete the Desert Survival Problem. The objective was to rank a set of twelve items in order of usefulness if stranded on a deserted island. They were told that their final rankings would be compared to the optimal solution devised by a group of survival experts. Participants first ranked the items on paper so that they would have a record of their choices. Next they were introduced to the two computers used in the study. The first computer was “their” computer and was used for all of their input. The second computer was introduced as the “Blue Computer” or the “Green Computer” and was the social actor in these experiments. Participants entered their own rankings into their computer, and then viewed the Blue/Green Computer’s rankings. They then discussed their answers with the Blue/Green Computer. For each item, participants typed their reasons for the rank of the item into their own computer, and then viewed the Blue/Green Computer’s explanation for that item. After interacting with the Blue/Green Computer about each item, participants were asked to write down their final rankings on their sheet.

Finally participants rated their experience by answering a series of questions using a 10-point Likert scale on a paper questionnaire. They were questioned about their interaction with the computer and their feelings towards the computer.

The results show that interdependence had a significant impact on the perception of teammates. Interdependent participants perceived themselves as more similar to the computer, they were more cooperative, and they were more open to the computer’s influence. They also perceived the computer’s information to be of higher quality and changed their rankings to match the computer’s significantly more often.

The results of this study suggested that while interdependence had a significant influence on team behaviour, identity had little impact. Further studies by Nass and Reeves varied only identity and left out the suggestion of interdependence. These showed that identity does in fact lead to the perception of a team. Participants felt that the computer was more similar to them and friendlier. It appears that both identity and interdependence affect team formation, but that interdependence is the stronger influence (Nass, Fogg, and Moon, 1996).

Politeness study

Social norms dictate how people respond in social situations. Most often people will act in ways that portray them in the best possible light (Brown and Levinson, 1987; Fraser, 1990; Fukushima, 2000). One situation where this social desirability effect manifests itself is in an interview situation, through an interviewer-based bias. This occurs when someone adjusts their responses to questions to suit the perceived preferences of the interviewer. An interviewer-based bias is most obvious when Person A is asked by Person B to evaluate Person B's performance. In this case, the evaluation will be much more positive than if Person C asked about Person B's performance. Politeness norms guide us to be mindful of others and to avoid hurting others' feelings, so responses are dependent on who asks the questions (Jones, 1964; Nass, Moon, and Carney 1999).

Nass, Moon, and Carney (1999) studied whether this interviewer-based bias exists when the interviewer is a computer. They recruited thirty undergraduate students to participate in the study.

Participants took part in a computerized tutoring session where the computer presented twenty facts on the topic of American culture. After each fact, participants indicated on a 3-point scale how much they knew about the fact. Participants believed that subsequent facts would be chosen based on their knowledge, with fewer facts given if they already knew the topic. In reality all participants received the same twenty facts in the same order. This added interaction was included to assure that the students felt like active participants in the interaction rather than passive readers of the presented facts.

After the tutoring, participants were tested by the computer. Each participant received the same twelve multiple choice questions, but believed that the questions were randomly chosen from a set of 5000.

The computer then scored the test and evaluated its own performance as a tutor as well as participant's performance. Each question was reviewed separately, assessing both the answer and its own tutoring ability. In actuality, everyone was told that the same 8/12 questions were correct and saw the same evaluation of the computer.

Following the session, participants were asked about the performance of the computer. This interview was conducted in one of the following three manners: by the same computer, by a different computer in the next room, or through a pen-and-paper questionnaire. The questionnaires asked how well certain adjectives described the computer. Participants ranked each adjective on a 10-point Likert scale.

As when the interviewer is human, participants gave more positive responses when the computer asked about its own performance. They also gave much more homogeneous responses, which is consistent with social psychology findings. Both pen-and-paper and different-computer conditions mimicked the case where a third person performed the interview: they gave more varied responses and more negative (honest) evaluations.

During debriefing, all participants stated that the source of the interview did not affect their responses and that they did not take into consideration the computer's feelings nor were they being polite. It appears that the results were based on subconscious behaviour and reactions.

This study used a text-based interface to minimize the possibility of social responses. They replicated the experiment using a voice interface and found the same results as with the first study (Nass, Moon, and Carney, 1999).

2.3.5. Summary of Media Equation Findings

The experiments conducted by Nass, Reeves, and their colleagues explored various facets of the Media Equation. Their findings support the claim that media equals real-life. With respect to television or video, people naturally respond to on-screen events as if they were occurring in real-life. The apparent closeness of a person on-screen leads to better memory of that person and invokes reactions consistent with invasion of personal space. Motion on the screen induces the natural responses related to motion in real-life and most importantly increases the viewer's attention. People also evaluate images on the screen similarly to scenes in real-life, automatically categorizing them as good or bad and assigning a level of arousal. Negative images are remembered longer, as are negative events. People automatically adapt to unclear images and extrapolate missing data on-screen and in real-life. Asynchrony on the screen, as in real-life, elicits negative responses from viewers. Lastly, the labelling of media as "specialist" encourages a confidence in the information given just as when the information is given by human specialists.

With respect to CASA, the studies demonstrate that intelligent, experienced computer users do in fact treat the computer as a social actor. Computers are treated politely, are assigned gender, are assigned personality, and can be teammates. Computer users respond to praise and criticism by computers, prefer computers who modify their personality to match the user's, and treat separate voices from the computer as individual social actors. Studies also show that people are responding to the computer and not to the programmer when they display these social responses.

It appears that people who watch media interpret what they see on the screen in much the same manner as they would interpret similar real-life events. They also appear to treat interactions with a computer in a manner consistent with human-human interactions. In both cases, people could consciously convince themselves to avoid such behaviour, but when left to react naturally, the result is a fundamentally social interaction.

2.4. Issues of Social Interaction

In order to understand whether people react socially to computers, it is important to first know how the human-human interaction unfolds. The field of social psychology has studied social relationships between humans and has a clear understanding of how people react in social situations. This section examines the social psychology literature in three specific areas relevant to the proposed research, namely praise, team formation, and politeness.

2.4.1. Praise

People like hearing nice things about themselves; this is true even when they know that there is no basis for the compliment. Social psychology has extensively studied this area of human interaction (Berscheid and Walster, 1978; Cialdini, 1993; Jones, 1964, 1990; Stengel, 2000). Praise involves positive feedback that "commends the worth of or expresses approval or admiration" (Campanella-Bracken, 2000) for others. Praise may be warranted or unwarranted but studies show that its positive effects are present in either case.

Those who are praised tend to accept the statements as truth, even when they know that the flatterer is insincere. As Cialdini puts it, "We are phenomenal suckers for flattery" (Cialdini, 1993). People enjoy and appreciate hearing nice things about themselves and will not expend much mental energy analyzing or disproving these statements (Cialdini, 1993; Jones, 1964; 1990). Praise from others creates positive affect on the target. People feel better about themselves upon being praised. They also feel more powerful and more important. This positive influence occurs even when the praise is unwarranted or known to be inaccurate (Pandey and Kakkar, 1987).

Praise also has a positive impact on the flatterer since people like those who flatter them. Studies show that people rate those who flatter them more favourably and are more likely to reciprocate with kind words or deeds of their own. Flatterers are also seen as more competent and intelligent by their targets (Pandey and Kakkar, 1982).

One case where praise has a surprising reverse effect is when praise is given in response to a very easy task. The target may see it as a perception of low-ability by the flatterer. For example, if lavish praise is given for completing a simple addition, the target will think that the flatterer must have a low opinion of their abilities to warrant such praise for a simple task (Meyer et al., 1979).

Children react to praise in the same positive manner as adults. They seek positive evaluation from others. In response to praise, they feel better about themselves and about the flatterer (Meyer et al., 1979). While adults may suspect praise given for the completion of an easy task, children have not yet developed this thought process. They accept praise at face value and believe that the flatterer is sincere. Children start to doubt praise in response to an easy task around eleven years of age (Barker and Graham, 1987).

2.4.2. Team formation

Social psychology has shown the many behavioural and attitudinal effects of being part of a team. It is obvious that teams have a huge influence on individual team members' attitudes, beliefs, and behaviours (Abrams et al., 1990; Allen and Wilder, 1975; 1979; Mackie, 1986; Mackie, Asuncion, and Worth, 1990; Wilder, 1990).

Two key elements are needed for people to feel part of a team: Identity and Interdependence. Identity refers to creating an affiliation by convincingly labelling individuals as team members. Simply feeling part of a team is enough to be more influenced by teammates than by outsiders. Psychology studies have shown that very little cues are needed to induce this behaviour. Telling someone that they are part of the "Blue Team", giving them a "Blue Team" badge, then introducing them to other "Blue Team" members are enough to create this affiliation (Allen and Wilder, 1975; Wilder, 1990).

The second element, interdependence, involves getting team members to rely on one another to reach some common goal. Each person's outcome is tied to the performance of the team as a whole. Interdependence leads people to view themselves as more similar to group members and encourages them to conform to group opinion (Mackie, 1986).

Once individuals are made to feel part of a team, their behaviour is predictable. Team behaviour has been studied by many social psychologists who have found that teams share several characteristics. Among them, team members perceive themselves as more similar to teammates than to outsiders, they tend to act more cooperatively with teammates than with outsiders, they feel a need to agree and share a common opinion with teammates, and they perceive messages from teammates to be of a higher quality than identical messages from an outsider (Wilder, 1990; Abrams et al., 1990; Allen and Wilder, 1975; Mackie, Asuncion, and Worth, 1990).

Some research on teams and group formation with children has been conducted, but most research used adult participants. The results of the work with children show that children are in fact influenced by team membership similarly to their adult counterparts. One relevant study by Bigler, Jones, and Lobliner (1997) demonstrated that the use of colour identifiers ('blue team" and "yellow team") to form groups in a classroom lead to the children showing consistent biases favouring their own group and the members of their own group regardless of whether the groups were initially randomly assigned or based on some categorization.

2.4.3. Politeness

One of the underlining motives of politeness is the desire to please others and portray oneself in the best possible light. This trend is well-documented in social psychology and there are many theories describing politeness (Brown and Levinson, 1987; Fukushima, 2000; Grice, 1975). The more common politeness theories are briefly explained in the following section. Another politeness concept of interest is the social desirability effect as it deals with how people modify their responses based on who is asking the questions. Social desirability effect is discussed in section 2.4.3.

Politeness theories

The Social-Norm view of politeness states that each society has a set of norms prescribing behaviour in social situations. Following these norms is considered polite, failing to abide by these rules of conduct is considered rude or impolite. The Social-Norm view is a commonsense approach to politeness, encompassing etiquettes, manners, and social rules (Fraser, 1990; Fukushima, 2000).

The Conversational-Maxim view deals with politeness at a more subconscious level. Grice sees conversation as a cooperative exchange where each participant contributes in turn to move towards a mutually accepted direction (Grice, 1975). To direct these contributions, Grice devised a set of maxims falling into the following categories: Quantity, Quality, Relation, and Manner. Quantity deals with giving as much information as is required but not more. The Quality maxim deals with giving truthful information, while Relation states that one should give only relevant information. The last category, Manner, details how one should avoid ambiguity and obscurity of expression, as well as be brief and orderly in the information given. Grice believes that most people do in fact follow these maxims regularly and appear impolite when they fail to do so (Grice, 1975; Fukushima, 2000).

The third approach to politeness is the Face-Saving view, best described by Brown and Levinson (1987). It adds to Grice's theory by attempting to account for deviations from Grice's Maxims. Their theory is based on a model person who has rationality and face. Rationality means that the person has capability of reasoning the means to an end. By face, they describe two particular wants – the want to be unimpeded and the want to be approved of. Face is "the public self-image that is emotionally invested and that can be lost, maintained, or enhanced, and must be constantly attended to in an interaction" (Brown and Levinson, 1987). They further state that all interactions are concerned with maintaining or enhancing one's own face while minimizing damage to others' and go on to describe the various politeness strategies involved. (Fukishima, 2000; Fraser, 1990; Holtgraves, 2001).

Social desirability effect

A social desirability effect can occur in two situations. The first occurs when a person changes their response to be more in line with what they perceive to be the socially accepted response. This may occur when the mere presence of an interviewer leads respondents to avoid displaying attitudes that run counter to prevailing social norms (Jones, 1964; Nass, Moon, and Carney, 1999; Singer, Frankel, and Glassman, 1983).

The second situation arises when respondents distort their responses to match the perceived preferences of the interviewer. This is most obvious when the interviewer is asking about their own performance. For example, Person A is asked by Person B to rate Person B’s performance. Politeness norms dictate a positive response to avoid offending Person B. If several people were asked to rate Person B’s performance, a more homogeneous, positive set of responses would be expected. However, if a third person is introduced into the mix as the interviewer, then the bias is reduced. If Person A is asked by Person C to rate Person B’s performance, then Person A will be more likely to give an honest evaluation, without worry about hurting Person B’s feelings. In this case, one would expect a more diverse, possibly more negative, set of responses (Jones, 1964; Nass, Moon, and Carney 1999).

3. Methodology

3.1. *Overview of the studies*

For this thesis research, three separate tasks were used to investigate different aspects of the Media Equation. To test whether praise from the computer affected children, a guessing game was used. Team formation was studied using a modified version of the Desert Survival Problem. Lastly a tutorial task was used to investigate whether children were polite to computers. These tasks were very similar to those used in the original studies by Nass et al. (Fogg and Nass, 1997; Nass, Fogg, and Moon, 1996; Nass, Moon, Carney, 1999). The studies were repeated with adult participants for comparison between the two groups.

3.2. *Goals of the studies*

The overall aim of the studies was to gather information about whether children respond to the Media Equation in the same manner as adults. I was interested in how strongly children were affected by the Media Equation, how it impacted their opinion of the computer, how it affected their emotional state, and whether it influenced their behaviour. A secondary goal was to see whether I would find the same large Media Equation effect with adults as in previous studies. I was also interested in whether simply changing the type of computer had any impact on how people responded to the Media Equation.

3.3. *Methodology*

The following sections describe the methodology followed in the three studies. The design of the studies, included participants, physical setup, procedure, and data collection tools are discussed.

3.3.1. Study Design

The studies used a between-subjects design. Each participant completed each task only once and answered a corresponding questionnaire after finishing each task. The questionnaires were the main source of data, measuring participants' opinions and perceptions after the interaction. If the Media Equation had a strong effect on participants, it should result in significantly more positive responses on the questionnaires.

Four independent variables were used: the effects of treatment (application of the Media Equation or not), group (children versus adults), gender (males versus females), and form factor (handheld versus desktop computers) were measured.

3.3.2. Participants

Thirty-nine children and thirty-three adults participated in these studies. Arrangements were made with the school board to have children from a grade 5 and a grade 6 classroom from a local elementary school in Saskatoon participate in the studies. The children were 10 to 12 years old and had parental consent to participate. Each class received a pizza party after the completion of the study to thank them for their time and cooperation. The adult participants were university students receiving class credit for participating in research experiments.

All participants were familiar with desktop computers; however, some had no experience using a handheld computer. The experimenter demonstrated to each participant how to use the stylus as a pointing device and how to type using the on-screen keyboard to assure that they could successfully complete the tasks on handheld computers.

Demographic details for the children are presented in Table 3.1. These figures are based on interviews with the children at the start of the experiments. Ninety percent of children said they used a computer at home and most reported using it on a weekly basis. Three quarters of 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. Roughly two-thirds of children also reported using the computer for homework, email, and listening to music. When it came to handheld devices, 95% of children said they had used a personal gaming device such as a Gameboy, but only 38% had ever tried using a handheld computer.

Table 3.1: Demographics of Children Participants

	Children					
	Males		Females		Total	
	#	%	#	%	#	%
# Participants	20	100%	19	100%	39	100%
Age						
10 years	11	55%	9	47%	20	51%
11 years	7	35%	7	37%	14	36%
12 years	2	10%	3	16%	5	13%
# years using computer						
Median	3	-	4	-	4	-
Average	3.25	-	4	-	3.6	-
Uses computer at home						
Yes	17	85%	18	95%	35	90%
No	3	15%	1	5%	4	10%
Usage – Home Computer						
>= 5 times / wk	8	40%	9	47%	17	44%
3-4 times / wk	0	0%	2	11%	2	5%
1-2 times / wk	7	35%	7	37%	14	36%
< 1 per week	2	10%	0	0%	2	5%
Never	3	15%	1	5%	4	10%
Uses computer at school						
Yes	13	65%	16	84%	29	74%
No	7	35%	3	16%	10	26%
Usage – School Computer						
>= 5 times / wk	0	0%	0	0%	0	0%
3-4 times / wk	0	0%	0	0%	0	0%
1-2 times /wk	7	35%	13	68%	20	51%
< 1 per week	6	30%	3	16%	9	23%
never	7	35%	3	16%	10	26%
Purpose of computer use						
Games	19	95%	16	84%	35	90%
Email	10	50%	15	79%	25	64%
Homework	12	60%	13	68%	25	64%
Chat	11	55%	8	42%	19	49%
Web browsing	19	95%	17	89%	36	92%
Music	12	60%	15	79%	27	69%

Other	1	5%	2	11%	3	8%
Uses a handheld game player (e.g. Gameboy)						
Yes	19	95%	18	95%	37	95%
No	1	5%	1	5%	2	5%
Usage – handheld game player						
>= 5 times / wk	2	10%	1	5%	3	8%
3-4 times / wk	1	5%	3	16%	4	10%
1-2 times / wk	5	25%	5	26%	10	26%
< 1 per week	11	55%	9	47%	20	51%
Never	1	5%	1	5%	2	5%
Uses a handheld computer						
Yes	8	40%	7	37%	15	38%
No	12	60%	12	63%	24	62%
Usage – handheld computer						
>= 5 times / wk	0	0%	0	0%	0	0%
3-4 times / wk	0	0%	1	5%	1	3%
1-2 times /wk	1	5%	0	0%	1	3%
< 1 per week	7	35%	6	32%	13	33%
Never	12	60%	12	63%	24	62%

The adult participants were university students receiving credit for participating in the experiment either through a Psychology or a Computer Science class. The median age for the adult participants was 22 years old. All but one participant (97%) reported using a computer at home, with an average use of 23 hours per week. Eighty-five percent said they used a computer at university and the average use was 11 hours per week. Everyone used a computer for email and for homework, 97% used it for web browsing, while 8 out of 10 said they listened to music on the computer. Almost two-thirds of participants reported having used a handheld computer, although most did not use one regularly.

3.3.3. Physical setup

To test the children, the equipment was set up in an unused classroom at their school. The adult participants came to the Human-Computer Interaction lab on the University campus to take part in the study.

Participants used several different computers during the one-hour session. The computers were set up around 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. The experimenter remained a short distance from the participants while they completed the tasks, except to provide assistance when needed.

Three desktop computers were required. These were Windows-based computers, with 15-inch monitors, keyboard, and mouse. The computers were set up near each other on separate desks. Nearby, three handheld devices were also set up. These had Windows CE installed, had a stylus as a pointing device, and used an on-screen keyboard to enter text.

3.3.4. Systems

Several small applications were developed using Visual Basic 6.0 for the desktop versions and Embedded VB for the handheld versions. The interfaces for the tasks were simple Visual Basic forms containing textboxes, buttons, and radio buttons. The size and layout of the forms were kept consistent across the two types of computers. While taking up the entire screen on the handheld device, the forms were centered on the screen for the desktop computers. The interfaces were kept as simple as possible, to avoid unduly influencing participants' reactions. This is consistent with the interfaces used in the original studies by Nass et al. (Fogg and Nass, 1997; Nass, Fogg, and Moon, 1996; Nass, Moon, Carney, 1999). The interfaces can be seen in Figure 3.1 through Figure 3.9.

3.3.5. Tasks

A different task was used to test each aspect of the Media Equation, namely praise, politeness, and team formation. Each participant completed the three tasks. The order of the tasks was varied to avoid having one task influence the others. Scripts were used in each task to ensure that all participants received the same information. The scripts are available in Appendix C. The following sections describe each task in turn.

Task 1 – Animal Guessing Game (Effects of Praise)

To test whether praise from the computer had any effect, participants played several rounds of a guessing game known as the Animal Guessing Game. This was the same task used in the previous experiments by Fogg and Nass (1997). It was felt that children would understand the simple game without modification. For a detailed explanation of the original study, see section 2.3.4.

Participants were first asked to think of an animal. The computer proceeded to ask 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 help improve 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.

Each participant played seven rounds of the guessing game. The number of rounds was determined during pilot testing, balancing between the amount of time it took to complete the rounds with having sufficient rounds so that participants recognized the praise. As they played, they saw their suggested questions from previous rounds being incorporated into the game. Figure 3.1 shows example screenshots from the system. Figure 3.2 and Figure 3.3 give examples of the feedback provided in the Praise and Neutral conditions.

After seven rounds, participants moved away from the computer and 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 self.

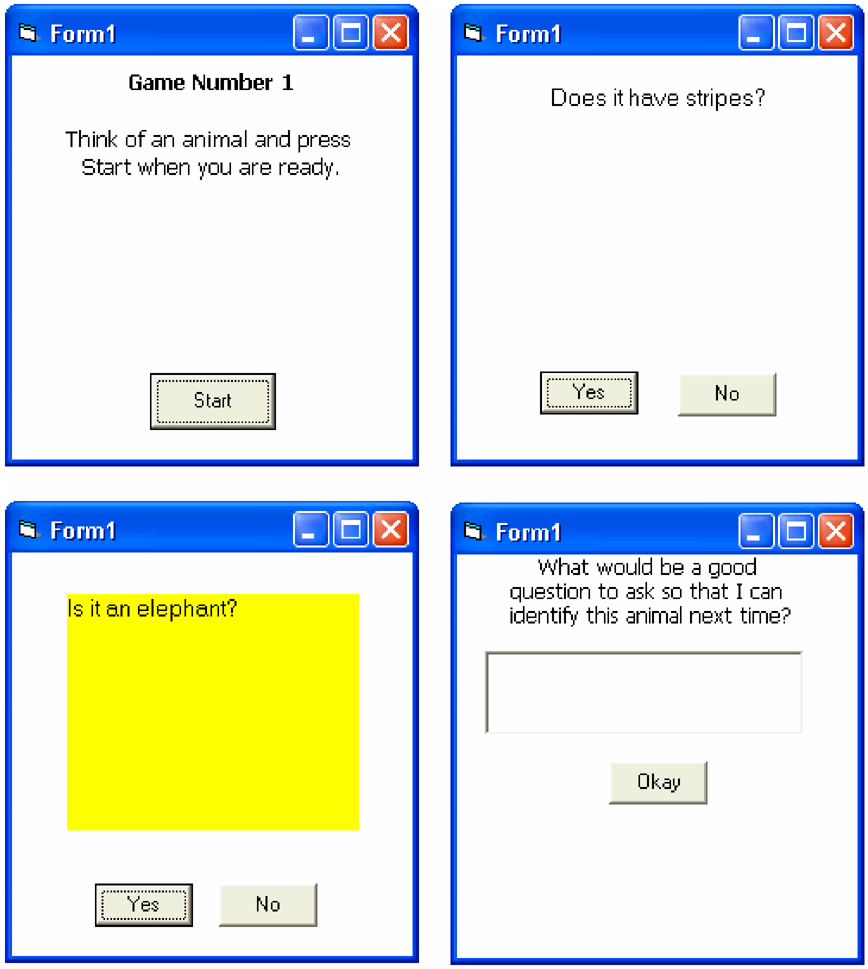

Figure 3.1: Screenshots of Guessing Game, Praise Study

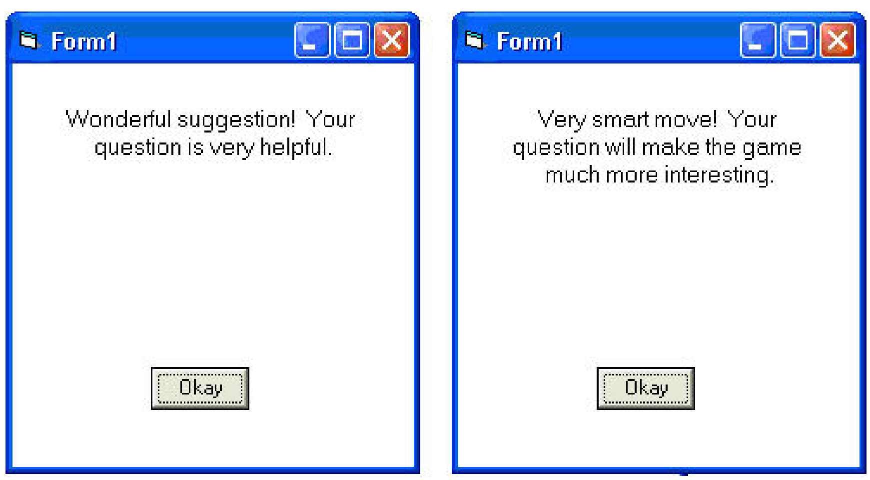

Figure 3.2: Guessing Game feedback in praise condition, Praise Study

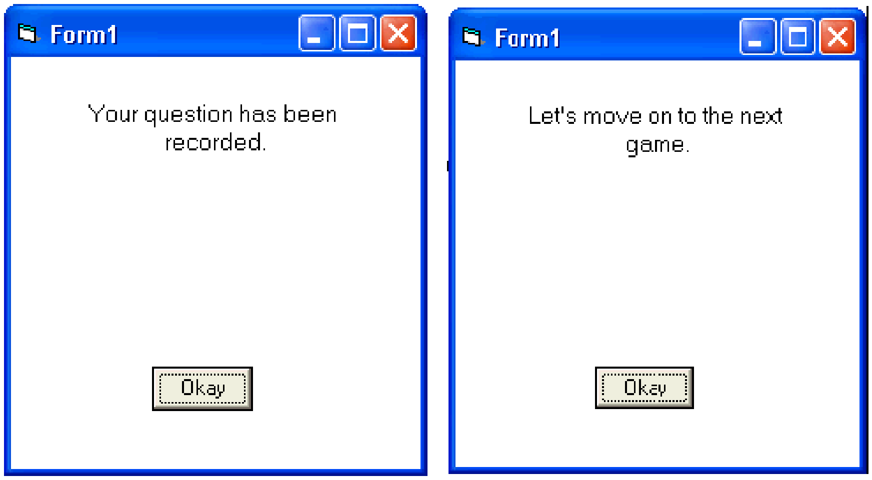

Figure 3.3: Guessing Game feedback in neutral condition, Praise Study

Task 2 – Desert Survival Problem (Effects of Team Formation)

The Desert Survival Problem was used to examine the computers as teammates portion of this study. The original task was deemed too time-consuming for children to complete and was modified accordingly. This version had a shortened explanation of the situation and required participants to select the five most important items out of eight items rather than ranking twelve items in order. The list of items was also made age-appropriate. For further explanation of the original study by Nass et al. (Nass, Fogg, Moon, 1996), see section 2.3.4.

Participants completed the first portion of this task on paper, away from the computer. They 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. Their task was to choose the five most important items out of a list of eight items and record their choice on the sheet provided (see Appendix B). Before interacting with the computer, the experimenter introduced the concept of teammates according to experimental conditions described later in this section. Participants then moved to the computer to discuss their answers. They were told that while the computer could provide useful suggestions, it did not necessarily have all the answers. This was to assure that participants felt that both their and the computer's input was needed to complete the task.

Two computers were used for this task. For simplicity, these are identified as A and B, although this distinction is not used during the actual experiments. Computer A was used only for the participants' input while B displayed the computer's choices and suggestions. Computer B was introduced to participants as the Blue or Green Computer. Participants first copied their five chosen items from paper to Computer A. Next, they moved to B to see the computer's selections and record these on their sheet. They started the discussion process by moving back to A and entering their reasons for selecting, or not selecting, the first item in the list. Next, they returned to B to see the computer's arguments for/against selecting the first item. This discussion process continued for all eight items. Once they discussed all of the items, participants wrote down a final set of selections, possibly altering their initial decisions.

The algorithm for the computer's choices was based on the participant's choices so that the computer's choices were consistently dissimilar to the participant's choices (i.e. the computer always selected two items that were the same as the participant's choices and three different items). A consistent script of reasons for and against each item was used, but since the computer's choices depended on the participant's initial selections, the reasons displayed varied from participant to participant.

Participants completed a paper questionnaire at the end of the session asking about their experience with the computer. Other collected data tracked the extent to which participants change their initial rankings after interacting with the computer and their reasons given for each item.

Figure 3.4 through Figure 3.6 provide example screenshots for the Desert Survival system. The background colour of each screen matched the team colour in the given condition (blue or green). Note that the background of each of the following screenshots is blue although it appears black in the printed images. Figure 3.4 and Figure 3.5 show screens displayed on the participant's computer (Computer A). Figure 3.6 provides examples of the Blue Computer's screen (Computer B). The Green Computer looked identical except for a green background instead of blue.

Figure 3.4: Screenshot of participant choosing 5 items in Desert Survival Problem, Team Formation study. Background is coloured blue in all conditions.

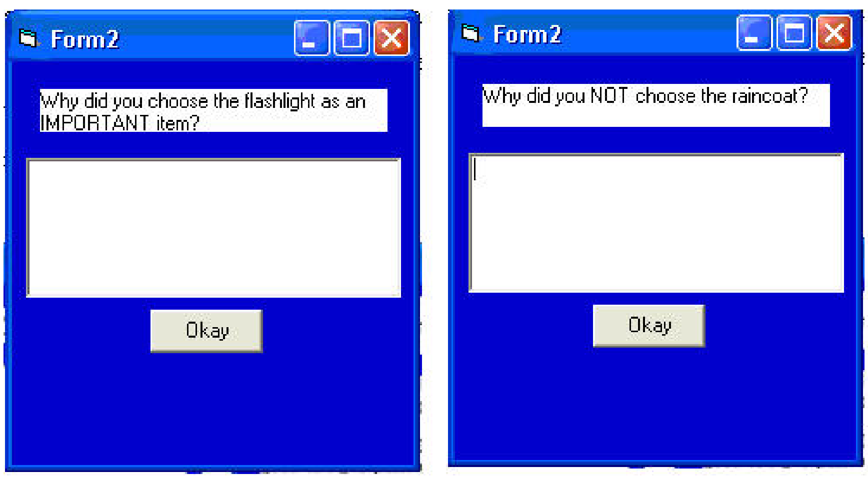

Figure 3.5: Screenshot of participant explaining their choices in Desert Survival Problem, Team Formation study. Background is coloured green or blue dependent on treatment condition.

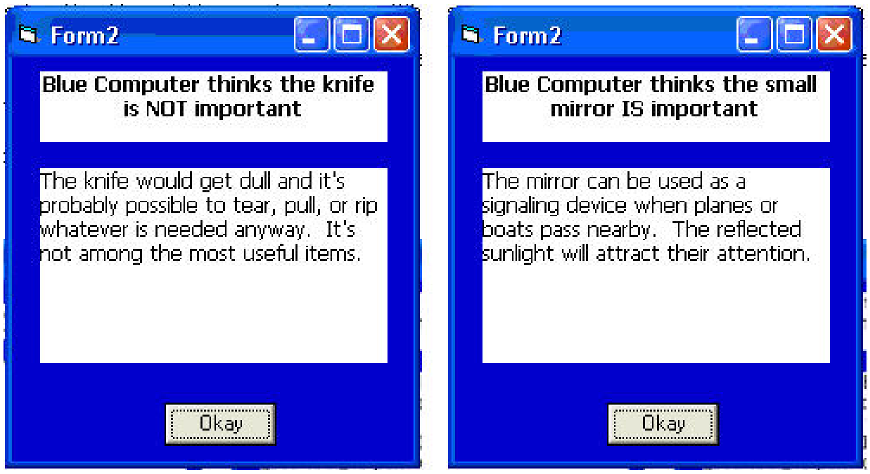

Figure 3.6: Screenshots of Blue Computer's reasons, Desert Survival Problem, Team Formation study. Background is coloured blue for the Blue Computer and green for the Green Computer.

The Desert Survival Problem was used to investigate whether participants treated the computer as a teammate. To manipulate the teammate condition, 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, to complete the task. The second half was told that they were Blue Individuals who would be interacting with the Green Computer to complete the task. No mention of the word team was made in the second condition.

To reinforce the idea of Blue and Green teams, visual cues were provided. The computer used by participants to enter their input had a blue background (Computer A), while the second computer (Computer B) had either a blue or green background, depending on the condition, as well as a large label at the top of the monitor saying "Blue Computer" or "Green Computer". In the team condition, the wording of instructions provided by the experimenter reinforced the idea of a team by saying "your teammate" when referring to the Blue Computer and "your team's choices" when referring to the final selection of items. In contrast, those working with the Green Computer heard no mention of the word team. The computer was always referred to as the Green Computer and the final selection of items as "your choices".

In the original studies, participants were informed that their answers would be evaluated by a team of specialists and compared to those of all other participants. They were told that they would either be evaluated as a team with the computer or as an individual. It was felt that children should not be told that they were being evaluated in such a way, so this manipulation was omitted from the study. To reinforce the idea of interdependence, although more weakly, the mention of "your team's choices" and "your choices" was used. Participants were told that the computer's choices were not necessarily ideal.

Task 3 – Animal Tutorial (Effects on Politeness)

To test whether participants were polite to computers, they completed the Animal Tutorial task. This task required participants to complete a tutorial giving unusual facts about animals. Nass, Moon, and Carney (1999) used a tutorial giving facts about American culture in the original study. This topic was considered inappropriate for children, so it was changed to facts about animals. Details of the original study are available in section 2.3.4.

The tutorial consisted of a sequence of three parts: presenting facts, answering questions, and reading the evaluation. In the first part, participants read fifteen facts about animals on the computer. After each fact, they selected whether they felt they knew nothing, a little, or a lot about the animal. They were told that subsequent facts would be chosen based on their current knowledge level. Secondly, participants answered twelve multiple choice questions about animals. Most of the questions were directly related to the facts presented, but a few were not. Participants were told that the questions came from a pool of several thousand questions, but in reality everyone received the same questions. Finally, the computer told participants whether the questions were answered correctly and that it felt it provided useful information to answer that particular question. The computer praised itself regardless of whether relevant information had been provided. The computer ended the evaluation by saying both itself and the participant had done a good job.

Participants finished the task by completing a questionnaire evaluating the computer's performance, their own performance, and their feelings towards the computer. In the treatment condition, participants answered the follow-up questionnaire on the same computer that gave them the tutorial. In the non-treatment condition, participants moved away from the computer and completed an identical questionnaire on paper.

Figure 3.7 provides example screenshots of the Presenting Facts and of the Question portion of the tutorial. Figure 3.8 presents screenshots of the Evaluation part. Participants completed the follow-up questionnaire on the computer in the treatment condition as opposed to paper in the non-treatment condition; Figure 3.9 provides a screenshot of the first question.

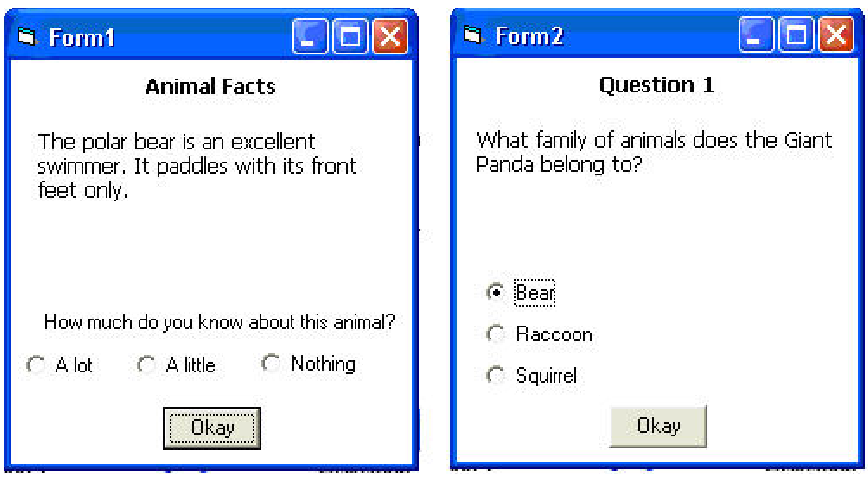

Figure 3.7: Screenshots of Fact and Question portions of Animal Tutorial, Politeness study

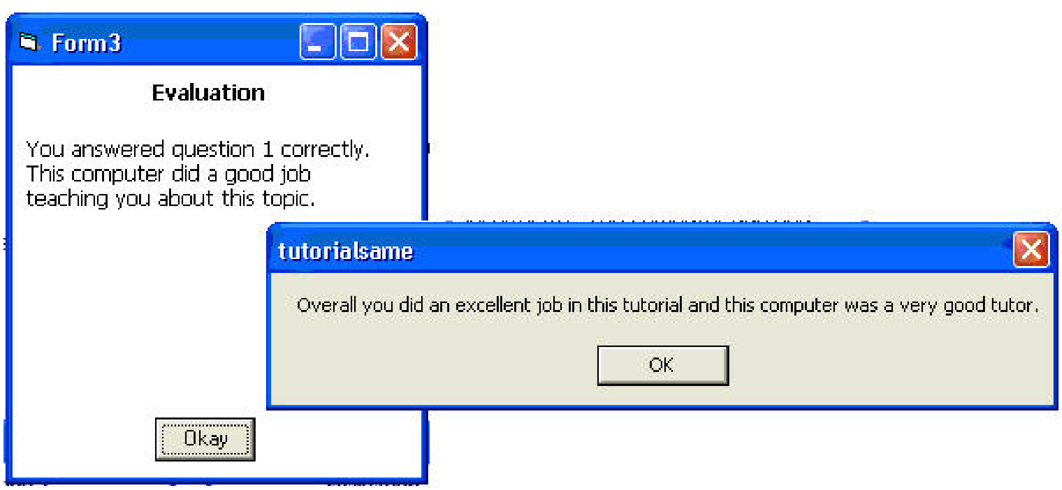

Figure 3.8: Screenshots of Evaluation portion of Animal Tutorial, Politeness study

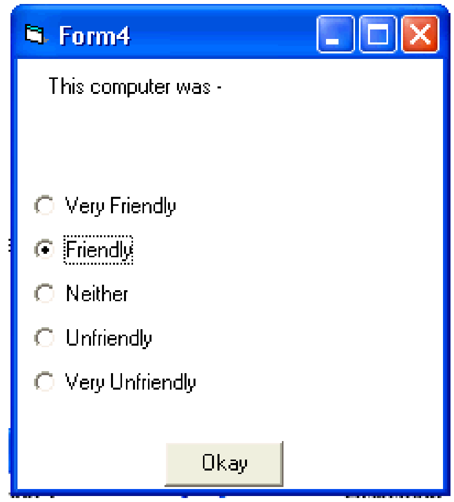

Figure 3.9: Computer Questionnaire in Polite condition of Animal Tutorial, Politeness study

3.3.6. Procedure

Participants were introduced to the study, although no mention was made of the real purpose of the study at this initial stage. They were simply told that they would be completing three short games on the computer, some on a desktop and others on a handheld computer. The entire session would last an hour and they could take breaks as required. Participants were asked to sign consent forms (in the case of the children, consent forms from their parents were collected and the children signed assent forms). See Appendix A for copies of the forms. The first task was introduced and participants moved to the appropriate station. Once they had completed the first task, they moved on to the second and third tasks in turn. They were given a few minutes break between each task.

The adults were tested individually. Due to time constraints in the school, the children were tested in pairs. Each completed the tasks alone, at separate stations, but two children were present in the room at a time. The children completed the tasks in parallel, one using the handheld computers and the other using the desktop computers. They changed computers after each task. Both were either in the treatment or non-treatment condition at the same time.

Once all three tasks were completed, participants were thanked and debriefed. In the case of the children, an explanation of the real purpose of the experiment was given to the entire class after everyone had participated, to avoid having the earlier participants influence the later ones. A handout was provided for their parents. The adult participants were debriefed immediately after the session and asked not to discuss the experiment until the end of the study.

3.3.7. Experimental Conditions

Each participant completed all three tasks. The order of the tasks was rotated so that approximately the same number of participants performed the tasks in each order. Participants switched forms of computer after each task, so each performed two tasks on one form and one task on the other. The number of females and males in each of the experimental conditions was also kept consistent. Participants were further divided into two groups – adults and children. The groups were given the same tasks, following the same experimental conditions.

The following table illustrates the division of participants into different experimental conditions:

Table 3.2: Breakdown of experimental conditions, across all tasks

Treatment				Non-Treatment			
Desktop		Handheld		Desktop		Handheld	
Male	Female	Male	Female	Male	Female	Male	Female

Two sample participants may have gone through the tasks in the following order:

Table 3.3: Sample participant assignments to experimental condition

Participant A	Task 1: Desert Survival – Handheld – Treatment Task 2: Guessing Game – Desktop – Non-Treatment Task 3: Tutorial – Handheld - Treatment
Participant B	Task 1: Tutorial – Desktop – Non-Treatment Task 2: Guessing Game – Handheld – Treatment Task 3: Desert Survival – Desktop – Non-Treatment

3.3.8. Data Collection

Data was collected in several ways to provide an overall picture of the interaction. The experimenter initially interviewed participants about their prior experience with computers and current use of computers. The experimenter also noted any relevant comments by participants during the completion of the tasks. The software recorded data during the interaction, creating logs of the participants' responses as entered into the computer.

Questionnaires

The most important data collection tools were the follow-up questionnaires answered after each task. The questionnaires measure participants' opinion of the computer, the overall interaction, their own performance, and asked some task-specific questions. For each question, participants circled their answer among five choices ranging from strong agreement to strong disagreement or strongly positive to strongly negative. Half of the scales were inverted by phrasing the questions in a negative fashion to avoid a bias if, for example, participants consistently circled the first item. Previous Media Equation studies used ten choices; however it was decided that children would be more comfortable choosing from among five choices. Instead of using a 5-point Likert scale, it was determined during the pilot tests that matching each point on the scale to words was more understandable for children. For example, a "1" on the Likert scale would be associated with "very dumb" while "dumb" was assigned to "2", and so on for all five points. The questionnaires are included in their original form in Appendix B. The questionnaires from the original studies were more thorough and therefore much longer, but these were considered inappropriate for children even with adjusted language because they took too long to complete. Questions were selected that provided a good representation of the range of questions asked in the original questionnaires and that involved concepts children would understand.

For analysis, similar questions were grouped together into sets to test an overall hypothesis. Within each study, question sets were labelled QA, QB, and so on. These labels were used in the tables and charts presenting the analysis and results in the following chapter. One of the question sets (QA) was included across all three tasks and it contained exactly the same questions. Their opinion of the computer was measured in all three tasks with the following question set (Table 3.4):

Table 3.4: Question set (QA) - "Opinion of the Computer", across all tasks

Opinion of the Computer	*The computer was:*				
	Very Friendly	Friendly	Neither	Unfriendly	Very Unfriendly
	Very Boring	Boring	Neither	Interesting	Very Interesting
	Very Helpful	Helpful	Neither	Unhelpful	Very Unhelpful
	Very Dumb	Dumb	Neither	Smart	Very Smart
	Very Likeable	Likeable	Neither	Dislikeable	Very Dislikeable
	Very Polite	Polite	Neither	Rude	Very Rude
	Very Mean	Mean	Neither	Nice	Very Nice

For the questionnaire testing the effect of praise, three other question sets were created. The first (QB) looked at participants' opinion of self and is described in Table 3.5. The last two question sets looked specifically at their opinion of the computer's feedback (QC) and at how participants rated their own performance during the task (QD). These question sets were formed as described in Table 3.6 and Table 3.7.

Table 3.5: Question set (QB) - "Opinion of Self", Praise study

Opinion of Self	*While working with the computer, I felt:*				
	Very Busy	Busy	Neither	Bored	Very Bored
	Very Happy	Happy	Neither	Sad	Very Sad
	Very Comfortable	Comfortable	Neither	Uncomfortable	Very Uncomfortable
	Very Bad	Bad	Neither	Good	Very Good
	Very Pleasant	Pleasant	Neither	Unpleasant	Very Unpleasant

	Very Unimportant	Unimportant	Neither	Important	Very Important
	Very Stressed	Stressed	Neither	Calm	Very Calm
	Very Unfriendly	Unfriendly	Neither	Friendly	Very Friendly
	How long did the interaction with the computer seem to take?				
	A Very Long Time	A Long Time	Neither	A Short Time	A Very Short Time
	If you had more time, would you be willing to continue working with this computer?				
	Very Willing	Willing	Neither	Unwilling	Very Unwilling
	How willing would you be to continue creating questions for the game?				
	Very Willing	Willing	Neither	Unwilling	Very Unwilling
	How willing would you be to work on a different game with the same computer?				
	Very Willing	Willing	Neither	Unwilling	Very Unwilling

Table 3.6: Question set (QC) - "Opinion of the Computer's Feedback", Praise study

Opinion of the Computer's feedback	*The feedback from the computer was:*				
	Very Accurate	Accurate	Neither	Incorrect	Very Incorrect
	Very Boring	Boring	Neither	Interesting	Very Interesting
	Very Fair	Fair	Neither	Unfair	Very Unfair
	Very Nasty	Nasty	Neither	Nice	Very Nice
	Very Generous	Generous	Neither	Mean	Very Mean
	Very Positive	Positive	Neither	Negative	Very Negative
	Very Friendly	Friendly	Neither	Unfriendly	Very Unfriendly
	Very Unhelpful	Unhelpful	Neither	Helpful	Very Helpful

Table 3.7: Question set (QD) -"Opinion of Their Own Performance", Praise study

Opinion of their own performance	*How well did you play the game?*				
	Very Well	Well	Neither	Poorly	Very Poorly
	How helpful were the questions you suggested?				
	Very Helpful	Helpful	Neither	Unhelpful	Very Unhelpful
	How accurate were the computer's evaluations of your work?				
	Very Accurate	Accurate	Neither	Not Accurate	Not Accurate At All
	How do you think you compare with others who played this game?				
	Much Better	Better	Same	Worse	Much Worse

The Politeness study's questionnaire was also divided into four question sets (labelled QA to QD). The first identified participants' opinion of the computer (QA), as described in Table 3.4. The second set looked at how participants' opinion of self during the task (QB) and is detailed in Table 3.8. Table 3.9 and Table 3.10 describe question sets QC and QD, which look at participants' opinion of the tutoring session and opinion of the scoring session respectively.

Table 3.8: Question set (QB) – "Opinion of Self", Politeness Study

Opinion of Self	*While working with the computer, I felt:*				
	Very Busy	Busy	Neither	Bored	Very Bored
	Very Happy	Happy	Neither	Sad	Very Sad
	Very Comfortable	Comfortable	Neither	Uncomfortable	Very Uncomfortable
	Very Bad	Bad	Neither	Good	Very Good
	Very Pleasant	Pleasant	Neither	Unpleasant	Very Unpleasant
	Very In Control	In Control	Neither	Powerless	Very Powerless
	Very Unimportant	Unimportant	Neither	Important	Very Important
	Very Stressed	Stressed	Neither	Calm	Very Calm
	Very Unfriendly	Unfriendly	Neither	Friendly	Very Friendly

Table 3.9: Question set (QC) – "Opinion of Tutoring Session", Politeness Study

Opinion of Tutoring Session	*The tutoring session was:*				
	Very Fun	Fun	Neither	Dull	Very Dull
	Very Boring	Boring	Neither	Interesting	Very Interesting
	Very Helpful	Helpful	Neither	Unhelpful	Very Unhelpful
	Very Useless	Useless	Neither	Useful	Very Useful
	Very Difficult	Difficult	Neither	Easy	Very Easy
	Very Time Consuming	Time Consuming	Neither	Quick	Very Quick
	Very Creative	Creative	Neither	Tedious	Very Tedious

Table 3.10: Question set (QD) – "Opinion of Scoring Session", Politeness Study

Opinion of Scoring Session	*The tutoring session was:*				
	Very Accurate	Accurate	Neither	Incorrect	Very Incorrect
	Very Boring	Boring	Neither	Interesting	Very Interesting
	Very Fair	Fair	Neither	Unfair	Very Unfair
	Very Nasty	Nasty	Neither	Nice	Very Nice
	Very Generous	Generous	Neither	Mean	Very Mean
	Very Positive	Positive	Neither	Negative	Very Negative
	Very Friendly	Friendly	Neither	Unfriendly	Very Unfriendly
	Very Unhelpful	Unhelpful	Neither	Helpful	Very Helpful

The questionnaire from the Team Formation study was broken down into five question sets (labelled QA to QE). The first question set (QA) included the same questions as the other two studies, looking into participants' opinion of the computer, and is described in Table 3.4. Participants' opinion of self is investigated using question set QB, available in Table 3.11. To see whether participants thought of the computer as a partner, question set QC was created as detailed in Table 3.12. Question set QD investigated whether participants perceived their opinions to be the similar to those of the computer and is described in Table 3.13. Lastly, participants' level of trust and confidence in the computer was tested using question set QE, available in Table 3.14.

In the case of team formation, a sixth data point was considered: the number of items changed on their rankings sheet to match the computer's advice after interaction with the computer. This number was tabulated based on the items checked on their answer sheets. The sheet (see Appendix B) was comprised of three columns, one for each of the participant's initial selections, the computer's selections, and the participant's final selection. The number of items changed reflected how many changes were made from the participant's initial selections to their final selection.

Table 3.11: Question set (QB) – "Opinion of Self", Team Formation Study

Opinion of Self	*While working with the computer, I felt:*				
	Very Busy	Busy	Neither	Bored	Very Bored
	Very Happy	Happy	Neither	Sad	Very Sad
	Very Comfortable	Comfortable	Neither	Uncomfortable	Very Uncomfortable
	Very Bad	Bad	Neither	Good	Very Good
	Very Pleasant	Pleasant	Neither	Unpleasant	Very Unpleasant
	Very In Control	In Control	Neither	Powerless	Very Powerless
	Very Unimportant	Unimportant	Neither	Important	Very Important
	Very Stressed	Stressed	Neither	Calm	Very Calm
	Very Unfriendly	Unfriendly	Neither	Friendly	Very Friendly
	How much did you enjoy the game?				
	Very Much	A Little	Neither	Not Much	Not At All

Table 3.12: Question set (QC) – "Perception of the Computer as a Partner", Team Formation Study

Perception of Computer as a Partner	*How well did you and the computer work together?*				
	Very Well	Well	Neither	Poorly	Very Poorly
	How much did you cooperate with this computer?				
	Very Much	A Little	Neither	Not Much	Not At All
	How much did the computer cooperate with you?				
	Very Much	A Little	Neither	Not Much	Not At All
	How much did you think of the computer as a helper?				
	Very Much	A Little	Neither	Not Much	Not At All
	How much did you think of the computer as a competitor?				
	Very Much	A Little	Neither	Not Much	Not At All
	How much did you think of yourself as part of a group?				
	Very Much	A Little	Neither	Not Much	Not At All
	How much did you think of the computer as a partner?				
	Very Much	A Little	Neither	Not Much	Not At All

Table 3.13: Question set (QD) – "Perception of Similarity to the Computer", Team Formation Study

Perception of Similarity to the Computer	*How similar were the computer's suggestions to your suggestions?*				
	Very Similar	Similar	Neither	Different	Very Different
	How much did you agree with the computer's reasons?				
	Very Much	A Little	Neither	Not Much	Not At All
	How similar was your initial ranking to the computer's initial items?				
	Very Similar	Similar	Neither	Different	Very Different
	How similar were your final items to the computer's items?				
	Very Similar	Similar	Neither	Different	Very Different

Table 3.14: Question set (QE) – "Trust and Confidence in the Computer", Team Formation Study

Trust and Confidence in the Computer	*How much did you trust the information from the computer?*				
	Very Much	A Little	Neither	Not Much	Not At All
	How helpful were the computer's suggestions?				
	Very Helpful	Helpful	Neither	Unhelpful	Very Unhelpful
	How difficult was it to choose your final items?				
	Very Difficult	Difficult	Neither	Easy	Very Easy
	Are you sure you chose the best set of items?				
	Very Sure	Sure	Neither	Not Sure	Not Sure At All

4. Results

4.1. General Observations

The three main questions studied in this experiment were whether children would respond more strongly to the Media Equation than would adults, whether males and females would respond differently, and whether the form factor of the computer affected people's responses. The experiments investigated how these three questions could be answered with respect to praise, team formation, and politeness. I found that overall, children were less affected by the addition of social characteristics to computer software than were adults. It was also discovered that there were very few differences between how females and males responded; but in those instances where differences were shown, males were more affected by the addition of social characteristics than females. I also found virtually no differences in how participants responded to social characteristics based on the form of the computer.

Overall, adding social characteristics to computer programs had little effect on children aged 10-12. In none of the three tasks did the addition of social characteristics lead to significant differences in children's responses; this stands in contrast to Nass and Reeve's studies where differences were found for adults in similar situations. The children responded very positively to the computer regardless of whether social characteristics were added. The addition of these social characteristics had no significant impact on children's opinion of the computer, opinion of self, or impression of their own work. This may mean that the Media Equation has no effect on children. However, it may also indicate that children respond so strongly to the Media Equation that additional social cues have limited effect.

The overall results for adults were mixed. Adults were significantly affected by praise from the computer. Those who were praised gave higher evaluations of their emotional state, of their overall opinion of the computer, and of the computer's feedback. However, contrary to Nass's results, the addition of social characteristics to the software did not affect adults' responses in the cases of team formation or politeness.

The form of the computer had no significant impact on participants' responses in any of the three studies. This was true of children and adult participants. Neither adults nor children showed any gender differences in how they responded to the computer in any of the three studies.

In the sections below, results for the three studies are given based on parametric analysis of the grouped questionnaire questions. Non-parametric analyses are also presented for comparison. A significance level of $p<=0.01$ in both the parametric and non-parametric analyses was considered statistically significant.

4.2. Effects of Praise

Participants were expected to respond more positively when the computer praised their work than when it provided only neutral feedback. The following sections detail the results of my analysis for children and adults. They also address the questions of whether gender or form factor had any impact.

Data from the questionnaire was grouped into four question sets (QA to QD). Each question set included similar questions testing an overall hypothesis. The question sets are described in section 3.3.8. Responses for each set were averaged to produce a single score for each participant. A summary of the question sets used in the Praise study is available in Table 4.1. The QAll question set is an overall measure, taking into account every question on the questionnaire.

Table 4.1: Question sets for Praise study

Question Set	Description
QA	Their opinion of the computer
QB	Their opinion of self
QC	Their opinion of the computer's feedback
QD	Their opinion of their own performance in the task
QAll	All questions in the questionnaire

Each question had five possible answers, ranging from negative to positive. These were converted to values from one to five. The means, medians, and standard deviations for each question set are displayed in Table 4.2. It shows three sets of numbers, one set grouping all participants and two sets showing adults and children respectively. The overall values are given for each group, as well as values for the praise and no-praise conditions.

Graphical representation of the means is provided in Figure 4.1 through Figure 4.4. Parametric and non-parametric analyses of the means are given in Table 4.3. Table 4.4 contains the parametric analysis for the interaction between participant group (adults and children) and treatment condition (praise and no-praise).

Children and adults' responses were significantly different from each other (see Figure 4.4), with children responding much more positively overall than the adults, regardless of whether they received praise. This difference (approximately 0.5 on the 1-5 scale of the questionnaire) implies that approximately half of the child participants chose a questionnaire response that is one step higher (e.g. "very happy" instead of "happy") than adults' responses.

Table 4.2: Effect of praise, means

	QA			QB			QC			QD			QAll		
	mean	std dev	median	mean	std dev	median	mean	std dev	median	mean	std dev	median	mean	std dev	median
All participants															
Overall	3.78	0.60	3.86	3.94	0.54	3.92	3.72	0.61	3.75	3.50	0.69	3.50	3.80	0.52	3.78
Praise	3.94	0.50	3.86	4.02	0.45	4.00	3.90	0.53	3.88	3.57	0.66	3.50	3.92	0.46	3.88
No-Praise	3.60	0.66	3.71	3.85	0.61	3.85	3.52	0.63	3.38	3.41	0.73	3.25	3.66	0.57	3.63
Adults															
Overall	3.51	0.53	3.57	3.58	0.48	3.65	3.42	0.51	3.38	3.10	0.64	3.25	3.45	0.45	3.55
Praise	3.71	0.40	3.71	3.77	0.35	3.69	3.64	0.42	3.69	3.19	0.61	3.25	3.65	0.33	3.69
No-Praise	3.31	0.59	3.43	3.40	0.57	3.62	3.20	0.53	3.25	3.01	0.67	3.25	3.26	0.52	3.34
Children															
Overall	3.94	0.60	3.86	4.17	0.45	4.08	3.92	0.60	3.88	3.78	0.60	3.75	4.01	0.47	3.89
Praise	4.10	0.50	4.07	4.20	0.43	4.08	4.08	0.54	4.06	3.85	0.57	3.75	4.10	0.44	4.06
No-Praise	3.78	0.66	3.71	4.15	0.48	4.08	3.76	0.63	3.81	3.71	0.64	3.75	3.91	0.48	3.75

Table 4.3: Effect of praise, significance

TREATMENT (PRAISE)	Parametric - Univariate				Non-Parametric	
Question Set	**F**	**p**	**Partial Eta squared**	**Observed Power**	**Asymp. Sig.**	**Mann-Whitney U**
All Participants						
QA – opinion of computer	8.37 [¤]	0.01	0.13	0.81	0.01	428.00
QB - opinion of self	3.94 [¤¤]	0.05	0.07	0.50	0.31	524.50
QC - opinion of computer's feedback	9.24 [¤¤¤]	0.00	0.14	0.85	0.01	389.50
QD – opinion of own performance	1.16 [¤¤¤]	0.29	0.02	0.18	0.31	542.00
QAll – all questions	7.87 [¤¤]	0.01	0.13	0.79	0.4	432.50
Adults						
QA – opinion of computer	5.88 [£]	0.02	0.19	0.64	0.06	83.00
QB - opinion of self	6.48 [££]	0.02	0.21	0.69	0.21	94.50
QC - opinion of computer's feedback	7.34 [£]	0.01	0.23	0.74	0.01	68.00
QD – opinion of own performance	0.54 [££]	0.47	0.02	0.11	0.43	107.00
QAll – all questions	7.47 [££]	0.01	0.24	0.75	0.09	82.00
Children						
QA – opinion of computer	3.17 [§]	0.09	0.09	0.41	0.06	124.00
QB - opinion of self	0.10 [§§]	0.75	0.00	0.06	0.62	163.00
QC - opinion of computer's feedback	3.00 [§§]	0.09	0.09	0.39	0.08	120.00
QD – opinion of own performance	0.60 [§]	0.44	0.02	0.12	0.39	159.50
QAll – all questions	1.69 [§§]	0.20	0.05	0.24	0.09	121.00

[¤] df = (1, 70) [¤¤] df = (1, 68) [¤¤¤] df = (1, 69)
[£] df = (1, 31) [££] df = (1, 30)
[§] df = (1, 37) [§§] df = (1, 36)

Table 4.4: Effect of interaction between group and treatment (praise), significance across all participants

GROUP X TREATMENT	Parametric - Univariate			
Question Set	**F**	**p**	**Partial Eta squared**	**Observed Power**
QA – opinion of computer	0.09 [¤]	0.76	0.00	0.06
QB - opinion of self	2.37 [¤¤]	0.13	0.04	0.33
QC - opinion of computer's feedback	0.24 [¤¤¤]	0.63	0.00	0.08
QD – opinion of own performance	0.02 [¤¤¤]	0.88	0.00	0.05
QAll – all questions	0.98 [¤¤]	0.33	0.02	0.16

[¤] df = (1, 70) [¤¤] df = (1, 68) [¤¤¤] df = (1, 69)

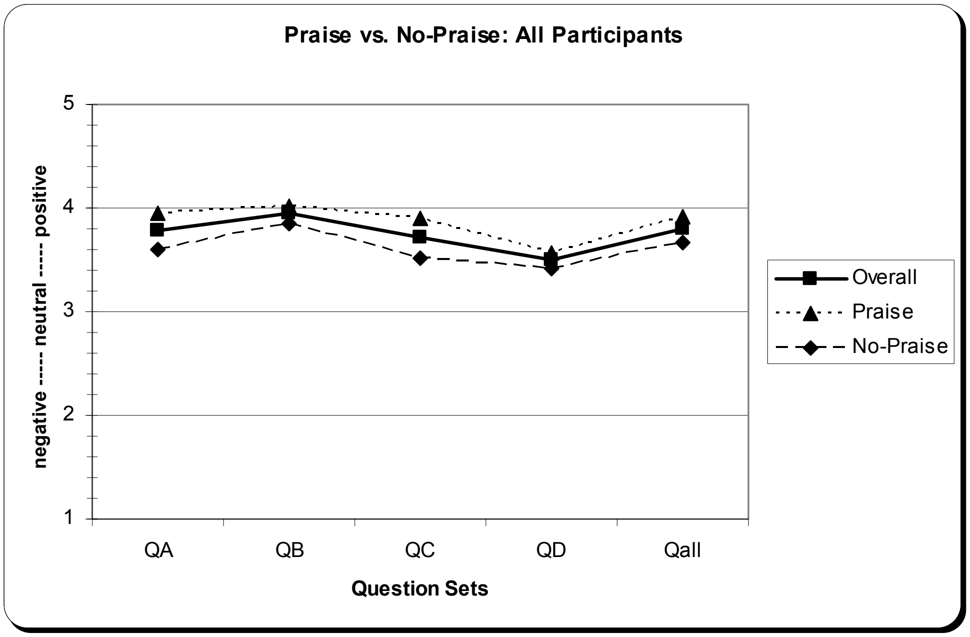

Figure 4.1: Effect of Praise, across all participants

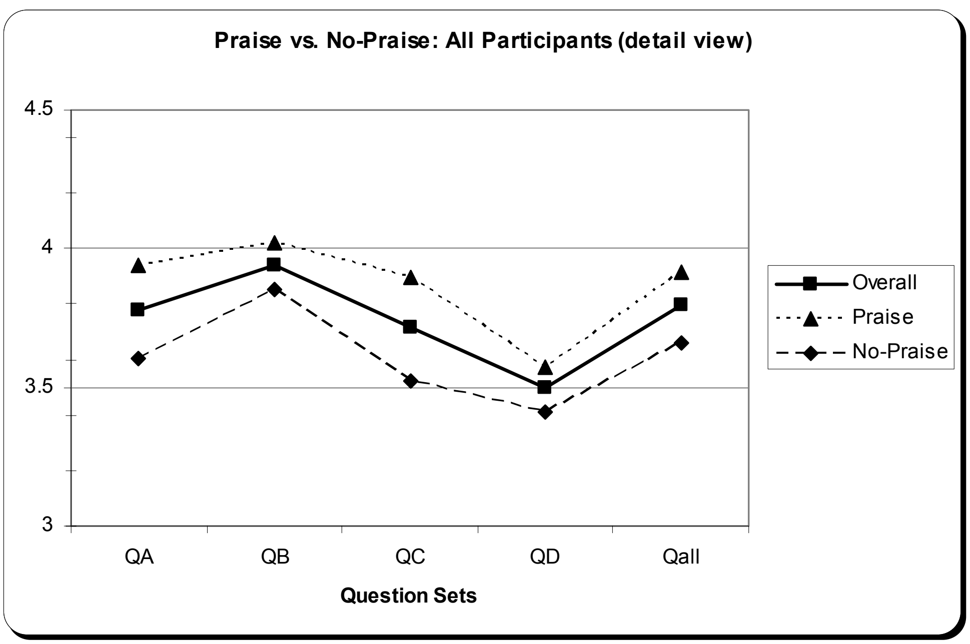

Figure 4.2: Effect of Praise, across all participants (detail view)

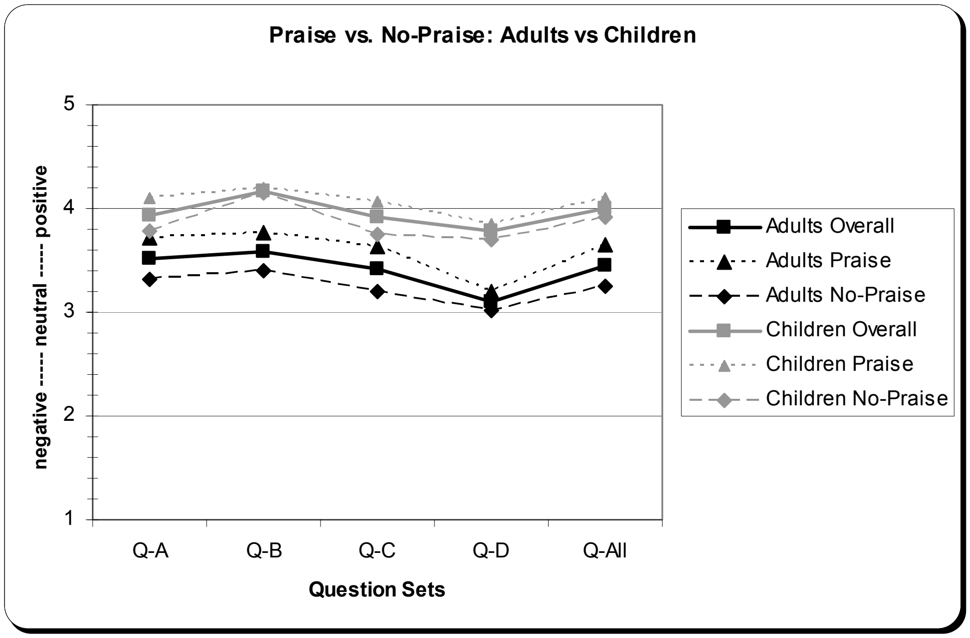

Figure 4.3: Effect of Praise, adults vs. children

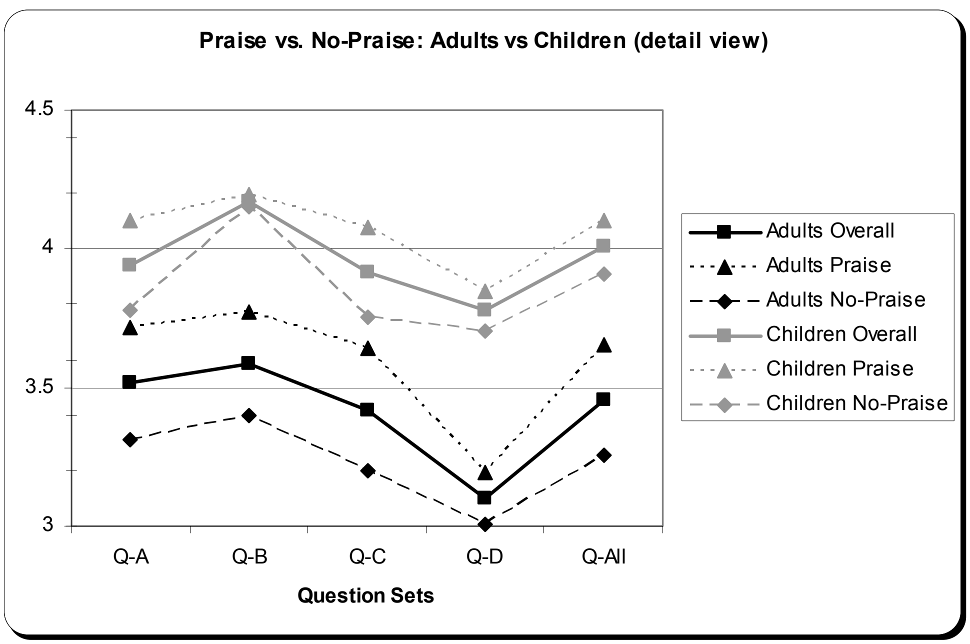

Figure 4.4: Effects of Praise, adults vs. children (detail view)

Despite large differences between the two groups (see Figure 4.4), further analysis revealed few significant results. When all participants were taken into consideration, there was an overall treatment effect but when broken down into adult and children groups, only the adults showed significant results (see Table 4.3). Since the differences between the two groups were so large, further analysis examines the two groups separately. Table 4.5 summarizes whether my results supported each of the earlier hypotheses. Details for each hypothesis are given in the following sections.

Table 4.5: Summary of hypotheses for Praise study

#	Hypotheses	All Participants	Children	Adults
1	Participants who receive praise will respond more positively than those who receive only neutral feedback	Yes	No	Yes
2	The effects of praise will be more pronounced for children than for adults.	No	-	-
3	Females will respond more strongly to praise than males.	No	No	No
4	The effects of praise will be more pronounced when participants interact with a handheld device than when they use a desktop computer.	No	No	No
5	When children are praised by the computer, they will believe that their own performance was better than when the computer says nothing about their work.	-	No	-
6	When children are praised by the computer, they will rate the computer more favourably than when the computer gives generic feedback.	-	No	-
7	When children are praised by the computer, they will feel more positively about themselves than when the computer says nothing about their work	-	No	-

4.2.1. Children in the Praise Study

Children were not affected by praise from the computer. They responded positively to all questions regardless of whether they received any praise from the computer. Children appeared confident in their abilities and happy to be using the computer even without being praised.

Hypothesis #1	Participants in the treatment condition will respond more positively to praise from the computer than those who receive only neutral feedback.

My results did not support this hypothesis when children received praise in the treatment condition. As shown in Figure 4.5 and Figure 4.6, only slight differences were visible, none of which were statistically significant. The corresponding numerical data is available in Table 4.2 and Table 4.3. Children did not react any differently to the computer when the computer praised them.

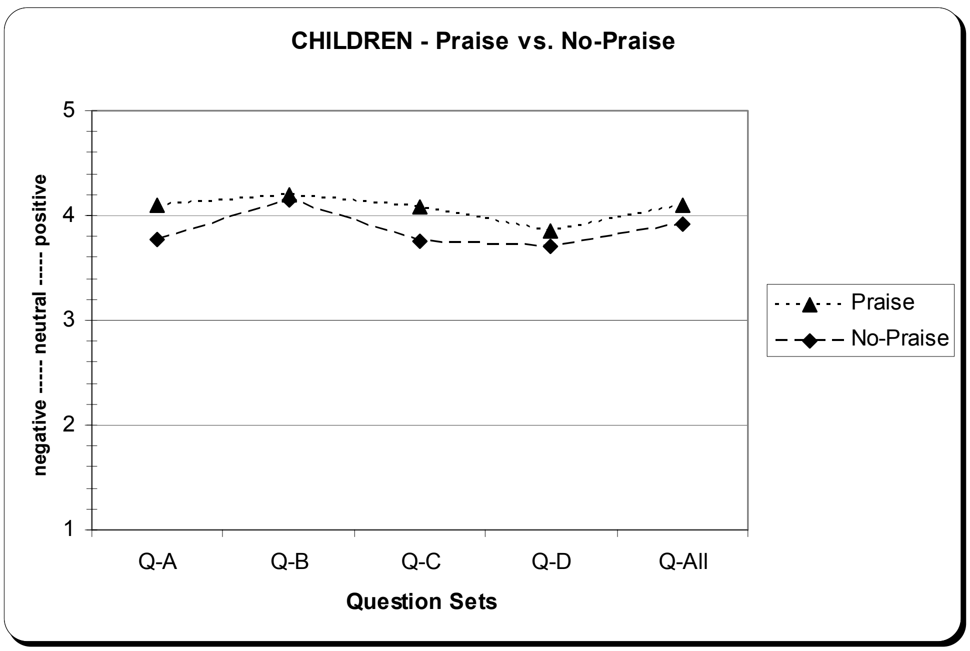

Figure 4.5: Effect of Praise, children

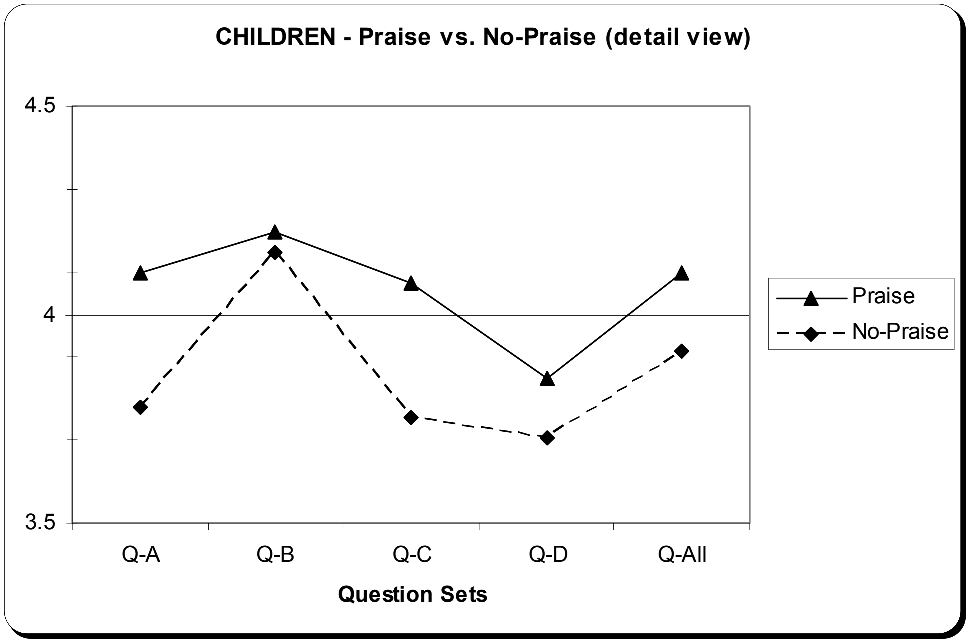

Figure 4.6: Effect of Praise, children (detail view)

Hypothesis #2	The effects of praise will be more pronounced for children than for adults.

Contrary to expectations, adults showed more differences between treatment and non-treatment conditions than children. However, children responded more positively than adults in all cases, regardless of whether they received praise. Hypothesis #2 was not supported by the results.

Hypothesis #3	Females will respond more strongly to praise than males.

Boys showed no differences in their responses when they received praise or neutral feedback. Girls did show slightly more positive responses when they were praised, but the results were not statistically significant. Table 4.6, Table 4.7, and Table 4.8 show the relevant analysis results, while Figure 4.7 and Figure 4.8 provide graphical representations of the means.

Table 4.6: Gender effect in Praise study, means for children

	QA			QB			QC			QD			QAll		
	mean	std dev	median	mean	std dev	median	mean	std dev	median	mean	std dev	median	mean	std dev	median
Females															
Overall	3.86	0.70	3.86	4.24	0.51	4.08	3.93	0.67	3.88	3.90	0.63	4.00	4.04	0.55	3.88
Praise	4.07	0.63	4.14	4.30	0.47	4.31	4.25	0.55	4.38	4.04	0.66	4.25	4.21	0.52	4.33
No-Praise	3.64	0.72	3.71	4.18	0.57	4.08	3.62	0.64	3.38	3.76	0.59	4.00	3.87	0.54	3.72
Males															
Overall	4.02	0.50	4.00	4.11	0.37	4.08	3.90	0.53	3.88	3.65	0.56	3.75	3.98	0.38	3.91
Praise	4.13	0.36	4.07	4.09	0.36	4.04	3.90	0.46	3.88	3.65	0.39	3.75	4.00	0.33	3.97
No-Praise	3.91	0.61	3.93	4.13	0.41	4.08	3.89	0.64	4.00	3.65	0.71	3.75	3.96	0.44	3.84

Table 4.7: Gender effect in Praise study, significance for children

GENDER	Parametric - Univariate				Non-Parametric	
Question Set	F	p	Partial Eta squared	Observed Power	Asymp. Sig.	Mann-Whitney U
QA – opinion of computer	0.84 ¤	0.37	0.03	0.14	0.54	168.50
QB - opinion of self	0.77 ¤¤	0.39	0.03	0.14	0.40	152.00
QC - opinion of computer's feedback	0.04 ¤¤	0.85	0.00	0.05	0.84	173.50
QD – opinion of own performance	1.96 ¤	0.17	0.06	0.27	0.13	137.00
QAll – all questions	0.17 ¤¤	0.68	0.01	0.07	0.58	161.50

¤ df = (1, 37) ¤¤ df = (1, 36)

Table 4.8: Effect of interaction between Gender and Treatment in Praise study, significance for children

GENDER X TREATMENT	Parametric - Univariate			
Question Set	F	p	Partial Eta squared	Observed Power
QA – opinion of computer	0.36 ¤	0.55	0.01	0.09
QB - opinion of self	0.29 ¤¤	0.59	0.01	0.08
QC - opinion of computer's feedback	2.89 ¤¤	0.10	0.09	0.38
QD – opinion of own performance	0.60 ¤	0.44	0.02	0.12
QAll – all questions	1.02 ¤¤	0.32	0.03	0.17

¤ df = (1, 37) ¤¤ df = (1, 36)

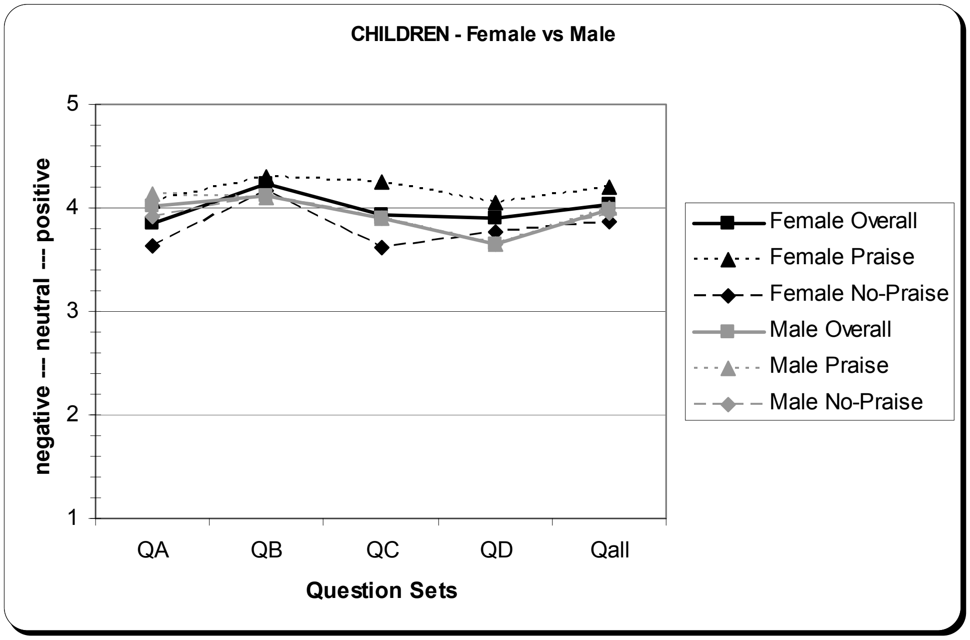

Figure 4.7: Gender effect for Praise study, children

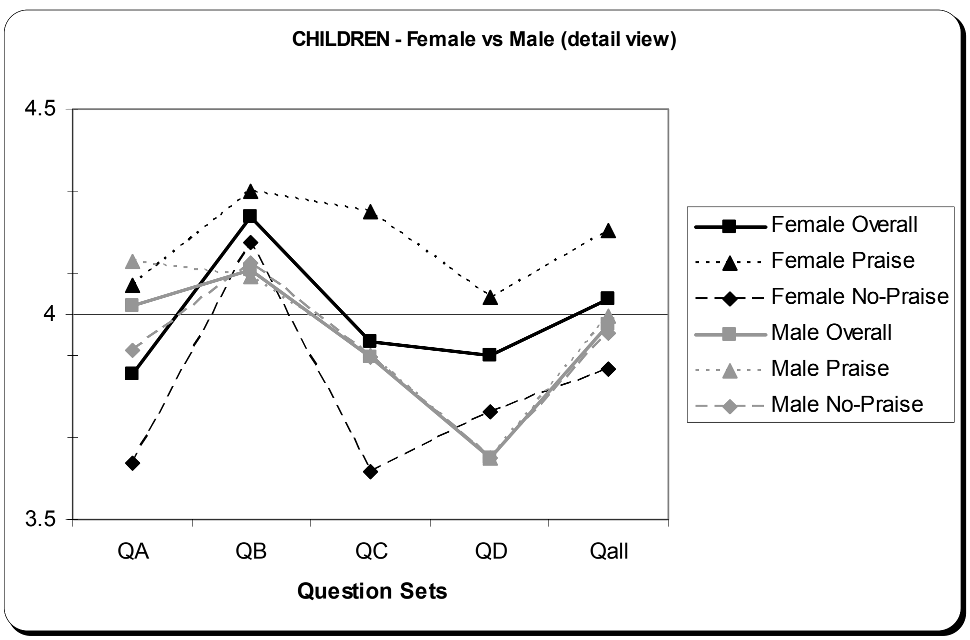

Figure 4.8: Gender effect for Praise study, children (detail view)

Hypothesis #4	The effects of praise will be more pronounced when participants interact with a handheld device than when they use a desktop computer.

As detailed in Table 4.9 through Table 4.11, children showed no difference in responses when they received praise or neutral feedback on a handheld computer. Children showed some differences when using a desktop computer, giving more positive responses when they were praised, but the results were not statistically significant. Figure 4.9 and Figure 4.10 show the means for handheld and desktop computers.

Table 4.9: Form factor effect for Praise study, means for children

	QA			QB			QC			QD			QAll		
	mean	**std dev**	**median**	**mean**	**std dev**	**median**	**mean**	**std dev**	**median**	**mean**	**std dev**	**median**	**mean**	**std dev**	**median**
Handheld															
Overall	3.95	0.43	3.86	4.10	0.41	4.08	3.85	0.48	3.88	3.66	0.57	3.75	3.95	0.39	3.88
Praise	4.01	0.36	4.00	4.02	0.18	4.08	3.86	0.37	3.88	3.79	0.38	3.75	3.95	0.20	3.88
No-Praise	3.89	0.49	3.79	4.19	0.53	3.96	3.84	0.59	3.81	3.53	0.70	3.38	3.95	0.51	3.72
Desktop															
Overall	3.93	0.74	4.00	4.24	0.49	4.31	3.98	0.69	4.00	3.90	0.61	4.00	4.06	0.54	4.03
Praise	4.19	0.60	4.29	4.37	0.51	4.54	4.29	0.57	4.50	3.90	0.70	4.00	4.25	0.54	4.53
No-Praise	3.67	0.83	3.71	4.12	0.44	4.15	3.67	0.71	3.63	3.89	0.53	4.00	3.87	0.47	3.88

Table 4.10: Form factor effect for Praise study, significance for children

FORM FACTOR	**Parametric - Univariate**				**Non-Parametric**	
Question Set	**F**	**p**	**Partial Eta squared**	**Observed Power**	**Asymp. Sig.**	**Mann-Whitney U**
QA – opinion of computer	0.01[¤]	0.93	0.00	0.05	0.60	171.50
QB - opinion of self	0.89[¤¤]	0.35	0.03	0.15	0.28	143.50
QC - opinion of computer's feedback	0.54[¤¤]	0.47	0.02	0.11	0.32	146.50
QD – opinion of own performance	1.77[¤]	0.19	0.05	0.25	0.11	133.00
QAll – all questions	0.01[¤¤]	0.93	0.00	0.05	0.32	146.50

¤ df = (1, 37) ¤¤ df = (1, 36)

Table 4.11: Effect of interaction between form factor and treatment, significance for children

FORM X TREATMENT	Parametric - Univariate			
Question Set	**F**	**p**	**Partial Eta squared**	**Observed Power**
QA – opinion of computer	1.24 ¤	0.28	0.04	0.19
QB - opinion of self	1.99 ¤¤	0.17	0.06	0.28
QC - opinion of computer's feedback	2.66 ¤¤	0.11	0.08	0.35
QD – opinion of own performance	0.47 ¤	0.50	0.02	0.10
QAll – all questions	1.72 ¤¤	0.20	0.05	0.25
¤ df = (1, 37) ¤¤ df = (1, 36)				

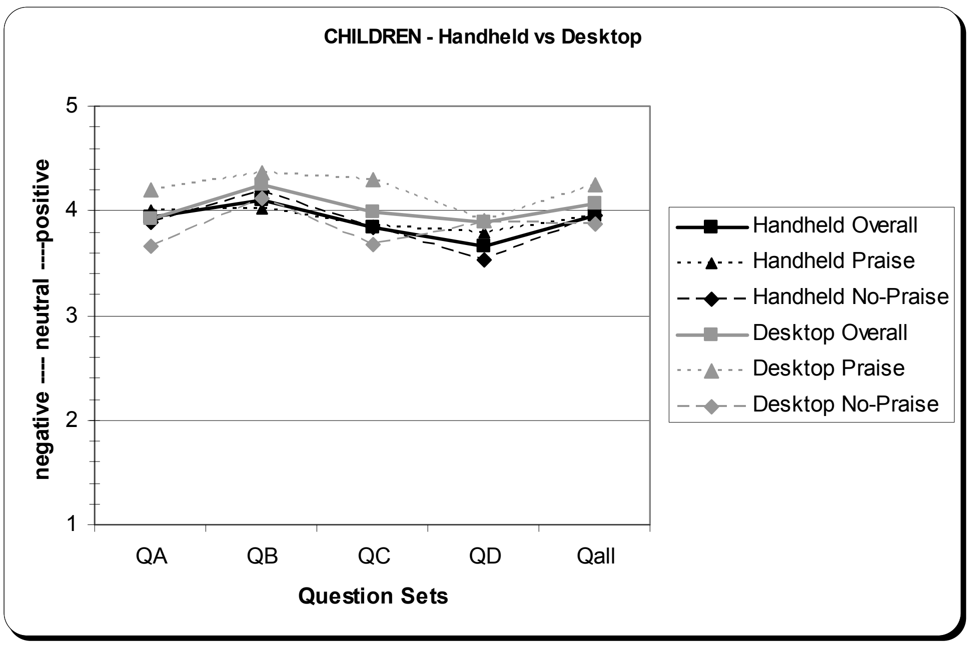

Figure 4.9: Form factor effect for Praise study, children

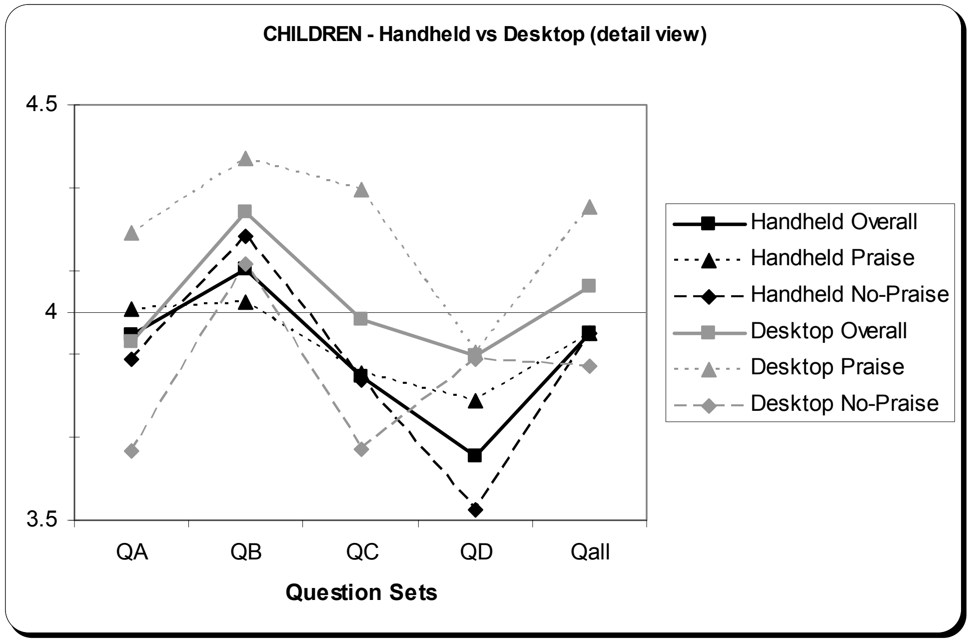

Figure 4.10: Form factor effect for Praise study, children (detail view)

Hypothesis #5	When children are praised by the computer, they will believe that their own performance was better than when the computer says nothing about their work.

While children did think their performance was slightly better when they were praised, the results are not statistically significant. It appears that praise from the computer had little impact on their perception of their own performance and abilities. The means are displayed in Figure 4.5 and Figure 4.6 (Question set QD), with accompanying numerical data provided in Table 4.2 and Table 4.3.

Hypothesis #6	When children are praised by the computer, they will rate the computer more favourably than when the computer gives generic feedback.

Children had a slightly higher opinion of the computer when the computer praised them, but the difference was not large enough to reach statistical significance. Figure 4.5 and Figure 4.6 (Question set QA) show the means, while numerical data is available in Table 4.2 and Table 4.3.

Hypothesis #7	When children are praised by the computer, they will feel more positively about themselves than when the computer says nothing about their work

Surprisingly, there was absolutely no difference in how children perceived themselves when they were praised. Praise from the computer had no effect on their current emotional state, as visible in Figure 4.5 and Figure 4.6 (Question set QB). The corresponding numerical data is provided in Table 4.2 and Table 4.3

4.2.2. Adults in the Praise Study

Adults were more affected by praise from the computer than children were. They had a higher opinion of the computer and of its feedback when praised. They also reported a more positive opinion of self when the computer praised them. These findings are consistent with those reported by Fogg and Nass (1997). In my study, adults did not, however, feel any differently about their own performance when praised, which is contrary to previous research findings. Table 4.2 and Table 4.3 display the relevant results from the analyses.

Hypothesis #1	Participants who receive praise will respond more positively than those who receive only neutral feedback

The results support this hypothesis. Adults did report more positive opinions of the computer (QA) and its feedback (QC) when the computer praised them. They also reported a more positive opinion of self (QB) in the treatment condition. They did not however, feel any differently about their own performance (QD) after being praised by the computer. Apparently, while praise from the computer made them happier, it did not affect their self-confidence. Figure 4.11 and Figure 4.12 show the means for the praise and no-praise conditions. It is based on data from Table 4.2 and Table 4.3.

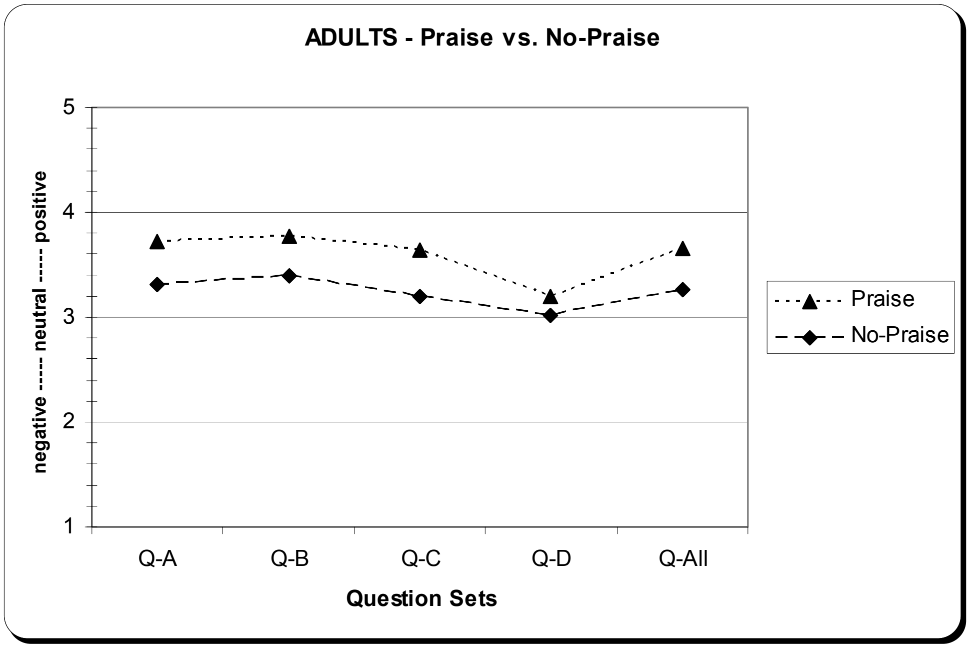

Figure 4.11: Effect of Praise, adults

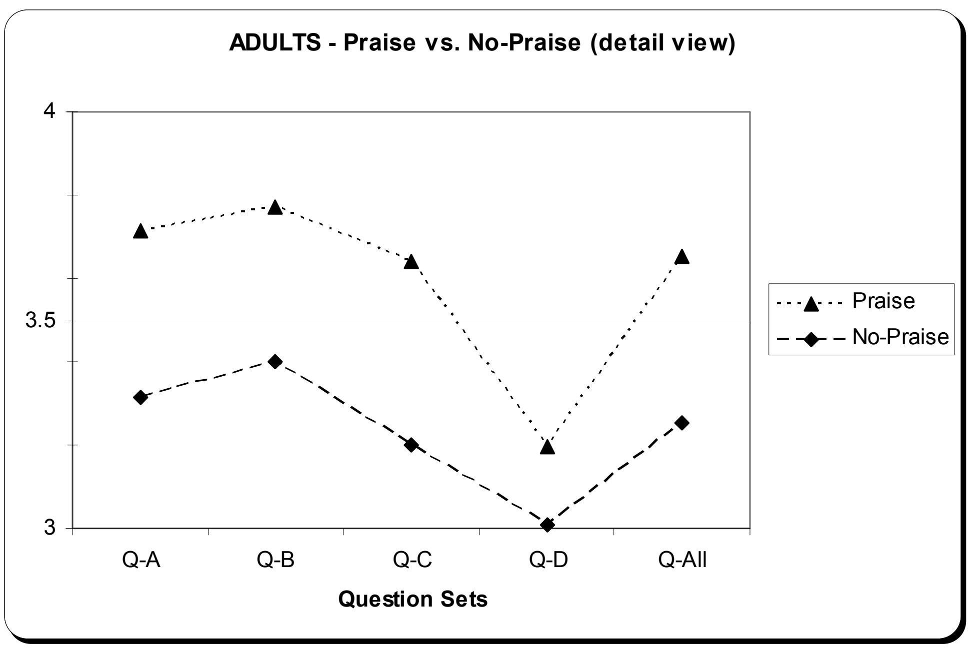

Figure 4.12: Effect of Praise, adults (detail view)

Hypothesis #2	The effects of praise will be more pronounced for children than for adults.

Since this was a relatively trivial task for adults to perform, I suspected that they might not take it seriously and therefore not be affected by praise from the computer. However, adults showed significantly more differences between the praise and no-praise conditions than children.

Hypothesis #3	Females will respond more strongly to praise than males.

While females generally responded more positively than males, no differences were found between how each gender reacted to praise. Males and females were equally affected by praise from the computer as evidenced in Table 4.12 through Table 4.14 as well as the corresponding charts in Figure 4.13 and Figure 4.14.

Table 4.12: Gender effect, means for adults

	QA			**QB**			**QC**			**QD**			**QAll**		
	mean	**std dev**	**median**	**mean**	**std dev**	**median**	**mean**	**std dev**	**median**	**mean**	**std dev**	**median**	**mean**	**std dev**	**median**
Females															
Overall	3.71	0.48	3.71	3.66	0.48	3.65	3.59	0.53	3.63	3.27	0.52	3.25	3.60	0.43	3.63
Praise	3.89	0.39	4.00	3.84	0.39	3.92	3.79	0.45	3.88	3.39	0.28	3.50	3.78	0.30	3.81
No-Praise	3.52	0.51	3.57	3.48	0.51	3.62	3.39	0.55	3.25	3.14	0.69	3.25	3.42	0.49	3.56
Males															
Overall	3.32	0.52	3.43	3.51	0.49	3.62	3.25	0.45	3.38	2.94	0.75	3.00	3.30	0.46	3.41
Praise	3.54	0.32	3.50	3.70	0.28	3.62	3.49	0.34	3.38	3.00	0.83	3.13	3.52	0.31	3.47
No-Praise	3.11	0.66	3.29	3.32	0.70	3.65	3.01	0.47	3.13	2.88	0.68	2.75	3.09	0.60	3.30

Table 4.13: Gender effect, significance for adults

GENDER	**Parametric - Univariate**				**Non-Parametric**	
Question Set	**F**	**p**	**Partial Eta squared**	**Observed Power**	**Asymp. Sig.**	**Mann-Whitney U**
QA – opinion of computer	5.40 ¤	0.03	0.18	0.61	0.05	82.00
QB - opinion of self	1.10 ¤¤	0.31	0.04	0.17	0.76	118.00
QC - opinion of computer's feedback	4.48 ¤	0.04	0.15	0.53	0.09	88.50
QD – opinion of own performance	1.71 ¤¤	0.20	0.07	0.24	0.14	87.50
QAll – all questions	4.23 ¤¤	0.05	0.15	0.51	0.14	87.00
¤ df = (1, 31) ¤¤ df = (1, 30)						

Table 4.14: Effect of the interaction between gender and treatment, significance for adults

GENDER X TREATMENT	Parametric - Univariate			
Question Set	F	p	Partial Eta squared	Observed Power
QA – opinion of computer	0.04 ¤	0.85	0.00	0.05
QB - opinion of self	0.00 ¤¤	0.96	0.00	0.05
QC - opinion of computer's feedback	0.06 ¤	0.81	0.00	0.06
QD – opinion of own performance	0.06 ¤¤	0.82	0.00	0.06
QAll – all questions	0.07 ¤¤	0.79	0.00	0.06
¤ df = (1, 31) ¤¤ df = (1, 30)				

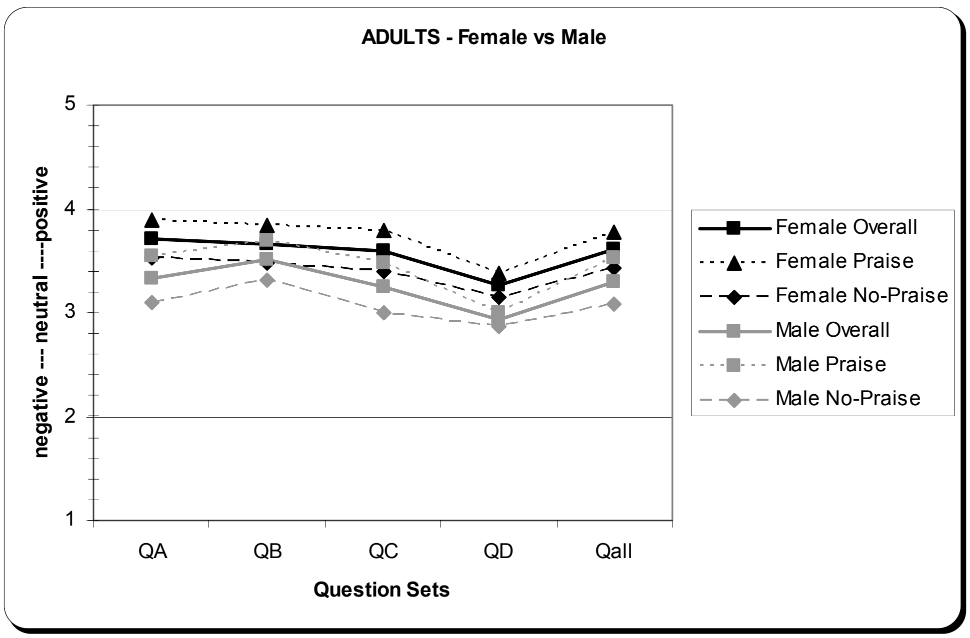

Figure 4.13: Gender effects for Praise study, adults

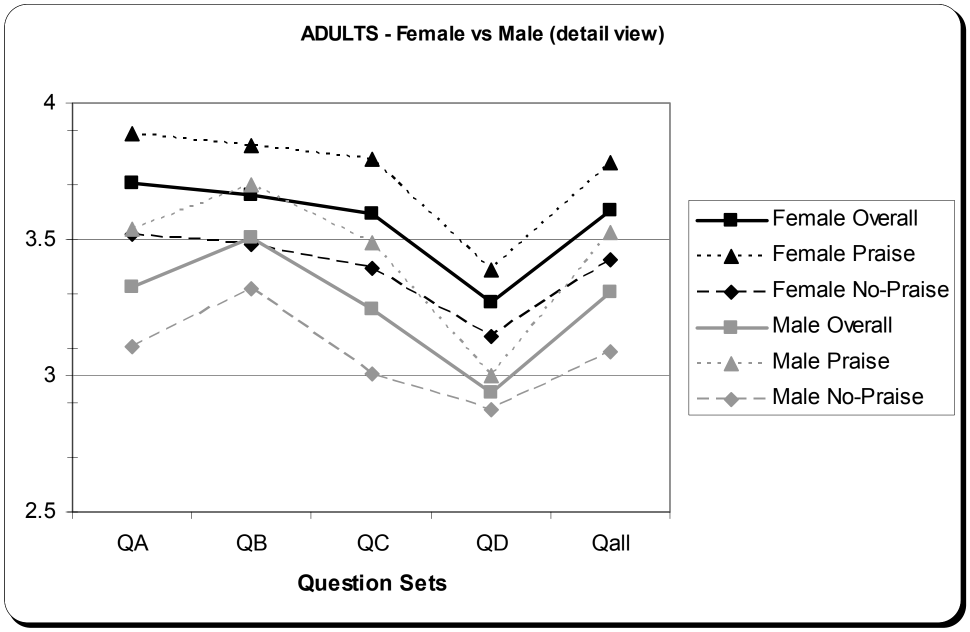

Figure 4.14: Gender effect for Praise study, adults (detail view)

Hypothesis #4	The effects of CASA will be more pronounced when participants interact with a handheld device than when they use a desktop computer.

Contrary to expectations, adults showed almost no difference between the praise and no-praise conditions while using a handheld computer. They did, however, show significantly more positive results in the praise condition when using a desktop computer, as shown in Figure 4.15 and Figure 4.16. They had a higher opinion of the computer and its feedback when being praised. They also reported a more positive opinion of self when the computer praised them. Table 4.15 through Table 4.17 provide the results of the analysis.

Table 4.15: Form factor effect for Praise study, means for adults

	QA			QB			QC			QD			QAll		
	mean	std dev	median	mean	std dev	median	mean	std dev	median	mean	std dev	median	mean	std dev	median
Handheld															
Overall	3.63	0.48	3.71	3.77	0.49	3.85	3.52	0.47	3.38	3.16	0.72	3.25	3.60	0.44	3.56
Praise	3.74	0.41	3.86	3.85	0.41	3.81	3.63	0.37	3.69	3.33	0.60	3.38	3.71	0.36	3.75
No-Praise	3.52	0.55	3.57	3.69	0.58	3.85	3.42	0.56	3.25	2.99	0.84	3.25	3.50	0.52	3.56
Desktop															
Overall	3.40	0.58	3.50	3.40	0.41	3.46	3.32	0.57	3.38	3.05	0.52	3.25	3.31	0.45	3.50
Praise	3.69	0.42	3.71	3.69	0.21	3.69	3.66	0.51	3.75	3.06	0.64	3.25	3.60	0.30	3.53
No-Praise	3.11	0.62	3.29	3.11	0.47	3.31	2.97	0.42	3.00	3.03	0.38	3.25	3.01	0.49	3.23

Table 4.16: Form factor effect for Praise study, significance for adults

FORM FACTOR	Parametric - Univariate				Non-Parametric	
Question Set	F	p	Partial Eta squared	Observed Power	Asymp. Sig.	Mann-Whitney U
QA – opinion of computer	2.06 ¤	0.16	0.08	0.28	0.30	104.50
QB - opinion of self	6.63 ¤¤	0.02	0.22	0.70	0.04	70.50
QC - opinion of computer's feedback	1.63 ¤	0.21	0.06	0.23	0.38	109.00
QD – opinion of own performance	0.19 ¤¤	0.67	0.01	0.07	0.64	111.50
QAll – all questions	4.14 ¤¤	0.05	0.15	0.50	0.20	90.00
¤ df = (1, 31) ¤¤ df = (1, 30)						

Table 4.17: Effect of interaction between form factor and treatment for Praise study, significance for adults

FORM X TREATMENT	Parametric – Univariate			
Question Set	F	p	Partial Eta squared	Observed Power
QA – opinion of computer	1.17 ¤	0.29	0.05	0.18
QB - opinion of self	2.03 ¤¤	0.17	0.08	0.28
QC - opinion of computer's feedback	2.15 ¤	0.16	0.08	0.29
QD – opinion of own performance	0.37 ¤¤	0.55	0.02	0.09
QAll – all questions	1.71 ¤¤	0.20	0.07	0.24
¤ df = (1, 31) ¤¤ df = (1, 30)				

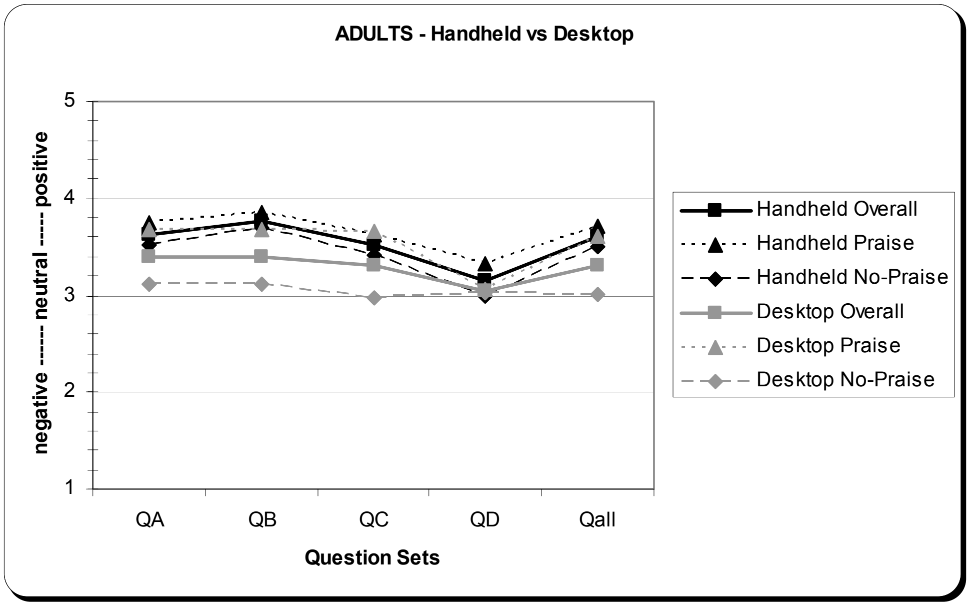

Figure 4.15: Form factor effect for Praise study, adults

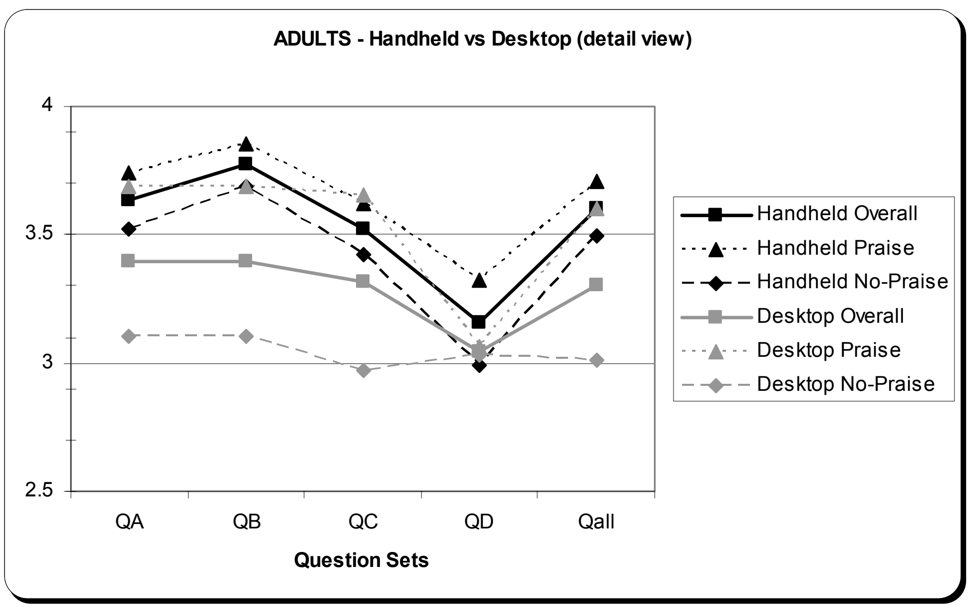

Figure 4.16: Form factor effect for Praise study, adults (detail view)

4.3. *Effects on Politeness*

Previous studies by Nass et al. (Nass, Moon, and Carney, 1999) indicate that adults will give more favourable answers on a questionnaire administered by the same computer they just interacted with than when that same questionnaire is answered on paper. I expected the same to occur when I replicated the experiment with adults. I also expected a stronger reaction when children completed the same task. The following sections provide a report of my results with adults and children participants. I also investigated whether gender or form factor had any influence on participants' responses and report those results as well.

As in the Praise study, data from the questionnaires was grouped into four question sets comprised of similar questions. Responses in each question set were averaged to produce a single question set score for each participant. The questions sets used in the Politeness study are summarized in Table 4.18. QAll represents an overall measure that includes every question on the questionnaire. The details of which questions are included in each set are available in section 3.3.8.

Table 4.18: Question sets for Politeness study

Question Set	Description
QA	Their opinion of the computer
QB	Their opinion of self
QC	Their opinion of the tutorial session
QD	Their opinion of the scoring session
QAll	All questions in the questionnaire

Responses to the questions were converted to a scale of 1 to 5, with five being most positive. Table 4.19 displays the means, standard deviation, and median values for each question set. The Polite rows indicate the cases where participants answered the questionnaire on the same computer and therefore should be giving more polite responses. The Non-polite rows represent the cases where participants responded to the questionnaire on paper. The Overall rows take into account all participants in that particular group, regardless of condition. The corresponding parametric and non-parametric analysis results are given in Table 4.20. Analysis of the interaction between participant group (children vs. adults) and treatment (polite vs. non-polite) is shown in Table 4.21. The means from Table 4.19 have been graphed to give a clearer representation of the results; these graphs are available in Figure 4.17 through Figure 4.20.

As can be seen in Figure 4.19 and Figure 4.20, adults and children responded quite differently from each other. Children gave much more positive answers than adults, regardless of whether they were in the polite or non-polite condition. Again, the difference is approximately 0.5 on a scale of 1 to 5 between the two groups.

Table 4.19: Effect of politeness, means

	QA			QB			QC			QD			QAll		
	mean	**std dev**	**median**	**mean**	**std dev**	**median**	**mean**	**std dev**	**median**	**mean**	**std dev**	**median**	**mean**	**std dev**	**median**
All Participants															
Overall	4.04	0.52	4.00	3.90	0.50	3.89	3.84	0.52	3.86	3.87	0.51	3.88	3.89	0.44	3.87
Polite	4.20	0.49	4.14	3.94	0.51	3.89	3.88	0.45	3.86	3.88	0.53	4.00	3.94	0.41	3.87
Non-polite	3.86	0.51	4.00	3.86	0.50	3.83	3.81	0.58	3.86	3.85	0.49	3.88	3.84	0.46	3.87
Adults															
Overall	3.77	0.42	3.86	3.64	0.36	3.67	3.71	0.42	3.86	3.61	0.47	3.75	3.68	0.32	3.74
Polite	3.86	0.37	3.86	3.67	0.35	3.67	3.71	0.41	3.71	3.61	0.47	3.75	3.70	0.24	3.81
Non-polite	3.68	0.46	3.79	3.61	0.38	3.67	3.71	0.45	3.86	3.62	0.50	3.75	3.65	0.40	3.69
Children															
Overall	4.27	0.49	4.14	4.14	0.50	4.00	3.97	0.57	4.00	4.12	0.41	4.00	4.10	0.44	4.06
Polite	4.49	0.37	4.57	4.19	0.51	4.11	4.05	0.42	4.14	4.17	0.45	4.00	4.19	0.40	4.11
Non-polite	4.03	0.50	4.00	4.09	0.50	4.00	3.90	0.68	3.93	4.07	0.38	4.00	4.02	0.46	3.94

Table 4.20: Effect of politeness, significance

TREATMENT (POLITENESS)	Parametric - Univariate				Non-Parametric	
Question Set	**F**	**p**	**Partial Eta squared**	**Observed Power**	**Asymp. Sig.**	**Mann-Whitney U**
All Participants						
QA – opinion of computer	9.00 [¤]	0.00	0.14	0.84	0.01	386.00
QB – opinion of self	0.43 [¤]	0.52	0.01	0.10	0.66	575.00
QC – opinion of tutorial	0.79 [¤¤]	0.38	0.02	0.14	0.65	541.50
QD – opinion of scoring	0.15 [¤¤¤]	0.70	0.00	0.07	0.59	502.50
QAll – all questions	1.62 [¤¤¤]	0.21	0.03	0.24	0.50	491.50
Adults						
QA – opinion of computer	1.38 [£]	0.25	0.05	0.20	0.40	113.00
QB – opinion of self	0.06 [£]	0.82	0.00	0.06	0.81	129.50
QC – opinion of tutorial	0.03 [£]	0.87	0.00	0.05	0.87	131.50
QD – opinion of scoring	0.01 [£]	0.92	0.00	0.05	0.94	134.00
QAll – all questions	0.18 [£]	0.68	0.01	0.07	0.96	134.50
Children						
QA – opinion of computer	9.89 [§]	0.00	0.25	0.86	0.00	76.00
QB – opinion of self	0.47 [§]	0.50	0.02	0.10	0.57	152.50
QC – opinion of tutorial	1.08 [§§]	0.31	0.04	0.17	0.50	132.50
QD – opinion of scoring	0.56 [§§§]	0.46	0.02	0.11	0.24	104.00
QAll- all questions	1.65 [§§§]	0.21	0.06	0.23	0.22	102.00

[¤] df = (1, 68) [¤¤] df = (1, 66) [¤¤¤] df = (1, 64)
[£] df = (1, 31)
[§] df = (1, 35) [§§] df = (1, 33) [§§§] df = (1, 31)

Table 4.21: Effect of interaction between group and treatment (politeness) significance across all participants

GROUP X TREATMENT	Parametric - Univariate			
Question Set	**F**	**p**	**Partial Eta squared**	**Observed Power**
QA – opinion of computer	1.69 [¤]	0.20	0.03	0.25
QB – opinion of self	0.13 [¤]	0.73	0.00	0.06
QC – opinion of tutorial	0.47 [¤¤]	0.50	0.01	0.10
QD – opinion of scoring	0.31 [¤¤¤]	0.58	0.01	0.08
QAll- all questions	0.57 [¤¤¤]	0.45	0.01	0.11

[¤] df = (1, 68) [¤¤] df = (1, 66) [¤¤¤] df = (1, 64)

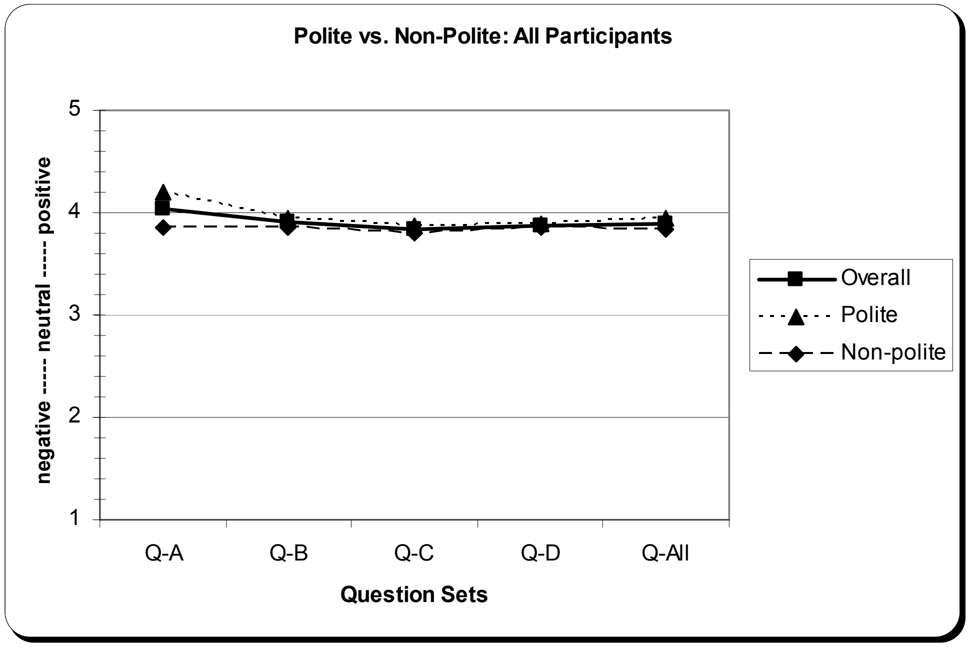

Figure 4.17: Effect of Politeness, across all participants

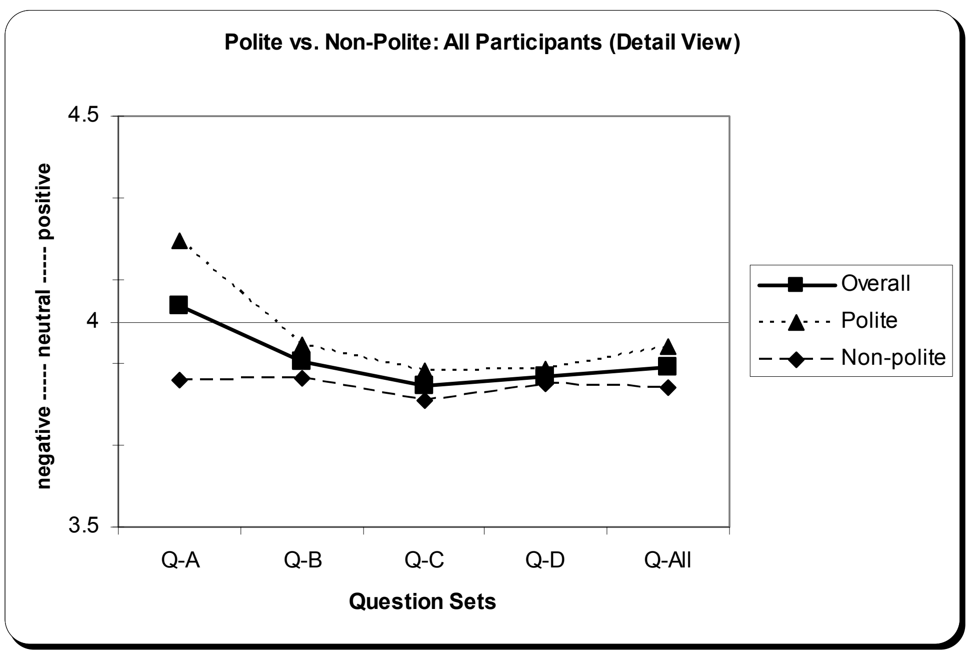

Figure 4.18: Effect of Politeness, across all participants (detail view)

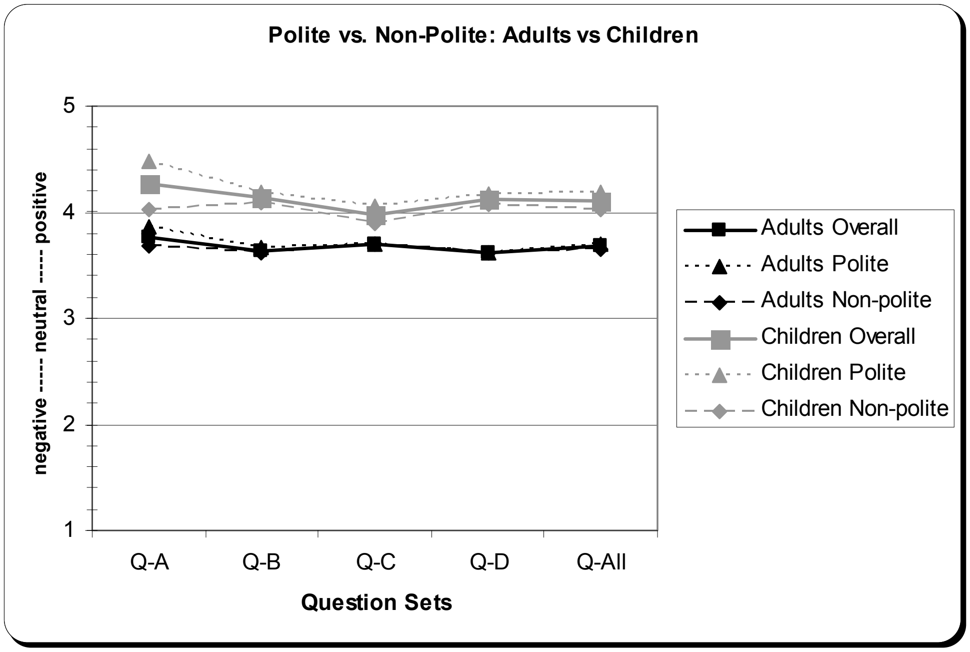

Figure 4.19: Effect of Politeness, adults vs. children

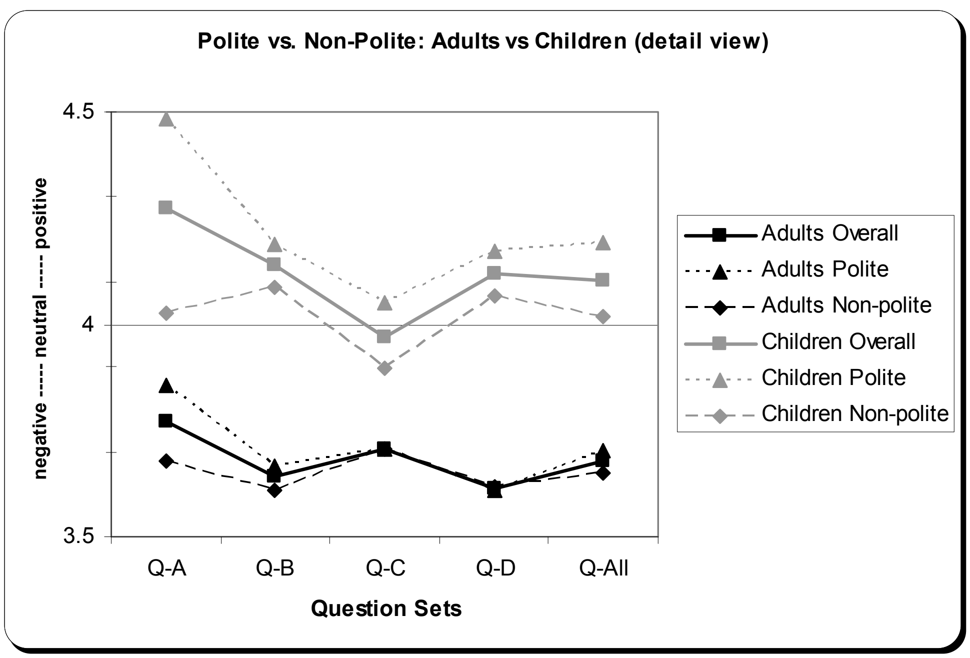

Figure 4.20: Effect of Politeness, adults vs. children (detail view)

Contrary to previous studies, I found few differences in how participants responded to the computer versus how they responded on a paper questionnaire. Other than the overall difference between adults and children, where children responded more positively regardless of any condition, there are virtually no differences between the various conditions tested. Table 4.22 summarizes the hypotheses and whether they were supported by the results. Details for each hypothesis are reported in the following sections.

Table 4.22: Summary of hypotheses for Politeness study

#	Hypotheses	All Participants	Children	Adults
1	Participants who answer the questionnaire on the same computer that provided the tutorial will respond more positively than those who respond on the paper questionnaire.	No	No	No
2	Children will be more polite to the computer than adults.	No	-	-
3	Females will be more polite to the computer than males.	-	No	No
4	Participants will be more polite when the computer is a handheld device than when it is a desktop computer.	-	No	No
5	When the computer asks about its own performance, children will give more positive responses than when they answer the same questions on a paper questionnaire.	-	Yes	No
6	When the computer asks about the children's experience, children will give more positive responses than when they answer the same questions on a paper questionnaire.	-	No	No

4.3.1. Children in the Politeness Study

Children generally rated the computer and their own experience positively regardless of where they answered the follow-up questionnaire. They did not appear to be significantly more polite in any one condition.

Hypothesis #1	Participants who answer the questionnaire on the same computer that provided the tutorial will respond more positively than those who respond on the paper questionnaire.

Children showed marginally more favourable responses when completing the questionnaire on the same computer, but the results were not statistically significant so the data does not support this hypothesis. The only question set that showed a significant result was the set evaluating their opinion of the computer. Children rated the computer more favourably when they responded on the same computer than when they responded on paper. The corresponding numerical data is provided in Table 4.19 and Table 4.20, with graphical representations available in Figure 4.21 and Figure 4.22.

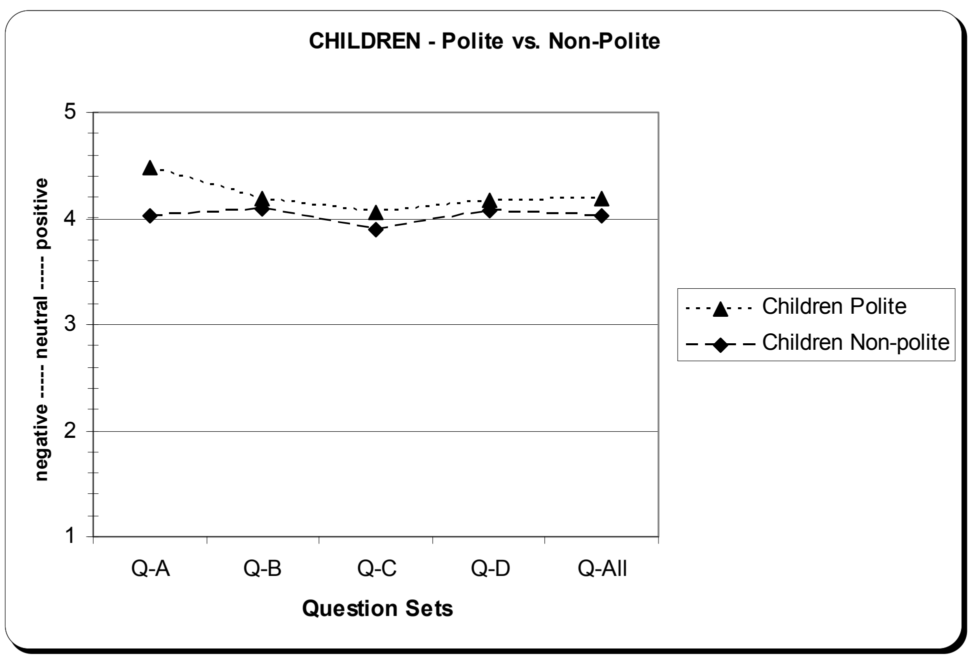

Figure 4.21: Effect of Politeness, children

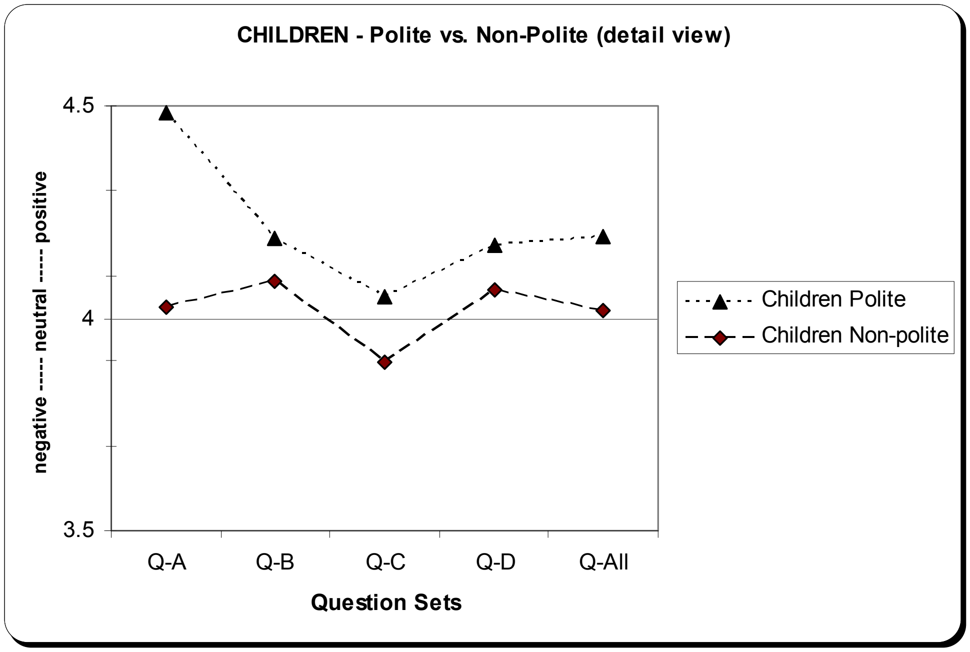

Figure 4.22: Effect of Politeness, children (detail view)

Hypothesis #2	Children will be more polite to the computer than adults.

While adults showed absolutely no differences in the polite and non-polite conditions on three out of four question sets, children did show differences for each question set. These differences however, were not statistically significant except for question set QA (opinion of the computer). These differences can be viewed in Figure 4.19 and Figure 4.20.

Hypothesis #3	Females will be more polite to the computer than males.

Girls did give more positive responses when responding on the same computer, but the results were not statistically significant. Boys, on the other hand, showed almost no differences between the polite and non-polite conditions. Table 4.23 through Table 4.25 provide the relevant analysis results, while Figure 4.23 and Figure 4.24 give graphical representations of the means for boys and girls.

Table 4.23: Gender effect in Politeness study, means for children

	QA			QB			QC			QD			QAll		
	mean	std dev	median	mean	std dev	median	mean	std dev	median	mean	std dev	median	mean	std dev	median
Females															
Overall	4.36	0.49	4.29	4.26	0.57	4.33	4.03	0.56	4.07	4.26	0.45	4.00	4.20	0.49	4.06
Polite	4.61	0.33	4.71	4.43	0.50	4.44	4.22	0.41	4.29	4.33	0.52	4.06	4.39	0.46	4.32
Non-polite	4.08	0.51	4.00	4.09	0.60	4.00	3.87	0.63	3.86	4.21	0.41	4.00	4.07	0.50	4.00
Males															
Overall	4.18	0.48	4.14	4.02	0.41	4.00	3.92	0.59	4.00	4.00	0.35	4.00	4.03	0.38	4.00
Polite	4.36	0.39	4.29	3.97	0.43	3.94	3.93	0.40	3.93	4.08	0.40	4.00	4.07	0.33	4.06
Non-polite	3.96	0.53	3.93	4.09	0.41	4.00	3.92	0.77	4.00	3.91	0.29	3.88	3.96	0.44	3.84

Table 4.24: Gender effect in Politeness study, significance for children

GENDER	Parametric - Univariate				Non-Parametric	
Question Set	**F**	**p**	**Partial Eta squared**	**Observed Power**	**Asymp. Sig.**	**Mann-Whitney U**
QA – opinion of computer	1.72 ¤	0.20	0.06	0.24	0.34	139.50
QB – opinion of self	2.45 ¤	0.13	0.08	0.33	0.11	118.00
QC – opinion of tutorial	0.71 ¤¤	0.41	0.03	0.13	0.68	139.50
QD – opinion of scoring	2.71 ¤¤¤	0.11	0.10	0.35	0.13	93.50
QAll – all questions	1.77 ¤¤¤	0.20	0.07	0.25	0.25	103.50
¤ df = (1, 35) ¤¤ df = (1, 33) ¤¤¤ df = (1, 31)						

Table 4.25: Effect of interaction between Gender and Treatment in Politeness study, significance for children

GENDER X TREATMENT	Parametric - Univariate			
Question Set	**F**	**p**	**Partial Eta squared**	**Observed Power**
QA – opinion of computer	0.21 ¤	0.65	0.01	0.07
QB – opinion of self	1.61 ¤	0.21	0.05	0.23
QC – opinion of tutorial	0.47 ¤¤	0.50	0.02	0.10
QD – opinion of scoring	0.14 ¤¤¤	0.71	0.01	0.07
QAll – all questions	0.33 ¤¤¤	0.57	0.01	0.09
¤ df = (1, 68) ¤¤ df = (1, 66) ¤¤¤ df = (1, 64)				

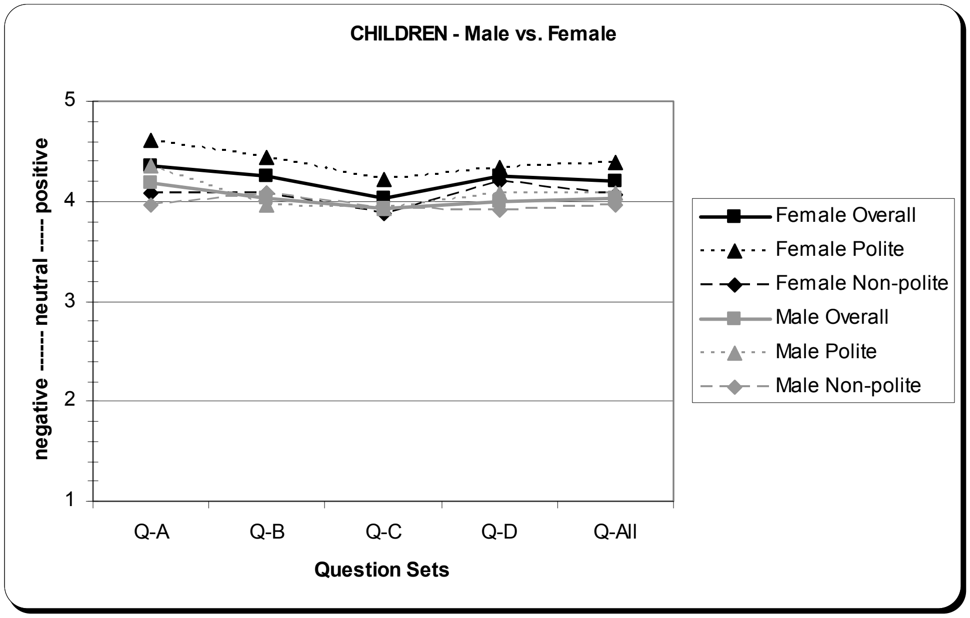

Figure 4.23: Gender effect for Politeness study, children

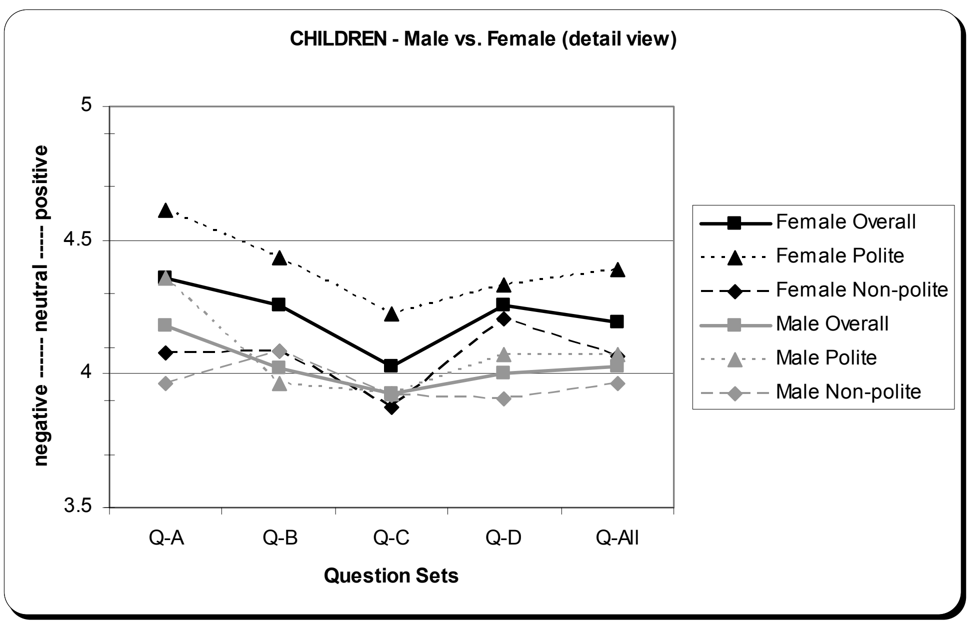

Figure 4.24: Gender effect for Politeness study, children (detail view)

Hypothesis #4	Participants will be more polite when the computer is a handheld device than when it is a desktop computer.

Contrary to my prediction, children showed very little difference in how they responded in the polite and non-polite conditions when they used a handheld computer. When using a desktop computer, children showed slightly more differences between the polite and non-polite conditions, but the results were not statistically significant. Table 4.26 through Table 4.28 provide the numerical results of the analysis. Figure 4.25 and Figure 4.26 give a graphical representation of the means.

Table 4.26: Form factor effect for Politeness study, means for children

	QA			QB			QC			QD			QAll		
	mean	**std dev**	**median**	**mean**	**std dev**	**median**	**mean**	**std dev**	**median**	**mean**	**std dev**	**median**	**mean**	**std dev**	**median**
Handheld															
Overall	4.34	0.44	4.21	4.18	0.53	4.11	4.15	0.49	4.21	4.15	0.46	4.00	4.20	0.44	4.10
Polite	4.46	0.39	4.29	4.06	0.65	3.78	4.06	0.54	4.14	4.18	0.57	4.00	4.19	0.52	3.97
Non-polite	4.20	0.48	4.07	4.30	0.37	4.33	4.24	0.44	4.29	4.11	0.34	4.00	4.22	0.35	4.11
Desktop															
Overall	4.21	0.54	4.00	4.10	0.48	4.00	3.78	0.60	3.86	4.12	0.41	4.00	4.00	0.42	3.94
Polite	4.51	0.38	4.64	4.30	0.34	4.33	4.04	0.26	4.07	4.16	0.28	4.00	4.20	0.21	4.16
Non-polite	3.87	0.50	3.86	3.88	0.54	3.78	3.56	0.73	3.43	4.03	0.43	3.88	3.84	0.49	3.81

Table 4.27: Form factor effect for Politeness study, significance for children

FORM FACTOR	Parametric - Univariate				Non-Parametric	
Question Set	**F**	**p**	**Partial Eta squared**	**Observed Power**	**Asymp. Sig.**	**Mann-Whitney U**
QA – opinion of computer	1.37 ¤	0.25	0.05	0.20	0.23	103.00
QB – opinion of self	0.94 ¤	0.34	0.03	0.15	0.30	137.00
QC – opinion of tutorial	0.44 ¤¤	0.51	0.02	0.10	0.73	159.50
QD – opinion of scoring	3.95 ¤¤¤	0.06	0.13	0.48	0.06	96.50
QAll – all questions	0.37 ¤¤¤	0.55	0.01	0.09	0.81	129.50
¤ df = (1, 68) ¤¤ df = (1, 66) ¤¤¤ df = (1, 64)						

Table 4.28: Effect of interaction between form factor and treatment, significance for children

FORM X TREATMENT	Parametric - Univariate			
Question Set	**F**	**p**	**Partial Eta squared**	**Observed Power**
QA – opinion of computer	0.33 ¤	0.57	0.01	0.09
QB – opinion of self	0.21 ¤	0.65	0.01	0.07
QC – opinion of tutorial	1.61 ¤¤	0.21	0.05	0.23
QD – opinion of scoring	0.47 ¤¤¤	0.50	0.02	0.10
QAll – all questions	0.14 ¤¤¤	0.71	0.01	0.07
¤ df = (1, 68) ¤¤ df = (1, 66) ¤¤¤ df = (1, 64)				

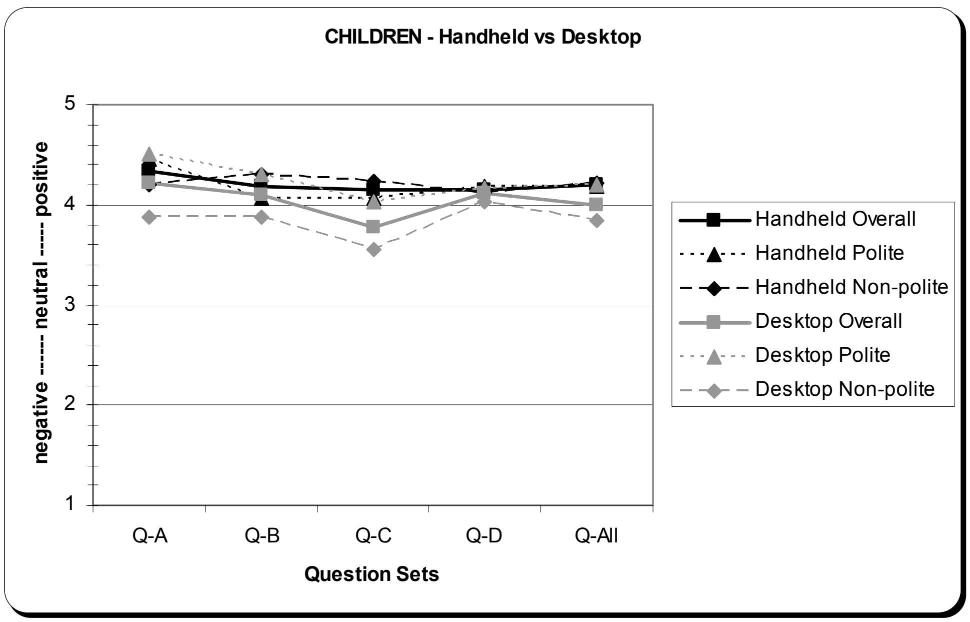

Figure 4.25: Form factor effect for Politeness study, children

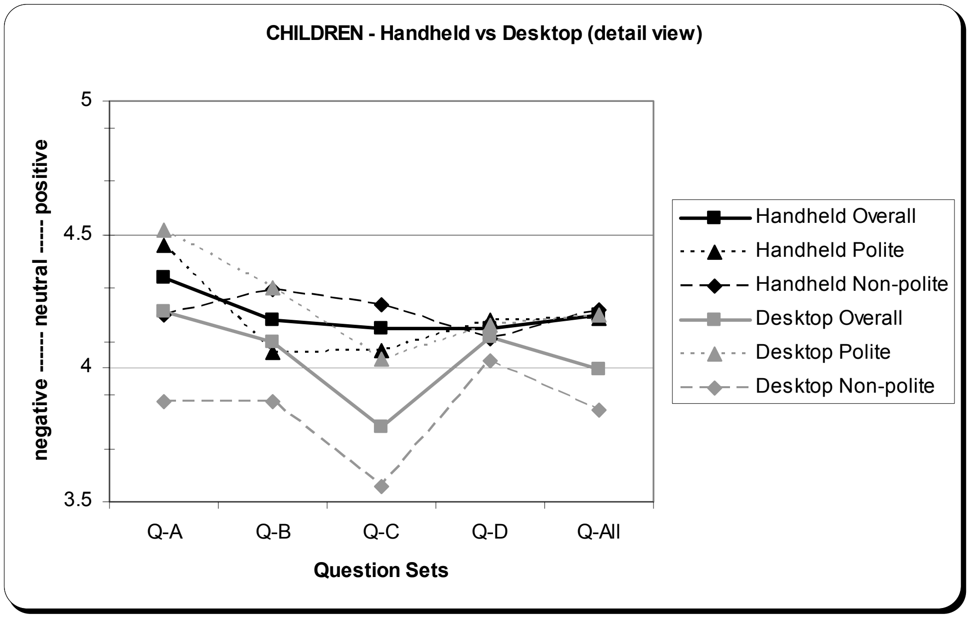

Figure 4.26: Form factor effect for Politeness study, children (detail view)

Hypothesis #6	When the computer asks about its own performance, children will give more positive responses than when they answer the same questions on a paper questionnaire.

As evidenced in Table 4.19 and Table 4.20, as well as Figure 4.21 and Figure 4.22 (examining question set QA), children did give significantly more positive evaluations of the computer when they answered the questions on the same computer that gave them the tutorial as compared to when they moved away and answered the same questions on a paper questionnaire. This is the only question set that showed statistically significant results for children.

Hypothesis #7	When the computer asks about the children's experience, children will give more positive responses on the computer than when they answer the same questions on a paper questionnaire.

Children generally gave a positive evaluation of their own experience; however they did not give any more positive responses when the computer administered the questionnaire than when the questionnaire was given on paper. Question set QB in

Table 4.19 and Table 4.20 show the results of analysis. Figure 4.21 and Figure 4.22 provide graphical representation of the means.

4.3.2. Adults (Politeness Study)

Adults showed virtually no differences in their responses in the polite or non-polite conditions. They also did not display any significant gender or form factor differences. Results for each hypothesis are presented in the following pages.

Hypothesis #1	Participants who answer the questionnaire on the same computer that provided the tutorial will respond more positively than those who respond on the paper questionnaire.

Contrary to Nass et al.'s (Nass, Moon, and Carney, 1999) findings, adults in my study responded in the same manner regardless of whether they answered the follow-up questionnaire on the same computer or on paper. As can be seen in Figure 4.27 and Figure 4.28, only adults' opinion of the computer varied slightly (QA), but it was not statistically significant. The results of analysis can be found in Table 4.19 and Table 4.20.

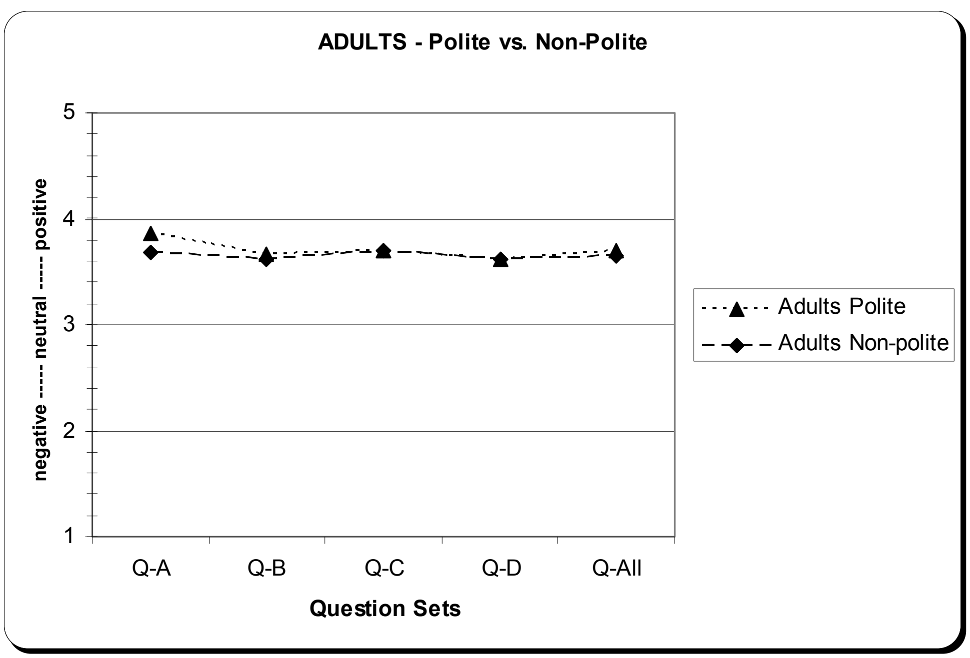

Figure 4.27: Effect of Politeness, adults

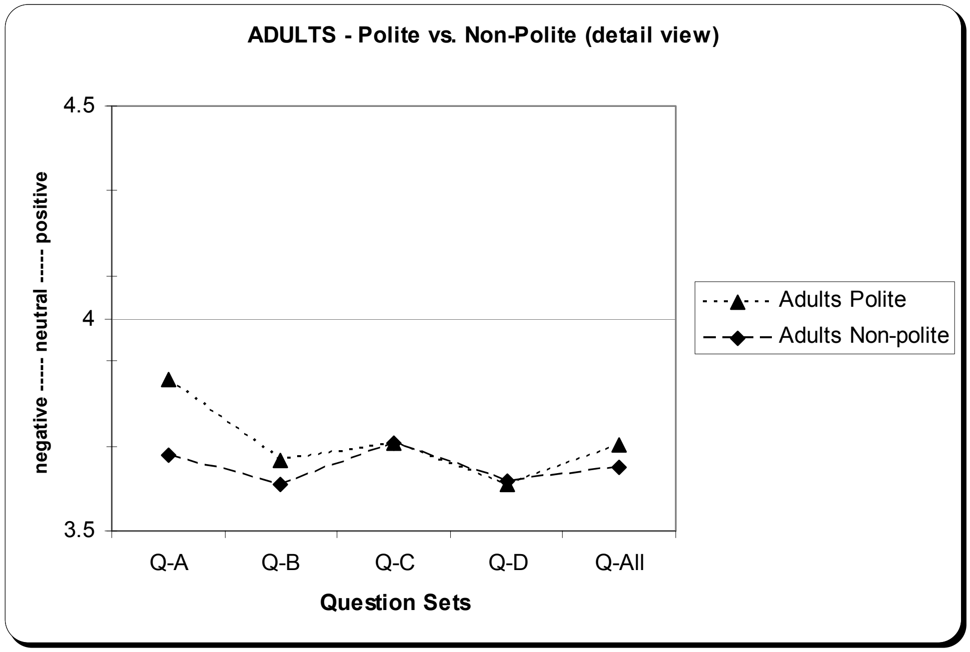

Figure 4.28: Effect of Politeness, adults (detail view)

Hypothesis #2	Children will be more polite to the computer than adults.

Children responded more positively than adults in all cases, regardless of whether they were in the polite or non-polite conditions. When comparing within groups however, few differences were apparent.

Hypothesis #3	Females will be more polite to the computer than males.

Table 4.29 through Table 4.31 provide the results of analysis for any gender differences in how adult participants responded. Graphical representations of the means are available in Figure 4.29 and Figure 4.30. Although not statistically significant, females responded more positively than men overall. Surprisingly, it was men who showed more differences between the polite and non-polite conditions, but these results were not statistically significant either.

Table 4.29: Gender effect in Politeness study, means for adults

	QA			QB			QC			QD			QAll		
	mean	std dev	median	mean	std dev	median	mean	std dev	median	mean	std dev	median	mean	std dev	median
Female															
Overall	3.87	0.41	3.93	3.68	0.35	3.61	3.74	0.44	3.79	3.66	0.52	3.75	3.73	0.32	3.81
Polite	3.90	0.43	3.86	3.67	0.38	3.56	3.60	0.50	3.71	3.57	0.55	3.63	3.68	0.29	3.81
Non-polite	3.83	0.42	4.00	3.69	0.34	3.67	3.87	0.35	3.86	3.75	0.50	3.88	3.78	0.36	3.87
Male															
Overall	3.66	0.41	3.71	3.59	0.38	3.67	3.67	0.41	3.86	3.56	0.43	3.75	3.62	0.32	3.58
Polite	3.80	0.32	3.79	3.67	0.34	3.72	3.82	0.27	3.86	3.66	0.39	3.81	3.73	0.19	3.71
Non-polite	3.49	0.46	3.57	3.51	0.44	3.67	3.49	0.49	3.71	3.45	0.47	3.38	3.48	0.40	3.42

Table 4.30: Gender effect in Politeness study, significance for adults

GENDER	Parametric - Univariate				Non-Parametric	
Question Set	F	p	Partial Eta squared	Observed Power	Asymp. Sig.	Mann-Whitney U
QA – opinion of computer	1.80 ¤	0.19	0.07	0.25	0.27	104.50
QB – opinion of self	0.19 ¤	0.66	0.01	0.07	0.74	126.00
QC – opinion of tutorial	0.07 ¤	0.80	0.00	0.06	0.69	124.00
QD – opinion of scoring	0.17 ¤	0.69	0.01	0.07	0.47	115.00
QAll – all questions	0.60 ¤	0.45	0.02	0.12	0.29	105.50
¤ df = (1, 31)						

Table 4.31: Effect of interaction between gender and treatment, significance for adults

GENDER X TREATMENT	Parametric - Univariate			
Question Set	F	p	Partial Eta squared	Observed Power
QA – opinion of computer	0.61 ¤	0.44	0.02	0.12
QB – opinion of self	0.21 ¤	0.66	0.01	0.07
QC – opinion of tutorial	4.34 ¤	0.05	0.15	0.52
QD – opinion of scoring	0.65 ¤	0.43	0.03	0.12
QAll – all questions	1.69 ¤	0.21	0.06	0.24
¤ df = (1, 31)				

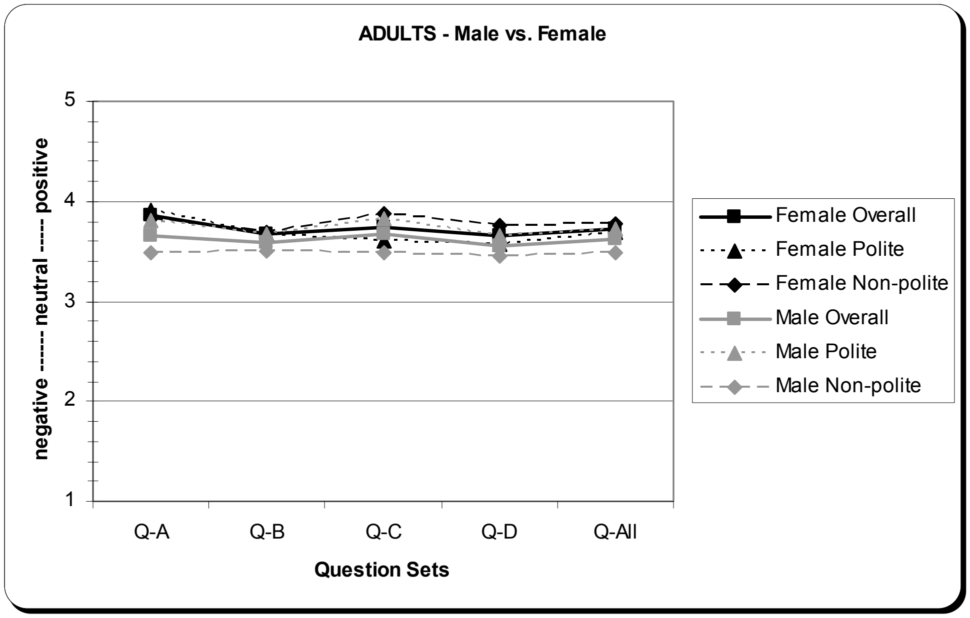

Figure 4.29: Gender effects for Politeness study, adults

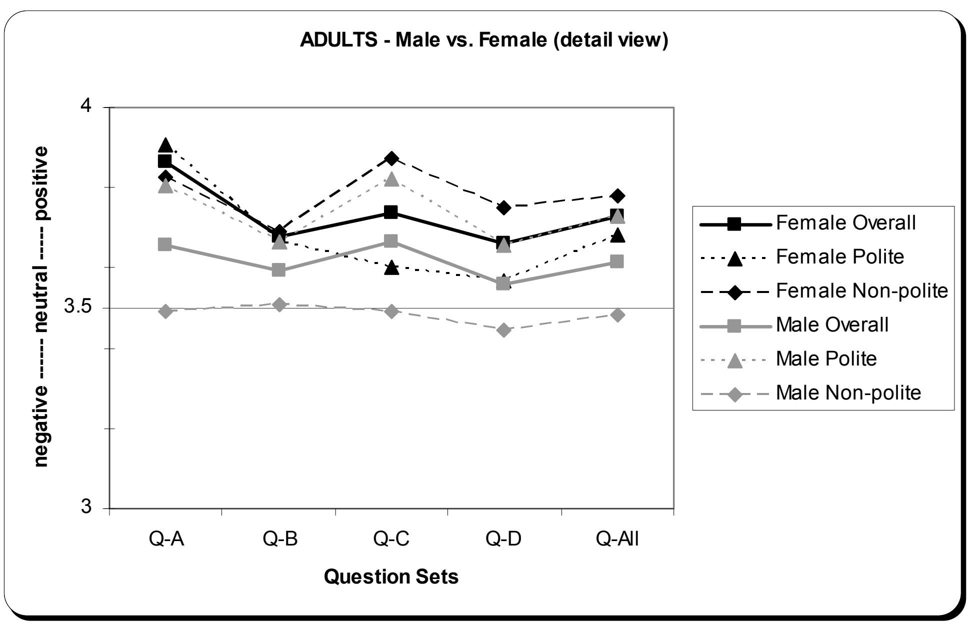

Figure 4.30: Gender effects for Politeness study, adults (detail view)

Hypothesis #4	Participants will be more polite when the computer is a handheld device than when it is a desktop computer.

Adults gave slightly more positive responses in general when interacting with a handheld computer than with a desktop computer. However, they did not show any differences between the polite and non-polite treatment conditions with either form of computer. Results of the analysis are provided in Table 4.32 through Table 4.34, as well as Figure 4.31 and Figure 4.32.

Table 4.32: Form factor effect for Politeness study, means for adults

	QA			QB			QC			QD			QAll		
	mean	std dev	median	mean	std dev	median	mean	std dev	median	mean	std dev	median	mean	std dev	median
Handheld															
Overall	3.87	0.42	3.86	3.73	0.36	3.67	3.84	0.27	3.86	3.65	0.49	3.88	3.77	0.25	3.81
Polite	3.96	0.40	3.86	3.72	0.38	3.67	3.88	0.23	3.79	3.56	0.61	3.81	3.77	0.17	3.81
Non-polite	3.76	0.44	4.00	3.75	0.35	3.67	3.80	0.33	3.86	3.75	0.32	3.88	3.76	0.33	3.74
Desktop															
Overall	3.69	0.41	3.71	3.56	0.36	3.61	3.60	0.50	3.79	3.58	0.47	3.69	3.60	0.36	3.60
Polite	3.76	0.34	3.71	3.62	0.33	3.56	3.56	0.49	3.71	3.65	0.33	3.63	3.65	0.29	3.61
Non-polite	3.62	0.48	3.71	3.51	0.40	3.67	3.63	0.53	3.86	3.51	0.60	3.75	3.56	0.44	3.58

Table 4.33: Form factor effect for Politeness study, significance for adults

FORM FACTOR	Parametric - Univariate				Non-Parametric	
Question Set	F	p	Partial Eta squared	Observed Power	Asymp. Sig.	Mann-Whitney U
QA – opinion of computer	0.47 ¤	0.50	0.02	0.10	0.37	110.50
QB – opinion of self	1.14 ¤	0.30	0.04	0.18	0.28	105.50
QC – opinion of tutorial	2.04 ¤	0.17	0.08	0.28	0.19	99.50
QD – opinion of scoring	0.11 ¤	0.75	0.00	0.06	0.40	112.00
QAll – all questions	1.21 ¤	0.28	0.05	0.18	0.31	107.00
¤ df = (1, 31)						

Table 4.34: Effect of interaction between form factor and treatment for Politeness study, significance for adults

FORM X TREATMENT	Parametric - Univariate			
Question Set	**F**	**p**	**Partial Eta squared**	**Observed Power**
QA – opinion of computer	0.17 ¤	0.68	0.01	0.07
QB – opinion of self	0.18 ¤	0.68	0.01	0.07
QC – opinion of tutorial	0.92 ¤	0.35	0.04	0.15
QD – opinion of scoring	0.52 ¤	0.48	0.02	0.11
QAll – all questions	0.00 ¤	0.97	0.00	0.05
¤ df = (1, 31)				

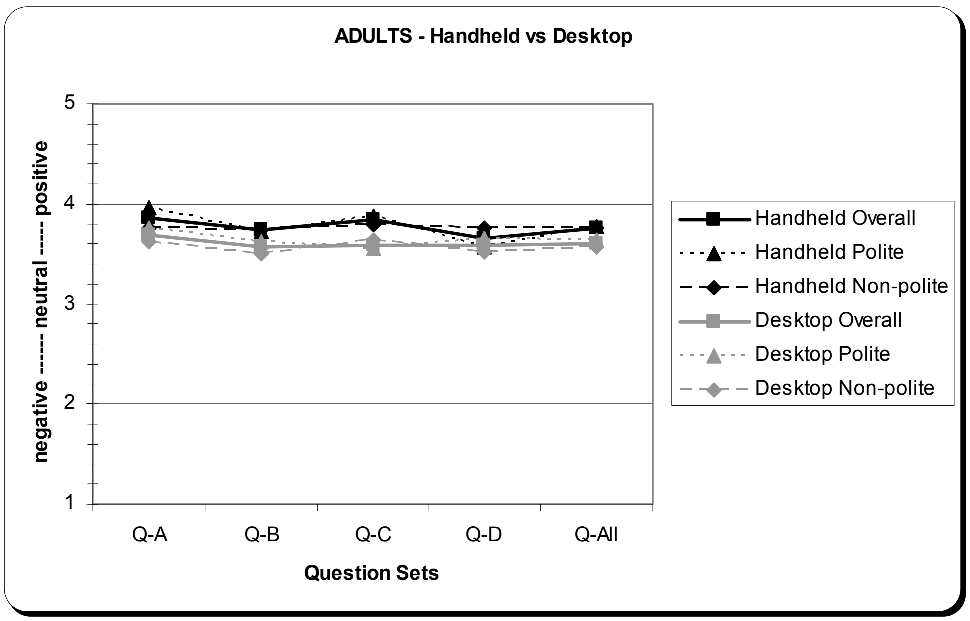

Figure 4.31: Form factor effect for Politeness study, adults

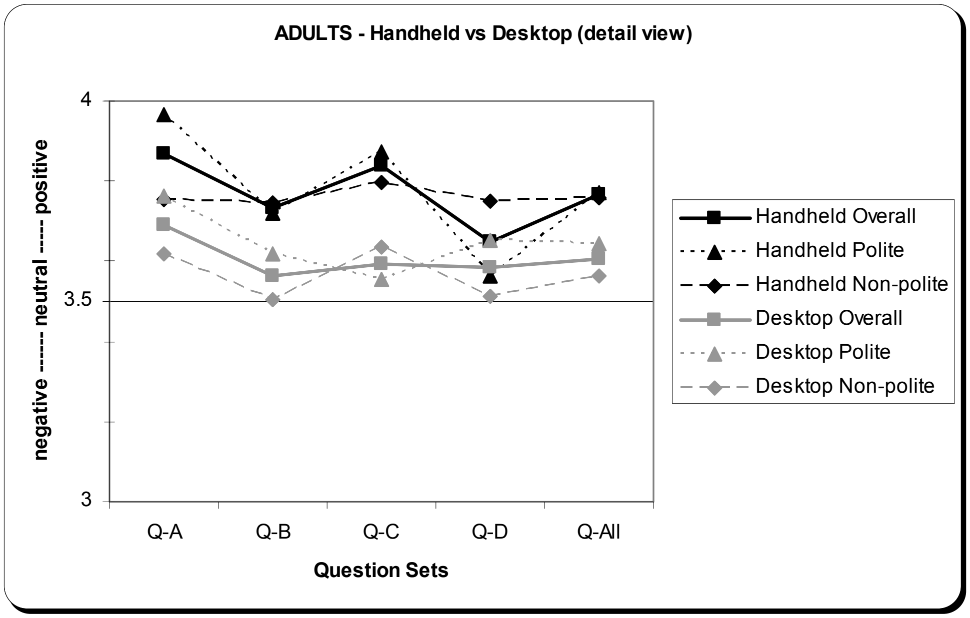

Figure 4.32: Form factor effect for Politeness study, adults (detail view)

4.4. Effects of Team Formation

Previous studies by Nass et al. (Nass, Fogg, Moon, 1996) have shown that when adults feel that the computer is a teammate, they respond more positively to the interaction. I tested whether team formation had the same effect on children. I also investigated whether gender or varying the form of the computer influenced how participants responded.

Data was collected from questionnaires completed by participants after the task. Questions from the questionnaires were divided into five question sets, as described in Table 4.35. Details of which questions were included in each group are available in section 0. Q-All is an overall score that takes into account every question on the questionnaire. Responses from the questionnaires have been translated to values on a scale of 1 to 5, with 5 being the most positive. Responses for each question set were averaged to produce a single score for each participant.

As part of the task, participants chose a list of items and then had the opportunity to modify their answers to match the computer's suggestions. The number of items they changed has been recorded and is also used in analysis. Since its value ranges from 0 to 3, rather than 1 to 5 like the other question sets reported, it will be graphed separately.

Table 4.35: Question sets for Team formation study

Question Set	Description
QA	Their opinion of the computer
QB	Their opinion of self
QC	Perception of computer as a partner
QD	Perceived similarity with the computer
QE	Confidence and trust in the computer
QAll	All questions in the questionnaire
# Changed	The number of items participants changed to match the computer (0 to 3)

The general results across all participants, the adult group, and the children group are presented in Table 4.36 through Table 4.39. In each case, the mean, median, and standard deviation is reported, as well as the results of parametric and non-parametric analysis (where applicable). Participants were placed into one of two experimental conditions: team or individual. More positive results were expected in the team condition. The "overall" numbers take into account all members in the group, regardless of experimental condition. Figure 4.33 through Figure 4.38 provide graphical representations of the means.

Once again, adults and children responded differently from each other, with children giving more positive responses overall. Children also changed significantly more items to match the computer's suggestions. As with the other tasks, children responded approximately 0.5 points higher than the adults.

Table 4.36: Effect of team formation (part 1 of 2), means

	QA			QB			QC			QD		
	mean	**std dev**	**median**	**mean**	**std dev**	**median**	**mean**	**std dev**	**median**	**mean**	**std dev**	**median**
All Participants												
Overall	3.87	0.58	4.00	3.89	0.52	3.91	3.61	0.74	3.71	3.48	0.83	3.75
Team	4.00	0.52	4.00	3.97	0.45	3.86	3.75	0.64	3.86	3.72	0.69	3.88
Indiv.	3.73	0.62	3.86	3.82	0.57	3.91	3.46	0.81	3.71	3.25	0.89	3.25
Adults												
Overall	3.62	0.44	3.71	3.60	0.40	3.73	3.26	0.69	3.43	3.42	0.73	3.50
Team	3.72	0.36	3.71	3.72	0.30	3.73	3.35	0.59	3.57	3.60	0.60	3.75
Indiv.	3.52	0.50	3.64	3.47	0.45	3.55	3.16	0.78	3.21	3.22	0.83	3.25
Children												
Overall	4.09	0.62	4.00	4.17	0.47	4.18	3.93	0.63	4.00	3.54	0.91	3.75
Team	4.28	0.51	4.14	4.22	0.45	4.09	4.15	0.40	4.29	3.84	0.77	4.00
Indiv.	3.92	0.67	4.00	4.12	0.49	4.18	3.73	0.75	3.93	3.28	0.96	3.25

Table 4.37: Effect of team formation (part 2 of 2), means

	QE			QAll			# Items Changed		
	mean	**std dev**	**median**	**mean**	**std dev**	**median**	**mean**	**std dev**	**median**
All Participants									
Overall	4.01	0.56	4.00	3.79	0.52	3.82	1.81	0.87	2.00
Team	4.10	0.50	4.25	3.92	0.43	3.92	1.95	0.74	2.00
Indiv.	3.91	0.61	4.00	3.66	0.58	3.82	1.66	0.97	2.00
Adults									
Overall	3.83	0.56	4.00	3.54	0.42	3.58	1.58	0.83	1.00
Team	3.91	0.54	4.00	3.65	0.34	3.58	1.53	0.62	1.00
Indiv.	3.73	0.59	3.88	3.41	0.48	3.48	1.63	1.02	1.50
Children									
Overall	4.18	0.51	4.25	4.03	0.50	3.97	2.00	0.86	2.00
Team	4.29	0.40	4.25	4.18	0.35	4.12	2.30	0.66	2.00
Indiv.	4.07	0.59	4.00	3.88	0.58	3.82	1.68	0.95	2.00

Table 4.38: Effect of Team formation, significance

TREATMENT (TEAM FORMATION)	Parametric - Univariate				Non-Parametric	
Question Set	**F**	**p**	**Partial Eta squared**	**Observed Power**	**Asymp. Sig.**	**Mann-Whitney U**
All Participants						
QA - opinion of computer	4.48 ¤	0.04	0.08	0.55	0.11	463.00
QB - opinion of self	2.80 ¤	0.10	0.05	0.38	0.67	560.00
QC - perceived partner	3.35 ¤¤	0.07	0.06	0.44	0.19	471.00
QD - perceived similarity	7.04 ¤	0.01	0.12	0.74	0.02	408.00
QE - perceived trust	2.38 ¤¤	0.13	0.04	0.33	0.11	449.50
QAll - all questions	6.01 ¤¤	0.02	0.10	0.67	0.06	426.50
# Changed	1.74 ¤¤¤	0.19	0.03	0.25	0.20	540.50
Adults						
QA - opinion of computer	2.12 £	0.16	0.08	0.29	0.27	105.50
QB - opinion of self	4.73 £	0.04	0.16	0.55	0.15	96.00
QC - perceived partner	0.86 £	0.36	0.03	0.15	0.64	123.00
QD - perceived similarity	3.33 £	0.08	0.12	0.42	0.19	100.50
QE - perceived trust	0.83 £	0.37	0.03	0.14	0.41	113.50
QAll - all questions	3.41 £	0.08	0.12	0.43	0.15	96.50
# Changed	0.23 £	0.64	0.01	0.07	0.79	129.00
Children						
QA - opinion of computer	2.59 §	0.12	0.08	0.34	0.13	114.00
QB - opinion of self	0.08 §	0.78	0.00	0.06	0.99	61.00
QC - perceived partner	3.04 §§	0.09	0.10	0.39	0.07	99.00
QD - perceived similarity	4.02 §	0.05	0.13	0.49	0.06	101.50
QE - perceived trust	1.71 §§	0.20	0.06	0.24	0.16	111.00
QAll - all questions	2.74 §§	0.11	0.09	0.36	0.08	100.50
# Changed	7.63 §§§	0.01	0.20	0.76	0.03	119.00

¤ df = (1, 67) ¤¤ df = (1, 66) ¤¤¤ df = (1, 70)
£ df = (1, 31)
§ df = (1, 34) §§ df = (1, 33) §§§ df = (1, 37)

Table 4.39: Effect of interaction between group and treatment (Team formation), significance across all participants

GROUP X TREATMENT	Parametric - Univariate			
Question Set	**F**	**p**	**Partial Eta squared**	**Observed Power**
QA - opinion of computer	0.15 ¤	0.70	0.00	0.07
QB - opinion of self	1.61 ¤	0.21	0.03	0.24
QC - perceived partner	0.17 ¤¤	0.68	0.00	0.07
QD - perceived similarity	0.19 ¤	0.66	0.00	0.07
QE - perceived trust	0.01 ¤¤	0.92	0.00	0.05
QAll - all questions	0.00 ¤¤	0.96	0.00	0.05
# Changed	4.37 ¤¤¤	0.04	0.07	0.54
¤ df = (1, 67) ¤¤ df = (1, 66) ¤¤¤ df = (1, 70)				

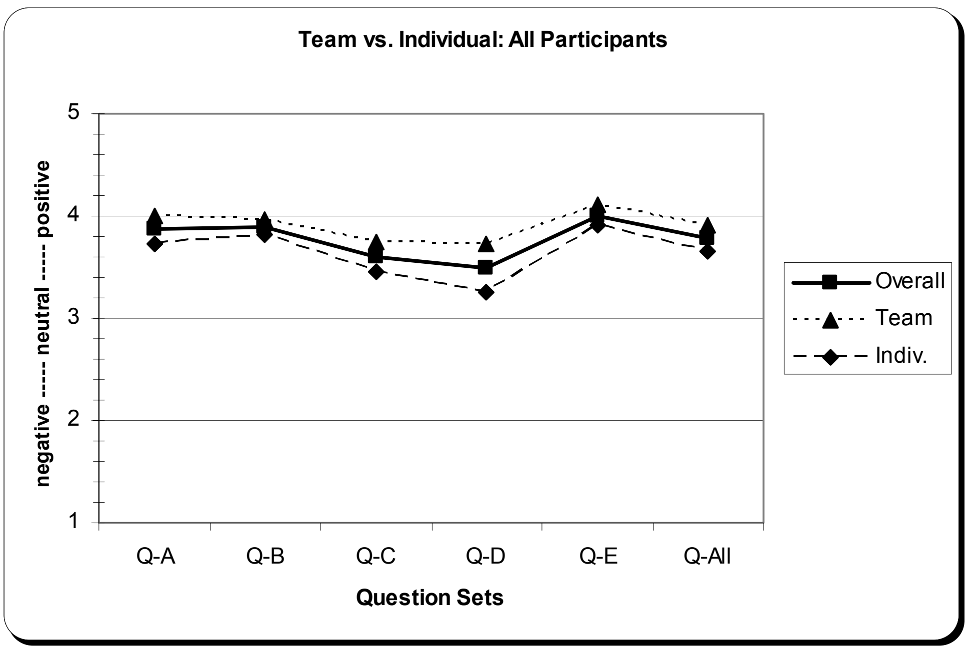

Figure 4.33: Effect of Team formation, across all participants

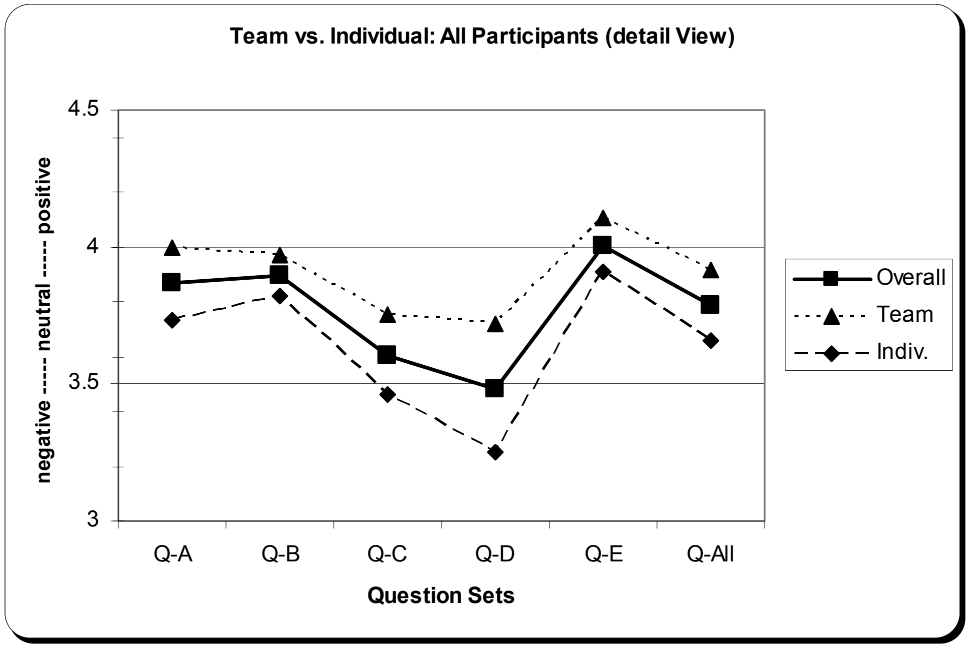

Figure 4.34: Effect of Team formation, across all participants (detail view)

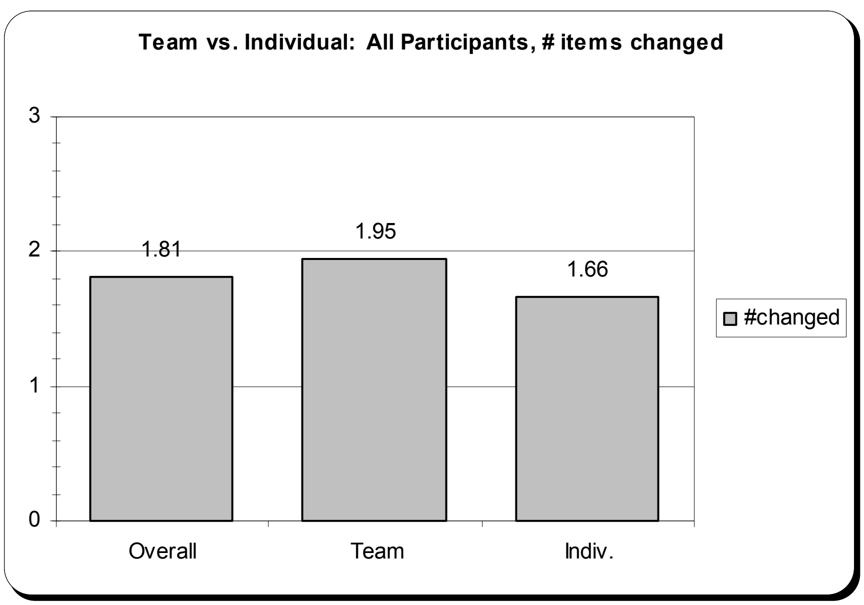

Figure 4.35: Effect of Team formation, across all participants - # items changed

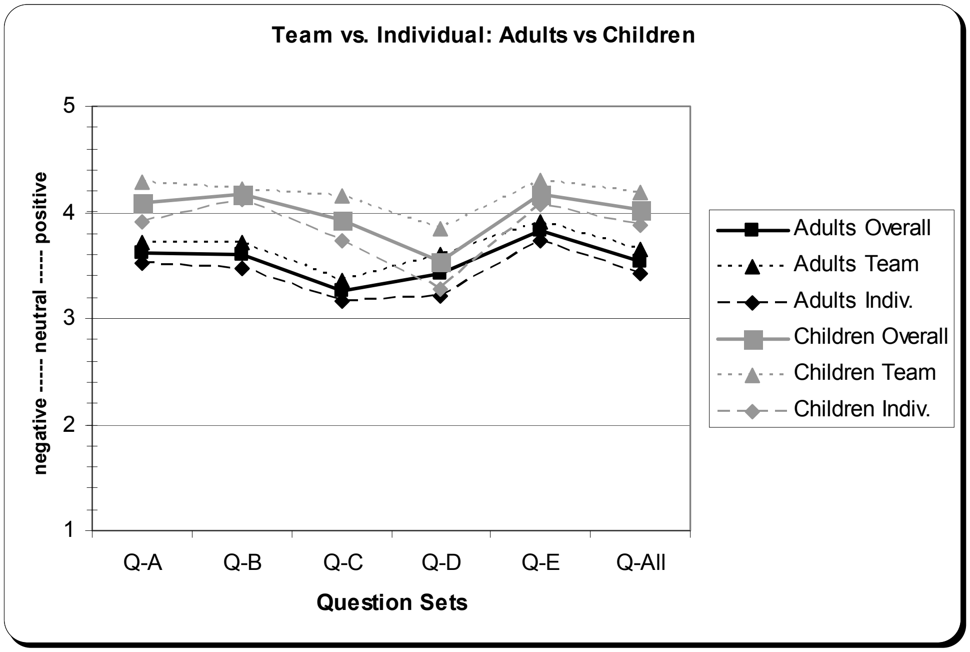

Figure 4.36: Effect of Team formation, adults vs. children

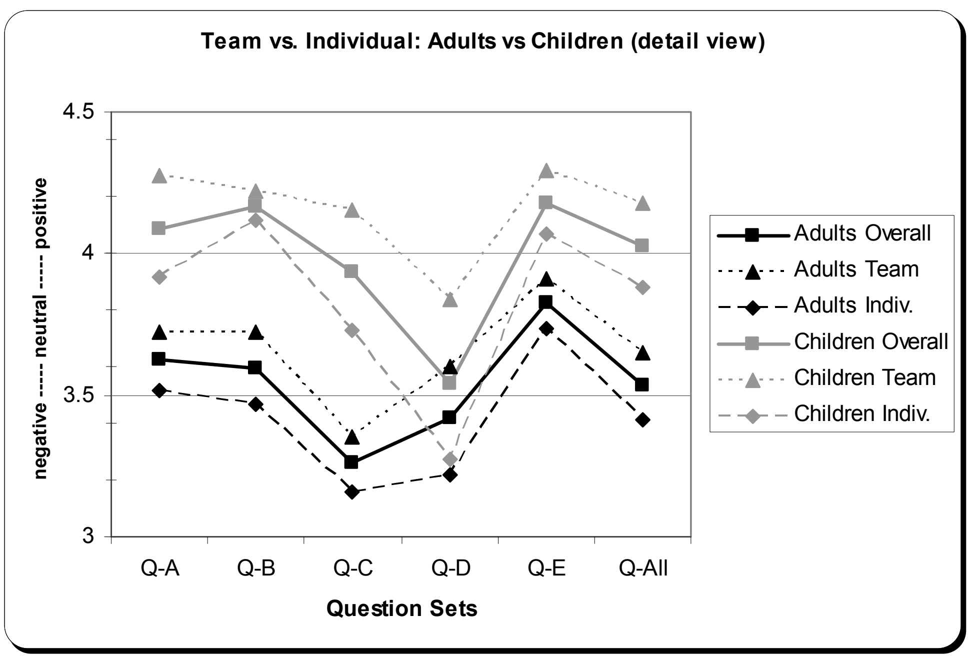

Figure 4.37: Effect of Team formation, adults vs. children (detail view)

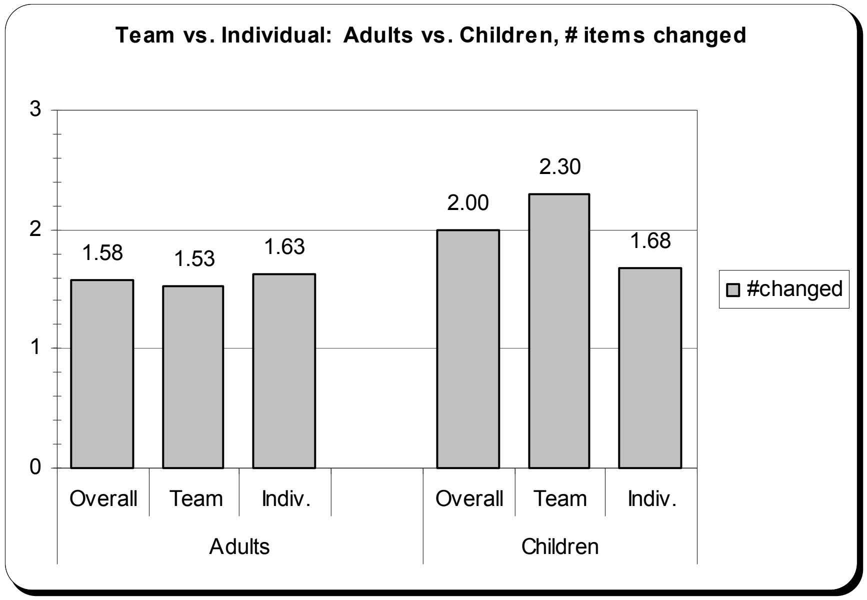

Figure 4.38: Effect of Team formation, adults vs. children - # items changed

Since such a wide difference between adults and children was observed, I performed further analysis on the two groups separately. Children appeared slightly more affected by team formation than adults, although most results did not reach statistical significance. One notable exception was with the number of items changed. Children did change significantly more items to match the computer's suggestions in the team condition. The following table summarizes the hypotheses and whether they were supported by the data for each group. Details of analysis for each hypothesis are provided in the following sections.

Table 4.40: Summary of hypotheses for Team formation study

#	Hypotheses	All Participants	Children	Adults
1	Participants who are told that the computer is a teammate will respond more positively than those who are told nothing about the relationship.	No	No	No
2	The effects of team formation will be more pronounced for children than for adults.	No	-	-
3	Females will respond more strongly to team formation than males.	-	No	No

#	Hypotheses	All Participants	Children	Adults
4	Participants will respond more strongly to team formation when the computer is a handheld device than when it is a desktop computer.	-	No	No
5	When children are teamed with the computer, they will feel that their choices and opinions are more similar to those of the computer than when not teamed.	-	No	No
6	When children are teamed with the computer, they will be more likely to cooperate with the computer and feel that the computer is a partner than when not teamed.	-	No	No
7	When children are teamed with the computer, they will rate the computer more favourably than when not teamed.	-	No	No
8	When children are teamed with the computer, they will be more confident about their choices than when not teamed.	-	No	No
9	When children are teamed with the computer, they will feel more positively about themselves than when not teamed.	-	No	No

4.4.1. Children in the Team Formation Study

Children responded slightly more positively in the team condition than in the individual condition. They also changed significantly more items to match the computer's items in the team condition. Being on a team however, had absolutely no impact on their opinion of self. Children's answers were more positive than those of adults in all question sets. This section discusses the hypotheses and results as they pertain to the children participants.

Hypothesis #1	Participants who are told that the computer is a teammate will respond more positively than those who are told nothing about the relationship.

As visible in Figure 4.39 and Figure 4.40, children did respond slightly more positively in the team condition, although the results were not statistically significant. Figure 4.38 shows that although they did not answer much more positively on the questionnaire, they did however take the computer's advice more frequently in the team condition. It appears that although being on a team did not influence their reported opinions, it did impact their behaviour. The means used in the charts and the related statistical analysis are available in Table 4.36 through Table 4.39.

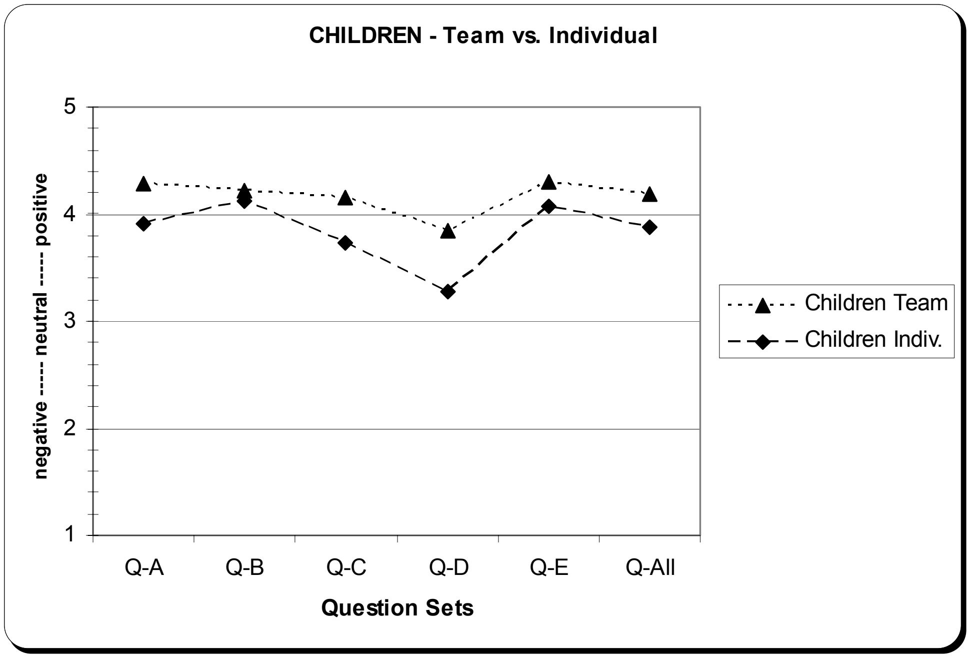

Figure 4.39: Effect of Team formation, children

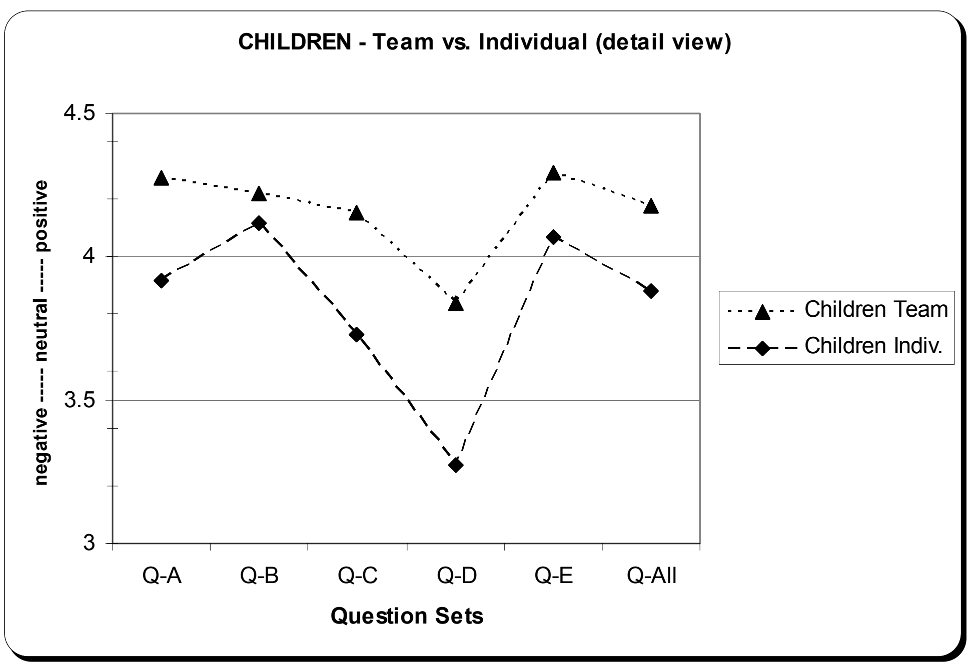

Figure 4.40: Effect of Team formation, children (detail view)

Hypothesis #2	The effects of team formation will be more pronounced for children than for adults.

Adults and children were similarly affected by team formation according to the question sets (see Figure 4.37). Contrary to the children, adults did not change any more items in the team condition than in the individual condition. Neither group showed the large differences reported in previous studies.

Hypothesis #3	Females will respond more strongly to team formation than males.

Interestingly, it was the boys who showed more differences between the team and individual conditions than girls, although neither groups showed statistically significant results. Boys also changed more items to match the computer's suggestions than girls, in all conditions. The corresponding means and results of analysis are presented in Table 4.41 through Table 4.44, as well as graphically in Figure 4.41 through Figure 4.43.

Table 4.41: Gender effect in Team formation study (part 1 of 2), means for children

	QA			QB			QC			QD		
	mean	**std dev**	**median**	**mean**	**std dev**	**median**	**mean**	**std dev**	**median**	**mean**	**std dev**	**median**
Females												
Overall	3.77	0.36	4.14	4.33	0.40	4.27	4.07	0.45	4.29	3.62	0.75	3.75
Team	3.81	0.36	4.14	4.30	0.49	4.27	4.14	0.37	4.29	3.70	0.77	3.75
Indiv.	3.73	0.37	4.14	4.36	0.28	4.18	3.98	0.53	4.14	3.53	0.76	3.75
Males												
Overall	3.45	0.47	4.00	3.98	0.49	3.91	3.78	0.79	3.86	3.46	1.07	3.75
Team	3.63	0.34	4.14	4.10	0.38	4.00	4.16	0.46	4.00	4.04	0.78	4.25
Indiv.	3.24	0.55	4.00	3.90	0.55	3.91	3.48	0.88	3.71	3.05	1.09	3.00

Table 4.42: Gender effect in Team formation study (part 2 of 2), means for children

	QE			QAll			# Items Changed		
	mean	std dev	median	mean	std dev	median	mean	std dev	median
Females									
Overall	4.28	0.49	4.25	4.16	0.38	4.15	1.84	0.96	2.00
Team	4.28	0.48	4.25	4.20	0.39	4.14	2.20	0.79	2.00
Indiv.	4.28	0.54	4.25	4.11	0.38	4.24	1.44	1.01	2.00
Males									
Overall	4.06	0.53	4.00	3.87	0.59	3.86	2.15	0.75	2.00
Team	4.32	0.28	4.25	3.87	0.59	4.00	2.40	0.52	2.00
Indiv.	3.86	0.60	3.75	3.65	0.67	3.82	1.90	0.88	2.00

Table 4.43: Gender effect in Team formation study, significance for children

GENDER	Parametric - Univariate				Non-Parametric	
Question Set	**F**	**p**	**Partial Eta squared**	**Observed Power**	**Asymp. Sig.**	**Mann-Whitney U**
QA - opinion of computer	1.80 ¤	0.19	0.06	0.25	0.25	126.00
QB - opinion of self	6.55 ¤	0.02	0.19	0.70	0.02	89.50
QC - perceived partner	2.05 ¤¤	0.16	0.07	0.28	0.22	115.50
QD - perceived similarity	0.04 ¤	0.83	0.00	0.05	0.75	151.50
QE - perceived trust	1.20 ¤¤	0.28	0.04	0.18	0.30	121.00
QAll - all questions	3.11 ¤¤	0.09	0.10	0.40	0.12	105.50
# Changed	1.64 ¤¤¤	0.21	0.05	0.24	0.35	158.50
¤ df = (1, 34) ¤¤ df = (1, 33) ¤¤¤ df = (1, 37)						

Table 4.44: Effect of interaction between Gender and Treatment in Team formation study, significance for children

GENDER X TREATMENT	Parametric - Univariate			
Question Set	**F**	**P**	**Partial Eta squared**	**Observed Power**
QA - opinion of computer	0.22 ¤	0.65	0.01	0.07
QB - opinion of self	0.45 ¤	0.51	0.02	0.10
QC - perceived partner	1.01 ¤¤	0.32	0.04	0.16
QD - perceived similarity	2.13 ¤	0.16	0.07	0.29
QE - perceived trust	2.10 ¤¤	0.16	0.07	0.29
QAll - all questions	1.34 ¤¤	0.26	0.05	0.20
# Changed	0.33 ¤¤¤	0.57	0.01	0.09
¤ df = (1, 34) ¤¤ df = (1, 33) ¤¤¤ df = (1, 37)				

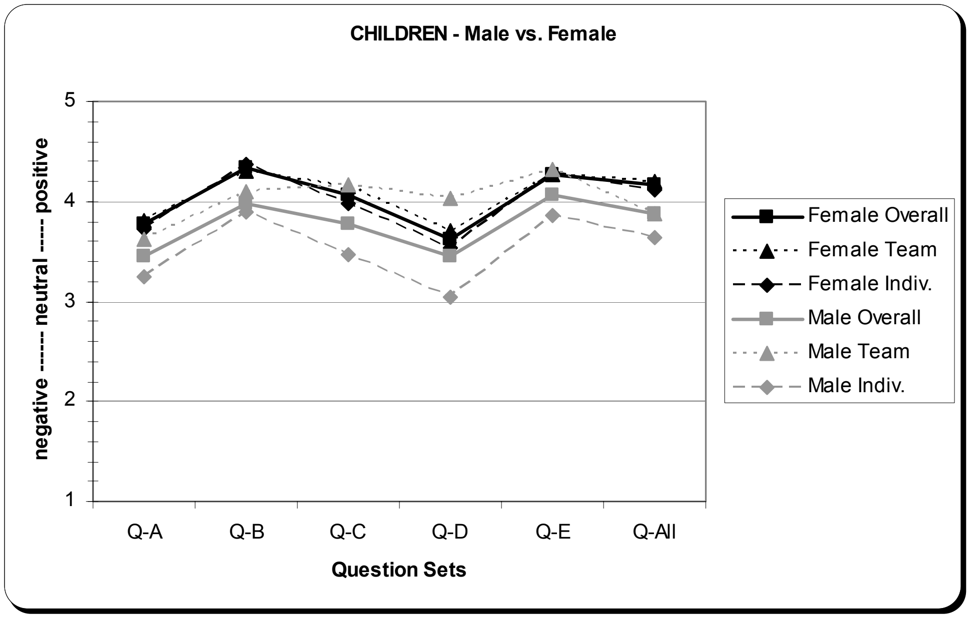

Figure 4.41: Gender effect for Team formation study, children

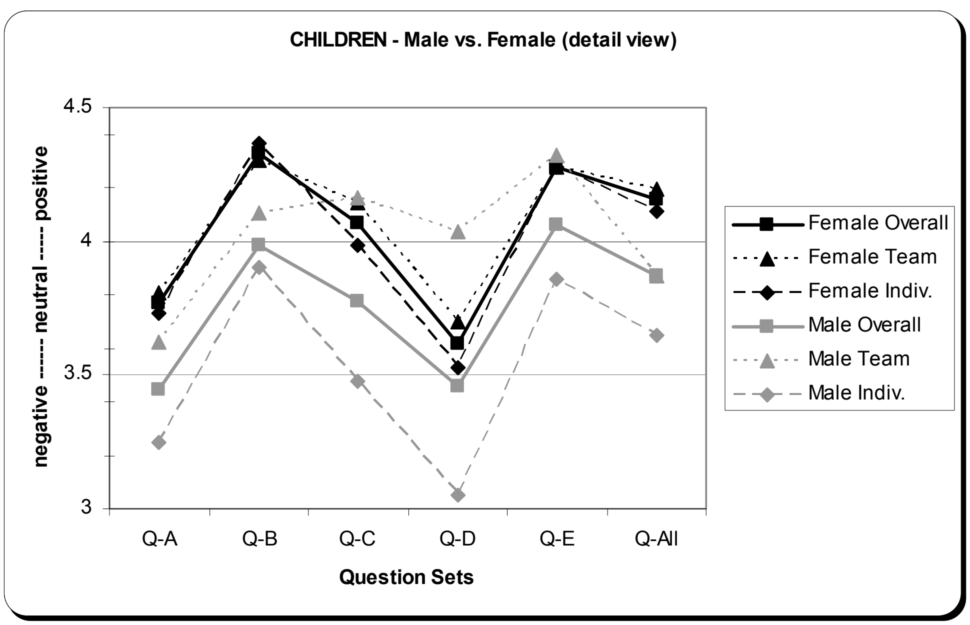

Figure 4.42: Gender effect for Team formation study, children (detail view)

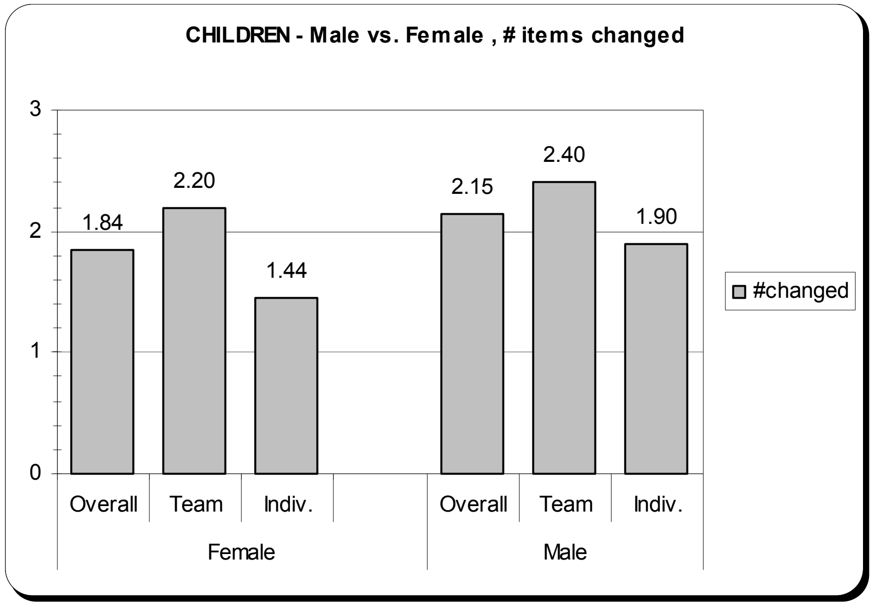

Figure 4.43: Gender effect for Team formation study, children - # items changed

Hypothesis #4	Participants will respond more strongly to team formation when the computer is a handheld device than when it is a desktop computer.

Children showed a wider range of responses between the team and individual conditions when using a handheld computer as opposed to a desktop computer, but these did not reach statistical significance. With the handhelds, they showed approximately a 0.5 difference in means for all question sets except for QB (opinion of self) between the team and individual conditions. A much smaller difference was seen for the desktop computers. Results of the analysis are provided in Table 4.45 through Table 4.47 and Figure 4.44 through Figure 4.46.

Table 4.45: Form factor effect in Team formation study (part 1 of 2), means for children

	QA			QB			QC			QD		
	mean	std dev	median	mean	std dev	median	mean	std dev	median	mean	std dev	median
Handhelds												
Overall	4.14	0.72	4.14	4.19	0.55	4.18	3.95	0.72	4.00	3.50	0.99	3.75
Team	4.40	0.55	4.50	4.32	0.45	4.27	4.21	0.39	4.29	3.80	0.96	3.88
Indiv.	3.84	0.79	3.86	4.05	0.65	4.18	3.67	0.91	3.86	3.17	0.97	3.25
Desktop												
Overall	4.03	0.50	4.00	4.14	0.37	4.18	3.91	0.53	4.07	3.59	0.83	3.75
Team	4.10	0.42	4.00	4.08	0.45	3.82	4.06	0.41	4.29	3.89	0.43	4.00
Indiv.	3.99	0.56	4.00	4.18	0.32	4.18	3.79	0.61	4.00	3.38	0.99	3.38

Table 4.46: Form factor effect in Team formation study (part 2 of 2), means for children

	QE			QAll			# Items Changed		
	mean	std dev	median	mean	std dev	median	mean	std dev	median
Handhelds									
Overall	4.18	0.59	4.25	4.04	0.59	4.15	2.05	0.76	2.00
Team	4.40	0.36	4.38	4.26	0.36	4.23	2.27	0.79	2.00
Indiv.	3.94	0.73	3.75	3.80	0.72	3.91	1.78	0.67	2.00
Desktop									
Overall	4.17	0.42	4.13	4.00	0.38	3.88	1.95	0.97	2.00
Team	4.14	0.43	4.25	4.06	0.34	4.00	2.33	0.50	2.00
Indiv.	4.19	0.43	4.00	3.96	0.42	3.82	1.60	1.17	1.50

Table 4.47: Effect of interaction between form factor and treatment, significance for children

FORM X TREATMENT	Parametric - Univariate			
Question Set	F	Question Set	Partial Eta squared	Observed Power
QA - opinion of computer	1.48 ¤	0.23	0.05	0.22
QB - opinion of self	2.88 ¤	0.10	0.09	0.37
QC - perceived partner	0.94 ¤¤	0.34	0.03	0.15
QD - perceived similarity	0.01 ¤	0.91	0.00	0.05
QE - perceived trust	1.90 ¤¤	0.18	0.07	0.26
QAll - all questions	1.67 ¤¤	0.21	0.06	0.24
# Changed	0.55 ¤¤¤	0.46	0.02	0.11
¤ df = (1, 34) ¤¤ df = (1, 33) ¤¤¤ df = (1, 37)				

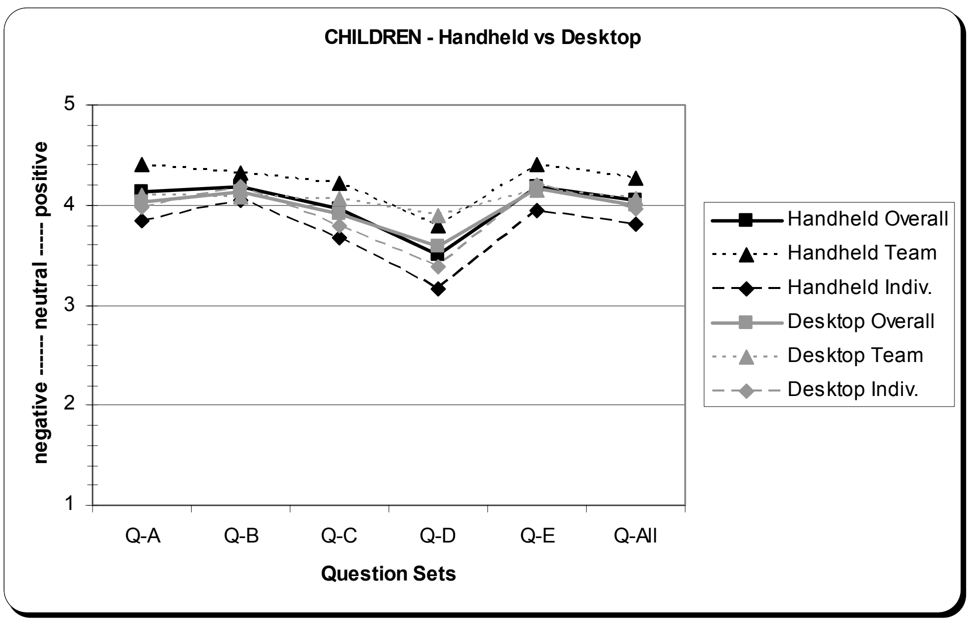

Figure 4.44: Form factor effect for Team formation study, children

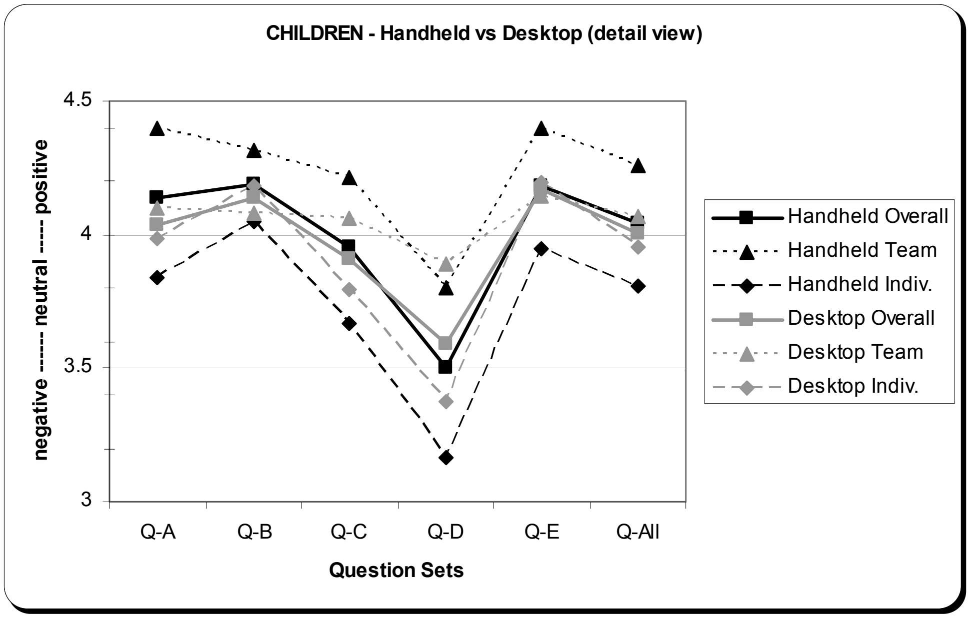

Figure 4.45: Form factor effect for Team formation study, children (detail view)

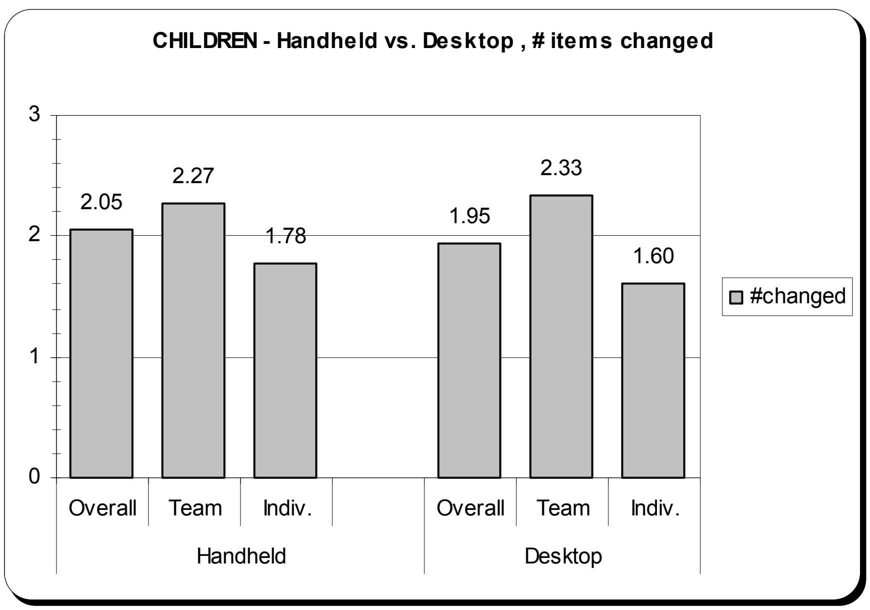

Figure 4.46: Form factor effect for Team formation study, children - # items changed

Hypothesis #5	When children are teamed with the computer, they will feel that their choices and opinions are more similar to those of the computer than when not teamed.

Children did rate themselves as having opinions more similar to the computer's opinions when in the team condition. They rated the similarity as approximately 0.5 points higher when they felt the computer was a teammate. This result however, does not reach statistical significance. The corresponding data and analysis can be found by looking at question set QD in Table 4.36 and Table 4.38, as well as Figure 4.36 and Figure 4.37.

Hypothesis #6	When children are teamed with the computer, they will be more likely to cooperate with the computer and feel that the computer is a partner than when not teamed.

Children were slightly more likely to feel that the computer was a partner in the team condition as opposed to the individual condition but the result was not statistically significant. See question set QC in Table 4.36 and Table 4.38, as well as Figure 4.36 and Figure 4.37 for further details.

Hypothesis #7	When children are teamed with the computer, they will rate the computer more favourably than when not teamed.

Again, children did rate the computer more favourably in the team condition, but the result was not statistically significant. Numerical data for the question set (QA) and a graphical representation of the means are available in Table 4.36 and Table 4.38, as well as Figure 4.36 and Figure 4.37.

Hypothesis #8	When children are teamed with the computer, they will be more confident about their choices than when not teamed.

A small difference was apparent in how much trust and confidence the children displayed with respect to their final choices. Children were slightly more confident in the team condition, but the results did not reach statistical significance. Question set QE represents the questions concerning this hypothesis. Data and analysis are available in Table 4.36 and Table 4.38, as well as Figure 4.36 and Figure 4.37.

Hypothesis #9	When children are teamed with the computer, they will feel more positively about themselves than when not teamed.

Children showed the least difference between the team and individual conditions on this topic. They reported a positive opinion of themselves regardless of condition. Question set QB grouped the questions relating to this hypothesis. Table 4.36 and Table 4.38 provide analysis results, while Figure 4.36 and Figure 4.37 show a graphical representation of the means.

4.4.2. Adults (Team Formation Study)

Adults were less affected by team formation than children. They showed very little difference between the team and individual conditions. There was also no difference in the number of items changed between conditions; in fact, they changed slightly more items in the individual condition. These results are contrary to those reported by Nass et al. (Nass, Fogg, Moon, 1996) in previous studies.

Hypothesis #1	Participants who are told that the computer is a teammate will respond more positively than those who are told nothing about the relationship.

Adults responded slightly more positively in the team conditions across all question sets, but the results are negligible. Table 4.36 through Table 4.39 show the relevant analysis results. The means for each question set are graphed in Figure 4.47 and Figure 4.48. Team formation had no effect on whether adults took the computer's suggestions. They changed approximately the same number of items in both the team and individual conditions. The number of items changed for adults was the only case across all three studies where the treatment condition resulted in a lower mean value than the non-treatment condition. The means for the number of items changed are graphed in Figure 4.38.

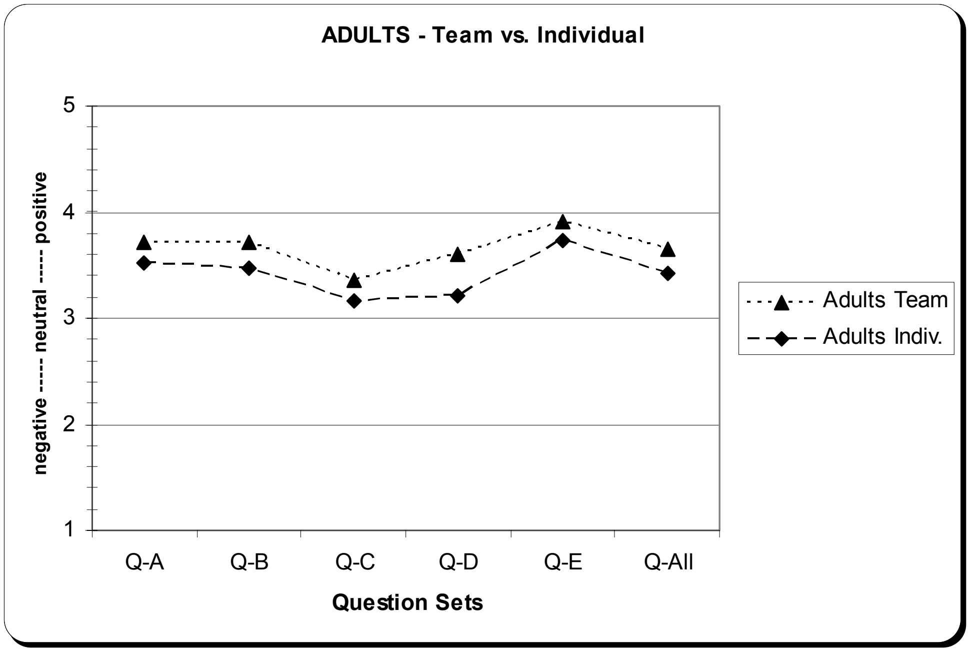

Figure 4.47: Effect of Team formation, adults

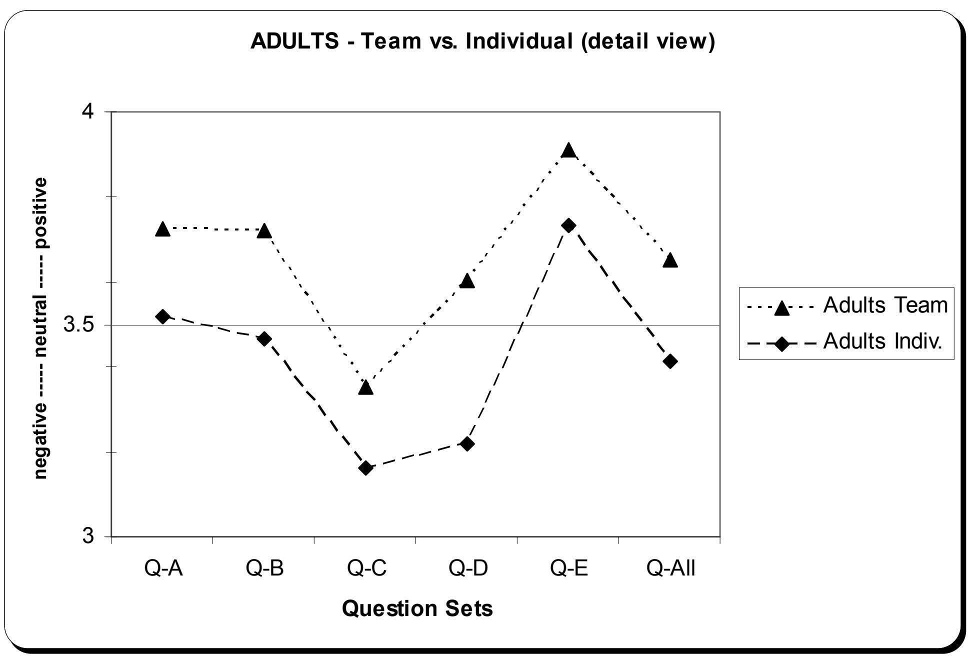

Figure 4.48: Effect of Team formation, adults (detail view)

Hypothesis #2	The effects of team formation will be more pronounced for children than for adults.

Children did show more differences between the team and individual conditions than the adults. However, for the most part the results were not statistically significant in either group. The biggest difference between the two groups was that children were influenced more strongly to change their items to match the computer's suggestions when in the team condition, while adults showed no influence. The corresponding data and analysis is available in Table 4.36 through Table 4.39 and Figure 4.36 through Figure 4.38.

Hypothesis #3	Females will respond more strongly to team formation than males.

Women responded more positively than men overall, but they showed less difference between the team and individual conditions. Men's responses were more varied between the team and individual conditions. Men's responses were especially different in question set QD, their perceived similarity to the computer. They felt that their opinions matched the computer's opinions significantly more often when they were part of a team ($p = 0.01$, $F = 7.75$). Neither group were influenced to change their items based on team formation. Analysis of the results are provided in Table 4.48 through Table 4.51, with graphical representations of the means available in Figure 4.49 through Figure 4.51.

Table 4.48: Gender effect in Team formation study (part 1 of 2), means for adults

	QA			QB			QC			QD		
	mean	std dev	median	mean	std dev	median	mean	std dev	median	mean	std dev	median
Females												
Overall	3.77	0.36	3.86	3.70	0.35	3.82	3.39	0.61	3.57	3.74	0.54	4.00
Team	3.81	0.36	3.86	3.84	0.28	3.82	3.56	0.47	3.57	3.83	0.45	4.00
Indiv.	3.73	0.37	3.86	3.57	0.37	3.64	3.22	0.72	3.29	3.64	0.63	4.00
Males												
Overall	3.45	0.47	3.43	3.47	0.43	3.45	3.10	0.75	3.29	3.03	0.77	3.00
Team	3.63	0.34	3.64	3.59	0.28	3.50	3.13	0.65	3.36	3.34	0.67	3.38
Indiv.	3.24	0.55	3.29	3.34	0.54	3.09	3.08	0.91	3.14	2.68	0.76	2.25

Table 4.49: Gender effect in Team formation study (part 2 of 2), means for adults

	QE			QAll			# Items Changed		
	mean	std dev	median	mean	std dev	median	mean	std dev	median
Females									
Overall	3.86	0.56	4.00	3.67	0.31	3.68	1.78	0.88	2.00
Team	3.81	0.65	4.00	3.77	0.30	3.70	1.67	0.71	2.00
Indiv.	3.92	0.50	4.00	3.58	0.31	3.58	1.89	1.05	2.00
Males									
Overall	3.78	0.57	4.00	3.37	0.49	3.45	1.33	0.72	1.00
Team	4.03	0.39	4.13	3.52	0.35	3.56	1.38	0.52	1.00
Indiv.	3.50	0.65	3.50	3.20	0.59	3.21	1.29	0.95	1.00

Table 4.50: Gender effect in Team formation study, significance for adults

GENDER	Parametric - Univariate				Non-Parametric	
Question Set	F	p	Partial Eta squared	Observed Power	Asymp. Sig.	Mann-Whitney U
QA - opinion of computer	4.01 ¤	0.06	0.14	0.49	0.05	80.50
QB - opinion of self	3.33 ¤	0.08	0.12	0.42	0.14	94.50
QC - perceived partner	0.47 ¤	0.50	0.02	0.10	0.37	110.50
QD - perceived similarity	7.75 ¤	0.01	0.24	0.76	0.01	64.00
QE - perceived trust	0.06 ¤	0.81	0.00	0.06	0.80	128.00
QAll - all questions	3.38 ¤	0.08	0.12	0.42	0.08	86.50
# Changed	0.89 ¤	0.36	0.03	0.15	0.12	94.50
¤ df = (1, 31)						

Table 4.51: Effect of interaction between gender and treatment, significance for adults

GENDER X TREATMENT	Parametric - Univariate			
Question Set	F	p	Partial Eta squared	Observed Power
QA - opinion of computer	1.02 ¤	0.32	0.04	0.16
QB - opinion of self	0.14 ¤	0.72	0.01	0.06
QC - perceived partner	0.08 ¤	0.78	0.00	0.06
QD - perceived similarity	1.17 ¤	0.29	0.04	0.18
QE - perceived trust	2.10 ¤	0.16	0.08	0.29
QAll - all questions	0.48 ¤	0.50	0.02	0.10
# Changed	0.05 ¤	0.83	0.00	0.06
¤ df = (1, 31)				

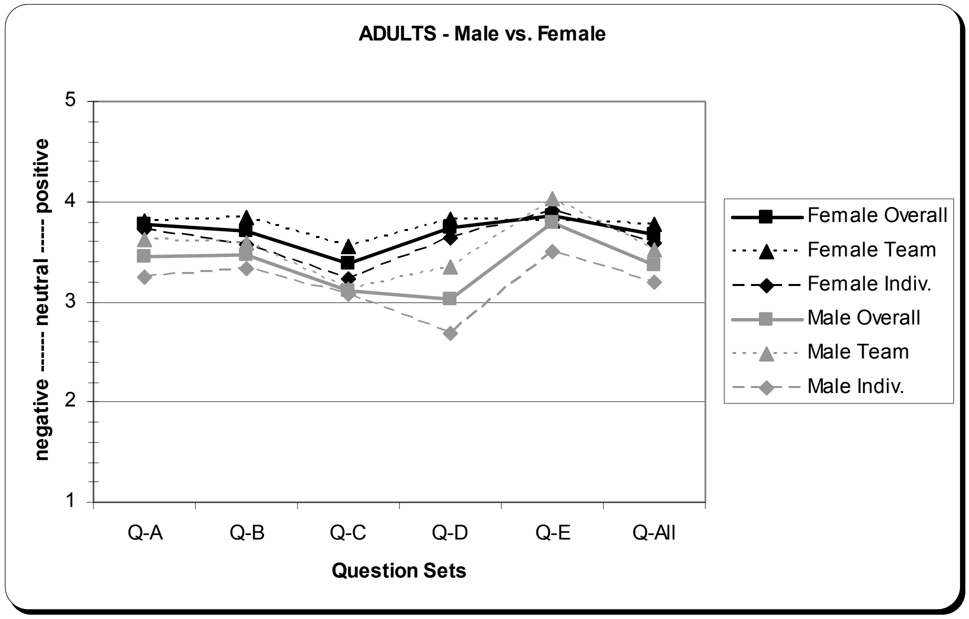

Figure 4.49: Gender effects for Team formation study, adults

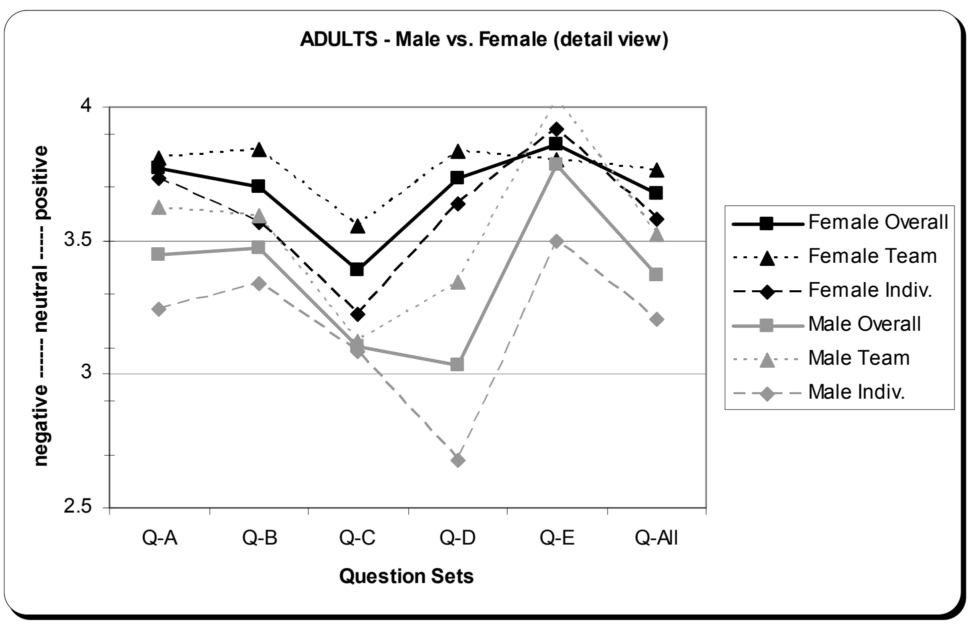

Figure 4.50: Gender effects for Team formation study, adults (detail view)

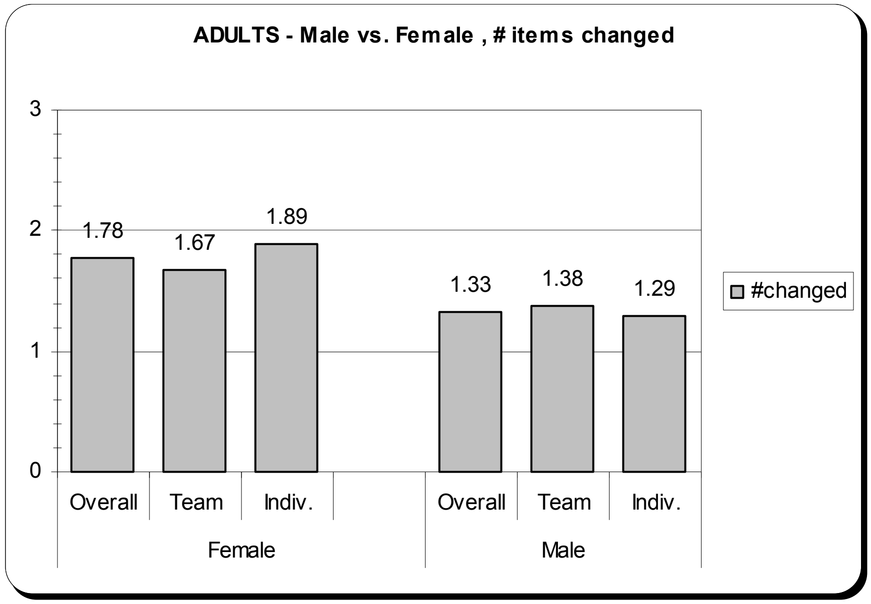

Figure 4.51: Gender effects for Team formation study, adults - # items changed

Hypothesis #4	Participants will respond more strongly to team formation when the computer is a handheld device than when it is a desktop computer.

Adults showed a wider range between the team and individual conditions when using a desktop computer. Contrary to my expectations, there was very little difference between conditions when they used a handheld device. They also gave generally more positive responses and changed more items to match the computer's advice when they used a desktop computer. However, the results did not reach statistical significance. Details can be found in Table 4.52 through Table 4.55 and Figure 4.52 through Figure 4.54.

Table 4.52: Form factor effect in Team formation study (part 1 of 2), means for adults

	QA			QB			QC			QD		
	mean	std dev	median	mean	std dev	median	mean	std dev	median	mean	std dev	median
Handhelds												
Overall	3.61	0.48	3.71	3.59	0.45	3.73	3.10	0.73	3.29	3.30	0.75	3.50
Team	3.70	0.36	3.71	3.65	0.34	3.59	3.13	0.59	3.21	3.48	0.61	3.63
Indiv.	3.51	0.59	3.71	3.53	0.55	3.82	3.06	0.89	3.29	3.11	0.88	3.00
Desktop												
Overall	3.64	0.40	3.64	3.60	0.34	3.68	3.48	0.58	3.57	3.57	0.70	3.63
Team	3.76	0.38	3.86	3.82	0.20	3.91	3.67	0.43	3.71	3.79	0.59	4.00
Indiv.	3.53	0.42	3.43	3.39	0.31	3.36	3.29	0.67	3.14	3.36	0.79	3.25

Table 4.53: Form factor effect in Team formation study (part 2 of 2), means for adults

	QE			QAll			# Items Changed		
	mean	std dev	median	mean	std dev	median	mean	std dev	median
Handhelds									
Overall	3.76	0.60	4.00	3.48	0.45	3.58	1.37	0.68	1.00
Team	3.88	0.54	4.00	3.56	0.34	3.58	1.40	0.52	1.00
Indiv.	3.64	0.66	3.50	3.39	0.56	3.52	1.33	0.87	1.00
Desktop									
Overall	3.91	0.52	4.00	3.62	0.38	3.64	1.86	0.95	2.00
Team	3.96	0.57	4.00	3.79	0.31	3.85	1.71	0.76	2.00
Indiv.	3.86	0.50	4.00	3.45	0.40	3.30	2.00	1.15	2.00

Table 4.54: Form factor effect for Team formation study, significance for adults

FORM FACTOR	Parametric - Univariate				Non-Parametric	
Question Set	F	p	Partial Eta squared	Observed Power	Asymp. Sig.	Mann-Whitney U
QA - opinion of computer	0.05 ¤	0.83	0.00	0.05	0.93	130.50
QB - opinion of self	0.26 ¤	0.62	0.01	0.08	0.91	130.00
QC - perceived partner	1.47 ¤	0.24	0.06	0.21	0.15	93.50
QD - perceived similarity	0.09 ¤	0.76	0.00	0.06	0.33	107.00
QE - perceived trust	0.44 ¤	0.51	0.02	0.10	0.57	117.50
QAll - all questions	0.17 ¤	0.68	0.01	0.07	0.44	112.00
# Changed	1.77 ¤	0.20	0.07	0.25	0.10	90.50
¤ df = (1, 31)						

Table 4.55: Effect of interaction between form factor and treatment for Team formation study, significance for adults

FORM X TREATMENT	Parametric - Univariate			
Question Set	F	p	Partial Eta squared	Observed Power
QA - opinion of computer	0.10 ¤	0.75	0.00	0.06
QB - opinion of self	1.41 ¤	0.25	0.05	0.21
QC - perceived partner	0.30 ¤	0.59	0.01	0.08
QD - perceived similarity	0.16 ¤	0.69	0.01	0.07
QE - perceived trust	0.01 ¤	0.92	0.00	0.05
QAll - all questions	0.54 ¤	0.47	0.02	0.11
# Changed	0.37 ¤	0.55	0.01	0.09
¤ df = (1, 31)				

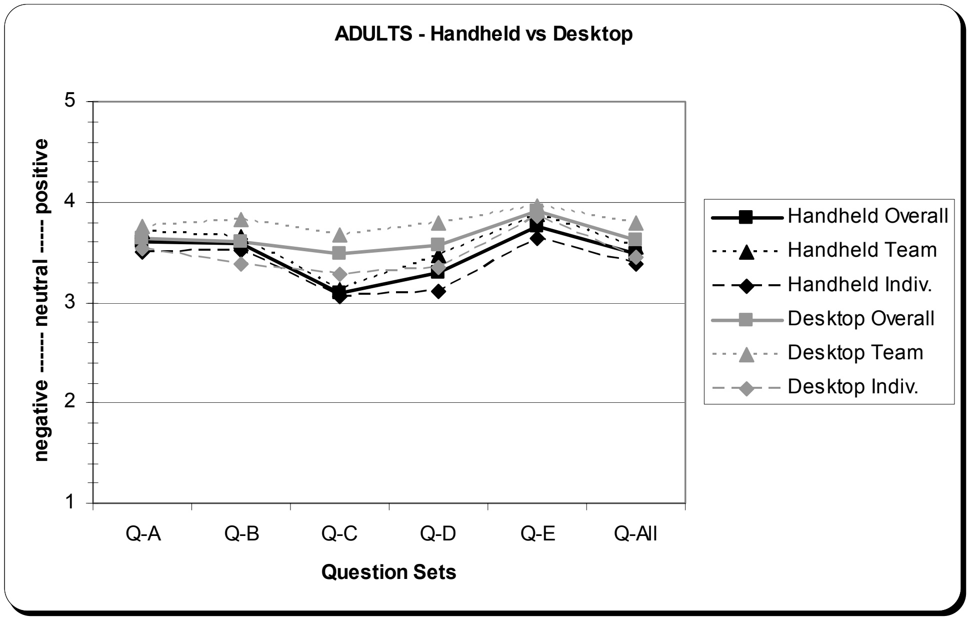

Figure 4.52: Form factor effect for Team formation study, adults

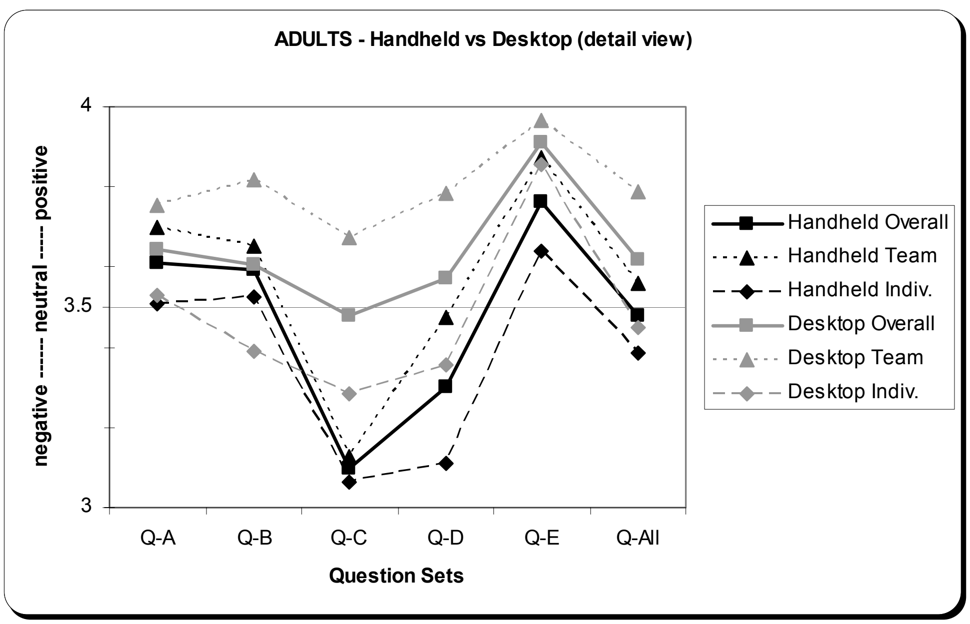

Figure 4.53: Form factor effect for Team formation study, adults (detail view)

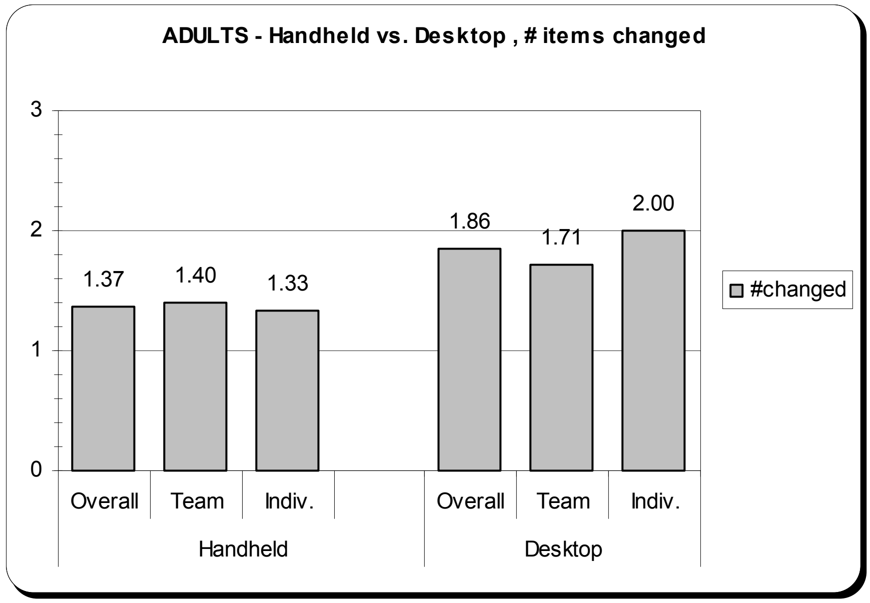

Figure 4.54: Form factor effect for Team formation study, adults - # items changed

5. Discussion

5.1. Summary of Results

These studies investigated whether children (aged 10-12) responded to the Media Equation with respect to praise, team formation, and politeness. I expected to find that children were more affected by the Media Equation than adults. I also expected to reproduce and confirm the effects found previously with adult participants. Surprisingly, neither of these overall hypotheses were supported by the results. In the studies, children and adults were barely affected by the Media Equation. Since my experiments were very similar to the original studies, it is interesting to note such contrary results. Although a few differences were observed, the overall results imply that the effects of the Media Equation are not as apparent, nor as easy to reproduce as initially thought. The main findings for each of the studies are discussed below.

I believed that praise from the computer should have resulted in participants reporting more positive opinions of the computer and of themselves, as well as a higher opinion of their own performance and of the computer's feedback. Children were not affected by praise from the computer; their responses were slightly more positive when they received praise, but not significantly so. Adults, on the other hand, were affected by praise. Those who received praise gave answers that were on average 0.5 points (out of 5) higher than those who received only neutral feedback.

In the politeness study, I expected those who responded to the questionnaire on the computer rather than on paper to provide more positive evaluations. Overall, this was not the case with either the children or the adults in my experiment. This study showed the least difference between treatment and non-treatment conditions. Children did give slightly more positive responses when answering on the computer (approximately 0.15 points higher) and one question set reached significance (their opinion of the computer was 0.5 points higher), but overall very little difference was seen. Adults showed approximately a 0.2 point difference in their opinion of the computer, but all other question sets revealed no differences whatsoever.

Team formation norms predict that if participants considered the computer as a teammate, they would have a more positive opinion of the computer and of themselves, feel more strongly that the computer is a partner, believe that the computer's suggestions are more similar to their own, and express more trust and confidence in the computer. Participants should also change their choices to match the computer's suggestions more often during the task.

Children did not show any significant differences in the team condition compared to the individual condition, although their answers were slightly more positive (approximately 0.4 points higher) on the questionnaire. Children did, however, change significantly more items (2.30 items versus 1.68 items) when they were in the team condition as opposed to the individual condition. The adults in the study did not show any significant differences on the questionnaires or in the number of items changed. Their responses in the team condition were approximately 0.2 points higher than in the individual condition and they changed 1.53 items in the treatment condition versus 1.63 items in the individual condition.

Across all three studies, one pattern was apparent. Children responded more positively than adults regardless of condition. The difference between the two groups was statistically significant for all three studies.

Looking at the form factor across all three studies revealed no significant differences between handheld and desktop computers. The effects of the Media Equation appeared slightly more pronounced on the desktop computer, but the results were not significant.

There were no significant differences in how each gender responded to the Media Equation. Slight variations were apparent, but no overall trend developed across all tasks. In some cases, females showed larger differences between the treatment and non-treatment conditions, while in other instances males did.

5.2. Comparison with other work

A few studies other than those conducted by Nass and Reeves have investigated the effects of the Media Equation. While the contrast in my results versus those of Nass and Reeves have already been examined, it is worthwhile to examine how these results compare with those of other researchers who attempted to show effects of the Media Equation.

A study by Campanella-Bracken (2000) weakly supported the idea that praise from the computer has a positive impact on children aged 8 to 10 years. Four of her eleven hypotheses tested reached a significance level of $p<0.1$. She found that praise from the computer leads to higher recall and recognition scores for a task where children read a story then answered questions about it. She also found that children liked the computer more when it praised them and that they perceived a greater ability to complete the task when praised. One significant difference in her methodology was the presentation of praise. Praise was presented on a brightly colored background, in large coloured font, in a pop-up window that covered the entire screen. Neutral feedback, on the other hand, popped up in a small window and was presented in small black text on white background. It is questionable whether her results were a direct result of praise or were from some aspect of the presentation style.

Goldstein, Alsio, and Werdenhoff (2002) investigated whether people were polite to handheld computers and smart phones. Their tasks involved completing several everyday tasks on the devices rather than replicating those used by Nass and Reeves. Their results revealed that participants actually rated the computer less favourably in the Polite condition, which is contrary to Media Equation findings. They further found that when participants felt they had done well on a task, they rated the computer more favourably than when participants felt they had done poorly on the task. This perception of performance had a larger impact on participants' evaluations than the presence of Media Equation elements. They conclude that further study is required to adequately answer the question of whether the Media Equation applies to small devices.

These two studies imply that other researchers have also had difficulty replicating Media Equation effects as described by Nass and Reeves. More extensive research needs to be done to determine whether the Media Equation is still as significant as was reported by Nass and Reeves.

5.3. Explanation of findings

As the results of these studies were contrary to expectations, it is necessary to examine why this is the case. Three possibilities exist: (1) there really is no Media Equation effect, (2) there is a Media Equation effect, but the effect is too small to reach significance, and (3) some problem in the studies prevented the effect from being noticed. Each of these possibilities is discussed in the following sections.

5.3.1. No Media Equation effect

Since children responded positively in all question sets, regardless of treatment, it may be that children are simply happy, content, and confident while using the computer and that the saturation point of "positive-ness" has already been met. In this case, adding Media Equation elements has no extra benefit because the ceiling has already been reached.

Another explanation is that today's children are the first generation to grow up surrounded by computers and that this has caused them to have a different perspective than previous generations. They may be so accustomed to interacting with these machines that they are not "fooled" into responding socially. Contrary to Nass and Reeves's (Reeves and Nass, 1996) theory that human brains respond socially to anything that gives even minimal social cues, perhaps today's children have been exposed to computers to a point where this is no longer the case. The argument was that until the invention of computers, anything that provided social cues deserved social consideration and a social response. These children have grown up with computers, so they may have adjusted to receiving social cues from computers. And as such, they can easily reconcile that the computer is inanimate and does not require social interaction.

The opposite may also be true. Children may respond in such an intensely social manner to computers that no extra cues are needed to elicit such responses. In this perspective, the Media Equation effect is so strong that we see it regardless of whether we actively try to encourage it. This could account for the overall positive responses given by children. In this case, no effect would be detected since both the treatment and non-treatment conditions elicit similar positive reactions.

Reasons why there may be no effect in the adults tested may lie in the participant pool used for this study. Over half of the adult participants were Computer Science majors at the University. Nass and Reeves (Reeves and Nass, 1996) state that their participants were all proficient computer users, however they do not clearly indicate whether this includes people whose field of expertise is Computer Science. It may be that these participants have reached a level of proficiency that makes them cynical to attempts at social interaction and too aware of the mechanics behind such programs. Rather than responding socially and paying attention to the interaction, they may be busy figuring out how the software was implemented and how they would build their own version.

It may also be the case that these participants are in fact representative of today's computer-savvy users and that the effect of the Media Equation is weakening. It has been more than a decade since some of the initial studies were conducted. It may be that the Media Equation effect was somehow transitional in nature. People may have responded in this manner initially, but with ever-increasing exposure and experience users have moved beyond these reactions. They may have formed a more complete model of the computer in their mind and no longer respond in the same social way.

The Politeness study showed virtually no differences between treatment and non-treatment conditions. Since Canadians are known worldwide for their abundant politeness, perhaps cultural factors played into the equation. There may have been a Media Equation effect, but their social response dictated that they were to be polite in all cases. If this is in fact the case, it may also have influenced the other two studies since the polite response would have been to answer positively all the time. This may have masked the effects of praise and team formation and thus resulted in smaller than expected differences. Nass et al.'s (Fogg and Nass, 1997; Nass, Fogg, and Moon, 1996; Nass, Moon, Carney, 1999) studies were done with American participants. Since social conventions and norms vary greatly between cultures, it may be that their measures of social interaction do not apply cross-culturally. People from other cultures may also respond to the Media Equation, but with different social behaviour, implying a need to set up experiments differently. Golstein, Alsio, and Wedenhoof (2002), whose study of politeness on handhelds was conducted in Sweden, also hypothesize that cultural differences between Americans and Swedes may be influencing their results.

5.3.2. Effects were too small to reach significance

In almost all cases, the results in these studies pointed in one direction: treatment resulted in more positive responses than non-treatment. These results however, did not reach statistical significance. If there really was no Media Equation effect, the results would be more varied, with some question sets showing more positive results in the non-treatment condition. But this was not the case here, leading to the possibility that there is a Media Equation effect that is too small to deliver significant results.

5.3.3. Problems in the study preventing the effects from being noticed

The studies were devised to resemble their respective original studies as closely as possible. However, some changes were necessary to accommodate younger participants. These changes may have inadvertently affected the results and prevented the Media Equation effect from being perceived.

The children were tested in pairs in order to limit the disruptions to the class. Even at this rate, each class took almost a week to complete; stretching it out any further would have been too much of an imposition on the class and the teacher. This arrangement however, may have affected the results of the studies. While the children completed the tasks individually, at separate stations, they were still in the same room. Some children engaged in conversation with each other (typically about the task at hand) while completing the tasks, which may have affected the interaction with the computer. The children were also aware of what their partner was doing and could tell when they had completed the task. This sometimes caused the second child to rush through the task and/or questionnaire in order to catch up.

The interfaces were totally text-based, as were the questionnaires, and as such required a significant amount of reading. I do not believe that all children carefully read the material presented; some simply read enough to get the general idea then clicked through the game or circled answers on the questionnaires without much consideration or reflection. For the Media Equation to have an effect, the children would need to be paying attention to the interaction or else they may miss some or all of the social cues provided.

The children were very happy to have been chosen to participate in the study and liked the special attention given to them. They brought their friends by the room where the studies were taking place and proudly told them that they were helping with a university project. They were also happy and eager to get an hour break from regular classroom activities. These conditions could lead to a Hawthorne effect where they responded more positively than they normally would, simply because they were happy with the extra attention and felt special for taking part in the studies. A Hawthorne effect is caused by the fact that the subjects in a study know that they are participating in a study. This theory states that responses are improved by the psychological stimulus of those being singled out and made to feel special. A novelty effect may also have come into play as the children were excited to play new games and did not seem to mind their simplicity. Longer exposure to the games would likely have resulted in less positive evaluations.

The children may also have been trying to please the invigilator by giving positive responses. Efforts were taken to convince them that their honest opinion was needed and that it was perfectly fine if that opinion was negative. They were also reminded that their answers were anonymous. These may not have been enough to convince the children or to avoid a halo effect. Figure 5.1 shows the total number of responses given by children and adults, across all studies, for the end points of the Likert scale. Obviously children were much more likely to give the most positive responses while avoiding the most negative responses. In the case of adults, the end-point responses were more evenly distributed.

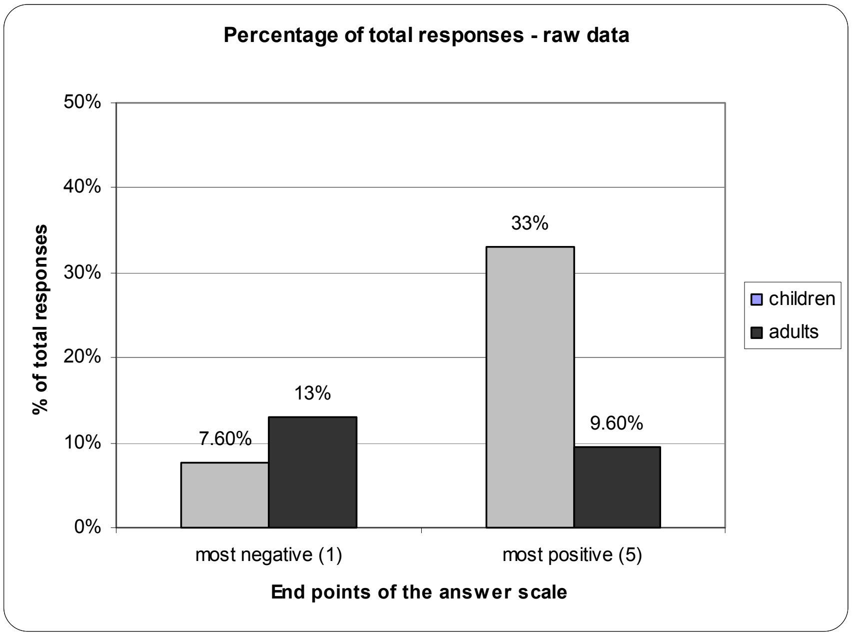

Figure 5.1: Percentage of total responses - raw data

A few factors could have affected all participants and led to the unexpected results. These deal with the data collection tools and the influence of running three studies consecutively. The questionnaires may not have been thorough enough to capture the Media Equation effects. Since the number of questions was reduced considerably (to approximately one third of the original questionnaires), perhaps I did not include sufficient questions to adequately capture the influence of the Media Equation. I also narrowed the range of possible responses from 10 to a 5 point scale and assigned words to each point. This was done after pilot testing indicated that it was the most understandable alternative for children. It may, however, have limited participants by not providing a broad enough range of responses.

Each session lasted approximately one hour. All three tasks were completed consecutively by each participant. While participants were asked if they were willing to continue between each task, the one-hour session may have been too long for children. They may have continued because they wanted to remain out of class, but they may not have been paying close enough attention to the tasks at hand.

Nass and Reeves (Reeves and Nass, 1996) completed one study at a time. Participants in the current studies may have been unduly influenced by previous tasks and interactions. An attempt was made to minimize this effect by alternating computers between tasks, but they may still have grouped the entire experience into one. The similarity of the questionnaires may also have prompted this undesirable effect since they may have glanced at the questions and thought “oh, I just did this” and answered in a similar manner, giving less consideration to the current task.

None of these possible influences have been confirmed. They would require further investigation and new studies to establish their validity and likelihood. In light of the results however, they should be taken into consideration and cannot be ignored as possible causes.

5.4. Guidelines and Lessons for Practitioners

Even though the results do not point towards widespread benefits of using the Media Equation with children, some lessons can still be learned from these findings. This section discusses those lessons, from a user interface designer and human-computer interaction researcher point of view.

5.4.1. The Media Equation is not as useful as previously thought

Previous findings led us to believe that adding Media Equation elements to an interface would automatically lead to obvious and desired benefits. The results of these current studies question this assumption. Even if there are effects of the Media Equation that were missed, these effects are apparently small; otherwise more indications of their existence would have been seen. With such small benefits, the Media Equation remains problematic as a design principle since there is little return for the effort expended. Designers need to weigh whether the effort involved in incorporating and implementing Media Equation elements justifies benefits that may or may not exist.

5.4.2. Eliciting predictable responses from the Media Equation is not easy

Either users are getting more mature in their interactions with the computer or it is not as easy as suggested to elicit predictable social responses from users during interactions with the computer. During the studies, some participants referred to the computer as “he” and attributed human characteristics to it such as “this one is smarter than the other one” and “I didn’t want to hurt its feelings”. They did not however, display the expected differences between treatment and non-treatment conditions. This suggests that while there may be a Media Equation effect, it is not easy to predict what may trigger such a reaction. 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.

5.4.3. Text-based praise is not useful for children

Children responded in the same way regardless of whether they were praised. Many children’s software with educational or motivational goals offer praise as a means of encouraging children. The results suggest little benefit to such praise – at least not if the praise is text-based. Further study is required to determine whether presenting the praise in other formats or otherwise bringing attention to it would provide more beneficial results. If no effort is made to distinguish the praise from regular interface features, it is of little value and will not have the expected positive effects.

5.4.4. Team formation influences children’s behaviour

Encouraging the formation of a team with the computer had no impact on the children’s reported opinions, but it did influence their behaviour. If the goal of a software program is to influence children’s actions, team formation appears to be a useful tool. When on a team, children took the computer’s advice and suggestions seriously and modified their behaviour accordingly.

5.4.5. The Media Equation does not influence children’s perception of self

These studies found no evidence that children change their perception of self as a result of interaction with the computer. None of praise, team formation, or politeness led to a more positive opinion of self. Designers should be aware that these Media Equation elements, as tested, did not lead to the expected benefits. When developing interfaces with a goal of encouraging children or boosting their confidence, these tools have little added benefit.

5.4.6. Media Equation elements have little impact during trivial tasks

Participants in these studies, as in previous Media Equation studies, completed relatively trivial tasks where their success or failure had little consequence. I found that in these situations, the addition of Media Equation elements had little or no impact. It may be that Media Equation elements have a stronger influence when children have a stronger interest or motive for successfully completing a task. However, further study would be required to confirm this hypothesis. In either case, designers should be aware that little is gained from adding Media Equation elements for trivial tasks.

5.4.7. Gender-specific designs are unnecessary with respect to the Media Equation

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. The results of these current studies show few differences in how each gender responded to the Media Equation with respect to praise, team formation, or politeness. In these areas, at least, designers do not need to worry about gender-specific designs.

In fact, boys and girls are not significantly different in terms of how they responded to questions about the computer or themselves, regardless of the Media Equation. It may be fruitless to design user interfaces differently for boys and girls irrespective of the Media Equation.

5.4.8. The form of computer does not affect the Media Equation

Few differences were apparent when children used handheld or desktop computers with respect to praise, team formation, or politeness. Designers should know that any Media Equation effects encountered in one form will most likely transfer to other types of computers as well.

When looking solely at the form factor, children reported much the same opinions on handheld computers and desktop computers, regardless of the Media Equation. It does not appear to matter whether software is displayed on different types of computers; children still felt the same about themselves and the computer. User interfaces designed for one form will likely be received in the same manner by children when transferred to another form.

5.4.9. Cultural differences may impact how people respond to the computer

Just as cultural differences influence how people respond to each other, these differences may also impact how they respond to the computer. For example, Canadians are known for being very polite; this may lead them to respond differently to Media Equation elements than their American counterparts. Designers should be aware that Media Equation influences may vary with different audiences. This may lead to unexpected reactions as well as a lack of expected responses.

5.4.10. Studying social effects of computers on children is problematic

Short-term studies, such as the ones used here to look for Media Equation effects on children, are problematic. The possibility of a Hawthorne or novelty effect is always present since children are placed in a new environment and perform novel tasks, then immediately asked to report on their experience. Actions taken to make the children feel at ease and feel that their contributions are valuable may also unfairly influence their responses. Researchers should be aware of how their actions and their environment can influence children, especially when investigating social effects.

5.4.11. Task selection is important when studying social effects on children

Tasks need to be engaging and entertaining enough to ensure that children pay attention and perform the tasks properly. If a task is deemed boring, it will be difficult to accurately measure the effects of the Media Equation since children will not be focused and may miss the social cues provided due to inattention. The other extreme can also be problematic. When a task is too novel and engaging, the children will be happy to perform it regardless of any manipulation. It will cause a ceiling effect, making it difficult to measure any added benefits since children will respond positively regardless of conditions. Researchers need to be careful in selecting tasks that will provide a clear and accurate picture of the effect being measured.

5.4.12. Data collection tools should be carefully considered

Questionnaires are a common way to gather data during research studies. Besides the usual considerations when creating questionnaires, like word choice and length of questionnaire, another aspect needs to be addressed. Researchers need a way of assuring that children actually take the time to carefully read and consider the questions. It is difficult to know whether they reflected on their answers or simply skimmed through to find the most positive or most acceptable response. This is especially difficult to do if several children are present, since they will most likely try to race each other. It is worth noting that the one measure in these studies that did not rely on children reporting an answer on a questionnaire, namely the number of items changed in the team formation study, showed a statistically significant result. Designers should consider alternative data collection tools when possible, rather than relying on reported opinions.

5.5. Generalizing the Results

A concern with testing social effects of computers in a controlled setting is that placing people in such a situation may alter their behaviour and provide an unrealistic snapshot of the interaction. This section compares the participants and tasks used in the studies to the real-world computer users and situations where the Media Equation would normally be applied.

5.5.1. Participants

The children who participated in the studies represent a typical group of 10 to 12 year olds. They attend a regular elementary school in a working class neighbourhood and were part of regular grades 5 and 6 classes. All children from both classrooms participated, with the exception of one student whose parents did not sign the consent form. Data was included from all children who took part in the studies.

The adults were all university students, taking Computer Science or Psychology classes. They represent primarily a young, educated, computer-literate portion of the adult population. While not representative of adults as a whole, this segment of the population are among the most frequent computer users, who are likely to use computers as part of daily life.

5.5.2. Tasks

Children frequently play computer games. In fact, ninety percent of those who took part in this study report playing games on the computer. In this respect, the tasks were realistic and familiar for the children. The children appeared to enjoy and understand the tasks; some even asked if they could bring the games home to continue playing. So although the interfaces were very plain and simple compared to their usual computer games, they appeared engaging enough to keep most children's attention throughout the session.

Being in a controlled environment obviously differs from the real-world settings where people normally use computers. Efforts were made to minimize the differences between the two settings but it remains a concern that the environment affected the results.

First, children completed the tasks in pairs. Each worked alone but in parallel with another student. Playing in the company of other children is not unusual, although it may have some influence on their behaviour. Secondly, in the real world, children play with software for more than a few minutes. Allowing children more time to interact with the games could reduce the novelty effect and lead to less positive responses. Thirdly, children sometimes use computers for tasks other than simple games in their daily lives. Alternate products such as education software, communication tools, and more complex entertainment software may lead to different responses from children. Lastly, the children were aware that they were participating in a study although the purpose was unknown. Most children assumed they were testing the games; in fact several of them came back after their session to suggest improvements to the games. In the real world, presumably children would respond more naturally and with less awareness that their actions and suggestions are being monitored.

Having been simplified for children, the tasks may have been too simple to fully engage the adult participants although they all completed the tasks anyway. However, adults often use software aimed at efficiently accomplishing a task rather than being engaging and entertaining to use, so the lack of engagement may not be an issue.

Adults were tested individually so there was no concern of participants influencing each other during the tasks. The controlled environment could have had much the same impact on adults as on children, although the adults were probably less influenced by the novelty of the tasks and less concerned with pleasing the researcher since they had a better understanding of the research process.

6. Conclusions

6.1. Summary of Research

The Media Equation has been described as an important factor in the design of user interfaces. However, most Media Equation research has focused on adult users interacting with a desktop computer, with the assumption that the findings applied across all users on any type of computer. It remained unknown whether this assumption was valid for children or for handheld computers. Since computers play an ever-increasing role in children's lives, it is important for designers to understand the possible impact of their design choices and to understand whether a principle like the Media Equation can lead to improved computer interfaces for children.

To investigate the effects of the Media Equation on children, I conducted three studies testing various aspects of the Media Equation with children aged 10 to 12 years. The first study looked at the effects of praise given by the computer, the second investigated whether children were polite to the computer, and the last study examined whether forming a team with the computer had any impact on children's opinions and behaviours. If the Media Equation held true, each of these manipulations should lead to more positive responses from participants.

As a secondary point of interest, I tested whether completing the tasks on a handheld computer led to different results than when participants interacted with a desktop computer. I also ensured that approximately equal numbers of males and females were assigned to each experimental condition, so that any gender differences with respect to the Media Equation could be discovered as well. Lastly, I repeated the studies with a group of adult participants for comparison between the two groups.

The results of the studies did not provide broad support for the Media Equation. As tested, the Media Equation had little impact on children. The adults were positively affected by praise from the computer, but showed few differences in the other two studies. For both groups, responses were more positive when Media Equation elements were applied, but the results did not reach statistical significance. There were no overall differences due to form factor or due to gender. Adults and children, however, did respond significantly different from each other, with children giving more positive responses than adults regardless of experimental conditions.

In light of these results, it is not possible to say that the Media Equation greatly affects children, nor that including it in children's interfaces has any significant benefits. It remains possible that other aspects of the Media Equation have an impact on children or that children of other age groups could respond differently than those in these studies. It is also possible that the methodology or data collection tools used were inappropriate for capturing Media Equation effects with children. Further study is needed to determine whether modifying any of these factors could lead to support for the Media Equation and children.

These results show that uncovering the effects of the Media Equation is not as simple as previously thought and that it is not easy to entice predictable responses to the Media Equation. Experience also shows that studying social effects of computers with children is problematic since many factors outside of the experimental conditions can influence children's behaviours, including conducting the experiments in a controlled environment.

6.2. Contributions

The main contribution stemming from this project is an understanding of a design factor in child-computer interaction; namely that the Media Equation is not as useful for design, nor as easy to implement, as previously thought. The results of these studies question whether there is a Media Equation effect on children and suggest that its inclusion in the design of children's interfaces has few added benefits.

Minor contributions include:

- an understanding of gender differences and similarities in the social relationships children form with the computer with respect to praise, politeness, and teammates,
- evidence that varying the form of the computer has little effect on child-computer interaction with respect to the Media Equation,
- an understanding of how children differ from adults in terms of treating computers as social actors on the basis of praise, politeness, and teammates

- evidence that varying the form factor does not affect how adults respond to computers,
- evidence that adults do not respond to the Media Equation as strongly as previously reported.

6.3. Future Work

The results from these studies were contrary to my expectations. Therefore, it is reasonable to question whether changes in the way the studies were conducted would produce statistically significant results. Many of these changes have already been discussed as potential reasons for a lack of Media Equation effects, but the following areas warrant further study to gain a better understanding of the effects of the Media Equation on children.

It would be worthwhile to run new studies that use alternative ways of getting participants' opinions instead of questionnaires to investigate whether Media Equation effects become apparent with different data collection tools. Children may be answering positively on questionnaires simply because they feel those are the "correct" answers. A method of testing their behaviour rather than their reported attitudes may reveal different results. One indication that this may be true is that the one measure in my analysis that was based on behaviour (switching items on the Desert Survival task) did in fact show statistically significant results.

Further studies should also be done to investigate whether the conditions under which the interaction takes place affects children's responses to the Media Equation. It would be valuable to know whether Media Equation effects occur only under certain circumstances. For example, I initially believed that doing the three studies consecutively with the same participants would not affect the results as the tasks were sufficiently different from each other. I also believed that testing the children in pairs would be acceptable. In light of the current results, these assumptions should now be questioned.

A new study should look into whether different modes of interaction (other than plain text) have an impact on how children respond to the Media Equation. Nass and Reeves claim that simple text-based interfaces are sufficient to elicit Media Equation effects. However, since little impact of the Media Equation was shown, it would be interesting to test the hypotheses with interfaces that are more similar to those children use every day. Children may not pay enough attention to text-based interfaces to be influenced by the Media Equation. For example, providing praise in the form of an audio comment rather than text on the screen may prove more effective for children.

It would be worthwhile to test whether different types of tasks lead to more significant results with children. It may be that the current results for children were caused by a ceiling effect; the children were just happy to be playing a new game. Further testing of the hypotheses with different tasks may show more effects. It should be investigated whether a "boring" task like spelling or math drills would show greater differences when Media Equation elements are applied.

Further studies are needed to look at the impact of testing for social effects in a controlled environment and for short periods of time. A longer-term study may yield different results. One way to accomplish this would be to have the games available for them in the classroom or for home download for a few weeks beforehand, then perform the test. This would minimize the novelty effect and give a more realistic picture of their interaction with real-world software. Of course, this would require more complex systems that the children could play several times without getting bored. Another alternative would be to introduce a "real" system that could be incorporated into their classroom activities over a period of time. By assigning the treatment and non-treatment conditions to separate classrooms, a better picture of whether the Media Equation has any long term effects in a realistic setting could be captured by comparing the results of different classrooms.

Another aspect that has not been examined is whether the same people who were or were not affected by Media Equation elements continue to respond in the same way with further computer experience. A new study should test the same people (adults and children) several times over an extended period to see whether they consistently respond the same way.

The results of these studies demonstrate that studying the Media Equation, especially with children, is difficult. Further studies are needed to determine for certain whether the Media Equation has any beneficial impact on children and whether it is worth the effort of including its elements in the design of children’s technology.

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Appendix A

Consent Form – Adult participants

Consent Form – Parents of children participants

Assent Form – Children participants

DEPARTMENT OF COMPUTER SCIENCE
UNIVERSITY OF SASKATCHEWAN
INFORMED CONSENT FORM

You are invited to participate in a study entitled "Effects of the Media Equation on Adults and Children". Please read this form carefully, and feel free to ask questions you might have.

Researchers: Dr. Carl Gutwin, Professor - Department of Computer Science (966-8646)

Sonia Chiasson, Graduate Student - Department of Computer Science (966-8647)

This consent form, a copy of which has been given to you, is only part of the process of informed consent. It should give you a basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, please ask. Please take the time to read this form carefully and to understand any accompanying information.

This study is concerned with evaluating the social interaction between people and computers. The goal of the research is to determine whether children react to computers in the same manner as adults. Design guidelines for computer interfaces will be derived from the results of the study

The session will require fifty minutes, during which you will be asked to play 3 short computer games. Following each game, you will be asked to answer a questionnaire about your experience. At the end of the session, you ill be given more information about the purpose and goals of the study, and there will be time for you to ask questions about the research.
The data collected from this study will be used in articles for publication in journals and conference proceedings.

As one way of thanking you for your time, we will be pleased to make available to you a summary of the results of this study once they have been compiled. This summary will outline the research and discuss our findings and recommendations. If you would like to receive a copy of this summary, please write down your email address here.

Contact email address:____

All of the information we collect (data logged by the computer, observations made by the experimenters, and the questionnaire responses) will be stored so that your name is not associated with it (using an arbitrary participant number). Any write-ups of the data will not include any information that can be linked directly to you. The research materials will be stored with complete security throughout the entire investigation. Paper data (e.g. questionnaires) will be securely stored by Dr. Carl Gutwin (locked file cabinet in locked office). Computer data will be stored by Dr. Carl Gutwin on a password-protected computer system. All data will be stored for a minimum of five years, and will be available only to the investigators. Do you have any questions about this aspect of the study?

You are free to withdraw from the study at any time without penalty and without losing any promised benefits. If you withdraw, your data will be deleted from the study and destroyed. Withdrawal from the study will not affect your academic status or your access to services at the university. In addition, you are free to not answer specific items or questions on the questionnaires. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to act as a participant. In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. If you have further questions about this study or your rights as a participant, please contact one of the following:

Dr. Carl Gutwin, Assistant Professor
Department of Computer Science
(306) 966-8646
gutwin@cs.usask.ca

Office of Research Services
University of Saskatchewan
(306) 966-2084

Participant's Signature: ______________________________

Date: ______________________________

Investigator's Signature: ______________________________

Date: ______________________________

A copy of this consent form has been given to you to keep for your records and reference. This study has been approved on ethical grounds by the University of Saskatchewan Behavioural Sciences Research Ethics Board on June 9, 2003.

DEPARTMENT OF COMPUTER SCIENCE

UNIVERSITY OF SASKATCHEWAN

INFORMED CONSENT FORM

You and your child are invited to participate in a study entitled "Effects of the Media Equation on Children". Please read this form carefully, and feel free to ask questions you might have.

Researchers: Dr. Carl Gutwin, Professor - Department of Computer Science (966-8646)

Sonia Chiasson, Graduate Student - Department of Computer Science (966-8647)

This consent form, a copy of which has been given to you, is only part of the process of informed consent. It should give you a basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, please ask. Please take the time to read this form carefully and to understand any accompanying information.

This study is concerned with evaluating the social interaction between children and computers. The goal of the research is to determine whether children react to computers in the same manner as adults. Design guidelines for computer interfaces aimed at children will be derived from the results of the study. This research will advance our knowledge of human-computer interaction and the resulting guidelines will lead to improved computer interfaces for children.

The session will require forty-five minutes, during which your child will be asked to play 3 short computer games. Following each game, they will be interviewed about their experience. At the end of the session, we will provide your child with a written document to bring home giving more information about the purpose and goals of the study, and you are invited to contact us if you have questions about the research.

Participants will gain experience with novel computer technologies and gain knowledge of the research process.

The data collected from this study will be used in articles for publication in journals and conference proceedings.

As one way of thanking you for your time, we will be pleased to make available to you a summary of the results of this study once they have been compiled. This summary will outline the research and discuss our findings and recommendations. If you would like to receive a copy of this summary, please write down your email address here.

Contact email address:____

All of the information we collect from your child (data logged by the computer, observations made by the experimenters, and the interview responses) will be stored so that your child's name is not associated with it (using an arbitrary participant number). Any write-ups of the data will not include any information that can be linked directly to your child. The research materials will be stored with complete security throughout the entire investigation. Paper data (e.g. questionnaires) will be securely stored by Dr. Carl Gutwin (locked file cabinet in locked office). Computer data will be stored by Dr. Carl Gutwin on a password-protected computer system. All data will be stored for a minimum of five years, and will be available only to the investigators. Do you have any questions about this aspect of the study?

You or your child may to withdraw from the study at any time without penalty and without losing any promised benefits. If you withdraw, your data will be deleted from the study and destroyed. In addition, your child is free to not answer specific items or questions during the interviews. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to have your child act as a participant. In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. If you have further questions about this study or your rights as a participant, please contact one of the following:

Dr. Carl Gutwin, Assistant Professor
Department of Computer Science
(306) 966-8646
gutwin@cs.usask.ca

Office of Research Services
University of Saskatchewan
(306) 966-2084

Parent / Guardian Signature: _______________________________________

Date: _______________________________________

Investigator's Signature: _______________________________________

Date: _______________________________________

A copy of this consent form has been given to you to keep for your records and reference. This study has been approved on ethical grounds by the University of Saskatchewan Behavioural Sciences Research Ethics Board on June 9, 2003.

DEPARTMENT OF COMPUTER SCIENCE

UNIVERSITY OF SASKATCHEWAN

INFORMED ASSENT FORM

You are invited to participate in a research project about children and computers. Please read this form carefully, and feel free to ask questions you might have.

Your participation is optional - you do not have to participate if you do not want to.

You will be asked to play three short computer games. After each game, the researcher will ask you some questions about the game you just played. The entire session will take about forty-five minutes.

You may quit at any time if you no longer feel like participating. No one will be angry or upset with you and there will not be any type of penalty. Participate only as long as you are comfortable.

Your contribution will be kept private. It will not be discussed or shared with other children or your parents.

Do you have any questions?

Please sign on the line if you are willing to participate in this project.

Signature of Participant: ____

Appendix B

Questionnaire for Praise Study – Animal Guessing Game

Form and Questionnaire for Team Formation Study – Desert Survival Problem

Questionnaire for Politeness Study – Animal Tutorial

Animal Guessing Game

For each row, circle the word that best describes the ***computer.***

The computer was:

Very Friendly	Friendly	Neither	Unfriendly	Very Unfriendly
Very Boring	Boring	Neither	Interesting	Very Interesting
Very Helpful	Helpful	Neither	Unhelpful	Very Unhelpful
Very Dumb	Dumb	Neither	Smart	Very Smart
Very Likeable	Likeable	Neither	Dislikeable	Very Dislikeable
Very Polite	Polite	Neither	Rude	Very Rude
Very Mean	Mean	Neither	Nice	Very Nice

Animal Guessing Game

For each row, circle the word that best describes ***your feelings*** during the session with the computer**.**

While working with the computer, I felt:

Very Busy	Busy	Neither	Bored	Very Bored
Very Happy	Happy	Neither	Sad	Very Sad
Very Comfortable	Comfortable	Neither	Uncomfortable	Very Uncomfortable
Very Bad	Bad	Neither	Good	Very Good
Very Pleasant	Pleasant	Neither	Unpleasant	Very Unpleasant
Very In Control	In Control	Neither	Powerless	Very Powerless
Very Unimportant	Unimportant	Neither	Important	Very Important
Very Stressed	Stressed	Neither	Calm	Very Calm
Very Unfriendly	Unfriendly	Neither	Friendly	Very Friendly

Animal Guessing Game

For each row, circle the word that best describes ***the computer's comments.***

The feedback from the computer was:

Very Accurate	Accurate	Neither	Incorrect	Very Incorrect
Very Boring	Boring	Neither	Interesting	Very Interesting
Very Fair	Fair	Neither	Unfair	Very Unfair
Very Nasty	Nasty	Neither	Nice	Very Nice
Very Generous	Generous	Neither	Mean	Very Mean
Very Positive	Positive	Neither	Negative	Very Negative
Very Friendly	Friendly	Neither	Unfriendly	Very Unfriendly
Very Unhelpful	Unhelpful	Neither	Helpful	Very Helpful

Animal Guessing Game

For each question, please circle the word that best describes your answer.

How well did you play the game?

Very Well	Well	Neither	Poorly	Very Poorly

How helpful were the questions you suggested?

Very Helpful	Helpful	Neither	Unhelpful	Very Unhelpful

How accurate were the computer's evaluations of your work?

Very Accurate	Accurate	Neither	Not Accurate	Not Accurate At All

How long did the interaction with the computer seem to take?

A Very Long Time	A Long Time	Neither	A Short Time	A Very Short Time

How do you think you compare with others who played this game?

Much Better	Better	Same	Worse	Much Worse

If you had more time, would you be willing to continue working with this computer?

Very Willing	Willing	Neither	Unwilling	Very Unwilling

How willing would you be to continue creating questions for the game?

Very Willing	Willing	Neither	Unwilling	Very Unwilling

How willing would you be to work on a different game with the same computer?

Very Willing	Willing	Neither	Unwilling	Very Unwilling

Desert Survival Problem

Description of the Situation

It's about 10am on a hot, sunny summer day. Your plane has just crashed on a deserted island in the middle of the ocean. You were not hurt in the crash but the plane cannot be fixed. There is no one else on the island, just sand and a few plants. No one knows you have crashed. You are wearing a t-shirt, pants, socks, and sneakers. Before the plane caught fire, you are able to retrieve a few items from the crash site.

Your task is to pick the 5 most important for your survival on this island.

The items are:

- A flashlight
- A knife
- A raincoat
- A small mirror
- A blanket
- A box of cookies
- A survival book
- A 2-metre length of rope

Ranking of items for Desert Survival Problem

In the first column, place a checkmark next to the 5 items that you think are most important to survival in the given situation.

	Your Items	Final Items	Computer's Items
Flashlight			
Knife			
Raincoat			
Mirror			
Blanket			
Cookies			
Survival Book			
Rope			

Desert Survival Problem

For each row, circle the word that best describes the ***computer.***

The computer was:

Very Friendly	Friendly	Neither	Unfriendly	Very Unfriendly
Very Boring	Boring	Neither	Interesting	Very Interesting
Very Helpful	Helpful	Neither	Unhelpful	Very Unhelpful
Very Dumb	Dumb	Neither	Smart	Very Smart
Very Likeable	Likeable	Neither	Dislikeable	Very Dislikeable
Very Polite	Polite	Neither	Rude	Very Rude
Very Mean	Mean	Neither	Nice	Very Nice

Desert Survival Problem

For each row, circle the word that best describes ***your feelings*** during the session with the computer**.**

While working with the computer, I felt:

Very Busy	Busy	Neither	Bored	Very Bored
Very Happy	Happy	Neither	Sad	Very Sad
Very Comfortable	Comfortable	Neither	Uncomfortable	Very Uncomfortable
Very Bad	Bad	Neither	Good	Very Good
Very Pleasant	Pleasant	Neither	Unpleasant	Very Unpleasant
Very In Control	In Control	Neither	Powerless	Very Powerless
Very Unimportant	Unimportant	Neither	Important	Very Important
Very Stressed	Stressed	Neither	Calm	Very Calm
Very Unfriendly	Unfriendly	Neither	Friendly	Very Friendly

Desert Survival Problem

For each question, please circle the word that best describes your answer.

How well did you and the computer work together?

Very Well	Well	Neither	Poorly	Very Poorly

How much did you cooperate with this computer?

Very Much	A Little	Neither	Not Much	Not At All

How much did the computer cooperate with you?

Very Much	A Little	Neither	Not Much	Not At All

How much did you trust the information from the computer?

Very Much	A Little	Neither	Not Much	Not At All

How much did you think of the computer as a helper?

Very Much	A Little	Neither	Not Much	Not At All

How much did you think of the computer as a competitor?

Very Much	A Little	Neither	Not Much	Not At All

How much did you think of yourself as part of a group?

Very Much	A Little	Neither	Not Much	Not At All

How much did you think of the computer as a partner?

Very Much	A Little	Neither	Not Much	Not At All

How helpful were the computer's suggestions?

Very Helpful	Helpful	Neither	Unhelpful	Very Unhelpful

How similar were the computer's suggestions to your suggestions?

Very Similar	Similar	Neither	Different	Very Different

How difficult was it to choose your final items?

Very Difficult	Difficult	Neither	Easy	Very Easy

How much did you agree with the computer's reasons?

Very Much	A Little	Neither	Not Much	Not At All

How similar was your initial ranking to the computer's initial items?

Very Similar	Similar	Neither	Different	Very Different

How similar was your final items to the computer's initial items?

Very Similar	Similar	Neither	Different	Very Different

How much did you enjoy the game?

Very Much	A Little	Neither	Not Much	Not At All

How much would you like to work with this computer again?

Very Much	A Little	Neither	Not Much	Not At All

Are you sure you chose the best set of items?

Very Sure	Sure	Neither	Not Sure	Not Sure At All

Animal Tutorial

For each row, circle the word that best describes the ***computer.***

The computer was:

Very Friendly	Friendly	Neither	Unfriendly	Very Unfriendly
Very Boring	Boring	Neither	Interesting	Very Interesting
Very Helpful	Helpful	Neither	Unhelpful	Very Unhelpful
Very Dumb	Dumb	Neither	Smart	Very Smart
Very Likeable	Likeable	Neither	Dislikeable	Very Dislikeable
Very Polite	Polite	Neither	Rude	Very Rude
Very Mean	Mean	Neither	Nice	Very Nice

Animal Tutorial

For each row, circle the word that best describes ***your feelings*** during the session with the computer**.**

While working with the computer, I felt:

Very Busy	Busy	Neither	Bored	Very Bored
Very Happy	Happy	Neither	Sad	Very Sad
Very Comfortable	Comfortable	Neither	Uncomfortable	Very Uncomfortable
Very Bad	Bad	Neither	Good	Very Good
Very Pleasant	Pleasant	Neither	Unpleasant	Very Unpleasant
Very In Control	In Control	Neither	Powerless	Very Powerless
Very Unimportant	Unimportant	Neither	Important	Very Important
Very Stressed	Stressed	Neither	Calm	Very Calm
Very Unfriendly	Unfriendly	Neither	Friendly	Very Friendly

Animal Tutorial

For each row, circle the word that best describes the ***tutoring session*** (where it gave you facts about animals).

The tutoring session was:

Very Fun	Fun	Neither	Dull	Very Dull
Very Boring	Boring	Neither	Interesting	Very Interesting
Very Helpful	Helpful	Neither	Unhelpful	Very Unhelpful
Very Useless	Useless	Neither	Useful	Very Useful
Very Difficult	Difficult	Neither	Easy	Very Easy
Very Time Consuming	Time Consuming	Neither	Quick	Very Quick
Very Creative	Creative	Neither	Tedious	Very Tedious

Animal Tutorial

For each row, circle the word that best describes the ***scoring session*** (where it told you how well you answered the questions about animals).

The scoring session was:

Very Accurate	Accurate	Neither	Incorrect	Very Incorrect
Very Boring	Boring	Neither	Interesting	Very Interesting
Very Fair	Fair	Neither	Unfair	Very Unfair
Very Nasty	Nasty	Neither	Nice	Very Nice
Very Generous	Generous	Neither	Mean	Very Mean
Very Positive	Positive	Neither	Negative	Very Negative
Very Friendly	Friendly	Neither	Unfriendly	Very Unfriendly
Very Unhelpful	Unhelpful	Neither	Helpful	Very Helpful

Appendix C

Scripts for Praise Study – Praise and Neutral conditions

Scripts for Team Formation Study – Team and Individual conditions

Scripts for Politeness Study – Polite and Non-polite conditions

Animal Guessing Game - praise

In this experiment, you and the computer will work together to design a guessing game, which is something like the game called "20 questions".

First, you will be asked to think of an animal. You will then answer yes/no questions about the animal you have in mind. If the program guesses the animal you have in mind, you simply start the game over again. If the program is wrong, the computer will ask you to enter a question that will help in future rounds of the game.
For example, if you picked a turtle, you could add "Does it have a shell?".
You will play the game 6 times, adding questions whenever your animal is not guessed. In this way you will help the computer improve the program.

At certain points during the computer will give comments about your work. Please read these evaluations so that you can get a clear idea of how you are doing.

As you work with the computer, you'll see that the questions you suggest will become part of the program. When you have completed 6 rounds of the game, the computer will tell you that you are finished. At that point, you can move over here and answer some questions on paper.

Do you have any questions?

(show computer)

To start the program, simply click on "start game".

Animal Guessing Game – neutral

In this experiment, you and the computer will work together to design a guessing game, which is something like the game called "20 questions".

First, you will be asked to think of an animal. You will then answer yes/no questions about the animal you have in mind. If the program guesses the animal you have in mind, you simply start the game over again. If the program is wrong, the computer will ask you to enter a question that will help in future rounds of the game.
For example, if you picked a turtle, you could add "Does it have a shell?".
You will play the game 6 times, adding questions whenever your animal is not guessed. In this way you will help the computer improve the program.

As you work with the computer, you'll see that the questions you suggest will become part of the program. When you have completed 6 rounds of the game, the computer will tell you that you are finished. At that point, you can move over here and answer some questions on paper.

Do you have any questions?

(show computer)

To start the program, simply click on "start game".

Desert Survival – Teammate

The first thing you'll do today is called the Desert Survival Problem. This sheet explains the situation.
[hand over sheet]

You can go ahead and read this now.
[give time to read]

Is the situation clear? Do you understand what you need to do?
[answer questions without adding extra info]

Like the sheet said, you'll need to pick the 5 most important items for surviving on the island. Here's the form you'll use.
[hand over ranking sheet]

You write your initial choices here in this column. Don't worry about these other to columns right now, we'll use them later in the experiment. Just go ahead no and make your initial ranking. Here's a pencil.
[hand over pencil]

Okay, I'm going to give you some time to make up your mind. I'll be waiting right over there. When you are done, come get me, and we'll move on to the next step in the experiment. Okay? Any questions?
[move away]
[when subject is done, bring over to the teammate computer]

Now I'm going to explain more about what you'll be doing. At the end of the experiment you are going to make another set of choices for the 8 items. Before you make your final choice, you'll be interacting with this computer here [point to Blue Computer]. For the rest of the experiment, you'll be working as part of a team, with this computer here as your teammate.
[point to computer]
You and this computer will be members of a team that we'll call the Blue Team. To remind you that you are on the Blue Team, I need you to wear these blue wristbands around your wrists.
[give blue wristbands]

You might have noticed that there is a Green Computer over there, but in this case, you will be teamed up with the Blue Computer instead. Again, you and the Blue Computer [point to blue computer] will work together as team – the Blue Team. Together you will try to come up with the best choice of items for the Desert Survival Problem. Your purpose in working with your teammate is to arrive at the best team choices as possible. Because you are working as a team, you'll be evaluated as a team. Is that clear?

Of course, you may be wondering about how you'll work with this computer as a teammate. It's pretty simple. Your teammate, the Blue Computer, will also choose its 5 most important items. In all probability, your teammate's choices will be different from yours. You will then have a chance to talk with your teammate about each of the chosen items. You will discuss each item, explaining why that item is valuable or not valuable in a desert survival situation. For example,. I see here that you've picked….

[give example by picking something from their sheet and explain… "… you've picked the compass. So what you'd do is explain to your teammate why you choose the compass as one of the important items. Your teammate will then give its own reasons for the item."]

You'll interact like this for the 8 items. After the interactions, you'll get to make a final choice. You'll fill in your final choices here in this column [point out column].

If you're a bit confused right now, don't worry. This whole process will become clearer in a few minutes. In fact, I'll help you through a practice round of interacting with your teammate.

You'll see how this interaction works now as I help you enter your choices onto your screen.
[help enter choices, allowing subject to do the work]

Now it's time to see your teammate's initial choices. Go over to your teammate and write down the choices in this column here.
[point to computer choice column.]

Okay, now, by looking at the sheet, you can see your choices and your teammate's choices.

The time has come to practice the interaction.
[return to subject's screen]

As I said before, you will be able to talk with your teammate about the items on the list. You will discuss the items one at a time. I'll help you practice the interaction. [have subject press Okay].
First, notice that at the top here, it shows what topic we are currently discussing. You will go first in all interactions, your teammate will go second. So in this case, you are discussing the flashlight. This is the field where you enter your text. Click inside the field and begin typing whatever you want to say to your teammate about the flashlight Go ahead and practice now.
[let subject type]

When you are done typing, simply click on this button. Clicking on this button sends your text to your teammate, the Blue Computer. In response, your teammate will provide information about the flashlight. To read your teammate's information, you have to move over here and read your teammate's screen.
[have subject go over and read]

When you are done reading, click Okay then return to your screen to discuss the next topic. This will take you to the next topic on the list

That's the entire interaction for one item.

After you have completed interacting with your teammate on the 8 items, you'll have a chance to make your final choices. In the end, you want to make the best team choices possible.

Do you have any questions?

I'm going to go over here and let you interact with your teammate. When you have finished all 8 items, come and find me. Okay?

[when subject is done with the interaction, take subject aside and give them the questionnaire. Instruct them to complete the questionnaire and come get you when they are done]

You are now done with this experiment. You can take off the blue wristbands [collect wristbands].

Desert Survival – Individual

The first thing you'll do today is called the Desert Survival Problem. This sheet explains the situation.
[hand over sheet]

You can go ahead and read this now.
[give time to read]

Is the situation clear? Do you understand what you need to do?
[answer questions without adding extra info]

Like the sheet said, you'll need to pick the 5 most important items for surviving on the island. Here's the form you'll use.
[hand over ranking sheet]

You write your initial choices here in this column. Don't worry about these other to columns right now, we'll use them later in the experiment. Just go ahead no and make your initial ranking. Here's a pencil.
[hand over pencil]

Okay, I'm going to give you some time to make up your mind. I'll be waiting right over there. When you are done, come get me, and we'll move on to the next step in the experiment. Okay? Any questions?
[move away]
[when subject is done, bring over to their computer]

Now I'm going to explain more about what you'll be doing. At the end of the experiment you are going to make another set of choices for the 8 items. Before you make your final choice, you'll be interacting with this computer here [point to Green Computer]. You'll notice this is a Green Computer. In contrast, you are a Blue Individual. To remind you that you are a Blue Individual, I need you to wear these blue wristbands around your wrists
[give blue wristbands]

You might have noticed that there is a Blue Computer over there, but in this case, you will be teamed up with the Green Computer instead. Again, you and the Green Computer [point to blue computer] will interact about the 8 survival items. The purpose is so that you can come up with your own individual best ranking on the Desert Survival Problem. Your purpose in this interaction is to arrive at your own best choices. Is that clear?

Of course, you may be wondering about how you'll work with this computer as a teammate. It's pretty simple. The Green Computer, will also choose its 5 most important items. In all probability, the Green Computer's choices will be different from yours. You will then have a chance to interact with the Green Computer about each of the chosen items. You will discuss each item, explaining why that item is valuable or not valuable in a desert survival situation. For example,. I see here that you've picked….

[give example by picking something from their sheet and explain… "… you've picked the flashlight. So what you'd do is explain to your teammate why you choose the flashlight as one of the important items. The Green Computer will then give its own reasons for the item."]

You'll interact like this for the 8 items. After the interactions, you'll get to make a final choice. You'll fill in your final choices here in this column [point out column].

If you're a bit confused right now, don't worry. This whole process will become clearer in a few minutes. In fact, I'll help you through a practice round of interacting with your teammate.

You'll see how this interaction works now as I help you enter your choices onto your screen.

[help enter choices, allowing subject to do the work]

Now it's time to see the Green Computer's initial choices. Go over to the Green Computer and write down the choices in this column here.
[point to computer choice column.]

Okay, now, by looking at the sheet, you can see your choices and the Green Computer's choices.

The time has come to practice the interaction.
[return to subject's screen]

As I said before, you will be able to exchange ideas with the Green Computer about the items on the list. You will discuss the items one at a time. I'll help you practice the interaction. [have subject press Okay]. First, notice that at the top here, it shows what topic we are currently discussing. You will go first in all interactions, the Green Computer will go second. So in this case, you are discussing the flashlight. This is the field where you enter your text. Click inside the field and begin typing whatever you want to say to the Green Computer about the flashlight Go ahead and practice now.
[let subject type]

When you are done typing, simply click on this button. Clicking on this button sends your text to the Green Computer. In response, the Green Computer will provide information about the flashlight. To read the Green Computer's information, you have to move over here and read the Green Computer's screen.
[have subject go over and read]

When you are done reading, click Okay then return to your screen to discuss the next topic. This will take you to the next topic on the list

That's the entire interaction for one item.

After you have completed interacting with the Green Computer on the 8 items, you'll have a chance to make your final choices. In the end, you want to make the best individual choices you can.

Do you have any questions?

I'm going to go over here and let you interact with the Green Computer. When you have finished all 8 items, come and find me. Okay?

[when subject is done with the interaction, take subject aside and give them the questionnaire. Instruct them to complete the questionnaire and come get you when they are done]

You are now done with this experiment. You can take off the blue wristbands [collect wristbands].

Animal Tutorial - Polite

In this experiment, you'll be working with a computer to help us test a tutorial system about animals. Do you know what "tutoring" means?
This system has three parts: A tutoring session, a question session, and a scoring session.

The tutoring session should help you learn by showing you facts that matches what you already know. There are 1000 possible facts, the computer will pick the 15 facts it feels will help you the most. After each fact, you will be asked to tell the computer how much you know about this animal. Based on this answer, the computer will decide how many more facts to give you about this type of animal. So, for example if you say you know a lot about zebras, then the computer will not show you many facts about zebras. Do you have any questions about the tutoring session?

The second part is a question session. The computer will ask you 12 multiple choice questions about animals. The computer will randomly pick 12 questions out of its set of 5000 possible questions. For this reason, you may get a question that is unrelated to the facts you were given earlier – just answer as best as you can. We want to see if the computer gave you good information.
Do you have any questions about the testing session?

The third part is the scoring session. Here, the computer will go over each of the multiple choice questions an give you feedback about whether you answered correctly and how it well it feels the tutoring session performed. Please read these carefully.
Do you have any questions about the scoring session?

When you have completed all 3 parts of the tutorial, the computer will tell you that you are finished. At that point, you will be asked to answer some questions about what you thought of the tutorial. The questions will be on the computer as well.

Is this clear?

I'll now show you the computer you'll use.

Animal Tutorial – Non-polite

In this experiment, you'll be working with a computer to help us test a tutorial system about animals. Do you know what "tutoring" means?
This system has three parts: A tutoring session, a question session, and a scoring session.

The tutoring session should help you learn by showing you facts that matches what you already know. There are 1000 possible facts, the computer will pick the 15 facts it feels will help you the most. After each fact, you will be asked to tell the computer how much you know about this animal. Based on this answer, the computer will decide how many more facts to give you about this type of animal. So, for example if you say you know a lot about zebras, then the computer will not show you many facts about zebras. Do you have any questions about the tutoring session?

The second part is a question session. The computer will ask you 12 multiple choice questions about animals. The computer will randomly pick 12 questions out of its set of 5000 possible questions. For this reason, you may get a question that is unrelated to the facts you were given earlier – just answer as best as you can. We want to see if the computer gave you good information.
Do you have any questions about the testing session?

The third part is the scoring session. Here, the computer will go over each of the multiple choice questions an give you feedback about whether you answered correctly and how it well it feels the tutoring session performed. Please read these carefully.
Do you have any questions about the scoring session?

When you have completed all 3 parts of the tutorial, the computer will tell you that you are finished. At that point, you will move over here and answer some questions on paper about what you thought of the tutorial.

Is this clear?

I'll now show you the computer you'll use.