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Your Computer is Watching You: Intelligent Agents and Social Facilitation

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by

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ABSTRACT

This study investigates whether the social facilitation effect takes place when a person performs a computerized task that includes an animated intelligent agent (IA). The moderating effects of two individual differences, locus of control (LOC) and microcomputer playfulness (MCP), are tested for. It was proposed that an IA's presence would cause participants to exhibit this effect and that LOC and MCP would moderate a participant's arousal, measured as state anxiety, such that those possessing an internal LOC and those exhibiting high MCP would experience less arousal when performing computerized tasks with an IA present. Data was analyzed using a 2 (task difficulty) x 4 (intelligent agent) repeated measures MANCOVA. Most hypotheses are not supported, however MCP does appear to moderate arousal depending on the behavior of the IA.

Chapter One: Introduction

Modern technology continues to advance at an amazing rate. Much that was implausible a few years ago is now a reality. Generally, technological advances are looked upon as a boon. Increased microprocessing speeds enable users to complete complex tasks in a fraction of the time they used to take. Messages can be communicated electronically across the globe nearly instantaneously and for free.

One technological advance, the intelligent agent, is gradually making its way into the workplace. The intelligent agent is a computer program that can take some of the burden of work off of the employee by completing routine tasks. Also, the intelligent agent is capable of monitoring a user's work, learning from his or her behavior and offering suggestions to improve performance. In many ways, intelligent agents resemble another coworker, and perhaps a tutor, inside the computer. This is indeed a wonderful invention. However, there may be some unforeseen consequences that could result from such a computerized "coworker/tutor."

There is a growing body of research that indicates, quite convincingly, that people often react socially to computers. Studies have demonstrated that people are sometimes polite to computers, suffer in-group out-group effects with computers, and even find some computers more attractive, trustworthy, and intelligent than other computers. At first, this may sound a bit odd to the reader, after all a computer is only a machine. But this is a response that has been demonstrated repeatedly in experiments (Nass & Moon, 2000; Nass, Moon, & Green, 1997; Nass, Steuer, Henriksen, & Dryer, 1994; Sproull, Subramani, Kiesler, Walker, & Waters, 1996; Sundar, 1993; Sundar & Nass, 2000). Consequently, if people actually respond to machines socially, then it is important to consider the effects that computerized technology might cause before blindly implementing new equipment in the workplace.

One possible social outcome is the social facilitation effect. For more than a century, social scientists have observed how the mere presence of a person can influence the performance of another. Research on this effect indicates that, oftentimes, simple tasks are facilitated and complex tasks are impaired when a person has a witness present (Aiello & Kolb, 1995; Aiello & Svec, 1993; Baron, Moore, & Sanders, 1978; Bond, 1982; Cottrell, 1972; Guerin & Innes, 1982; Hull, 1943; Mason & Brady, 1964; Sanna & Shotland, 1990; Schmitt, Gilovich, Goore, & Joseph, 1986; Spence, 1956; Thiessen, 1964; Triplett, 1898; Zajonc, 1965; Zajonc & Sales, 1966).

Undoubtedly, a large body of evidence suggests the existence of the social facilitation effect in person-person interactions. Might this phenomenon generalize to person-intelligent agent interactions in computerized settings as well? Is it possible that having an intelligent agent on a computer, one that is capable of evaluating performance, carrying out routine tasks, and offering helpful suggestions, might cause users to experience the social facilitation effect as if another person was present? If people respond to computers as they do other people, then it is logical to presume that having an intelligent agent present might also trigger the social facilitation effect, resulting in the improvement of simple and the hindrance of complex tasks.

In this study, the relationship between social facilitation and person-agent interaction was considered. Following a brief discussion of computers in the workplace, intelligent agents are defined in detail and modern examples of intelligent agents are provided. Next, research on social responses to computers is discussed in the context of various examples of how people respond to computers in social ways. Characteristics that invoke social responses in people and popular theories pertaining to this phenomenon are then detailed. Next, the social facilitation effect is described and theories on why social facilitation occurs are delineated. Finally, two likely moderators of this effect are considered: locus of control and microcomputer playfulness. Brief descriptions of these traits and the rationale for their relevance to this study are provided. It was hypothesized that people would experience social facilitation when they worked with intelligent agents, responding in much the same way they would were another person present. Furthermore, it was hypothesized that individual differences in locus of control and microcomputer playfulness would moderate this effect.

Computers at Work

It is difficult to come up with a list of occupations that do not involve the use of computers. Over the span of a few decades, computers have found their way into most jobs and have replaced many tools once considered commonplace. Nearly obsolete are the typewriter, carbon paper, adding machine, and address book, to name a few. It is unequivocal that computers have proven their worth to modern organizations and most employers would balk at the idea of carrying out business without them.

In the last several decades, the number of people using computers in the workplace has grown tremendously. At the same time, the number of people using the

Internet and e-mail programs has also rapidly increased. For instance, in 2001 it was estimated that over 80 percent of people working in the managerial and professional specialty occupations used computers and over 70 percent of people in technical, sales and administrative support occupations did so. Employees involved in these occupations perform a number of computer related tasks: word processing, use of spreadsheets and databases, connecting to the Internet, use of a computer for calendar and scheduling, graphics and design, and programming (National Telecommunications and Information Administration, n.d.).

All of the previously detailed uses for computers can and have served to change the nature of work. Productivity may increase as a result of more efficient computerized tasks. Access to upper levels of management may encourage employees to make themselves better heard (through e-mail). Telecommuting is becoming more common and allows for more flexible and accommodating employee scheduling, which may increase job satisfaction. Secretarial tasks are largely more streamlined as word processors and mail merging is now the norm. Alarm reminders can be used to prevent employees from forgetting important deadlines and schedules. Electronic spreadsheets can now keep figures almost flawlessly, eliminating the need to check and recheck one's arithmetic with a calculator (Ryburn, n.d.). It would seem that computers could only continue to improve productivity in the workplace.

All of the previous cases are examples of computer support. Computer support "involves goal-enabling technologies and associated hardware, software, services, and techniques (Coovert & Thompson, 2001, p. 10)." Some particularly advanced examples of computer support include: artificial intelligence, extended reality, nomadic computing technology, and intelligent agents. Although these types of advanced computer support are not as widespread, they are growing in popularity. This study will focus on intelligent agent technology specifically.

Intelligent Agents

Intelligent agents (IAs) are advanced computer programs that simulate intelligent behavior while executing specific tasks to assist computer users. The computer industry has developed a variety of programs of this type. They go by many names: autonomous agents, adaptive interfaces, intelligent interfaces, and knowbots (Chen, Houston, Nunamaker, and Yen, 1996). Research in IAs is pursued by a variety of disciplines including artificial intelligence, knowledge-based systems, cognitive science and psychology, machine learning, human-machine interaction, robotics, and data communications, to name a few (Sarma, 1996). Accompanying the variety of names to identify IAs and the assortment of fields in which it is studied, IAs also have several definitions. Coovert and Thompson (2001) define an IA as "a computer program that performs tasks without direct human supervision. An IA is considered to be an assistant or helper rather than a conventional electronic tool (p. 8)." Chen et al. (1996) view IAs as a way to help different computer programs perform "… convergent tasks, thus freeing users for more creative work (p.62)." Furthermore, Sarma (1996) describes IAs as "cousins of robots which give the impression that they are capable of thinking, feeling, and living (p. 105)."

As one can see, researchers define IA programs in different ways, attributing many different characteristics to them. At the same time, however, it is important to note that these definitions have a great deal in common. IAs appear to be in a category of their own, separate from conventional computer programs, and therefore worthy of specific research tailored to their exceptional roles.

Intelligent Agent Characteristics

Despite the many definitions for IAs, there is still a great deal left unexplained. Reviewing the various characteristics that IAs are thought to possess can further clarify what IA programs are. Although researchers do not completely agree on the characteristics of IAs, there is much overlap. Coovert and Thompson (2001) list the following seven characteristics for IAs in their book:

1. The ability to work asynchronously and autonomously without intervention from humans,
2. The ability to change behavior according to accumulated knowledge, that is, the ability to learn,
3. The ability to take initiative,
4. Inferential capability (i.e., the ability to go beyond the user's concrete instructions and use symbolic abstraction to solve problems),
5. Prior knowledge of general goals and preferred methods,
6. Natural language, and
7. Personality (p.14).

Similarly, Sarma suggests that an IA must possess: autonomy, social ability, reactivity, pro-activeness, intelligence, mobility, veracity, benevolence, rationality, selectivity, and robustness (1996). Further, Chen et al. (1996) believes that an IA must possess the following attributes: be integrated, expressive, goal-oriented, cooperative, and customized. Clearly, there is much expected of a computer program before it is worthy of the label "intelligent agent." As one might expect, some of these characteristics are easier to develop than others. Thus, one may find that most IAs exhibit reactivity and the ability to work asynchronously, while few agents show signs of true inferential capability.

Uses of Intelligent Agents

Referring to a computer program as "intelligent" brings up many assumptions and expectations. Books and movies are filled with tales about intelligent machines. Popular culture reflects a public fascination with cautionary tales of artificially intelligent computers run amuck or performing tasks that no human could aspire to. Despite our fascination, the reality of modern IAs is a far cry from this level of technological accomplishment. IAs today are not freethinking super machines. Instead, they are simply useful assistants, designed to help users carry out very specific tasks. For example, some agents help sort email so that important messages are brought to the reader's attention and junk mail is immediately deleted. Others continually scan the Internet, seeking news articles that the user might enjoy and find interesting. Further, Maes (1994) provided several examples of IAs that were currently in the process of being tested at the time of her article's publication. These were "Maxims," an electronic mail agent, "NewT," a news filtering agent, "Ringo," an entertainment selection agent, and a meeting-scheduling agent. These are but a few examples, many more types of IAs exist.

How Do Intelligent Agents Work?

Although a technical description of the inner workings of an IA program are beyond the scope of this paper, it is still important to have a general idea of what an IA does. One of the most important characteristics of IAs is the ability to learn. IAs are visualized as computer programs that learn from experience and get better at serving a computer user over time (Sarma, 1996). Computer programmers attempt to develop IA programs that can observe and imitate the behavior of a user while he/she is working on a task. The idea behind this is that the IA will eventually note patterns in the users' behavior that can be easily automated. The IA is essentially “looking over the shoulder” of the user (Maes, 1994) and learning from his/her actions. Other ways an IA can learn are through feedback from a user (e.g., instructions to do or not do some task), instructions received from a user (e.g., “Please delete all email that I receive from John Smith.”), and by requesting advice from other similar IAs either on the same computer or on other computers via the Internet.

This ability to learn forces programmers to approach the programming of IAs in an unusual manner. For example, sometimes programmers create IAs that a user must partially program. As one can imagine, this is not a very popular method. It requires the user to create a collection of rules that guide the action of the IA program. This method is exhibited in many email agents, such as Microsoft Outlook’s “email rule” option. In contrast to this approach, the most popular method of programming IAs is through the knowledge-based approach (Maes, 1994).

The knowledge-based approach requires that a programmer with extensive domain-specific background knowledge create an intelligent agent (Maes, 1994). In other words, an agent programmed according to the knowledge-based approach would already possess extensive knowledge and skills in some specific domain when purchased by the user. The agent would begin immediately offering to automate certain patterns of behavior that it notes and would interject comments to help the user along. Microsoft office has an agent very much like this. It is the office assistant (often depicted as an animated paperclip) that activates in Word, Excel, PowerPoint, and Outlook. Though it is a bit unsophisticated, the Microsoft office agent represents a simple example of an IA with domain-specific background knowledge (e.g., grammar and spelling rules) programmed beforehand. Agents can also learn from direct and indirect feedback provided by a user (Maes, 1994). Neglected agent suggestions would constitute indirect feedback while specific orders to stop a certain behavior would constitute a more direct feedback for the agent to learn from.

Another characteristic of IAs that is important to point out is that they exhibit initiative. This one characteristic makes IAs very different from traditional computer programs. Users manipulate traditional programs. They activate them, control them, and decide when they perform their tasks. In contrast, an IA is capable of performing tasks by itself, without being specifically activated by someone. This does not mean that the user is out of control. He or she may still perform the same tasks manually, bypassing the agent entirely. But if the user should so desire, the agent may be permitted to automatically carry out certain tasks without bothering the user (Sarma, 1996). It is this initiative that, in addition to certain anthropomorphized attributes and personality characteristics, can make an IA seem almost alive.

Why Use Intelligent Agents?

In "Intelligent Software" by Pattie Maes (1995), this theorist explains that many computer capabilities often go unrealized, and therefore unused, by the average computer user due to their complexity. Many of our daily activities have become computer based. There are computers on our cell phones, palm pilots, televisions, even in our cars, not to mention on many desktops around the world. At the same time, most people are not formally trained to use computers. Coupled with the fact that most programs currently respond only to direct manipulation, they are hardly utilized to their fullest ability. As time goes by and computers become more complicated, this problem is exacerbated.

What is needed is a way to delegate complex tasks to computers, a way around the passivity that is today's computer program. What is needed is a computer that knows what it is capable of and can carry out actions on its own, initiating communication with a user, and monitoring what is taking place in and on a computer. Intelligent agents may be the solution.

IAs will eliminate the need for highly detailed and specific instructions provided by computer users. In much the same way that graphical user interfaces have simplified the complicated jargon of operating systems (e.g., Windows), one day IAs may simplify most complex activities carried out by the computer system. In essence, the IA will be one's personal secretary or assistant, saving only the most creative functions for the user's limited attention and time.

Example of an Intelligent Agent

One example of an IA is COACH. Selker (1994) wrote about COACH, the Cognitive Adaptive Computer Help system. COACH is "a system that records user experience to create personalized user help (p. 92)." This program internally watches the users' actions on a computer, records those actions, and offers advice when it recognizes a need for it. The COACH program does not get in the way of the user. It merely waits for the right time to offer assistance. For instance, Selker offers the example of a person writing a computer program. The person types in a command that has certain requirements (i.e., must be named and have an argument list provided). COACH would be familiar with this need and remind the person to provide the required name and arguments if it recognized a need for guidance.

In addition to offering advice, COACH notes errors that are made over time in computer programming. If the programmer makes few, then COACH internally notes that the experience of the programmer is more advanced and consequently it offers advice that only a more advanced programmer would require. This expertise level designation is slow to change, in order to correctly assess programmer levels and not be in a constant state of flux and therefore relentlessly offering differing levels of advice, which would make it unappealing to a person. Slowly, COACH comes to understand its user's needs. This type of agent "builds a user relationship with the explicit goal of educating the individual (Selker, 1994, p.93)."

Problems Associated with Intelligent Agents

Intelligent agents may sound like a good solution to the ever-increasing complexity of computerized technology. However, it is important to note that there are still a variety of concerns about how people feel about and respond to them. Potential problems that people face when they interact with IAs include the loss of feelings of control, overblown expectations, and safety and privacy issues (Norman, 1994).

Feeling of control. People value the feeling of control over their lives and their surroundings. Before a person will be willing to use an IA, he/she must understand it, at least on a basic level, and have confidence in its abilities. History has shown us that, some people have a tendency to resist the introduction of novel automated functions in machines (e.g., automatic transmission, autopilot on a plane). This resistance is common and not completely unwarranted. Humans make machines. Humans make mistakes. Sometimes systems are poorly designed and problems occur. So, in order for IAs to be acceptable, users need to feel like they can control, undo, and monitor an IA's activities.

This need will be particularly evident when a user is first introduced to IAs. During this introductory period, an IA would do well to make its presence known and carefully explain what actions it performs. The user's desire for knowledge about the IA will likely fade with time as trust increases. Nonetheless, most users will appreciate the option of receiving a full report of an IA's actions (Norman, 1994).

Overblown expectations. It is likely that once IAs are accepted, expectations of their abilities will become exaggerated and perhaps unrealistic. Overblown claims about the capabilities of IAs, in conjunction with their anthropomorphized presentation, may contribute to this problem. Creating an IA with a human-like image (on the computer screen) may cause the user to form expectations of human-like behavior and thought. In fact, there are some who believe that it is immoral to offer agents in human form. Because this is such a controversial topic, it has been suggested that IAs be offered with the option to have the human-like image disabled for users who prefer not to see it (Norman, 1994).

Safety and privacy. A final concern is that IAs may eventually have access to personal records, correspondence, and financial activities. Even though IAs may be helpful to computer users, their intrusiveness makes some users uncomfortable. It is likely that when IAs become more common, that privacy and confidentiality will be one of the major issues confronting their widespread use. One day in the near future, there is likely to be much deliberation about IA access and limitations (Norman, 1994).

In summary, intelligent agents are computer programs that simulate intelligent behavior while executing specific tasks to assist computer users. Defined in many different ways, and going by a assortment of labels, these programs possess various similar characteristics including, but not limited to, the ability to learn, initiative, personality, social ability, and customizability. IAs are currently used for rather simplistic tasks such as email filtering or task scheduling, but have the potential to be used for much more. Most notably, IAs are programmed to be capable of learning from a person's computer-use habits and can automate routine behaviors to assist a user more and more over time. These characteristics, combined with a vast set of pre-programmed knowledge will allow IAs to assist users to utilize their computers to their fullest potential. It is worth noting that IAs have some potential pitfalls such as user issues with control, overblown expectations, safety, and privacy, but overall their benefits seem to overshadow their limitations. They are powerful, have the potential for great utility, and will likely continue to increasingly facilitate interactions with computers.

However, there is still much to be discovered about how people interact with IA programs. Over the years, researchers have observed that human interactions with computerized technology can be highly influenced by a person's social proclivities. When considering the utility of IA, it is important to be mindful of the social reactions that people can have with computerized technology in general.

Social Responses to Computers

It is often the case that people respond to, and interact socially with, computers. This is a strange phenomenon. After all, a computer is a machine. Machines do not possess emotions; they lack any feelings to hurt. Anything expressed by a computer is usually a preprogrammed response, not a personal message from the computer to a specific user. It is reasonable to assume that the proper way to treat a computer, besides with the customary care to avoid breaking it, is as an inanimate object, unworthy of social conventions and certainly undeserving of any type of emotional response.

In studies designed to examine human-computer social interaction, participants are often asked whether they think computers have feelings or any other humanlike characteristics. Participants in these types of studies tend to deny such beliefs (Nass & Moon, 2000; Nass, Moon, & Carney, 1999; Nass, Moon, & Green, 1997). Despite these assertions, people have been shown to exhibit social responses to computers (Nass et al., 1997; Nass et al., 1999; Nass & Moon, 2000; Sproull, Subramani, Kiesler, Walker, & Waters, 1996; Sundar & Nass, 2000). The manner in which people socially interact with computers would be better explained if participants were interacting with humanlike robots or computers displaying realistic faces and acting like humans (e.g., exhibiting emotions or referring to itself in the first person.) However, in studies of human-computer social interaction, most human characteristics or behaviors are deliberately excluded from the computers that participants are asked to interact with.

There are numerous examples to choose from of people interacting with computers in a social manner. Nass et al. (1999) provided one such example. They showed that people treat computers politely, as if concerned about hurting a computer's "feelings." Participants in this study were tutored by a computer and then later asked to rate the performance of that computer in the tutoring session. Some participants were asked to rate the computer on a pencil and paper questionnaire. Others were asked to rate the tutor computer on a separate computer across the room. Still others were asked to perform the rating on the same terminal on which they had received the tutoring. Participants rating the tutor computer on the same terminal, rated it more favorably than those asked to do the rating on a pencil and paper questionnaire or a separate terminal. It was as if the participants who had to rate the computer "face to face" so to speak, were being polite to it. But why would participants feel as though they had to be polite to a machine? Surely these participants would not have reported that the machines had feelings. Despite this, in this example, people reacted toward computers in a socially polite manner. In fact, in this experiment, during the post-experiment debriefing, participants denied having been polite to the computer and stated that doing so was unnecessary.

In a second example, Sproull et al. (1996) studied the effects of using a computerized face on participant behavior and arousal. These researchers developed two computer programs that performed the role of a career counselor for the participants. Some of the participants received counseling from an entirely text-based display while others received counseling from a talking-face display. No other attributes of the two programs differed. That is to say, the talking face used exactly the same script that the text-based display used. Sproull et al. found that participants were less relaxed and assured in the face conditions than in the text conditions. Also, participants in the face conditions displayed a more positive self-presentation. Apparently, having a computerized face displayed during a program had an effect on the social behavior of participants. In conditions in which the computer technology was presented as more human-like (i.e., possessing a face), the interaction between human and computer seemed to also be more human-like.

In one final example, Nass et al. (1997) showed that gender stereotypes could be attributed to computers. In their study, participants received tutoring and an evaluation from computers using either male or female sounding voices. Computers tutoring about the topic of computer technology were perceived by participants as being more informative if the message was delivered with a male sounding voice. Conversely, computers with female sounding voices were found to be more informative if the topic delivered was about love and relationships. Furthermore, the evaluation was received more positively if it came from a male voice rather than a female voice. All of these effects reflect well-established social theories about gender roles (e.g., evaluation is more valid if delivered by males and men know more about stereotypically "masculine" topics). What made these findings so interesting is that all the information received by the participants was identical in scripting, and was delivered by a computer, not a person. Nonetheless, the participants responded to the computers the same way that literature suggests they would have responded to a male or female delivering an identical tutoring or evaluative message.

In reviewing the preceding evidence, it becomes clear that there is something remarkable at work here. People are treating computers like other people even though they report that they realize these computers are just machines. Researchers of this occurrence have developed several theories to explain it. These theories include the Computer as Medium (CAM) model, deficiency, anthropomorphism, and the Computer as Source (CAS) model. In the next section, each theory is explained and considered as a possible explanation for this behavior.

CAM Model

According to the CAM model, people do not actually respond to the specific computer that they are using. Instead, the model proposes that people are interacting with the programmer that created the computer program that they are utilizing. When a person responds to a computer in a social manner, s/he is actually imagining the person who wrote the program and responding to that unseen person (Sundar, 1993). The term used to describe this phenomenon is parasocial interaction. According to the CAM model, when a person behaves socially towards a medium (i.e., computer, television, or radio) as if it were the source of the communication, that person is actually actively imagining the true source and reacting to it instead. For instance, if someone yells at a radio because of a message that they heard, this individual is not responding to the radio itself. Rather, the individual is yelling at the imagined source of the message, that is, the radio spokesperson.

In an attempt to examine the CAM model, Sundar and Nass (2000), devised an approach to test whether a person using a computer believed they were in fact communicating with an unseen programmer or the computer itself. In that study, these researchers clearly demonstrated that participants behaved towards computers as if they were the source of the interaction rather than the medium between user and programmer. They demonstrated this by having participants use a computer during a tutoring, testing, and evaluation session. Some of the participants were told that they were interacting with a computer, others that they were interacting with a programmer or a networker. After the interaction was completed, participants were asked to fill out a questionnaire on the performance of the computer, programmer, or networker. Participants exhibited differences in their evaluations of the performance depending on which group they were assigned. Clearly this would not have occurred if a person is merely visualizing an unseen programmer when working on a computer and reacting to him/her. The labeling should not have made a difference in post task evaluations. This study casts some doubt on the CAM theory of human-computer interaction.

In other studies of this type, participants have been asked directly if they are thinking about a programmer when they are responding to the computers. Most deny any such thoughts (Nass & Moon, 2000; Nass et al., 1997).

Deficiency

Another proposed explanation for human-computer social interaction is deficiency. According to this theory, people respond to computers in a social manner because they do not realize that they should not do so. Deficiency theory states that people who are very young, socioemotionally limited, or ignorant, exhibit these social behaviors towards computers. In other words, people respond the way they do because it is the only way they know to respond. Although, it is logical to expect such people to have some difficulty with proper responses to computers (i.e., not in a social manner), in most of the studies cited, college students are used as participants (Nass et al., 1997; Nass et al., 1999; Nass & Moon, 2000; Sproull et al., 1996; Sundar & Nass, 2000). These students, who are not children, can be safely assumed to possess some minimal level of intelligence, and certainly aren't all socioemotionally limited. Given the age and educational level of the average participant, it would seem that deficiency is an inadequate explanation for their behaviors. Furthermore, it has been shown, in at least one study (Nass & Moon, 2000) that both experienced and novice computer users alike respond socially to computers.

Anthropomorphism

Some theorists have tried to explain human-computer social interaction by way of anthropomorphism. Anthropomorphism is the assignment of human traits to something that is not human. However, anthropomorphism does not appear to be a suitable explanation (Nass and Moon, 2000). Some have argued that, in the case of children, anthropomorphism may be an explanation due to cognitive limitations (Turkle, 1984). But, children are rarely the subjects of human-computer social interaction studies. Participants in research of this nature are almost exclusively college students. Furthermore, the idea behind anthropomorphism is that a person actually believes that an inanimate object or animal possesses human characteristics. However, if participants were questioned as to whether they believed inanimate objects possessed human characteristics, they would likely deny harboring any belief of this nature.

Some researchers propose that human social reactions to computers are a case of ethopoeia (Nass and Moon, 2000; Nass, Steuer, Henriksen, & Dryer, 1994). The Greek word ethopoeia describes a situation in which someone exhibits "a direct response to an entity as human while knowing that the entity does not warrant human treatment or attribution" (p. 96). The Computer as Source (CAS) model further describes the case of ethopoeia applied to human-computer interaction.

CAS Model and Mindlessness

According to recent research, people do not seem to be responding to a hidden programmer in human-computer interaction experiments (cf. Nass & Moon, 2000; Sundar & Nass, 2000). Further, mental insufficiency or anthropomorphism has been effectively ruled out as possible explanations. Given the apparent logical constraints of the previous arguments, one might consider the possibility that people are actually responding to computers as the source of communications and consequently reacting socially to them.

But how can an intelligent adult, fully aware that s/he is interacting with a machine, respond to a piece of machinery, a computer, as if it were a person? Nass and Moon (2000) proposed that the key to understanding this phenomenon is Langer's (1992) mindlessness theory.

According to Langer, when someone is behaving in a mindless manner, s/he is on autopilot. Essentially, such a person is behaving in predetermined ways with very little attention being devoted to responding to new stimuli or absorbing novel information. When in this state, a person behaves according to rules and mental shortcuts that have been developed in the past (Langer, 2000).

Langer (2000) describes mindlessness this way:

> When we are in a state of mindlessness, we act like automatons that have been programmed to act according to the sense our behavior made in the past, rather than the present. Instead of actively drawing new distinctions, noticing new things, as we do when we are mindful, when we are mindless we rely on distinctions drawn in the past. We are stuck in a single, rigid perspective, and we are oblivious to alternative ways of knowing. (p. 220)

Nass and Moon (2000) propose that when a person responds mindlessly to a computer, they are in fact responding to a few salient contextual cues that the computer exhibits. "These cues trigger various scripts, labels, and expectations, which in turn focus attention on certain information while diverting attention away from other information" (p. 83). In other words, people note certain cues and respond to those cues without giving any further consideration to the fact that they are coming from an inanimate object, a computer. When this happens, people rely on scripts and schemata that were previously developed in response to other people, not machines. Mindlessly, people react to the computer-generated cues as if they were dealing with another human being.

So what types of cues are necessary to generate a social response from a computer user? Nass and Moon (2000) suggest three cues that computers regularly employ that may cause a person to mindlessly treat their computer in a social manner. One cue is language. Computer programs, to communicate with users, are programmed to use language in the form of text or audible verbal output. A second cue is interactivity. Some computer programs are designed to respond based on prior inputs by a user. Such user contingent behavior may elicit social responses from a person. Finally, computers often fill certain roles, normally held by people. Computers can serve as tutors, evaluators, and counselors, to name but a few. The role a computer fills may also cause a person to respond socially.

In summary, cues such as language, interactivity, and role filled, may cause a computer user to temporarily forget or fail to even consider that s/he is using a machine when certain social responses are called for. Nass and Moon (2000) propose that it is this mental lapse, this automated response in reaction to contextual cues, which causes people to treat their computers like they would treat another person. That is to say, it is not the case that people think the computer is alive or deserving of this special treatment.

Rather, people simply react thoughtlessly, in a manner to which one is accustomed, when exposed to certain cues.

So, we have an odd tendency to follow some social conventions with computers despite the fact that we are aware that we are dealing with an inanimate object (Nass & Moon, 2000; Nass et al., 1999; Nass et al., 1997; Nass et al., 1994; Sproull et al., 1996; Sundar, 1993; Sundar & Nass, 2000; Turkle, 1984). Researchers have demonstrated that we treat our computers with politeness, react physiologically to a computerized face, and even attribute gender stereotypes to computers. Several theories have been offered to explain this: the CAM model, deficiency, anthropomorphism, and the CAS model. Of them, the CAS model seems most promising. It proposes that people attend to environmental cues and mindlessly respond according to predetermined scripts. Cues found to do this include language use, interactivity, and role filled.

Might people exhibit social responses to intelligent agent technology as well? Software designers have programmed intelligent agents to be extremely human-like. It is therefore critical for researchers to consider this possibility and examine the effect of human social interactions with intelligent agent programs. There are a variety of types of social interactions with intelligent agents that could be of interest. The present study will focus on the effect of one of these possible types, social facilitation.

Social Facilitation Effect

For over a century, the social facilitation effect has been a topic of interest and research. In 1898, Norman Triplett first documented social facilitation in a study of the dynamogenic factors in pacemaking and competition. Triplett discovered that children would wind fishing reels faster when another person was competing with them than when performing the same task alone. He concluded that the "bodily presence of another contestant, participating simultaneously in the race, serves to liberate latent energy not ordinarily available" (p. 533). Triplett theorized a number of possible reasons for this phenomenon including encouragement, brain worry, hypnotic suggestion, and automatic movement.

Researchers since have developed their own theories to explain why the mere presence of another person can cause an individual to perform differently on a task as compared to when performing the task alone. Researchers have examined the social facilitation effect by asking participants to partake in numerous tasks including, but not limited to, recognition tasks (Zajonc & Sales, 1966), typing tasks (Schmitt, Gilovich, Goore, & Joseph, 1986), word pair recall tasks (Barron, Moore, & Sanders, 1978), data entry tasks (Aiello & Kolb, 1995), and anagram solving tasks (Aiello and Svec, 1993). Experiments that have employed these types of tasks have yielded a variety of findings, but generally a similar conclusion has been arrived at. When people perform simple tasks, their performance is enhanced by the presence of another individual. Conversely, when people perform complex tasks, their performance is inhibited by that same presence.

Although researchers have generated several lines of evidence demonstrating the existence of social facilitation, the reasoning behind what causes this effect is debatable. Researchers have attributed social facilitation to a number of possible causes including physiological arousal (Zajonc & Sales, 1966), arousal due to evaluation apprehension (Sanna & Shotland, 1990; Schmitt et al., 1986), arousal due to attentional conflict (Baron et al., 1978), arousal due to monitoring of others (Guerin & Innes, 1982), and self-presentation (Bond, 1982). In what follows, each of these theorized causes will briefly be detailed in the context of studies that have demonstrated the presence of a social facilitation effect.

Physiological Arousal

Zajonc (1965) postulated that the mere presence of others could cause an organism to become physiologically aroused. Evidence at the time suggested that the mere presence of others was positively correlated with increased adrenal (Thiessen, 1964) and adrenocortical activity (Mason & Brady, 1964). Furthermore, Zajonc believed that this physiological arousal would have the same effect as when a person's generalized drive is increased. That is, certain responses, dominant responses, would be enhanced and consequently be more likely to be exhibited by an organism. He based this hypothesis on the Hull-Spence behavior theory (Hull, 1943; Spence, 1956). This occurrence is advantageous if the dominant response in a situation happens to be the correct response, but objectionable if a different response is desired in that situation.

Therefore, when the dominant response in a situation happens to be the correct one, the presence of another individual may enhance performance by increasing the likelihood of this correct response. However, when the dominant response is undesired in that situation, the presence of an individual may retard performance of a task by causing the individual performing the task to respond in an incorrect manner (the dominant response being incorrect in that instance). In short, Zajonc used this increase in arousal, due to the presence of others, to explain the social facilitation effect.

To test this theory, Zajonc and Sales (1966) designed an experiment wherein "subjects performed a pseudo-recognition task in which their guessing responses were based on dominant and subordinate habits" (p. 160). Participants were required to learn a number of nonsense words shown to them, ostensibly words in Turkish. The amount of training a participant received differed depending on which group the participant was assigned to. Participants were exposed to the words 1, 2, 4, 8, or 16 times. Next, the words were tachistoscopically displayed and participants were instructed to try to identify the words shown.

Subjects participated in one of two task conditions. In one of the task conditions, the participants performed the recognition task alone. In the other task condition, participants performed before an audience of two confederates who silently witnessed the participants' attempts at word recognition. Zajonc and Sales (1966) hypothesized that the presence of spectators would increase the arousal of participants, therefore increasing the production of dominant behaviors. They found that word recognition responses that were well trained (and therefore were dominant behaviors) benefited from the presence of the two confederates. However, responses that were not well trained (and therefore were not dominant behaviors) showed a marked disadvantage when an audience was present. These results were taken to support Zajonc's (1965) drive/arousal theory of social facilitation.

Since then, researchers have sought a plausible reason for why the presence of others is arousing. Several reasons have been suggested.

Evaluation Apprehension. Some researchers believe that the presence of others can influence performance on a task, by way of generalized drive, but for a very specific reason not previously detailed. One such researcher, Cottrell (1972), proposed that what actually affects human performance on tasks, in the presence of others, is the arousal generated by the anticipation of a valenced evaluation based on performance outcomes. That is, if an individual performs a task in the presence of others that are capable of evaluating one's performance positively or negatively, then this individual's anticipation of a positive evaluation (because a task is easy) may cause him or her to perform better than when performing alone. Conversely, if an individual experiences apprehension about a possible negative evaluation (because a task is difficult), this may cause him or her to perform worse than when performing alone. Cottrell suggests that if this is the impetus behind the social facilitation effect, then what causes the arousal that leads to social facilitation is not the mere presence of an individual per se, but rather the presence of an individual who is watching and capable of evaluating one's performance.

Sanna and Shotland (1990) sought to generate evidence in support of this theory. These researchers designed a study in which participants were asked to perform a series of memory tasks. These participants were manipulated to believe that they had either performed very well or very poorly on early tasks. Later, they performed a similar task either in the presence of an audience or alone. When compared to those performing alone, participants who believed that they were going to do well, based on prior experience, performed better than those working alone. Also, participants who were led to believe that they were going to perform poorly did so when in the presence of others. Apparently their expectations of a positive or negative evaluation affected their performance accordingly.

Schmitt et al. (1986) also tested Cottrell's supposition about evaluation apprehension as a cause of social facilitation. These researchers designed their study to be sensitive to the fact that when participants volunteer to be in a study, they may be particularly aware that they are being studied by the experimenter and hence, evaluation apprehension can take place, whether another individual is present or not. To offset this effect, participants were asked to enter their names and a password composed of their name backwards with numbers interspersed between the letters into a computer. The participants were led to believe that this must be done before the actual experiment took place.

Unbeknownst to the participants, the computer they used to type in this information recorded their typing speed. Entering their name was treated as a simple task (which should elicit a dominant behavior) and the password portion was considered a complicated task (for which no dominant behavior should exist). Participants performed this task either alone, with a watcher present, or with someone else in the room that appeared to be attending to something else and hence seemed to be ignoring the participant. After entering the information into the computer, the experiment ended and participants were thanked for their participation in the study. Participants seemed to believe the deception and expressed surprise that the study was over, suggesting that they may not have been aware of being observed by an experimenter during that particular portion of the experiment.

Results from the study suggest that the mere presence of an individual was sufficient to cause the social facilitation effect. Participants who typed the information with a watcher or with another person present, but ignoring them, exhibited social facilitation. They typed their name faster and their password slower than the people in the control condition with nobody present during the tasks. Based on these findings, Schmitt et al (1986) suggest that, although evaluation apprehension may be sufficient to cause social facilitation, it is not a necessary component for this effect to occur. After all, the participants seemed be affected by the mere presence of another person that was not attending to them and consequently incapable of evaluating their behavior.

Attentional Conflict/Distraction. Another line of research in social facilitation effects suggests that the presence of others is arousing due to attentional conflict or distraction. Researchers espousing this cause believe that it is the distracting effect that the presence of others can have on people, which actually causes the increased arousal that leads to social facilitation (Baron et al., 1978; Sanders & Baron, 1975).

Baron et al. (1978) developed an experiment to test this theory. These researchers asked participants to learn a list of word pairs and later to try to recall them. Some of the word pairs were fairly easy to learn, others were more difficult. The participants were required to recite these word pairs either alone or in the presence of an onlooker. Under these conditions, the traditional social facilitation effect was exhibited. An additional measure of level of distraction was taken during the study. After completing the tasks, participants were asked several questions pertaining to their level of distraction during the experiment such as, “How frequently did you find your attention was focused on something other than the task?” and “To what extent was your attention focused on the learning task during the task period?” (p. 818). A main effect for absence or presence of an audience on distraction was found. Participants in “audience present” conditions reported being more distracted from their task when compared to those in the “audience absent” conditions. People working in the presence of another individual reported being more distracted, regardless of whether they performed a simple or a complex task.

Based on this evidence, Baron et al (1978) proposed that the findings documented in the social facilitation literature were at least partially due to the distracting effects of having an audience present. These researchers were careful to mention that they had not established why drive effects were produced when a participant was distracted.

Monitoring of others. Guerin and Innes (1982) believe that social facilitation simply reflects arousal due to the natural instinct that all creatures have to monitor other organisms, which are in their presence, for dangerous or potentially threatening behavior. In their brief review of the social facilitation literature, Guerin and Innes suggest that the oftentimes-contradictory results of the social facilitation literature can be explained if this explanation is taken into account.

These theorists believe that when a person finds him or herself in the presence of another individual, certain aspects of the other individual may cause that person to monitor him/her: proximity, movement, vocal, facial, postural, and gestural communication, novelty, and eye gazing behavior. The person is looking for any possibility of a future or present threat. Consequently, if the other is familiar or similarly predictable to that person (e.g., if the present individual is blindfolded), very little monitoring is necessary and therefore, little arousal results from the experience. On the other hand, Guerin and Innes (1982) suggest that someone arouses us when we feel the need to prepare to respond to his or her unpredictable, possibly threatening behavior. If there is no perceived threat, then there is no preparation needed, and hence, no heightened arousal.

Guerin and Innes (1982) went on to attempt to explain contradictory results in the social facilitation literature with consideration for this proposed cause. This article did not include an empirical test per se, but instead was a reconsideration of past results under a different assumption. In their survey of past empirical studies, they demonstrated, rather convincingly, that in instances in which the participants were unable to monitor and/or predict the behavior of their audiences, participants exhibit the social facilitation effect. Conversely, in instances where the audiences were predictable and/or inattentive, they were less likely to. This is a compelling alternative explanation for the social facilitation effect although still ultimately dependent upon arousal as a cause. It is merely suggested that the arousal is brought about for a different reason, self-protection.

Self-presentation

Bond (1982) suggests that social facilitation is the result of an individual's active regulation of a public image when an audience is present. On the surface, this theory seems similar to Cottrell's (1972) evaluation apprehension theory. Bond's theory differs, however, in that it does not attribute social facilitation to increased arousal. Rather, Bond proposes that social facilitation is the result of a performer's anticipations of either being able to maintain a positive public self-image or not. Bond suggests that the social impairment that usually occurs when someone attempts to perform a difficult task in the presence of others is due to embarrassment. This embarrassment impedes cognitive and motor control and consequently results in lackluster output.

To test this theory, Bond (1982) asked participants to perform word association tasks. The difficulty of the tasks was varied. Interestingly, Bond surreptitiously included some difficult problems amongst the easy ones and included some easy problems amongst the difficult ones. Hence, a participant in the simple task condition would have mostly easy word associations but would occasionally be presented with a difficult word association. Likewise, a participant in the complex task condition would have mostly hard word associations, but would occasionally be presented with an easy word association. Bond's belief was that a participant performing an easy task would not suffer embarrassment and would perform better in an effort to maintain a positive public image. When this participant encounters a difficult word association, he or she will not have experienced the anticipation of performing poorly, and therefore should not suffer any impairment. The results supported Bonds' hypothesis. Participants, who believed that they were able to do well, did so, even when occasionally given a difficult item. Conversely, participants who believed that they were going to perform poorly, due to the embarrassment of performing a difficult task and continually failing in the presence of another, exhibited impaired performance even when given occasional easy task items amongst the hard ones. Clearly, the participants' expectations had some effect on their performance of the tasks.

Electronic Performance Monitoring and Social Facilitation

A more contemporary line of research relating to social facilitation is the study of the effect of the "virtual" presence of another. Organizations are increasingly employing the use of electronic performance monitoring (EPM). EPM enables an employer to monitor an employee's work behavior at any time by using a network of computers and/or cameras. Essentially, EPM allows an employer to spy on employees at will. Some of the theories about what causes social facilitation effects would suggest that social facilitation could take place even when someone is simply "watching" you by way of computer or video camera. If social facilitation is actually the result of evaluation apprehension, self-presentation concerns, or distraction, then it would seem likely that this effect could result when EPM is used by an organization.

Aiello and Svec (1993) designed an experiment to determine whether a person would perform poorly when being monitored by computer. These researchers asked participants to perform anagram-solving tasks and to enter their responses into a computer. Some of the participants performed this task alone, some in the presence of an audience, and yet others under the impression that someone linked to their computer was monitoring them. Performance was poor for participants who did the task in the presence of an audience and participants who were supposedly monitored by computer. Because Aiello and Svec were interested in demonstrating impairment in the presence of others, simple tasks were not included in this study. Nonetheless, the results of this study suggest that impairment due to performing in the presence of others was generalizable to situations in which someone's "presence" was merely electronic.

Aiello and Kolb (1995) tested and extended this line of inquiry. These experimenters studied the effects of EPM on both simple and complex tasks. Their results supported the findings of previous social facilitation effects studies. That is, participants who were asked to perform a data entry task for which they were highly skilled performed better when being monitored electronically. Participants who were asked to perform the same type of task but who possessed low skill, predictably, performed worse when monitored by computer.

The results of the previously detailed studies suggest that people perform simple tasks better and difficult tasks worse when they perceive the presence of another individual either physically or "virtually." However, it is also clear that the impetus behind the social facilitation effect is highly disputed. It is possible that the effect is the result of physiological arousal due to evaluation apprehension, distraction, or monitoring of others. It is also possible that the effect is due to a person's concerns with self-presentation. Studies have supported all of these theories to one degree or another. Regardless of the reason why the social facilitation effect occurs, it is clear that it does take place and, according to recent research, can occur even when the person watching is doing so from another location such as by computer. Now we will move on to some possible moderators of this effect that were considered in this study.

Possible Moderators of Social Facilitation

Locus of Control

Researchers have investigated the effects of a variety of individual differences on the social facilitation effect. These differences include Type A personality (Gastorf, Suls, & Sanders, 1980), the need for social approval (Adams, Beatty, & Behnke, 1980), social anxiety (Fouts, 1979; Geen, 1991), and locus of control (Aiello & Svec, 1993; Kolb & Aiello, 1996; Martin & Knight, 1985,). In the present study, locus of control was considered as one potential moderator of social facilitation.

Locus of control (LOC), first conceptualized by Julian Rotter in the 1950's, is a social-cognitive learning theory about the way that people respond to reinforcers in their environment. Rotter noticed, during his observations of people in therapy, that people who are exposed to identical conditions for learning can exhibit marked differences in what they actually learn. Rotter attempted to explain this difference in learning by way of how a person perceives the connections between cause and effect. Simply put, some people are able to see the connection between the actions that they take and the consequences generated, while others do not seem to be able to accurately distinguish this relationship (Carver & Scheier, 1996).

Based on his observances, Rotter began to describe people as possessing either an internal or an external LOC. Rotter postulated that people with a more internal LOC tend to believe in their ability to make changes in their environment. These people feel more in control of their lives. However, Rotter suggested that people with a more external LOC tend to see the reinforcers in their lives as being under the control of others or occurring by chance. That is to say, people with a more external LOC believe that their actions have little effect on their environment (Rotter, 1966).

Many lines of research on LOC have tested its relationship with other psychological effects. Social facilitation is no exception. Speculation about a relationship between LOC and social facilitation is explicable by the following logic. A person exhibiting a predominantly external LOC (henceforth referred to as an "external") believes that he or she is not in control of the reinforcers in his/her life. If placed in a social facilitation setting (i.e. performing tasks in the presence of an onlooker) an "external" may become particularly sensitive to the onlooker's presence and exhibit a stronger reaction to his or her presence than someone with a more internal LOC (an "internal"). Researchers speculate that this sensitivity occurs because externals oftentimes attribute control to others, rather than to themselves. Internals, on the other hand, consider themselves in greater control and may therefore exhibit less sensitivity to the presence of an onlooker. There have been several findings that have supported the preceding logic (Aiello & Svec, 1993; Martin & Knight, 1985; Rickenberg & Reeves, 2000). Furthermore, others have demonstrated that externals seem to be more sensitive to some environmental stressors than internals (Coovert & Goldstein, 1980; Lefcourt, Miller, Ware, & Sherk, 1981).

Aiello and Svec (1993) demonstrated that people performing a complex task while being monitored (either by a nearby person or via computer) exhibited the social facilitation effect. What they also discovered was that externals performing this type of task experienced significantly greater anxiety than internals in response to being monitored. Conversely, Kolb and Aiello (1996) found exactly the opposite result in their study. Externals experienced greater stress when not monitored and internals experienced greater stress when monitored. It is not clear why these two studies found opposing results.

Rickenberg and Reeves (2000) found results similar to those of Aiello and Svec (1993). They had participants perform a difficult computerized task either in the presence of animated agents (on the computer screen) or without any agents present. They found that all participants felt more anxiety when agents were present, but anxiety was highest for externals working with an agent monitoring their work.

In 1985, Martin and Knight found a significant interaction between LOC and performance in testing conditions. These researchers had participants carry out a simple paired-associate task either in the presence of an onlooker or alone. They found that internals performed relatively well regardless of whether an onlooker was present or not (they did not exhibit the social facilitation effect at all). But externals showed a striking difference depending on the monitoring condition. If they were not monitored they performed at a lower level than they would if a person was present. LOC seemed to moderate the social facilitation effect for these participants. That is, internals did not exhibit the effect at all, but externals exhibited the responses that would be expected of someone performing a simple task either in the presence of another or alone.

So the results to date are somewhat mixed. But one thing seems to be constant across these studies. Locus of control moderates the social facilitation effect and most of the time, it is the external that seems to be the most affected by the presence of an onlooker (Aiello & Svec, 1993; Martin & Knight, 1985; Rickenberg & Reeves, 2000). Occasionally this influence extends so far as to affect performance on tasks (Martin & Knight, 1985), but most of the time the interaction between LOC and social facilitation is exhibited in relation to the amount of stress or anxiety that the observed person experiences. Thus, externals become most anxious of all when asked to perform while being monitored (Aiello & Svec, 1993; Rickenberg & Reeves, 2000).

Microcomputer Playfulness

Some theorists propose that computers can promote a state of playfulness in their operators due to several characteristics computer's possess including: ease of use, brief latency of responses, and possession of options that can be customized to an operator's preferences (Webster & Martocchio, 1992). Microcomputer playfulness (MCP) is "the degree of cognitive spontaneity in microcomputer interactions" a person exhibits (Webster & Martocchio, 1992, p. 201). It is considered to be a situation specific trait. Webster and Martocchio describe MCP as "a type of intellectual or cognitive playfulness. It describes an individual's tendency to interact spontaneously, inventively, and imaginatively with microcomputers (1992, p. 202)."

The concept of MCP evolved out of the psychological construct "playfulness" (Barnett, 1991). Playfulness is thought to be a trait that is made up of five factors: sense of humor, physical spontaneity, manifest joy, social spontaneity, and cognitive spontaneity (Barnett, 1991). Webster and Martocchio (1992) decided that the last factor, cognitive spontaneity, was the most appropriate factor of playfulness to study in relation to human-computer interaction. These researchers thought that the other four factors seemed more appropriate for social interactions amongst people only.

People who rate high on MCP have the potential for both positive and negative experiences relating to this trait. On one hand, Webster and Martocchio (1992) suggest that people high in MCP may exhibit greater involvement, positive mood, and satisfaction when operating a computer and consequently may exhibit a greater motivation to use computers in the future. However, these researchers propose that those high in MCP may take longer to complete tasks on a computer and may exhibit over-involvement. For example, a person high in MCP might look for chances to do tasks other than work on a computer (e.g. play games) and may become distracted with unimportant aspects of a computer program (e.g. continuously trying different functions on a program or experimenting with formatting options.) Clearly high MCP has the potential of being both beneficial and detrimental for a computer user who is trying to complete a task.

In developing and testing the measure for MCP, the Computer Playfulness Scale, Webster and Martocchio (1992) hypothesized about numerous correlations to determine the convergent, discriminant, and predictive validity of the measure. Their results indicated that people who were rated high in MCP were also high in positive computer attitudes and computer competence. In addition, these researchers found that MCP was negatively correlated with computer anxiety and positively correlated with positive affect, satisfaction during computer use, and other outcome measures. Test-retest reliability was found to be .85 ($p<.001$) at an interval of three months and this was taken as evidence of MCP's trait-like quality. Based on the preceding evidence, it seems logical to suppose that MCP may very well be a stable trait that is associated with positive attitudes towards computers and may be indicative of a lack of computer anxiety. Computer users who are high in MCP tend to react positively when they work with a computer. The stability of this construct was tested again by Yager, Kappelman, Maples, and Prybutok (1997) who also found the Computer Playfulness Scale to be reliable over several administrations with a mean $r = .81$ ($p<.001$).

Several research projects have been conduced to understand the relationship between MCP and computers. For example, Atkinson and Kydd (1997) tested whether computer users who were rated high in playfulness (from which MCP is derived) were more likely to embrace and use the World Wide Web (WWW). They found that playfulness was indeed positively correlated with WWW use. From this, one might speculate that the attribute of playfulness in participants could encourage computer use and buffer fears or anxieties one might have about using a computer to explore the WWW. In fact, Bozionelos and Bozionelos (1997) tested the relationship between playfulness and computer anxiety specifically. These researchers also found that playfulness and computer anxiety were negatively correlated. They concluded that those high in playfulness "have an advantage in terms of experiencing less anxiety when they use computers (p. 957)."

Some researchers who have investigated the effects of MCP (or its close relative playfulness) have done so in relation to training in computers (Martocchio & Webster, 1992; Potosky, 2002) with the finding that those high in playfulness tend to experience more positive outcomes (test performance or post-training programming efficacy judgments) from training. However, MCP's negative association with computer anxiety and its positive correlation with involvement and positive mood during computer use suggest that MCP may have effects beyond training scenarios. Speaking to this issue, Woszczynski, Roth, and Segars (2002) proposed an integrated theory of playfulness in computer interactions. As a part of their model, these researchers projected that computer users that are high in playfulness will experience temporary states of playfulness (compared to Csikszentmihalyi's 1975 theory of flow) that will result in increased satisfaction, computer proficiency, and innovative behaviors during computer use.

It was possible that the microcomputer playfulness trait, which is associated with several positive outcomes in computer use, would have a moderating effect on performance and anxiety during a social facilitation type scenario on a computer. It was possible that individuals high in MCP would experience less anxiety when required to perform a task on a computer that has an IA present due to their playful approach to computer technology. However, whether this reduction in anxiety would affect performance was unclear.

Summary and Hypotheses

Given the importance of computers in the workplace, the growing popularity of intelligent agent computer support, and the evidence suggesting that people mindlessly react to computers according to identifiable social conventions, it would behoove researchers to investigate our responses to intelligent agents. Social facilitation is one social effect that could affect computer users should they find themselves performing tasks on a computer with an intelligent agent installed. Furthermore, it is likely that individual differences such as locus of control and microcomputer playfulness may moderate the effects that an intelligent agent may have on a person. It is with this in mind that the following research hypotheses were proposed:

> Hypothesis 1: Participants will exhibit the social facilitation effect when performing a task on a computer that has an intelligent agent operating. Simple tasks will result in a greater number of correct responses and complex tasks will result in a greater number of incorrect responses when compared to a control condition.
>
> Hypothesis 2: Participants will exhibit greater arousal (as measured by Spielberger, Gorsuch, and Lushene's 1970 state anxiety scale) when performing a task on a computer that has an intelligent agent operating (due to the arousing effects of having an "onlooker" witnessing one's performance.)
>
> Hypothesis 3: The amount of arousal exhibited while performing a task on a computer with an intelligent agent operating will vary depending on whether the agent appears to be actively monitoring the participant or not. That is, an apparently idle agent, not attending to participant behavior, will elicit less arousal than an openly monitoring agent.
>
> Hypothesis 4: Participants' level of arousal will be moderated by their locus of control trait. Participants that are predominantly external in locus of control will exhibit greater arousal as a result of the intelligent agent's presence during tasks than participants that are more internal in locus of control.
>
> Hypothesis 5: Participants' level of arousal will be moderated by their microcomputer playfulness trait. Participants that are high in microcomputer playfulness will exhibit less arousal as a result of the intelligent agent's presence during tasks than participants that are low in microcomputer playfulness.
>
> Exploratory question 1: Will a participant's performance on the computerized tasks be moderated by locus of control?
>
> Exploratory question 2: Will a participant's performance on the computerized tasks be moderated by microcomputer playfulness?
>
> Exploratory question 3: Will an agent, believed to be monitoring a participant from a nearby networked computer, cause participants to exhibit the social facilitation effect?

Chapter Two: Method

Participants

Participants were undergraduate students from the University of South Florida. They were recruited online (using etoolkit) by offering the opportunity to earn extra credit in undergraduate psychology classes. No attempt was made to gather an equal proportion of males to females in this study, as gender was not a variable under consideration. Due to the population of psychology students at the university, females were expected to be over represented in the study. It was anticipated that 84 participants would be necessary for the study (21 per between-subjects condition) as suggested in Cohen and Cohen (1983, p. 59-61) for experiments involving medium effect sizes. The actual number of participants what were included in the study was 103, nineteen more than were proposed. As expected, participants were mostly female (92%). Furthermore, participants were composed primarily of 22 year old, Caucasian (43.7%), college level juniors (37%).

Most participants indicated little if any prior knowledge about intelligent agents (M=2.97, SD=2.62, on a scale ranging from 1 to 10 with 10 indicating much experience with intelligent agents) and only moderate experience at data entry type tasks (M=5.36, SD=2.96, on a scale ranging from 1 to 10 with 10 indicating much data entry experience).

Procedure

Participants were run one at a time, in isolation. When participants arrived for the study, they were escorted to a small private room. This room had a door and provided complete privacy during the main experimental conditions. Participants were seated before a computer. The experimenter explained that the experiment was designed to study how people behaved while working on computers. Participants were to perform two short computerized tasks and their performance would be recorded for later analysis. Next, they were asked to read and sign an informed consent form.

After they signed the informed consent, they were asked to fill out an online questionnaire. They filled out a questionnaire designed to measure microcomputer playfulness (see Appendix A) and some demographic variables (see Appendix B). Data collected by the questionnaires was recorded electronically and, upon completion of the questionnaires, was sent via email to a preset email account. The data collected in this manner did not contain the participants' names. Instead it contained a pre-assigned code number for identification.

Depending on which agent condition participants were assigned to, some participants viewed a computerized introduction to intelligent agents. This consisted of a computerized agent appearing on the monitor and explaining aloud what intelligent agents are, their purpose, and their importance. However, participants in the control condition received a filler task during that time period instead of the computerized introduction to intelligent agents.

Finally, participants in the remotely monitored condition received the same IA introduction, but on a different computer than the one that they would be performing the computerized tasks on. This was done to emphasize to participants that monitoring was to take place from a different location than the computer that the participant was performing the computerized task on. In other words, there was concern that if participants received the IA introduction on the same computer that they performed the computerized tasks, they might not believe that they were being monitored by that agent from another computer. Using separate computers for the introduction and tasks, in this condition only, was thought to make the "remote monitoring" more salient to participants.

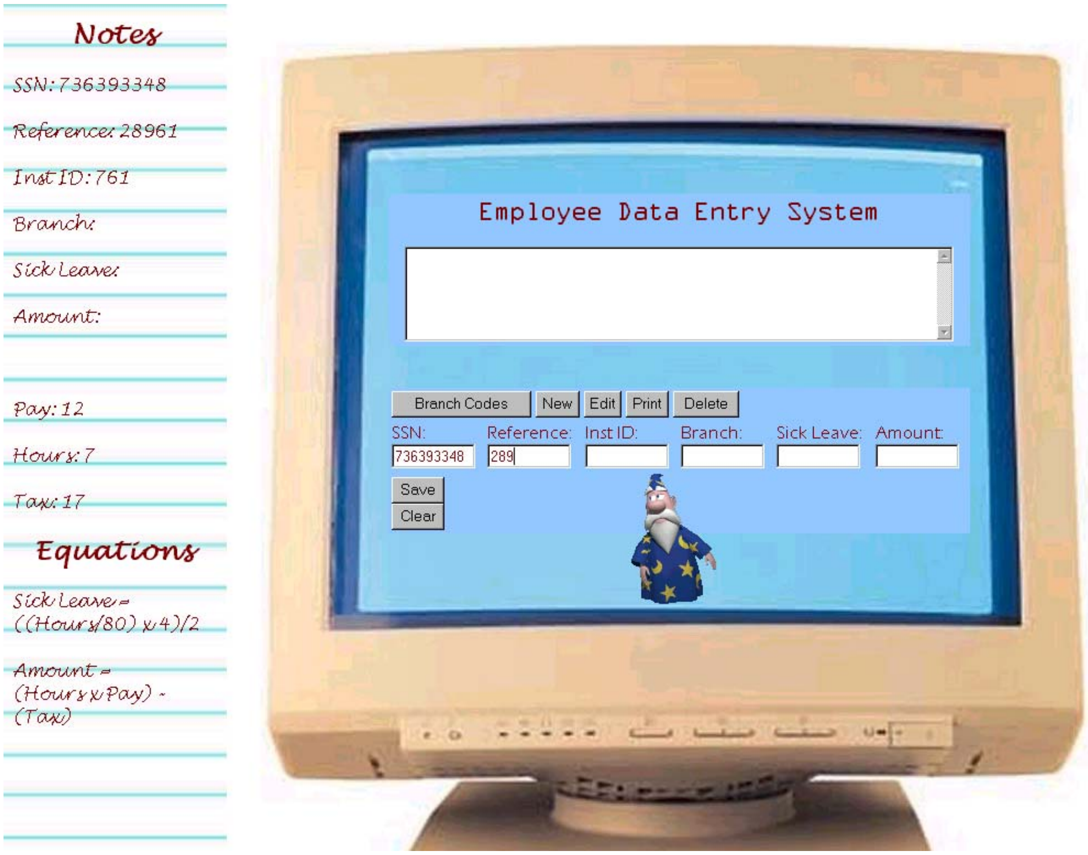
In the three conditions that supposedly involved intelligent agent monitoring (all but the control condition) the participants were deceived. They were told that the agent was observing their onscreen behavior and recording their responses. In reality, the agent was simply responding to specific mouse button clicks. For example, when the participants clicked on the "save" button, the agent appeared to look in the direction of the button and write something down on a piece of paper. It was important that participants felt as if the agent was watching their onscreen behaviors. This was necessary to generate the appropriate arousal that might result in the social facilitation effect.

After the introduction to intelligent agents was complete, the experimenter guided participants through a short practice session to ensure that they fully understood the simple and complex tasks that they were to perform. During the practice sessions, no agent was present. After participants were able to demonstrate an understanding of the tasks, they were ready to begin the experiment. Understanding of the tasks was assumed when a participant was able to complete a trial of entries successfully.

Next, participants performed the simple and complex tasks in the isolated room alone. At no time during the experimental condition was another person present. In the control condition, tasks were performed without any agent onscreen. In the idle agent condition, tasks were performed with an agent present that appeared to be ignoring the participants. Regardless of a participant's onscreen actions, the agent would appear to yawn, avoid responding to participants, and generally ignore them until it fell asleep. In the monitoring agent condition, tasks were performed with an agent present that appeared to be actively watching the participants. The agent appeared to look at participants, turn its head to watch data being entered into onscreen fields, and react to onscreen button clicks. Finally, in the remotely monitoring agent condition, tasks were performed without any agent present. Participants were told that they are being monitored by an intelligent agent that was present on another computer that was networked to the one that participants were working on. Participants were asked to perform two timed computerized tasks: a simple numerical data entry task and a more difficult task that involved both data entry and some more complicated tasks. Those more complicated tasks included the looking up of data in a chart and the computation of two short mathematical formulae. As participants carried out the computerized tasks, performance data was recorded electronically and, upon completion of the tasks, sent via email to a preset email account.

During both computerized tasks, at preset times, a questionnaire designed to measure participants' level of state anxiety appeared on the screen for participants to fill out (see Appendix C). This occurred three times during each task. This data was transmitted electronically along with the performance data at the end of both tasks.

Figure 1: Screen Shot of the Computerized Task



Between the simple and complex tasks, participants were instructed to fill out an additional online questionnaire that measured locus of control (see Appendix D). It was presented between tasks both to collect the data of interest on locus of control and to give participants a break between tasks and hopefully relax a bit.

When both tasks were complete, participants were instructed onscreen to inform the experimenter that they were finished. The experimenter then asked them to complete a manipulation check and follow-up questionnaire online (see Appendix E). Data collected by the questionnaires was recorded electronically and, upon completion of the questionnaires, sent via email to a preset email account. Finally, participants were debriefed. The experimenter explained the purpose of the study to the participants and asked them not to discuss it or the manipulations involved with anyone else.

Measures

Performance was measured as the number of correct responses made during the computerized tasks. As there were six data fields to input, responses for each field were collected to be analyzed both separately and as an aggregate.

Microcomputer playfulness was measured using Webster and Martocchio's (1992) Microcomputer Playfulness Questionnaire. This questionnaire is a 7-item, Likert type scale composed of adjectives that participants use to indicate how they characterize themselves while using computers (see Appendix A).

Locus of control was measured using the Spheres of Control Scale developed by Paulhus (1990). This scale is a 30-item, Likert type scale that is designed to measure three dimensions of locus of control: personal control, interpersonal control, and socio-political control. For the purposes of this study, 20 of the items were used. Specifically, 10 items that measured personal control and 10 items that measured interpersonal control (See Appendix D).

Arousal was measured using the portion of Spielberger's (1970) State-Trait Anxiety Inventory (Form Y) that measures state anxiety. This modified version only contained 10 of the 20 items originally intended to measure state anxiety. The items ask participants to report how strongly they feel at the time by rating their feelings on a 4-point scale with choices that range from "not at all" to "very much so" (See Appendix C).

Additionally, several demographic questions were asked of participants. Specifically, participants were asked to indicate their gender, age, education level, and ethnicity. Also, several items specifically aimed at determining a participant's knowledge of and experience with intelligent agents measured intelligent agent experience. Also, a manipulation check was performed. Participants were asked to indicate whether they believed they were being monitored during the computerized tasks. This was measured to be certain that participants believed that the agent was watching them and monitoring their performance (in the monitoring agent and remotely monitoring agent conditions) or not (in the no agent and idle agent conditions) (See Appendix B).

Apparatus

This study involved the use of two computers. A computer was used to administer one of the initial online questionnaires that all participants were asked to fill out at the experiment's beginning. That same computer was used to introduce the intelligent agent to participants that were assigned to the agent conditions (all except control).

The other computer was located in a private room and was used for the computerized tasks that participants were asked to perform, measurement of locus of control, and the follow up questionnaire/manipulation check. The computerized tasks took place on a web page that had been designed specifically for this study (see figure 4). The web page was created to resemble a screen shot from a computerized payroll application. It consisted of an image of a computer monitor and a separate section in which data is generated. The computer monitor image included several text fields that participants entered data into and several buttons that participants had to click with their mouse during the tasks. Also on the computer monitor image (in idle and monitoring intelligent agent conditions) was a small animated cartoon wizard that represented the intelligent agent. The wizard performed specific actions during the task depending on the experimental condition (as explained in the procedure above).

Data was randomly generated by the computer and appeared before participants in the data section of the screen. Participants used this data to complete the simple and complex tasks.

Chapter Three: Results

Specific Hypotheses and Results in Brief

The following hypotheses are addressed by the forthcoming analyses. This list is repeated at the end of the results section for the reader's convenience.

> Hypothesis 1 (Participants will exhibit the social facilitation effect when performing a task on a computer that has an intelligent agent operating. Simple tasks will result in a greater number of correct responses and complex tasks will result in a greater number of incorrect responses when compared to a control condition.) is not supported.
>
> Hypothesis 2 (Participants will exhibit greater arousal, as measured by Spielberger, Gorsuch, and Lushene's 1970 state anxiety scale, when performing a task on a computer that has an intelligent agent operating.) is not supported.
>
> Hypothesis 3 (The amount of arousal exhibited while performing a task on a computer with an intelligent agent operating will vary depending on whether the agent appears to be actively monitoring the participant or not. That is, an apparently idle agent, not attending to participant behavior, will elicit less arousal than an openly monitoring agent.) is not supported.
>
> Hypothesis 4 (Participants' level of arousal will be moderated by their locus of control trait. Participants that are predominantly external in locus of control will exhibit greater arousal as a result of the intelligent agent's presence during tasks than participants that are more internal in locus of control.) is not supported.
>
> Hypothesis 5 (Participants' level of arousal will be moderated by their microcomputer playfulness trait. Participants that are high in microcomputer playfulness will exhibit less arousal as a result of the intelligent agent's presence during tasks than participants that are low in microcomputer playfulness.) is partially supported.

Repeated Measures Multivariate Analysis of Variance (MANOVA)

A 2 x 4 Difficulty (simple and complex) x Agent (control, idle, active, and remote) repeated measures MANOVA was conducted on task performance and arousal. Difficulty was the within-subjects (WS) variable and Agent was the between-subjects (BS) variable. Following the MANOVA, a 2 x 4 Difficulty (simple and complex) x Agent (control, idle, active, and remote) repeated measures analysis of variance (ANOVA) was conducted on task performance and arousal separately.

Rationale. A repeated measures MANOVA was used to analyze the data because this is a mixed design (one BS variable and WS variable) with two dependent variables. Rather than simply performing two ANOVAs, one MANOVA was used in an attempt to keep familywise error to a minimum.

Agent condition. There is not a significant Agent multivariate main effect, $F(6, 198) = .99$, $p > .05$. Neither is there a significant Agent main effect for the univariate analysis on task performance $F(3, 99) = .90$, $p > .05$, nor on arousal $F(3, 99) = 1.19$, $p > .05$.

Difficulty condition. There is a significant Difficulty multivariate main effect, $F(2, 98) = 718.36$, $p < .01$. There is a significant Difficulty main effect for the univariate analyses on both task performance $F(1, 99) = 1440.97$, $p < .01$, and arousal $F(1, 99) = 8.67$, $p < .01$. Post hoc analyses are not necessary because Difficulty only has two levels. The Simple condition results in significantly greater task performance ($M = 43.78$, $SD = 9.13$) than the Complex condition ($M = 19.40$, $SD = 5.25$). Furthermore, the Simple condition results in significantly less arousal (M = 15.77, SD = 5.19) than the Complex condition ($M = 16.81$, $SD = 5.48$).

Agent x Difficulty condition. There is not a significant Agent x Difficulty multivariate interaction effect, $F(6, 198) = .74$, $p > .05$. Additionally there is neither a significant Agent x Difficulty interaction effect for the univariate analysis on task performance $F(3, 99) = .07$, $p > .05$, nor on arousal $F(3, 99) = 1.31$, $p > .05$.

Table 1: Descriptive Statistics

Agent and Difficulty	M (and SD) mean task performance	M (and SD) mean participant arousal
Control (n = 26)		
Simple	44.00 (11.40)	16.75 (5.70)
Complex	19.23 (6.31)	16.88 (4.81)
Idle agent (n = 27)		
Simple	44.85 (9.98)	14.33 (4.41)
Complex	20.44 (5.73)	15.13 (4.81)
Active agent (n = 25)		
Simple	41.76 (7.13)	15.74 (5.32)
Complex	17.80 (4.58)	17.84 (6.60)
Remote agent (n = 25)		
Simple	44.40 (7.35)	16.34 (5.24)
Complex	20.04 (3.87)	17.52 (5.47)

Repeated Measures Multivariate Analyses of Covariance (MANCOVA)

A 2 x 4 Difficulty (simple and complex) x Agent (control, idle, active, and remote) repeated measures MANCOVA was conducted on task performance and arousal with locus of control (LOC) and microcomputer playfulness (MCP) included in the analysis as covariates. Following the MANCOVA, separate 2 x 4 Difficulty (simple and complex) x Agent (control, idle, actively monitoring, and remotely monitoring) repeated measures ANCOVAs were conducted on task performance and arousal with LOC and MCP included in the analysis as covariates.

Rationale. Repeated measures MANCOVA is used to further analyze the data because it is necessary to test for the potentially moderating effects of LOC and MCP, which are continuous variables. When data is being analyzed that contains both continuous and categorical independent variables, oftentimes ANCOVA is used. Because there are two dependent variables, a MANCOVA is used in an attempt to keep familywise error to a minimum.

When a significant interaction between a continuous and categorical variable occurs, this is indication of moderation (Pedhazur, 1997). In that case, further tests must be carried out to investigate the relationship between the variables of interest (see *Testing for Moderation* below).

Agent condition. There is not a significant Agent multivariate main effect, $F(6, 182) = 1.02$, $p > .05$. Moreover there is neither a significant Agent main effect for the univariate analysis on task performance $F(3, 91) = .21$, $p > .05$, nor on arousal $F(3, 91) = 1.85$, $p > .05$.

Difficulty condition. There is a significant Difficulty multivariate main effect, $F(2, 90) = 5.93$, $p < .01$. Like the results of the MANOVA, there is still a significant Difficulty main effect for the univariate analysis on task performance $F(1, 91) = 11.18$, $p < .01$. Post hoc analyses are not necessary because Difficulty only has two levels. Unlike the results of the MANOVA, there is no longer a significant Difficulty main effect for the univariate analysis on arousal $F(1, 91) = .17$, $p > .05$ when LOC and MCP are controlled for in the MANCOVA.

LOC condition. There is a significant LOC multivariate main effect, $F(2, 90) = 4.49$, $p < .05$. There is not a significant LOC main effect for the univariate analysis on task performance $F(1, 91) = .34$, $p > .05$. But there is a significant LOC main effect for the univariate analysis on arousal $F(1, 91) = 9.03$, $p < .01$. This is because LOC and arousal are negatively correlated (see *Other Interesting Findings* below).

MCP condition. There is not a significant MCP multivariate main effect, $F(2, 90) = .02$, $p > .05$. Furthermore there is neither a significant MCP main effect for the univariate analysis on task performance $F(1, 91) = .36$, $p > .05$, nor on arousal $F(1, 91) = .07$, $p > .05$.

Agent x Difficulty condition. There is not a significant Agent x Difficulty multivariate interaction effect, $F(6, 182) = .47$, $p > .05$. Also there is neither a significant Agent x Difficulty interaction effect for the univariate analysis on task performance $F(3, 91) = .43$, $p > .05$, nor on arousal $F(3, 91) = .60$, $p > .05$.

Agent x LOC condition. There is not a significant Agent x LOC multivariate interaction effect, $F(6, 182) = .53$, $p > .05$. In addition there is neither a significant Agent x LOC interaction effect for the univariate analysis on task performance $F(3, 91) = .20$, $p > .05$, nor on arousal $F(3, 91) = .79$, $p > .05$.

Agent x MCP condition. There is a significant Agent x MCP multivariate interaction effect, $F(6, 182) = 2.34$, $p < .05$. There is not a significant Agent x MCP interaction effect for the univariate analysis on task performance $F(3, 91) = .1.47$, $p > .05$. But there is a significant Agent x MCP interaction effect for the univariate analysis on arousal $F(3, 91) = 3.08$, $p < .05$.

Difficulty x LOC condition. There is not a significant Difficulty x LOC multivariate interaction effect, $F(2, 90) = .08$, $p > .05$. What's more, there is neither a significant Difficulty x LOC interaction effect for the univariate analysis on task performance $F(1, 91) = .08$, $p > .05$, nor on arousal $F(1, 91) = .06$, $p > .05$.

Difficulty x MCP condition. There is not a significant Difficulty x MCP multivariate interaction effect, $F(2, 90) = .55$, $p > .05$. Also there is neither a significant Difficulty x MCP interaction effect for the univariate analysis on task performance $F(1, 91) = .69$, $p > .05$, nor on arousal $F(1, 91) = .59$, $p > .05$.

Agent x Difficulty x LOC condition. There is not a significant Agent x Difficulty x LOC multivariate interaction effect, $F(6, 182) = .43$, $p > .05$. Also there is neither a significant Agent x Difficulty x LOC interaction effect for the univariate analysis on task performance $F(3, 91) = .17$, $p > .05$, nor on arousal $F(3, 91) = .76$, $p > .05$.

Agent x Difficulty x MCP condition. There is not a significant Agent x Difficulty x MCP multivariate interaction effect, $F(6, 182) = .39$, $p > .05$. Moreover there is neither a significant Agent x Difficulty x MCP interaction effect for the univariate analysis on task performance $F(3, 91) = .57$, $p > .05$, nor on arousal $F(3, 91) = .22$, $p > .05$.

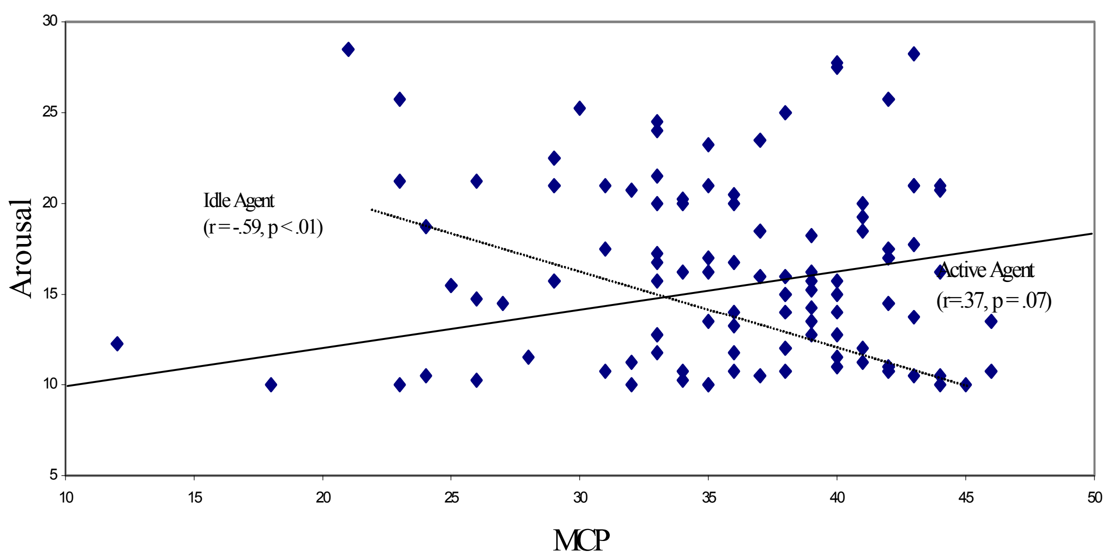
Testing for Moderation

The repeated measures MANCOVA revealed a significant Agent x MCP interaction. Therefore it is necessary to further investigate this finding. First, because there is no main effect of difficulty on arousal when controlling for the two covariates, the two arousal scores for each participant are averaged to form one mean arousal score for each participant in the study.

Second, using multiple regression, Arousal is regressed on Agent, MCP, and a multiplicative term representing the Agent x MCP interaction (Pedhazur, 1997). This results in the unstandardized regression equation: Arousal = 28.94 – 4.95(Agent) – 0.37(MCP) + 0.15(Agent x MCP). This regression equation is not significant, $F(3, 102) = 1.52$, $p > .05$. However the parameter estimates indicate that the interaction term is significant at p < .05, as previously indicated by the MANCOVA. Therefore it is justifiable to conduct further regression analyses for each level of Agent as suggested by Pedhazur.

Third, in order to further test the interaction, the data is split into four groups based on the four Agent conditions (control, idle, active, and remote). Next, four separate regression analyses are conducted, one for each Agent condition. Consequently, Arousal is regressed on MCP four times. This results in four unstandardized regression equations. The control condition unstandardized regression equation, Arousal = 21.50 – 0.13(MCP), is not significant, $F(1, 25) = 0.97$, $p > .05$. But the idle condition unstandardized regression equation, Arousal = 30.88 – 0.44(MCP), is significant, $F(1, 26) = 13.27$, $p < .01$. The active condition unstandardized regression equation, Arousal = 7.95 + 0.25(MCP), is not significant, $F(1, 24)$ 3.58, $p = .07$. It is, however, approaching significance. Finally, the remote condition unstandardized regression equation, Arousal = 16 + 0.03(MCP), is not significant, $F(1, 24) = 0.01$, $p > .05$.

Figure 2: Scatterplot of MCP x Arousal



Chi-squares and One-way ANOVAs to Test Agent Group Equality

Chi-square analyses were used to establish whether statistically significant differences existed between agent conditions on several potentially relevant participant characteristics that are measured categorically. Agent condition groups are equally proportioned by ethnicity (χ^2 (15, N = 103) = 14.71, p > .05), gender (χ^2 (3, N = 103) = 1.93, p > .05), and year in college (χ^2 (12, N = 103) = 12.08, p > .05).

Finally, one-way ANOVAs were used to establish whether statistically significant differences existed between agent conditions on two potentially relevant participant characteristics that were measured on a continuous scale. Agent condition groups are equally proportioned in terms of prior data entry experience F(3, 102) = .27, p > .05 and prior experience with intelligent agents F(3, 102) = 2.58, p > .05.

Other Interesting Findings

The post task questionnaire allowed for a number of additional analyses of interest to be conducted. Chi-square, ANOVA, and correlational analyses were used, as needed, to determine that which follows.

In the post task questionnaire, participants are asked, “During the computerized tasks that you worked on, did you feel as if your performance was being monitored?” Across all four Agent conditions, participants answer similarly (χ^2 (3, N = 103) = 2.55, p > .05). Answers to this yes or no question reveal that 70% of all participants feel as if their performance is being monitored in some way. Also, their responses correlate significantly with arousal scores (r = -.24, p < .05), such that those indicating that they feel they are being monitored report greater arousal during the tasks (*M* = 17.08, *SD* =

5.41) than those indicating that they do not feel that they are being monitored (*M* = 14.46, *SD* = 3.36).

In the post task questionnaire, participants are asked to, "Please indicate how much you felt as if your behavior was being watched during the computerized tasks." Answers are of a 5-point Likert scale format with 1 meaning "Not at all" and 5 meaning "Very much". Across all four Agent conditions, participants answer similarly $F(3, 102) = .57$, $p > .05$. Means reveal that at least 86% of all participants feel that their behavior is being watched to one degree or another. Also, their responses correlate significantly with arousal scores ($r = .30$, $p < .01$), such that those indicating that they felt very much that their behavior was being watched report greater arousal during the tasks (*M* = 21.17, *SD* = 4.01) than those indicating that they do not feel that they were being watched (*M* = 14.43, *SD* = 5.16).

In the post task questionnaire, participants are asked, "How did you feel about the intelligent agent during the computerized tasks?" Answers are on a 5-point Likert scale with low scores indicating dislike and high scores indicating that a participant liked the agent. Participants indicate equal levels of liking for the idle and active agents, $F(1, 51) = .87$, $p > .05$. However, their responses correlate significantly with arousal scores ($r = -.35$, $p < .05$), such that those indicating that they really liked the agent report less arousal during the tasks (*M* = 13.15, *SD* = 2.48) than those indicating that they dislike it (*M* = 18.58, *SD* = 6.79).

In the post task questionnaire, participants are asked, "How distracting was the intelligent agent during the computerized tasks?" Answers are on a 5-point Likert scale with low scores indicating little distraction from the agent and high scores indicating that the participant found the agent very distracting. Participants indicate that the idle and active agents are equally distracting, $F(1, 51) = 1.04$, $p > .05$. However, their responses correlate significantly with arousal scores ($r = .38$, p , .01), such that those indicating that they find the agent very distracting report greater arousal during the tasks ($M = 19.88$, $SD = 5.83$) than those indicating that they do not find the agent distracting ($M = 13.65$, $SD = 4.10$)

In the post task questionnaire, participants are asked, "During the computerized tasks that you worked on, at what point did you stop paying attention to the intelligent agent?" Answers are of a 5-point Likert scale format with low scores indicating that the participant claims to have stopped paying attention to the agent early in the tasks and high scores indicating that the participant claims to have attended to the agent for a longer period of time. Participants indicate that they stop attending to the idle and active agents at approximately the same time, $F(1, 51) = 1.97$, $p > .05$. Furthermore, 63% of all participants indicate that they stop attending to the agent within a couple of minutes of the task's start.

Finally, a number of interesting correlations worthy of mention were found while analyzing the data. LOC correlates negatively with participants' self-reported perceptions of difficulty of the computerized tasks. LOC correlates negatively with how hard participants believed the simple task to be ($r = -.20$, $p < .05$) and with how hard they believe the complex task to be ($r = -.21$, $p < .05$). Therefore, the more internal a person's LOC, the easier they perceive the computerized tasks to be. Also, LOC correlates negatively with participants' arousal during the computerized tasks ($r = -.35$, $p < .01$).

The more internal a participants' LOC, the less arousal they report experiencing during the tasks.

Microcomputer playfulness correlates positively with participants' self-report of when they stop attending to the agent during the computerized tasks ($r = .20$, $p < .05$). Therefore, the more playful a participant is when working on computers, the longer they report attending to the agent during the computerized tasks.

Specific Hypotheses and Results Summary

In review, the following hypotheses were addressed by the analyses. This is simply an abbreviated recap of that originally pointed out at the beginning of the results section.

> Hypothesis 1 (Participants will exhibit the social facilitation effect when performing a task on a computer that has an intelligent agent operating.) was not supported.
>
> Hypothesis 2 (Participants will exhibit greater arousal when performing a task on a computer that has an intelligent agent operating.) was not supported.
>
> Hypothesis 3 (The amount of arousal exhibited while performing a task on a computer with an intelligent agent operating will vary depending on whether the agent appears to be actively monitoring the participant or not.) was not supported.
>
> Hypothesis 4 (Participants' level of arousal will be moderated by their locus of control trait.) was not supported.
>
> Hypothesis 5 (Participants' level of arousal will be moderated by their microcomputer playfulness trait.) was partially supported.

Chapter Four: Discussion

Summary of Results

Intelligent agents (IA) have the potential to become a technological marvel. They are capable of assisting computer users in numerous helpful ways. Despite their already impressive level of ability, it is predicted that agents of the future will be even more capable, more able to assist users, more able to automate routine functions, and will be far more life-like. Indeed there may come a day when intelligent agent technology is truly ubiquitous, with an anthropomorphized IA on every computer screen, watching, learning, and automating a person's computerized tasks. This, of course, leads one to ask how people will respond to them.

Will the presence of a human-like IA on computers affect the way people use them? Will a person's performance suffer, or perhaps improve, as a result of IA involvement in computerized activities? Will a person experience a certain level of heightened anxiety when faced with a computerized agent that is interacting with them in a very personal way? Furthermore, will individual differences affect a person's reactions to an IA? Will there be some people who respond well to IAs while others do not? What will cause them to differ? Or will people simply find themselves unaffected by IAs in all but the most superficial of ways? This thesis set out to begin investigating these questions.

The presence of an IA on a computer screen during a computerized task was expected to cause people to exhibit the social facilitation effect. In other words, people were expected to perform simple tasks better and complex tasks worse when there was an IA present on screen during the execution of the task. It was also proposed that merely being aware that an IA was remotely monitoring one's performance might cause one to exhibit social facilitation. The data failed to support these hypotheses. Participants performing a computerized task exhibited equivalent performance regardless of whether an intelligent agent was on screen or not. All participants, regardless of which agent condition they found themselves in, performed alike.

Because many researchers have proposed that the presence of an onlooker during task performance causes one to experience an increase in physiological arousal (for a number of proposed reasons), it was expected that people would experience an increase in physiological arousal when they performed the previously mentioned computerized tasks with an IA present. Also, it was proposed that the specific behavior of the IA might have an effect on someone's physiological arousal. It was anticipated that an IA that appeared idle, apparently ignoring the actions of a computer user, might cause a person to experience less physiological arousal than a more active IA, one that appeared to carefully watch what the user was doing on the computer. However, the data failed to support these hypotheses. Participants performing a computerized task exhibited equivalent physiological arousal (measured as state stress) regardless of whether an intelligent agent was on screen or not. Furthermore, the specific behaviors of the agent seemed to leave a participant's arousal unaffected. Consequently all participants, regardless of which agent condition they found themselves in, seem to have experienced the same levels of arousal.

It has been suggested by past researchers that certain personality characteristics relate to one's experience of stress. Some people seem to respond well to stressors, others less so. Two personality characteristics in particular were investigated in this study due to their purported relationship with stress and feelings of computer anxiety, locus of control and microcomputer playfulness respectively. It was proposed that as people differ on these two traits, they might respond to the onscreen presence of an IA differently. Specifically, it was hypothesized that those participants who possess a more external locus of control might experience greater arousal, and perhaps a change in task performance, as a result of the presence of an IA than those who possess a more internal locus of control. In addition, it was proposed that those participants who possess a more playful attitude when working with computers might experience less anxiety, and therefore less arousal, as a result of the presence of an IA. This too might affect a user's computerized task performance. These moderating effects are considered separately next.

The data suggests that locus of control, although not a moderator of the effects of IAs on arousal or task performance, nonetheless does relate to someone's experience of arousal while performing a computerized task. When efforts were made to control for a person's locus of control, the effects of a task's difficulty on arousal changed. When considered without taking a person's locus of control into account, the difficulty of the computerized tasks had a direct effect on a participant's arousal. In other words, people experienced more arousal when performing the more complex task than they did when performing the simpler one. However, when locus of control was controlled for, the effects of difficulty on arousal were undetectable. Apparently the differences in arousal, based on the difficulty of the tasks, were merely the result of a person's locus of control rather than how difficult the tasks were. Furthermore, it was found that there was a negative relationship between locus of control and a person's overall arousal experienced during the study. Those individuals possessing a more internal locus of control experienced less arousal during the tasks.

Finally, the data suggests that microcomputer playfulness (MCP) does not moderate the effect of IAs on task performance but may in fact moderate the effect of IAs on arousal. When MCP was controlled for, the effects of an IA on a participant's arousal were different. Originally, without controlling for MCP, IAs appeared to have no effect on a person's arousal while performing a computerized task. Furthermore, MCP appeared to be unrelated to arousal. However, when the data was separated into its four conditions (representing the four levels of the Agent independent variable), one condition, the idle agent condition, revealed a relationship between MCP and arousal. In fact, in the idle condition those who possessed a more playful attitude towards computers appeared to experience less arousal/stress during the computerized tasks. Conversely, those with a less playful attitude appeared to have experienced greater arousal/stress during the task.

Also, in the active agent condition, the data suggests that another interesting relationship between MCP and arousal might exist. Although the relationship was not statistically significant, it was approaching significance and merits attention. In the active condition those who possessed a more playful attitude towards computers appeared to experience more arousal/stress during the computerized tasks and those with a less playful attitude appeared to have experienced less arousal/stress during the task. This disordinal relationship between MCP and arousal, depending upon the behavior of the IA, is an interesting discovery.

Two additional unexpected relationships were discovered while analyzing the data. LOC was found to be negatively correlated with how hard participants reportedly perceived the computerized tasks to be. Those participants who possessed a more internal LOC appear to have found the tasks to be easier than those who possessed a more external LOC. Also, MCP was found to be negatively correlated with how long participants reportedly attended to the intelligent agent on the computer screen. Participants who describe themselves as possessing a more playful attitude when using computers found themselves attending to the IA for a longer period of time during the tasks. Those with a less playful attitude attended to the IA for a shorter period of time.

Explanations for Findings

Agents on performance and arousal. In this study, IAs were found to leave a participant's performance on a computerized task and physiological arousal relatively unaffected. Participants carried out two tasks, of varying difficulty. If the social facilitation effect had taken effect, according to theory, then participants would have performed the simpler task better and their performance of the more difficulty task would have been worsened. The results, however, suggest that an IA doesn't affect someone's computerized performance or arousal one whit, regardless of how it behaves.

One possible explanation for this result is that current IAs don't exhibit enough of the traits that are required to trigger the mindlessness that leads to social reactions to computers. It has been suggested that in order for a computer to cause one to mindlessly respond socially to it, it must exhibit three traits: use of language, interactivity, and the assumption of a traditionally human role. IAs, at present, are infrequently programmed to use audible verbal output. Their output is typically presented in the form of "word balloons." Much like the dialogue of comic strips, when an IA communicates with a computer user, it is usually programmed to present readable text appearing beside it. The IA in this experiment is no exception. Even if audible verbal output is used, it is often difficult to understand. Technology is improving, but at present the voice of an IA often resembles a synthesizer version of human speech. This results in a clearly non-human sounding dialogue that is often difficult to completely understand without the assistance of a "word balloon" presenting the dialogue beside it. Additionally, the interactivity of an agent sometimes appears quite artificial. It doesn't take much insight for a user to quickly realize that an IA is appearing and initiating contact due to some pre-arranged condition. For example, the paper clip IA that appears in Microsoft Word will always appear when a person begins a document with the words "Dear" and then offers to format the document. Although this offer of assistance is welcome, and sometimes useful, it probably doesn't create the illusion of true interactivity. It is very obvious that it appeared merely because of the word that was typed. Finally, an IA's assumption of a human role is somewhat believable, however the appearance of most IAs reminds the user immediately that they are dealing with something non-human. At present, most agent technology appears in the form of cartoon-like characters. Although impressively programmed, a mindless social response is likely not triggered by the appearance of a purple cartoon gorilla on the screen that offers to teach something to the user.

In past studies of social responses to computers, a human image was usually not used. In fact, in most studies great pains were taken to remove any resemblance to a human visage. However, this absence of a human image may in fact aid the studies. At least there is not a less than perfect image to draw a person's attention to the fact that they are dealing with a machine. The social response to computers requires a certain unawareness to occur.

In this study, the IA appeared as a small cartoon wizard. In it's self-introduction, it used synthesized verbal output, with a word balloon. During the computerized tasks the IA, depending on the condition, either ignored the user (thus being clearly not interactive) or attended to mouse clicks on the screen. This was somewhat interactive, but quickly repetitive and predictable, as the task progressed. Taken all together, the appearance, artificial sounding verbal output, and eventual lack of spontaneous interactivity may have resulted in insufficient triggers for a mindless social response.

The predictability of the agent's responses begs consideration of another factor. Some researchers have suggested that in order for the social facilitation effect to occur, a person must view his audience as unpredictable and potentially threatening (Guerin and Innes, 1982). Concerns about the IA's ability to trigger a mindless social response notwithstanding, there is a possibility that the agent was too predictable to cause a participant to experience increased physiological arousal and exhibit the social facilitation effect. Indeed, if this explanation of the social facilitation effect is accurate, then it is unlikely that an intelligent agent would be able to cause changes in a person's task performance. An IA on a computer screen is hardly threatening, and oftentimes predictable.

Another problem with the predictability of the IA is the question of distraction. Baron et al. (1978) attributes social facilitation and the arousal that causes it to the distraction that an onlooker causes. They believe that the distraction caused by an audience is what makes one become physiologically aroused and change their performance. The IA in this study might not have been sufficiently distracting to affect anyone. As already addressed, it was quite predictable. Furthermore, participants indicated that all four Agent conditions were equally distracting. It is hard to determine why this is so. Perhaps the IAs were too repetitive and participants simply tuned them out shortly after the computerized tasks began. After all, most participants indicated that they stopped attending to the IA fairly early on into the computerized tasks. Regardless, if distraction is the true cause of social facilitation, then the four Agent conditions were not sufficiently different in terms of this variable to cause a difference in arousal and performance. Whether this lack of IA distraction is due to insufficient planning on the part of the experimenter or if the type of IA used is simply not very distracting is difficult to determine. Attempts were made to make the IA noticeable (i.e., use of sound effects, position of IA in the center of the computer screen, size of IA), but it was also important that it not be so distracting as to make completion of the computerized task impossible or improbable.

Another consideration in this particular study is that the task deemed complex may not have been complex enough. In other words, perhaps both tasks were "simple" and consequently, the complex task was not affected by social facilitation in the manner expected. Perhaps both tasks, simple and complex, were instead facilitated. This is possible, however the lack of difference compared to the control condition casts doubt on this explanation. Also, analysis of the difficulty variable lends support to the idea that there truly was a difference between the simple and complex condition. When comparing the simple to the complex condition, participants completed more simple entries, entered them faster, experienced less arousal during them, and indicated that they considered them to be of lesser difficulty compared to the complex tasks. Unfortunately, past social facilitation studies fail to indicate how much more difficult a complex task must be compared to a simple one. They simply refer to one task being hard and another one being easy. How they arrive at this operationalization is a mystery. Usually one task appears to be more difficult than the other one, as in this study, but whether it is sufficiently more difficult is not addressed. One can only hope that the difference in difficulty between the tasks in this study was sufficient. The data would suggest that it was.

Finally, a last concern for this study's failure to find a significant effect for the Agent condition is the participants' self-report of feeling monitored. Participants were asked whether they felt that they were being monitored during the experiment in a questionnaire at the end of the study. Regardless of which condition they found themselves in, all four conditions indicated that they felt equally monitored. In other words, participants in the control condition said that they felt monitored just as much as participants in the idle, active, and remote agent conditions. Also, when asked how much they felt like they were being watched, most participants answered that they did feel like they were being watched at least a little bit, regardless of which agent condition they found themselves in. If this is true, then it is possible that the participants in the control condition exhibited social facilitation just the same as the other conditions. Perhaps participants did not believe that they were being left alone, unmonitored, to complete their computerized tasks in the control condition. Perhaps they believed that the experimenter was videotaping them or somehow watching secretly. If they believed this, then perhaps they experienced just as much arousal as the other conditions and exhibited social facilitation too.

So we are left with several possibilities. It is certainly feasible that the presence of an IA during a computerized task does not cause sufficient physiological arousal to cause a change in task performance. However, it is also a possibility that the stimuli were insufficient to cause the social facilitation effect to take place. Maybe none of the participants were exhibiting social facilitation due to the predictability or lack of distraction that the agent presented. Conversely, perhaps all of the participants were exhibiting social facilitation due to the belief, across all conditions, that the experimenter was monitoring their performance.

The role of LOC. In this experiment, the data indicated that locus of control did not moderated the effects of IAs on physiological arousal nor task performance. Before even considering LOC, the Agent condition was found to have no effect on arousal or performance. However, it was possible that an interaction might exist between the Agent condition and LOC that was simply cancelled out at the aggregate level. But that was not the case. No interaction was found.

Notably, LOC was found to correlate significantly with the arousal that participants reported during the computerized tasks. Some studies have found similar results. Researchers have demonstrated that people possessing a more external LOC seem to be more sensitive to some environmental stressors than internals (Coovert &

Goldstein, 1980; Lefcourt et al., 1981). This experiment's results proved to be no exception to that finding. Participants measured as possessing a more internal LOC experienced less arousal during the computerized tasks. This finding further reinforces that externals may in fact be more sensitive to stressors.

Another interesting finding was that participants with a more internal LOC reported in the post task questionnaire that they judged the computerized tasks to be less difficult when compared to the judgments of externals. This also seems to follow past observations that externals are more sensitive to stressors. Perhaps those with a more external LOC experienced more stress while performing the computerized tasks and consequently found the tasks to be more difficult because of their heightened anxiety.

Finally, when initial analyses were performed on the data, the difficulty variable appeared to have a main effect on both participant performance and arousal. However, when LOC was controlled for, as a covariate, the effects of task difficulty no longer appeared to have an effect on arousal. This comes as no surprise because LOC was shown to correlate with arousal, but not with performance. Controlling for the influence of LOC left difficulty affecting only performance. Had LOC not correlated with arousal, this effect would not have occurred.

The role of MCP. Microcomputer playfulness turned out to have some interesting relationships in this study. Initially MCP did not correlate significantly with either performance or arousal. However, upon further investigation, when MCP was included in the analyses as a covariate, an interaction with the Agent condition was uncovered. Following Pedhazur's (1997) instructions on testing for moderation between a continuous and categorical variable, it was found that although at the aggregate level MCP did not correlate significantly with arousal or performance, when the data was separated into four groups based on membership in the Agent conditions, MCP did correlate significantly with arousal in one condition and approached significance in another.

In the two conditions that had no IA visibly present on the computer screen, MCP did not correlate with arousal. However, in the other two conditions that did have an IA on screen, MCP was found to correlate significantly with arousal in one condition and appeared to be approaching significance in the other. In the idle Agent condition, MCP was found to negatively correlate with arousal. In other words, participants who reported having a more playful attitude towards computers also experienced less arousal when the IA was present and appeared to pay no attention to the participant's behavior. In that condition, the IA appeared somewhat attentive when the task began, but quickly began to ignore the participant's onscreen behaviors and soon appeared to fall asleep for the remainder of the task. Apparently, participants with a less playful attitude towards computers found this IA behavior to be more stressful than their more playful counterparts.

With the potential to be even more interesting, in the active Agent condition the results were reversed. In that condition, MCP was found to be approaching a statistically significant positive correlation with arousal ($p = .07$). Although not achieving the alpha limit, it is nonetheless suggestive of a reversal in the relationship between MCP and arousal. In this condition, the IA appeared very attentive when the task began and continued to attend to many of the participant's onscreen behaviors throughout the entire task. It would seem that, in this case, participants with a less playful attitude towards computers found this IA behavior to be less stressful than more playful participants.

These findings are curious. The literature on MCP suggests that in both Agent conditions those participants with higher levels of the playfulness trait would experience less stress. Webster and Martocchio (1992) found that people who were high in MCP exhibited a positive mood and greater satisfaction when operating computers. They also found that MCP was negatively correlated with computer anxiety and positively correlated with positive affect and satisfaction during computer use. However, the findings in this study suggest that in order for MCP to result in such desirable effects, it might be important to consider exactly what is taking place on the computer. Perhaps simply having an idle agent on the screen resulted in a more positive experience for those with high MCP but actually having the IA actively monitoring the high MCP participant proved too much a distraction and resulted in increased arousal. Future research will have to address this question in greater detail.

Lastly, MCP was found to correlate with how long participants reported attending to the IA during the computerized tasks. Those with high MCP reported attending to the IA for a longer duration. This finding converges well with past literature. Webster and Martocchio (1992) warn that those with high MCP might take longer to complete tasks on a computer and may exhibit overinvolvement. They caution that high MCP individuals might become easily distracted with unimportant aspects of computer programs. This study is no exception, participants with higher MCP appear to have found themselves attending to the IA longer than others.

Correlates of Arousal. Finally, arousal, measured in this study as state stress (Spielberger et al., 1970) correlated as would be generally expected. Although not particularly unexpected, it deserves a brief mentioning. Participant reports of whether they felt monitored or not during the tasks correlated with arousal. Those who believed they were being monitored reported higher arousal than those who believed they were not. Similarly, participant reports of how much a participant felt that s/he was being watched during the tasks correlated with arousal too. Those most felt that they were being watched reported the highest arousal in the study. Participant reports of how much they liked the IA correlated with arousal. Those expressing that they liked the IA experienced less arousal than those who did not. Also, participant reports of how distracting they found the IA correlated with arousal. Those finding the IA most distracting experienced greater arousal than those who did not find the IA distracting. All of these correlations, make intuitive sense and further speak to the apparent validity of the measures used in this study.

Implications of the Findings

There are several notable implications of the findings in this study. Intelligent agents and the two traits, locus of control and microcomputer playfulness, were revealed to have effects and relationships that future employers and computer programmers might do well to attend to.

Intelligent agents were demonstrated to have no effect on the performance of participants in this study. Assuming for a moment that these results are accurate, it would seem that software programmers need not concern themselves with worries that having an IA present on a computer screen might prove so distracting or stressful as to retard the performance of an individual using them. However, IAs are not completely without effect. In this study it was found that certain people, based on individual differences, might experience more or less arousal (stress) as a result of an IA's presence and apparent behavior. This is an area in the literature that requires more attention. Some people may find the actual IA behaviors more stressful than others. This would certainly be a drawback to IAs. IAs are meant to be assistants to computer users. If their behaviors are found to be stressful, they may be an unwelcome guest on some people's computers. Employers, hoping that the addition of an IA on an employee's computer will result in greater productivity, might be disappointed. Although the IA in this study did not affect performance, the cumulative effect of multiple stressors, the IA being one of them, might have deleterious effects on employees. Eventually this is likely to impact one's performance in a negative way. Also, as IA technology improves, more lifelike IAs may eventually possess the traits necessary to cause a person to mindlessly react to them in a social manner. When this day comes, we may find that people actually do exhibit the social facilitation effect in the presence of an IA. One published study already suggests that this is the case (Rickenberg & Reeves, 2000).

Another important implication of this study is locus of control's relationship with stress/arousal. Clearly, those with a more external LOC seem to have experienced more stress. Also, externals reported that their tasks were more difficult overall. Organizations need to be aware of this relationship. Some jobs that are particularly high in stress might be better served by individuals possessing a more internal LOC. Externals put into a particularly stressful situation might suffer more than their more internal counterparts, perhaps experiencing the side effects of prolonged stress sooner and with more severity. It is also possible that externals might find their tasks at work to be more difficult and stressful. This is not to say that organizations should only hire those who possess an internal LOC, however in occupations that are especially stressful it might be in the external's best interest to avoid such occupations or at least find effective ways to deal with stress while on the job.

Microcomputer playfulness turned out to an important factor in this study. It needs to be studied more carefully. Apparently participants reacted to different IA behaviors in opposite ways depending on their level of MCP. Idle IA behaviors caused high MCPs to experience less arousal but active IA behaviors caused them to experience more. This is difficult to explain. Despite the uncertainty this produces, one thing is clear. High MCP in employees that work with computers may not be entirely beneficial in all cases. It may depend on the type of program that is being used. Different onscreen output may cause differing stress reactions from a person high in MCP. Prior to this study, it might have been assumed that high MCPs approached all computer problems similarly, that is, in a positive and upbeat manner. This study casts doubt on that assumption.

Also, MCP was related to how long the participants attended to the IAs. This further emphasizes a previous conclusion about MCP. Those high in MCP may become distracted or preoccupied with their computers. This might be a good quality to seek in employees who are expected to be creative on their computers. It might be desirable in programmers, graphic artists, and the like. However, the employee who is expected to simply use his/her computer to perform a specific task, such as an accountant, data analyst, or receptionist, without wasting undue time with a program's many options and extras might be better off with a more moderate level of MCP. Extremely low levels of MCP, which might correlate strongly with computer anxiety would be undesirable, but extremely high levels might be equally so. An organization cannot afford to pay an employee who'd rather spend their time continually testing out a computer's menu of options than doing their assigned job tasks.

Study Limitations

Every study has limitation and shortcomings, this one had several important ones. Participants used in this study were primarily female. Although it would be preferable to have an equal mix of both genders, at the university that this study was conducted at, females appear to outnumber males in the psychology department. Hence this affects generalizability. It would be a stretch to generalize results to both males and females because of the disproportionate number of females in the sample.

Also, the stimuli in this study were presented in a small private room. This was necessary to be certain that participants, should they exhibit the social facilitation effect, were doing so entirely because of the IA's presence and nothing else. However, in the real world people rarely work on their computers in complete isolation. Many do their tasks in cubicles, with people moving about, and are distracted by a variety of unforeseen events. Therefore it is possible that the arousal that participants displayed, as a result of the interaction between MCP and IAs, would not occur in the real world where there are many more important things to worry and stress out about. This is another obstacle to the external validity of this study. This is often the case in controlled experiments. What they gain in internal validity, they lack in external validity.

On the subject of internal validity, there was one substantial concern related to this. As mentioned earlier, participants reported that they believed they were being watched or monitored equally across all four Agent conditions. This is unfortunate. It would have been more desirable for participants in the control condition to indicate that they believed that they were not being monitored in any way. It is understandable that a participant, placed in a room by themselves during an experiment, might believe that they are being watched. It is understandable, but greater pains should have been taken to convince them that they were in fact not being observed in any way while performing their tasks. It could be, however, that when participants indicated that they felt they were being monitored, what they meant was they believed that their performance was being scored and recorded electronically by the computer. This question should have been written differently. Future research should be alert to address this question more carefully.

Finally, the sample size is another concern. Most literature indicates that the social facilitation effect is of medium effect size. However, some have hypothesized that it is instead a small effect size (Bond & Titus, 1983). If they are correct, then the sample (N= 103) may have been of insufficient power to detect a small effect size, particularly in the interactions.

Future Directions

If this topic should be investigated further in the years ahead, it would be beneficial to attempt it in a field setting. The arousal that an intelligent agent causes might fade in a work setting where many distractions and stressors exist. Also, as intelligent agent technology progresses, it would be good to revisit this topic to see if improvements in the technology cause people to respond mindlessly in other ways. It is easy to imagine a person responding to an image of a human face occupying their monitor space, looking into their eyes, and interacting and making suggestions to them just like a regular person. One day, that might be exactly the way an intelligent agent operates.

The locus of control trait has been the subject of innumerable studies. It is likely that this will continue to be the case. Further study of the relationship between locus of control and perceived stress might be beneficial. Also, the microcomputer playfulness trait has barely caught the notice of most researchers. Clearly, based on the results of this study, it is a significant trait that merits further investigation. Future scientists should study it and its interactions in different computerized situations. It may eventually become an important trait to select employees for in the computer field.

Also, if this study should be replicated, it must be done so with a more gender representative sample. It is important that results be generalizable to both males and females. They might be found to react differently to IAs. Also, it is crucial that future social facilitation studies go to great lengths to assure that those who are in the control condition truly believe that they are performing without an onlooker. This is harder than it sounds. Participants are curious and suspicious of deception when they knowingly enter an experimental setting. They are likely to doubt that they are performing a task without any witnesses present. Most probably believe that they are being watched, either by a person or by video camera. After all, why would someone be asked to perform in an experiment if nobody was interested in what they were doing?

In conclusion, despite the several limitations that existed in this experiment, its results are interesting and important. Intelligent agents seem to leave a person's computerized task performance unaffected despite their subtle effect on some people's arousal. Further verification of the role of the locus of control trait on stress was found and suggests the need for a closer look at that relationship. Finally, the microcomputer playfulness trait, a young variable in the psychological field, was revealed to interact with intelligent agents and affect participant arousal. It was also found to relate to one's attention to intelligent agents. Both are interesting findings and possible sources of future research.

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Appendices

Appendix A: Microcomputer Playfulness Questionnaire

DIRECTIONS**:** There are seven items listed below. Each one is a different way a person might describe him or herself when using a personal computer. For each item, please click the response that best matches how much you agree or disagree with the word as a description of yourself when you use a personal computer. For example, if the item was “impulsive” and you think that when you work on a personal computer you are not impulsive, you would want to click on either the statement “disagree” or “strongly disagree.”

1. Spontaneous
2. Unimaginative
3. Flexible
4. Creative
5. Playful
6. Unoriginal
7. Uninventive

(Answers range from “strongly disagree” to “strongly agree.”)

Appendix B: Demographics Questionnaire

1. What is your age?

2. What is your ethnic heritage?

   - American Indian or Alaska Native
   - Asian, Asian American or Pacific Islander
   - African American/Black
   - Hispanic/Latino
   - Caucasian/White
   - Other (Specify)__________

3. What is your gender?

   - Male
   - Female

4. What is the highest grade you have completed in college?

   - Freshman
   - Sophomore
   - Junior
   - Senior
   - Some Graduate School

Appendix C: State Stress Questionnaire

Please read these instructions carefully. Ten statements that people have used to describe themselves will appear next. Read each statement and type the appropriate value in the box provided to indicate how you feel right now, that is, at this moment. There are no right or wrong answers. Do not spend too much time on any one statement. Give the answer that seems to best describe your present feelings.

1. I feel calm.
2. I am tense.
3. I am presently worrying over possible misfortunes.
4. I feel at ease.
5. I feel nervous.
6. I am jittery.
7. I am relaxed.
8. I am worried.
9. I feel frightened.
10. I feel steady.

(Answers range from "not at all" to "very much so.")

Appendix D: Sphere of Control Questionnaire

DIRECTIONS: Twenty statements that people have used to describe themselves are below. Read each statement and click the appropriate answer to indicate how much you agree with the statement. There are no right or wrong answers. Do not spend too much time on any one statement. Give the answer that seems to best describe you.

1. I can usually achieve what I want when I work hard for it.
2. I have no trouble making and keeping friends.
3. I prefer games involving some luck over games of pure skill.
4. I often find it hard to get my point of view across to others.
5. Almost anything is possible for me if I really want it.
6. I find it easy to play an important part in most group situations.
7. I usually do not set goals because I have a hard time following through on them.
8. I can usually develop a close personal relationship with someone I find appealing.
9. Bad luck has sometimes prevented me from achieving things.
10. I can learn almost anything if I set my mind to it.
11. In my personal relationships, the other person usually has more control over the relationship than I do.
12. My major accomplishments are entirely due to my hard work and ability.
13. If there is someone I want to meet I can usually arrange it.
14. I'm not good at guiding the course of a conversation with several others.
15. Most of what will happen in my career is beyond my control.
16. When I need assistance with something, I often find it difficult to get others to help.
17. Once I make plans I am almost certain to make them work.
18. In attempting to smooth over a disagreement I sometimes make it worse.
19. I find it pointless to keep worrying on something that is too difficult for me.
20. I can usually steer a conversation toward the topics I want to talk about.

(Answers range from "strongly disagree" to "strongly agree.")

Appendix E: Post Experiment/Manipulation Check Questionnaire

1. How much experience have you had with intelligent agents prior to this study? Please indicate your experience level on a scale from 1 to 10 (If you don't know what an intelligent agent is, answer 1).
   - o 1
   - o 2
   - o 3
   - o 4
   - o 5
   - o 6
   - o 7
   - o 8
   - o 9
   - o 10

2. During the computerized tasks that you worked on, did you feel as if your performance was being *monitored*?
   - o Yes
   - o No

3. Please indicate how much you felt as if your behavior was being *watched* during the computerized tasks.
   - o Not At All
   - o Very Little
   - o Some
   - o Quite a bit
   - o Very much

4. Was there an intelligent agent on the computer screen during the computerized tasks that you worked on? (The intelligent agent would have looked like a small animated wizard.)
   - o Yes
   - o No

5. Did you see a small animated character, that looked like a wizard, on the computer screen during the computerized tasks that you worked on?
   - o Yes
   - o No

6. Did you feel like the experimenter was secretly watching you during the computerized tasks that you worked on in private?
   - Yes
   - No

7. Prior to this study, how much experience have you had with data entry type tasks (1=No experience to 10=Very experienced)?
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10

8. During the computerized task that you worked on, did the mouse work ok?
   - Yes
   - No (If no, please tell the experimenter)

9. During the computerized tasks that you worked on, at what point did you stop paying attention to the intelligent agent? (The intelligent agent would have looked like a small animated wizard.)
   - There was no intelligent agent present
   - Almost immediately
   - After just a couple of minutes
   - About halfway through the tasks
   - Near the end of the tasks
   - I was continually aware of the intelligent agent

10. On a scale from 1 to 10, with 1 = very east and 10 = very difficult, how would you rate:
    a. The task that involved data entry only?
    - 1
    - 2
    - 3
    - 4
    - 5
    - 6
    - 7
    - 8
    - 9
    - 10

b. The task that involved some data entry, as well as branch code lookups, and some use of equations?

- o 1
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7
- o 8
- o 9
- o 10

11. How distracting was the intelligent agent during the computerized tasks? (The intelligent agent would have looked like a small animated wizard.)
    - o There was no intelligent agent present
    - o Did not distract me at all
    - o He was a little bit distracting
    - o He distracted me a lot
    - o He was a continual source of distraction

12. How did you feel about the intelligent agent during the computerized tasks? (The intelligent agent would have looked like a small animated wizard.)
    - o There was no intelligent agent present
    - o I disliked him
    - o I found him mildly unappealing
    - o I liked him a little bit
    - o I really liked him

13. During the computerized tasks, did the intelligent agent ever disappear from the screen and fail to return? (The intelligent agent would have looked like a small animated wizard.)
    - o There was no intelligent agent in my computerized tasks
    - o It stayed on screen continually
    - o It disappeared at one point and then reappeared (Please inform the experimenter if this occurred)
    - o It disappeared and never reappeared (Please inform the experimenter if this occurred)

14. During the computerized tasks, did any unexpected pop-up windows appear on the screen (other than the branch codes window)?
    - o Yes (If yes, please tell the experimenter)
    - o No