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ANTHROPOCENTRISM AND ANTHROPOMORPHSIM TOWARDS COMPUTERS: DEFINITIONS, PREDICTORS, AND RELATIONSHIPS WITH COMPUTER ATTITUDES

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Dissertation submitted to the Faculty of Arts, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Arts by Coursework (Industrial Psychology).

Johannesburg, 1997

DECLARATION

I hereby declare that this dissertation is my own unaided work. It has not been submitted to any other university in fulfilment of any other degree.

Benoit Raffray 15.1.1997

Benoit Raffray.

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ABSTRACT

The paper set out to define anthropocentrism and anthropomorphism with respect to computers as well as creating valid and reliable scales to measure these constructs. It also explored these constructs' relationship with attitudes towards computers and began to explore possible predictors of anthropocentrism and anthropomorphism. Anthropocentrism with respect to computers was defined as a motive or value in which people perceive humanity to be the most significant of all entities and in which computers are seen as valuable to the extent that they are able to maintain or enhance the quality of life of humans or provide benefits to them. Anthropomorphism with respect to computers was defined as the extent to which people believe that computers have the same capabilities and characteristics that humans have. As hypothesised, anthropocentrism, anthropomorphism and attitudes towards computers were found to be negatively related but distinct constructs. Anthropocentrism was found to be positively related to attitudes towards computers and anthropomorphism was inversely related to attitudes towards computers. Exploratory studies found that predictors of anthropocentrism included gender, and predictors of anthropomorphism included gender, culture, and experience with computers.

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CHAPTER 1: INTRODUCTION

Advances in technology in the last few years have given rise to computers which are relatively inexpensive and capable of performing a wide range of complex tasks. This has led to the introduction of computers into almost every aspect of our day to day lives and these days, almost every organisation which wants to operate efficiently relies on some or other form of computer technology. Most computers modify job tasks, work environments and job opportunities; therefore, with computers playing an ever increasing role at work, it is necessary to understand how workers may react toward and interact with this technology as well as what affects their attitudes, and hence behaviours, towards computers.

This study defines and explores the concepts of anthropocentrism (valuing computers to the degree that they enhance our quality of life and to the degree that they provide benefits for humans) and anthropomorphism (the degree to which a person believes that computers have the same capabilities and characteristics as human beings) towards computers. It then sets out to create two valid and reliable measures, one for anthropocentrism towards computers and the other one to measure anthropomorphism towards computers. Finally, it sets out on some exploratory research to see how anthropocentrism and anthropomorphism with respect to computers are related to attitudes towards computers as well as some other demographic variables including gender, age, culture, educational level and experience with computers.

CHAPTER 2: LITERATURE REVIEW

Definitions of the Constructs

With the exception of Nass, Lombard, Henriksen, and Steuer (1995), there seem to be no studies exploring anthropocentrism with respect to computers. Nass et al. (1995) defined this construct as "the tendency of individuals to perceive the world from a human-centred perspective, in which humankind is the most significant of all entities" (p.229). Similarly, the South African Pocket Oxford dictionary defines anthropocentrism as regarding humans to be the centre of existence (Branford, 1987). Finally, Eysenck and Arnold (1972) define anthropocentrism as a theory or doctrine which elevates humankind as the centre of the world and sees the well-being of humanity as the ultimate purpose of things. These definitions all emphasise the point that humanity is the most important of all entities but do not detail where other, less important entities (such as computers) fit into the whole picture.

Although very little work has been done to explore anthropocentrism with respect to computers, there has been work done on anthropocentrism with respect to the environment (Chandler & Dreger, 1993, Dreger & Chandler, 1993, Gagnon Thompson & Barton, 1994). Gagnon Thompson and Barton (1994) defined anthropocentrism towards the environment as "valuing nature because of material or physical benefits it can provide for humans" (p.148). Of importance in this study is that it highlights the role of the less important entity (ie. nature) as existing in order to provide benefits to humans. Also of importance is that Gagnon Thompson and Barton (1994) define anthropocentrism as a value or motive underlying attitudes towards the environment. Chandler and Dreger (1993) also noted that anthropocentrism is a value by stating that

> "The foundation of an anthropocentric stance involves a subjective statement of value postulating "man" (ie. humanity) as the most important of all forms of life" (p.170).

From this research, one can put forward a formal definition of anthropocentrism with respect to computers (henceforth to be simply termed anthropocentrism) as a motive or value in which people perceive humanity to be the most significant of all entities and in which computers are seen as valuable to the extent that they are able to maintain or enhance the quality of life of humans or provide benefits to them. Therefore, a highly anthropocentric person will value computers if they provide benefits to him/her and have a positive effect on his/her quality of life. On the other hand, if a person low in anthropocentrism values computers, then it is for their (the computers') own sake.

Nass et al. (1995) were of the opinion that a highly anthropocentric person makes numerous distinctions between human beings and computers, so they divided anthropocentrism with respect to computers into three dimensions: physical anthropomorphism, psychological anthropomorphism and acceptance of computers. Nass et al. (1995) defined physical anthropomorphism as "the extent to which individuals believe that computers have the same physical capabilities that humans have" (pp.229-230) and psychological anthropomorphism as "the extent to which individuals believe that computers have the same psychological capabilities that humans have" (p.230). Therefore physical anthropomorphism with respect to computers would include the beliefs that computers can, for example hear, see and move while psychological anthropomorphism with respect to computers would include the beliefs that computers can have feelings or be self aware (Ibid.). Acceptance of computers describes the extent to which humans believe that computers should fill various roles that have traditionally been filled by people. Therefore, Nass et al. (1995), felt that anthropomorphism with respect to computers was an aspect of anthropocentrism rather than a separate construct (the higher an individuals anthropocentrism, the more likely he/she is to make numerous distinctions between humans and computers, hence the lower the individual's anthropomorphism). Nass et al.'s (1995) view that anthropomorphism with respect to computers is a dimension of

anthropocentrism will be challenged later in the study. Also of importance to the study by Nass et al. (1995), is the fact that anthropomorphism was defined as a belief.

Other definitions of anthropomorphism are provided by Branford (1987) who defines it as the "attribution of human form to god, animal, or thing." (p.28) and Caporael (1987) who defines anthropomorphism as "the ascription of human characteristics to nonhuman entities" (p.215). Therefore one could broadly define anthropomorphism towards computers (henceforth to simply be termed anthropomorphism) as the extent to which people believe that computers have the same capabilities and characteristics that humans have.

According to Nass et al. (1995), physical anthropomorphism involves objectively verifiable distinctions that people make between themselves and computers. Hence there is a "true" level of physical anthropomorphism because these distinctions between humans and computers can be made on fact rather than attitudes. However, no facts will lead to an agreement as to the "true" level of psychological anthropomorphism because of the subjectiveness of this construct (Ibid.). Due to the fact that the present study is exploring anthropomorphism in relation to subjective attitudes towards computers, physical anthropomorphism will not be considered any further in this study, nor included in the Anthropomorphism Scale although one must bear in mind that it is to be considered a dimension of anthropomorphism.

Since the psychological aspect of humans can be broadly divided into affect and cognition, it seems that psychological anthropomorphism could also be divided into these two dimensions. Therefore, psychological anthropomorphism can be defined as the extent to which individuals believe that computers have the same psychological capabilities and characteristics as humans. Furthermore, psychological anthropomorphism can be considered to have two dimensions: cognitive and affective anthropomorphism Cognitive anthropomorphism can be defined as the extent to which individuals

believe that computers have the same cognitive capabilities and characteristics that humans have (ie. computers are capable thinking and being self aware) and affective anthropomorphism can be defined as the extent to which individuals believe that computers have the same affective capabilities and characteristics as humans (ie. computers can have feelings). These two dimensions of psychological anthropomorphism are probably related and overlap to some degree.

The reader may look at these definitions of anthropomorphism with no small amount of humour so the concept should be elaborated to some degree. According to Caporael (1987), anthropomorphism has become so wide-spread in modern life that people often take it for granted and fail to react to its peculiarity despite objective knowledge. Some good examples of anthropomorphism are when people get attached to their cars and speak of them as living objects, when people curse vending machines that do not deliver the goods, or in the fact that ships are given the feminine gender. Another good example of anthropomorphism with respect to computers is the on-going debate as to whether or not computers are capable of thinking (see Kruger, 1996 for an interesting view on whether or not machines are capable of thought). This includes the view by Alan Turing (1950) that if a computer and a human were put behind a screen and were asked questions, the computer could be considered capable of thinking if the person asking the questions could not distinguish between the human and computer. This came to be known as the Turing test, a debate which still goes on today as up until now, no computer has been able to pass this test (Kruger, 1996). According to Weizenbaum (1976), anthropomorphism is a psychological consequence of an emotional tie with a machine as an extension of the body. Therefore, anthropomorphised entities become social entities (Caporael, 1987). Many people gain high levels of anthropomorphism because of the deficits in their interpersonal relationships (Turkle, 1980). These individuals would use a computer as "someone" to talk to and the computer can be seen as "the human that never was"- challenging, compliant, never rejecting, and incapable of causing emotional pain (Ibid.). Additionally, people could anthropomorphise computers

because of their unclear status as social or non-social objects. Since computers are animate and give one the impression that they can think and communicate, people may attribute sentience to them (Caporael, 1987). It would make an interesting study to see if E-mail or internet chat lines increase the degree of anthropomorphism an individual may have since the computer communicates messages sent by humans.

Anthropocentrism, Anthropomorphism and Relationships with Computer Attitudes

In order to understand how anthropocentrism (defined as a value) and anthropomorphism (defined as a belief) and attitudes towards computers relate to one another, it is necessary to explore what beliefs, values and attitudes are in general and how they relate to one another.

It was mentioned that a highly anthropocentric person will value computers to the degree that they provide benefits to that individual or have a positive effect on his/her quality of life. If a person low in anthropocentrism values computers, then it is for the computers' own sake. Rockeach (1979) defines a value as a desirable end-state that a person would like to see prevail above all others. Williams (1968) defines them as criteria or standards in terms of which evaluations are made. Rockeach (1968) brings these two definitions together by distinguishing between instrumental and terminal values. Instrumental values are specific modes of conduct that are personally or socially preferable to alternative modes of conduct while terminal values are desirable end-states that one would like to see prevail above all others (Ibid.). Anthropocentrism, according to the definition provided, falls into the terminal values category.

Values are stable and enduring constructs that have affective, cognitive and behavioural aspects (Rockeach, 1973, Williams, 1979). They are affective in the sense that a person can feel emotional

about them, cognitive in the sense that the person knows the end-state to strive for, and behavioural in the sense that they serve as criteria for selection in action (Rockeach, 1979). Therefore, due to the behavioural component, values have an important effect on behaviour, even more so than attitudes (Williams, 1979). According to Rockeach (1973), values serve a number of important functions. Firstly, they serve as standards to take one position or behaviour over possible others. They also help people to rationalise their beliefs, attitudes, and actions. In addition to this, values guide human behaviour because the idealised modes of behaviour they are concerned with are perceived to be instrumental in the attainment of desired end-states. Fourthly, values can be used to persuade others to change their beliefs, values, attitudes and/or actions. Fifthly, they are used to evaluate ourselves in relation to others. Finally, they are motivational in that they enhance or maintain self esteem (Rockeach, 1973).

According to Rockeach (1973) and Homer and Kahle (1988), values are a type of belief. Morgan (1961) defines a belief as the acceptance of a statement or proposition. Rockeach (1968) described three types of beliefs: descriptive/existential, evaluative, and prescriptive/postscriptive beliefs. Descriptive or existential beliefs are those capable of being true or false. Evaluative beliefs are those beliefs where the object of the belief is judged to be good or bad. Prescriptive or postscriptive beliefs are beliefs that some means or end of action is desirable or not (Rockeach (1968). According to Rockeach (1973), values, and hence anthropocentrism, fall into the prescriptive/postscriptive category of belief. In line with the definition provided, anthropomorphism falls into the descriptive/existential category of beliefs in that an individual either believes that a computer has a certain human characteristic or capability or not.

As with values, beliefs have affective, cognitive and behavioural components (Rockeach, 1973). In addition to this, beliefs and values are both determined by one's culture, society (including family and

peers), personal experience, and personality (Morgan, 1961, Rockeach, 1979). Although having a belief does not imply having an attitude towards the object of the belief, beliefs do often serve as rationalisations for attitudes and behaviour (Morgan, 1961).

An attitude can be defined as a learned predisposition to respond in a consistently favourable or unfavourable way with respect to some object termed the attitude object (Fishbein & Ajzen, 1975). The literature on the subject of attitudes is vast and the present study will only focus on how attitudes relate to beliefs and values.

Like values and beliefs, attitudes have been said to have affective, cognitive and behavioural dimensions as is evident in the tripartite model of attitude structure (Pratkanis & Greenwald, 1989, Weiten, 1992). The cognitive component is made up of beliefs about the attitude object, the affective component consists of feelings created by the attitude object in the individual, and the behavioural (or conative) component involves behavioural tendencies towards the attitude object (Ibid.). From the tripartite model of attitude structure, it can be seen that beliefs are a significant aspect of attitudes. Therefore, a belief that computers have human characteristics or capabilities (ie. anthropomorphism) should affect one's attitudes towards computers since it is a part of the components of attitudes. Since it was stated by Rockeach (1973) that values are prescriptive beliefs, then anthropocentrism with respect to computers (as a value) should also have an effect on attitudes towards computers in that it is one of the components of these attitudes in the same way that anthropomorphism is. The tripartite model does however have its problems. Studies have had a difficult time proving that all three domains of the tripartite model apply to any given attitude (Olson & Zanna, 1992). Also, researchers rarely, if ever, operationalise attitudes in terms of the three dimensions of attitudes in the tripartite model (Tesser & Shaffer, 1990). Despite the criticisms of the tripartite model of attitudes, it does highlight well how attitudes, beliefs and values are inter-related.

There are however a number of important differences between attitudes and values (hence beliefs). Attitudes refer to an organisation of several beliefs around an object or situation while values are based on a belief of a very specific kind (Rockeach, 1973). Values also tend to transcend objects and situations while attitudes are focused on these. People also tend to have fewer values than attitudes and values are considered to be a stronger predictor of behaviour than attitudes due to the fact that they are more deeply embedded in an individual's personality (Ibid.). Finally, beliefs and values are considered to be a cause of attitudes (Allport, 1961, Watson, 1966. Rockeach, 1973, Homer & Kahle, 1988). One reason for this is that beliefs and values enable an individual to rationalise his/her attitudes.

There is other research that links beliefs and values to attitudes such as the cognitive consistency theories which link beliefs and attitudes very well. According to Foster and Nel (1992), cognitive consistency theories state that an individual will strive to maintain consistency between his/her cognitive elements or among his/her beliefs, attitudes and actions. Probably the most well known of these theories is Heider's (1958) balance theory. According to balance theory, a person (p) will attempt to keep his/her attitudes regarding another person or object (o) consistent with his/her relationship with a third object or concept (x) (Foster & Nel, 1992). This theory can be applied to explain the relationships between anthropocentrism and attitudes towards computers and anthropomorphism and attitudes towards computers. For example, if a person (p) does not like the idea of computers (o) being alive (x), then the person will not like computers if he/she perceives computers as being alive. Similarly, a person (p) will have a positive attitude towards computers (o) if that person thinks that computers should enhance the quality of life for humans (x) and believes that computers do in fact enhance human's quality of life. The problem with balance theory is that it has been criticised for being too simple and only being able to encompass three elements (Weiten, 1992). Like the tripartite

model however. balance theory does show how anthropocentrism and anthropomorphism can be related to attitudes towards computers.

Fishbein and Ajzen's (1975) expectancy value theory is another theory that can describe how anthropocentrism and anthropomorphism relate to attitudes towards computers. According to Fishbein and Ajzen (1975), an attitude structure has a composite of value (evaluation of the attributes of the object) and expectancy (the subjective probability that the attitude object will bring about valued ends). In other words, attitudes consist of numerous beliefs and values concerning the attitude object (Foster & Nel, 1992). Although the theory has been criticised for its algebraic formulation (the attitude is equal to the product of the sum of beliefs and the sum of values) in that people do not make complicated calculations in their heads when deciding upon an attitude to take towards an object, it is considered to be one of the best attitude theories (Tesser & Shaffer, 1990, Foster & Nel, 1992).

The problem with the research on attitudes and how they relate to beliefs and values is that although it shows that anthropocentrism and anthropomorphism are conceivably related to attitudes towards computers, research does not indicate how strong the relationships are and whether these relationships are positive or negative. The answer to these questions can only be found by correlating the measures of anthropocentrism, anthropomorphism and attitudes towards computers with one another. However, computer attitude scales by Lee (1970) and Rafaeli (1986) can suggest the nature of the relationships between anthropocentrism, anthropomorphism and attitudes towards computers. Lee (1970) found two major factors influencing attitudes towards computers. The first of these was seeing computers as a beneficial tool to be utilised by humans and this factor was seen as positive. The second major factor was a belief that computers are an autonomous entity that can perform the functions of human thinking thus downgrading humans. The second factor was associated with negative attitudes towards computers (Ibid.). Similarly, Cancro and Slotnik (1970) hypothesised that humans view computers as a tool to

be utilised or as a mind controlling entity to be feared. They also classified these factors as positive (computers are a tool to be used) and negative (computers are a mind controlling entity). From this work, both Lee (1970) and Rafaeli (1986) based the positive attitudes of their questionnaires on the computers as a beneficial tool factor and the negative items were based on the computer as a mind controlling entity factor.

The links between these two factors and anthropocentrism and anthropomorphism respectively are evident. Looking at beneficial tool items from Lee (1970) and Rafaeli's (1986) scales such as "Computers bring about a better way of life for the average person." (Lee, 1970) and "Using a computer at work would significantly increase my productivity." (Rafaeli, 1986), it is clear that these items are based in anthropocentric values. Similarly, items such as "Computers can think like a human being thinks." (Lee, 1970) and "Someday in the future, these machines may be running our lives." (Lee, 1970) show anthropomorphic beliefs. The items in both Lee (1970) and Rafaeli's (1986) questionnaires can be found in Brock and Sulsky (1994).

Based on this evidence, anthropocentrism and anthropomorphism should be negatively related to one another, anthropocentrism should be positively related to attitudes towards computers, and anthropomorphism should be negatively related to attitudes towards computers. This is in line with the views held by Nass et al. (1995) that a anthropomorphism forms a part of anthropocentrism but in a negative relationship.

If anthropocentrism and anthropomorphism are negatively related as suggested by the above research, the question arises as to whether they are distinct constructs or not. As was mentioned, Nass et al. (1995) considered anthropomorphism to be an aspect of anthropocentric thinking and hence the two constructs were not distinct. In support of this point, Dambrot, Watkins-Malek, Silling, Marshall, and Glover (1985) believed that the two factors in Lee's (1970) scale are in

fact antithetical. The basic idea behind this idea is that people who believe computers are a beneficial tool to be used by humans reject the notion that computers are an autonomous entity that will replace the tasks that humans perform. Therefore if this is true, anthropocentrism and anthropomorphism could just be two different sides to the same coin. However, according to Brock and Sulsky (1994), Lee's (1970) scale was considered to be bi-dimensional and that it was possible to perceive computers both as a beneficial tool and as an autonomous entity. The present study agrees with this latter point of view in that it is conceivable that an individual values computers for the benefits they can provide to humans yet believes that computers have human capabilities or characteristics (although due to the negative relationship hypothesised between anthropocentrism and anthropomorphism, this is unlikely).

Predictors of Anthropocentrism and Anthropomorphism

Assuming that anthropocentrism and anthropomorphism are related to attitudes towards computers as suggested in the previous section, it seems likely that some of the predictors of attitudes towards computers may also be able to predict anthropocentrism and anthropomorphism. The predictors that will be considered are gender, age, culture, educational level, and experience with computers.

With regards to gender, females are more likely than males to have computer anxiety and express more negative attitudes towards computers than males do (Chen, 1985, Shashaani, 1994). Assuming this is the case, it seems that females should have lower levels of anthropocentrism due to the expected positive relationship between anthropocentrism and attitudes towards computers. Similarly, due to the expected negative relationship between anthropomorphism and attitudes towards computers, females should have higher levels of anthropomorphism. Experience with computers may be the variable that causes these differences between males and females (Shashaani, 1994). Studies have shown that gender differences in computer anxiety and attitudes towards computers have been reduced when the exposure to

computers has been controlled (Chen, 1986, Chambers & Clarke, 1987, Campbell, 1989). However, so far, it has not been proven for sure that the differences between males and females are entirely due to the differences in experience with computers (Shashaani, 1994). Experience with computers does, however, seem to be a powerful mediator in the gender-attitudes towards computers relationship.

Many studies have shown that experience with computers is positively related to attitudes towards computers (Loyd & Gressard, 1984, Koohang, 1987), and that this effect is stronger than that of the relationship between gender and attitudes towards computers (Levin & Gordon, 1989). Therefore due to the strong relationship between experience with computers and attitudes towards computers and due to the hypothesised relationships between attitudes towards computers, anthropocentrism, and anthropomorphism, an individual's level of anthropocentrism should increase and level of anthropomorphism should decrease with an increase in computer experience. In support of this last point, a lack of experience with computers is generally associated with a poor understanding of how computers work and hence unreasonable expectations of computers' capabilities (Winograd & Flores, 1987). Therefore individuals with less experience with computers should understand the differences between humans and computers less well and hence have a higher degree of anthropomorphism than individuals with a lot of experience with computers (Nass et al., 1995). Conversely, however, if one takes into account Weizenbaum's (1976) view that anthropomorphism is a result of an emotional tie between a human and machine, then it seems that the more time spent with computers, and hence the more experience an individual gets with computers, the more likely he/she is to develop emotional ties with a computer and hence the more likely he/she is to anthropomorphise computers. The present study accepts the former view that experience with computers is positively related to attitudes with computers and hence positively related to anthropocentrism and inversely related to anthropomorphism.

Culture may also have an effect on an individual's level of anthropomorphism. According to Caporael (1987), anthropomorphism has traditionally been associated with non-westernised cultures in the past. According to this, Africans and Asians should display higher degrees of anthropomorphism towards computers than whites. Additionally, since Africans in South Africa have been disadvantaged until only recently (and many of them still are at present), they may have a higher level of anthropomorphism and lower degree of anthropocentrism towards computers than whites due to the fact that many of them will have had a lot less experience with computers than white people. This point is supported by studies that have shown that disadvantaged students were less likely to have positive attitudes towards computers than their more advantaged counterparts (Chambers & Clarke, 1987). If this is the case, Africans should also have lower levels of anthropocentrism than whites.

Finally as an individual becomes more educated and/or older, he/she may get more experience with computers. Therefore the older or more educated an individual gets, the more positive his/her attitudes towards computers should become if he/she has the opportunity to use computers. Rogers (1983) provides some support for this point in that he states that individuals with higher levels of education are more likely to adopt and accept new technologies. Therefore age and educational level should both be positively related to anthropocentrism and inversely related to anthropomorphism. This is partially supported by Caporael (1987) who states that children are more likely to think in an anthropomorphic way than adults.

CHAPTER 3: AIMS AND HYPOTHESES OF THE STUDY

Since many hypotheses have been put forward throughout the literature review, this section will summarise how these hypotheses fit in with the three broad aims of the study.

The first aim of the study is to define anthropocentrism and anthropomorphism towards computers and to develop two valid and reliable measures of these constructs.

The second aim of the study is to explore how anthropocentrism and anthropomorphism towards computers relate with each other and attitudes towards computers; as well as to see whether these three construct are distinct or not. From this, four hypotheses are put forward.

Hypothesis 1: Anthropocentrism with respect to computers, anthropomorphism with respect to computers and attitudes towards computers are distinct but related constructs.

Hypothesis 2: Anthropocentrism is inversely related to anthropomorphism with respect to computers.

Hypothesis 3: Anthropocentrism with respect to computers is positively related to attitudes towards computers.

Hypothesis 4: Anthropomorphism with respect to computers is inversely related to attitudes towards computers.

The third aim of the study is to explore some possible predictors of anthropocentrism and anthropomorphism. This part of the study is exploratory in nature and only sets out to determine rather than explain the relationships that may exist. From the literature reviewed, ten hypotheses can be put forward.

Hypothesis 5: Males are more likely to have a higher degree of anthropocentrism with respect to computers than females.

Hypothesis 6: Males are more likely to have a lower degree of anthropomorphism with respect to computers than females.

Hypothesis 7: The older one gets, the more likely one is to have a higher degree of anthropocentrism with respect to computers.

Hypothesis 8: The older one gets, the more likely one is to have a lower degree of anthropomorphism with respect to computers.

Hypothesis 9: The higher ones education, the higher one's degree of anthropocentrism with respect to computers.

Hypothesis 10: The higher ones education, the lower one's degree of anthropomorphism with respect to computers.

Hypothesis 11: Africans and Asians are more likely to have a lower degree of anthropocentrism with respect to computers than whites.

Hypothesis 12: Africans and Asians are more likely to have a higher degree of anthropomorphism with respect to computers than whites.

Hypothesis 13: The more ones experience with computers, the more likely one is to have a high degree of anthropocentrism with respect to computers.

Hypothesis 14: The more experience one has with computers, the less likely one is to have a high degree of anthropomorphism towards computers.

CHAPTER 4: ANALYSIS OF THE PILOT SCALES

Method

Subjects

The pilot study involved 22 male and female subjects who were students at the University of the Witwatersrand or employees working at a media monitoring organisation. Of these, 13 were male and 8 were female; and 5 were African with the rest being white. The age of the subjects ranged from 18 to 38 years old with a mean of 23.55 and a standard deviation of 4.77. The subjects were randomly approached and asked to fill out the questionnaire.

Instruments

The questionnaire itself consisted of two pilot scales: the Anthropocentrism Pilot Scale consisting of 18 items and the Anthropomorphism Pilot Scale consisting of 22 items. All the items in both pilot scales had to be answered on a 5 point Likert-type scale ranging from 'strongly disagree' (1) to 'strongly agree' (5). The pilot scales are scored by subtracting each reverse item from 6 and then adding all the scores. This results in a score ranging from 18 to 90 for anthropocentrism (a high score denoting a high level of anthropocentrism) and a range from 22 to 110 for anthropomorphism (the higher the score, the higher one's anthropomorphism level). The items in the Anthropocentrism and Anthropomorphism Pilot Scales appear in Appendices 1 and 2 respectively.

Procedure

The Anthropocentrism and Anthropomorphism Pilot Scales were designed based upon the guidelines of Oppenheim (1966). According to Oppenheim (1966), the purpose of a pilot study for exploration and to devise the actual wording of the questions. It was decided to use a self administered questionnaire because these have the advantages of a high response rate, accurate sampling, and allows for explanations (but not interpretation) of the questions to subjects (Ibid.).

Oppenheim (1966) gives certain guidelines as to how questions should be worded in order to maximise the effectiveness of the test and these were followed as much as possible when choosing items. Firstly, the items in the scale must not be too long or one sided. A loaded word is "one which is emotionally colored and suggests an automatic feeling of approval or disapproval" (Oppenheim, 1966, p.59). Naturally, loaded words should be avoided at all costs. The questions should be easy to answer and the wording must be suitable in order to avoid possible confusion or lack of understanding on the part of subjects; therefore simple and familiar words should be used as often as possible and double negatives should be avoided. Questions should also naturally be unambiguous and in order to do this, the purpose of each item in the scale should be carefully questioned and examined to see if there may not be another way of interpreting it. Double-barrelled statements should also be avoided as these can lead to ambiguity. Additionally, questions that require the admission of foolish or unacceptable behaviour should be avoided as these will cause response bias in the questionnaire. Another important point is that the items in the questionnaire must seem relevant to the experimenter's explanation of the purpose of the research to subjects and that the questions must be meaningful and interesting for the subjects. Finally, since values, beliefs and attitudes are being measured, subjects must be told that there are no "correct" answers and must not get the impression that there are any right or wrong answers (Ibid.).

Question items for the Anthropocentrism Pilot Scale were selected based upon the scales of Gagnon Thompson and Barton (1994) and Chandler and Dreger (1993) measuring anthropocentrism with respect to the environment. Where possible, items that aimed at the environment were simply changed to apply to computers. Chandler and Dreger (1993) also came up with a number of items in a factor analysis that reflected what they termed "pure anthropocentrism". Many of these items were also used for the Anthropocentrism Pilot Scale where possible and again, these terms were changed from applying to nature to applying to computers. Also, some of the "computers as a

beneficial tool" items from Lee's (1970) scale appear to suggest anthropocentric values and these items were modified to be put in the Anthropocentrism Scale. Finally, some other items were added into the Anthropocentrism Pilot Scale based on the literature on anthropocentrism.

In the case of the Anthropomorphism Pilot Scale, almost all the items were created based upon the literature regarding the subject such as Caporael (1987). In the Caporael (1987) article, many descriptions of the characteristics of anthropomorphism were given and this was used to create the Anthropomorphism Pilot Scale. Also, some of the items from Lee's (1970) scale regarding computers as an autonomous entity were also used.

The subjects were approached and asked to answer a questionnaire about their "general attitudes towards computers". They were told that their responses would be treated as confidential and asked to answer the questions. They were also told that there are no right or wrong answers and that what was wanted was their views on each question. First they were required to answer some demographic questions that asked for their gender, age, cultural group, and educational level as well as some questions exploring their experiences with computers. The latter set of questions asked if subjects had a computer at home, how long they had been using a computer, how many hours per week they used computers, and how many different computer applications they had used this year. The second part of the questionnaire involved answering the questions on the Anthropocentrism and Anthropomorphism Pilot Scales.

Once they had completed both pilot scales, subjects were asked to identify any items that they found difficult to understand or ambiguous for whatever reason and their responses were recorded. This was done in order to see if any items consistently came up as being ambiguous so that the wording of these items could be changed. Subjects were then thanked for assisting in the study.

Experimental Design

The purpose of the pilot study was to check that every item was easy to understand and relatively normally distributed as well as to check the reliabilities of both scales to see if any changes had to be made to them. Firstly, the distribution of each item was checked and all items with a problematic distribution were eliminated from the pilot scales. Problematic distributions include U-shaped curves and those that were too strongly skewed to one direction. In the case of checking the internal-consistency reliability of the scales, item analyses were performed on each of the scales by examining the inter-item correlations and the raw Cronbach's alpha level. Items not well correlated with the rest of the scale were eliminated from it one by one until an acceptable alpha level was reached. Finally, any ambiguous items were reworded for the main study.

Results

With respect to the Anthropocentrism Pilot Scale, none of the items had unacceptable distributions. Roughly half of the items however were slightly skewed to the right. The inter-item correlations done on the 18 item Anthropocentrism Pilot Scale yielded a raw Cronbach's alpha of 0.48 and standard alpha of 0.55; consequently items 1, 6, 7, 8, 10, 11, 12, 13, and 14 were dropped from the Anthropocentrism Pilot Scale due to low inter-item correlations. The resultant raw Cronbach's alpha was 0.72 and the standard alpha was 0.74. The final item-total correlations for the Anthropocentrism Pilot Scale are shown on Table 1. Finally, it was decided to reword item 17 in the Anthropocentrism Pilot Scale to "No matter how superiority is defined, humans are to be considered superior to computers.". This was done due to the fact that many of the subjects found it ambiguous. A further item was also added to the Anthropocentrism Scale, namely "Humans are more important than computers.". Therefore the final Anthropocentrism Scale consisted of 11 items which appear in Appendix 3.

Table 1:
Item-Total Correlations for the Anthropocentrism Scale Items Chosen in the Pilot Study

Test Item	Item-Total Correlation	Alpha if deleted
Item 2	.272	.713
Item 3	.179	.735
Item 4	.174	.735
Item 5	.296	.710
Item 9	.569	.675
Item 15	.495	.674
Item 16	.721	.644
Item 17	.420	.690
Item 18	.636	.635

Table 2:
Item-Total Correlations For The Anthropomorphism Scale Items Chosen In The Pilot Study

Test Item	Item-Total Correlation	Alpha if deleted
Item 1	.105	.755
Item 2	.426	.725
Item 3	.281	.739
Item 4	.773	.680
Item 7	.279	.738
Item 9	.501	.713
Item 11	.380	.728
Item 12	.539	.710
Item 13	.476	.718
Item 14	.046	.756
Item 15	.258	.739
Item 16	.083	.762
Item 18	.517	.712
Item 20	.283	.739
Item 22	.257	.740

Of the 22 original items in the Anthropomorphism Pilot Scale, items 6, 8, and 21 had poor distributions and thus were taken out of the scale. Inter-item correlations done on the remaining 19 items yielded a raw Cronbach's alpha of 0.62 and standard alpha of 0.61. Due to low item-total correlations, items 5, 10, 17, and 19 were dropped from the Anthropomorphism Pilot Scale yielding a final raw

Cronbach's alpha of 0.75 and standard alpha of 0.74. The final item-total correlations for this pilot scale can be viewed in Table 2. It can be seen from this table that the removal of items 14 and 16 could raise the raw Cronbach's alpha level but it was decided that the rise of 0.01 in the reliability measure did not justify the removal of these items. None of the remaining items in the scale were found to be ambiguous by subjects so none were changed or reworded. The final Anthropomorphism Scale thus consists of 15 items which are listed in Appendix 4.

CHAPTER 5: MAIN STUDY

Method

Subjects

The main study consisted of 185 subjects that can be broadly divided into three groups: scholars, students and employees. Of the subjects, 119 were female and 66 were male with ages ranging from 14.5 years to 51.5 years (the mean was 23.26 and standard deviation 7.24). 19 subjects were Asian, 46 were African, 4 were coloured, and 115 were white. Table 3 shows the breakdown between gender and race. Subjects' educational level ranged from standard 8 to postgraduate degrees. 42 subjects had a standard 8, 25 subjects had a matric, 14 had a diploma, 68 had or were undertaking a university undergraduate degree, and 35 subjects had or were undertaking a post-graduate degree. Subjects were randomly approached.

Table 3:
Breakdown of Gender and Race of Subjects in the Sample

	Female	Male	Total
African	32	14	46
Asian	9	10	19
Coloured	4	0	4
White	73	42	115
Total	118	66	

There were 43 scholars from a private all girls school. Of these, 2 were Asian, 12 were African, 2 were coloured, and 27 were white. The students were undertaking undergraduate or post graduate degrees at the University of the Witwatersrand. There were 67 of them with 45 females and 22 males. Of the students, 12 were Asian, 26 were African, 2 were coloured, and 27 were white. Finally, the 75 subjects in the 'employee' category came from private organisations

including an accounting firm, an estate agency and a computer firm. These different organisations were chosen in order to ensure as broad a range of computer knowledge and experience as possible. Of this group of subjects, 31 were female and 44 were male and the racial breakdown was 5 Asians, 9 Africans, and 61 whites.

As in the pilot study, subjects were asked questions about their experience with computers. 127 subjects had access to a computer at their homes while 57 of them did not and 1 person did not answer the question. Some subjects had never used a computer so the length of time that subjects had been using a computer for was between 0 and 27 years with a mean of 6,25 and a standard deviation of 4.24. Subjects used a computer between 0 and 70 hours per week with a mean of 15.65 hours and a standard deviation of 17.70. During 1996 subjects had used between 0 and 9 different types of applications (including word processing, internet access, spreadsheet packages, games etc.) with a mean of 3.68 and a standard deviation of 2.06.

Instruments

Subjects were given the Anthropocentrism Scale and Anthropomorphism Scale in Appendices 3 and 4 respectively as well as Nickell and Pinto's (1986) Computer Attitude Scale which appears in Appendix 5. The Computer Attitude Scale was selected because it has undergone extensive development and it has a high reliability (Cronbach's alpha of 0.81 and test-retest of 0.86 after 2 weeks) as well as good construct validity (LaLomia & Sidowski, 1991). The reliability and validity of the Computer Attitude Scale applies for undergraduate students as well as professionals (Ibid.). Another reason that it was chosen is that it does not seem to have the "beneficial tool-autonomous entity" dimension as do computer attitude scales such as Lee (1970) and Rafaeli (1986). Therefore Nickell and Pinto's (1986) Computer Attitude Scale seems to be a broader measure of attitudes than the afore-mentioned two scales. Thus the correlations between attitudes towards computers, anthropocentrism and anthropomorphism will be a purer measure of the relationships between these constructs than if Lee's (1970) or Rafaeli's (1986) computer attitude scales had

been used. This is the case because of the strong links between the items in the Anthropocentrism Scale and the "computers as a beneficial tool" items and between the items of the Anthropomorphism Scale and the "computers as an autonomous entity" items of Lee's (1970) and Rafaeli's (1986) computer attitude scales.

The Anthropocentrism Scale consisted of 11 items and the Anthropomorphism Scale consisted of 15 items based on the work done in the pilot study. The Computer Attitude Scale consisted of 20 items. All the scales were answered on a 5 point Likert-type scale. Similarly, all the tests were scored by subtracting reversed items from 6 and adding the items together. Thus scores ranged from 11 to 55 for the anthropocentrism scale, 15 to 75 for the anthropomorphism scale, and 20 to 100 for the Computer Attitude scale. High scores indicated a high level of anthropocentrism and anthropomorphism and a positive attitude towards computers.

Procedure

As in the pilot study, subjects were randomly approach and asked to fill in a questionnaire for a study involving the use of computers. With respect to the scholar sample, two classes were chosen at random and given the questionnaire to complete. The questionnaire included the same demographic and computer experience questions as in the pilot study questionnaire as well as the three scales mentioned in the previous section. Again subjects were assured that their answers would be treated as confidential and that there were no right or wrong answers as the questions were asking "what they thought". Once subjects had completed the questionnaire, they were thanked and the ideas behind the questionnaires were explained to them in greater detail if they were interested.

Experimental Design

As mentioned, the main aim of the study is to find valid and reliable measures of anthropocentrism and anthropomorphism towards computers. There are a number of different ways to establish the reliability and validity of a scale. Rosnow and Rosenthal (1991) define reliability

as the extent to which a scale "consistently discriminates individuals at one time or over the course of time" (p.47). Test-retest reliability refers to the stability of a scale over time. It is arrived at by testing individuals at one time and then testing them with the same test gain after a period of time. These two sets of results are then correlated (Rosenthal & Rosnow, 1991). The problem with test-retest reliability is that there is a problem in distinguishing between the effects of memory and those of real change (Ibid.). For the purposes of this study assessing the reliability of the Anthropocentrism Scale and the Anthropomorphism Scale in this way is not possible because it would not be possible to find all the subjects who answered the questionnaire after a fixed period of time because they were assured confidentiality and their names were not taken. Another problem with test-retest reliability is that the present study is exploring attitudes and beliefs which may change over time. Another measure of reliability is that of internal-consistency which depends on the average of the inter-correlations among each test item and tests for the homogeneity of the items in the scale (Rosenthal & Rosnow, 1991). Since internal-consistency reliability does not have the problems of test-retest reliability, this was the reliability used in the study. More specifically, Cronbach's alpha was the internal-consistency test that was used to check the reliability of the scales in this study.

Validity was a bit more difficult to establish for the Anthropocentrism and Anthropomorphism Scales. The primary reason for this is that they are the first scales testing these constructs with respect to computers. According to Rosenthal and Rosnow (1991), validity refers to the meaningfulness or appropriateness of a test (does the test measure what it is meant to measure?) and determining a test's validity is the most important aspect of developing it. There are three categories of validity: content validity, criterion validity and construct validity. Content validity requires that the items in the test measure the types of construct that they are meant to. This type of validity is usually expressed in terms of a non-quantitative judgement or in terms of the adequacy of sampling of the

contents to be covered (Rosnow & Rosenthal, 1991). With respect to the Anthropocentrism and Anthropomorphism Scales, content validity will be established by seeing if the scales show face validity; that is, do they look as if they measure the constructs they are meant to measure. Criterion validity refers to "the degree to which the test or questionnaire correlates with one or more outcome criteria" (Rosenthal & Rosnow, 1991, p.60). This is often established by correlating the test with an established measure of the construct (ie. concurrent validity) or by seeing how well the test predicts the construct with respect to a future criterion (ie. predictive validity) (Ibid.). Since no criteria exist for anthropocentrism and anthropomorphism with respect to computers, it is difficult to establish criterion validity in this study. There is however a way of doing this and that is by including an item in each scale that defines the constructs of anthropocentrism and anthropomorphism and then correlating these items with the rest of their respective scales. Therefore the definitions of the two constructs serve as criteria against which to compare the rest of the items in the two scales. Finally, construct validity refers to "the degree to which the test or questionnaire score is a measure of the psychological characteristic of interest (Rosenthal & Rosnow, 1991, p.61). Construct validity involves testing for convergence (seeing if the construct being tested correlates with another test that tests for that construct) and divergence (seeing if the construct being measured does not correlate with another similar but distinct construct) (Rosenthal & Rosnow, 1991). This is not possible in the study since there is no way of testing for convergent validity as no other measures of anthropocentrism nor anthropomorphism with respect to computers exist.

As mentioned, reliability will be tested by looking at the item-total correlations of both the scales to see if they have an acceptable internal consistency or if any further items need to be removed. According to Rosenthal and Rosnow (1991), a Cronbach's alpha of around 0.75 is acceptable for non-clinical psychological tests. With respect to content validity, both the measures seem to have face

validity in the questions that they ask. As mentioned, criterion validity is sought to be established by correlating each scale with an item that closely resembles the definition of each construct. In other words, item 1 in the Anthropocentrism Scale ("The primary value of computers is to serve humanity.") is correlated to the sum of the rest of the scale and item 2 in the Anthropomorphism Scale ("The similarities between humans and computers are more numerous than the differences.") is correlated with the sum of the rest of this scale. Reliability and validity tests will be performed in the same way on each of the three groups of subjects (ie. scholars, students and employees) to explore whether or not the scales are suitable for each group.

Another aim of the study was to establish that anthropocentrism, anthropomorphism and attitudes towards computers are related yet distinct constructs. This is done by correlating the different constructs and through factor analysis. The correlations set out to examine the relationships between anthropocentrism, anthropomorphism and attitudes towards computers. The factor analysis sets out to explore whether or not anthropocentrism, anthropomorphism and attitudes towards computers are distinct constructs by examining how the test items are grouped together. If the constructs are distinct from one another, the items from each measure should be grouped together rather than grouped with items from the other scales.

Finally, the study sets out in an exploratory examination of the differences in anthropocentrism and anthropomorphism according to age, gender, racial group, educational level and the various measures of experience with computers. This is done with correlations for the continuous variables in order to explore the relationships between them; and with Anova and LSD Post-Hoc analyses for the categorical variables. Anova explore whether or not there are significant differences between the categories of a variable and the LSD Post-Hoc test sees which of the categories of the variable are significantly different.

Results

Reliabilities

Anthropocentrism Scale

Item-total Correlations for the Anthropocentrism Scale yielded a Cronbach's alpha and standardised alpha of 0.74, a skewness of -0.85 and kurtosis of 1.86. The average score by subjects on the scale was 42.73 with a standard deviation of 6.27. The average inter-item correlation was 0.21 and the item-total statistics can be viewed in Table 4. Therefore, the items are slightly skewed to the right and their distribution is slightly leptokurtic but acceptable nonetheless. The alpha levels are acceptable for a non-clinical test and thus the Anthropocentrism Scale has internal consistency.

Table 4:
Item-Total Correlations for the Anthropocentrism Scale

Test Item	Item-Total Correlation	Alpha if deleted
Item 1	.432	.716
Item 2	.307	.732
Item 3	.457	.714
Item 4	.454	.713
Item 5	.453	.712
Item 6	.139	.753
Item 7	.268	.737
Item 8	.396	.721
Item 9	.449	.713
Item 10	.399	.721
Item 11	.525	.705

It was decided to perform item-total statistics on each of the three sub-groups of subjects in order to see if the reliability of the scale held for these groups. For the employee group, the scale yielded a mean of 42.90 and standard deviation of 6.57. The Cronbach's alpha and standardised alpha were 0.77 with a skewness of -0.63 and kurtosis of 1.36. The average inter-item correlation was 0.24 and the results of the item-total statistics can be viewed in Appendix 6. These results are similar to the ones reported above and

thus the Anthropocentrism Scale can be considered a reliable measure for this group of people.

The same can be said about the reliability of the Anthropocentrism Scale for students. Similarly, the mean score attained by subjects in this group was 43.00 and the standard deviation was 6.93. The Cronbach's alpha and standardised alpha were slightly higher in this group at 0.80 with a skewness of -1.19 and kurtosis of 2.30. Therefore, the distribution of the test items for students was slightly more skewed to the right and leptokurtic than the distribution of the test items for employees, but acceptable nonetheless. The average inter-item correlation was 0.27 and the results of the item-total statistics can be viewed in Appendix 7.

The Anthropocentrism Scale however does not seem to be reliable for scholars. Although the mean score achieved was similar to the other two groups of subjects (mean = 42.05, standard deviation = 4.47), the alpha levels and average inter item correlation were much lower for this group than in the other two groups. The Cronbach's alpha was 0.47 and standardised alpha was 0.54 with a skewness of -0.53 and kurtosis of -0.12. Thus the distribution of test items was slightly skewed to the right and platykurtic for this group of subjects. The average inter-item correlation was 0.10. The results of the item total statistics can be viewed in Appendix 8.

In all these cases with the exception of one, the item-total statistics did not give the indication that any of the test items should be removed. The one exception is that of item 6 in the item-total statistics of the scholar group of subjects (on Appendix 8), however, the Anthropocentrism Scale is assumed not to be reliable for this group of subjects and the removal of item 6 from the scale would only push up the alpha level to 0.55 which is still not acceptable. Also, when looking at item 6 in the other item-total statistics, its removal would not affect the reliability of the scale in any significant way.

Therefore from these statistics, it can be seen that the Anthropocentrism Scale is a reliable measure when tested on the entire group of subjects, the employee group, and the student group. It does not seem to be a reliable measure for subjects who are still at school.

Anthropomorphism Scale

The mean score for the Anthropomorphism Scale for the entire group of subjects was 33.04 with a standard deviation of 9.56. The scale showed a good reliability with a Cronbach's alpha of 0.83 and a standardised alpha of 0.84. The skewness was 0.70 and the kurtosis was 1.07. The average inter-item correlation was 0.26 and the item-total statistics can be viewed on Table 5. From these statistics, it can be seen that the distribution of the items is very slightly skewed to the left and leptokurtic and that the alpha levels are more than acceptable. Thus the measure has a good distribution and shows a good internal-consistency reliability for all the subjects.

Table 5:
Item-Total Correlations for the Anthropomorphism Scale

Test Item	Item-Total Correlation	Alpha if deleted
Item 1	.301	.830
Item 2	.437	.820
Item 3	.483	.817
Item 4	.500	.815
Item 5	.469	.817
Item 6	.676	.804
Item 7	.105	.840
Item 8	.450	.819
Item 9	.648	.806
Item 10	.429	.820
Item 11	.517	.815
Item 12	.351	.825
Item 13	.447	.819
Item 14	.480	.817
Item 15	.558	.814

In the case of the employee group of subjects, the reliability figures were a bit better with a Cronbach's alpha of 0.87, standard alpha of 0.88, skewness of 1.12, and kurtosis of 2.21. The mean score attained by subjects in this group was 30.78 with a standard deviation of 10.40. The average inter-item correlation was 0.34 and the results of the item-total statistics can be viewed in Appendix 9. Therefore, for employees, the internal-consistency reliability is good and the distribution of the test items is slightly leptokurtic and skewed to the left.

The student group of subjects attained a mean score of 35.75 on the Anthropomorphism Scale with a standard deviation of 9.10. The reliability figures were slightly lower than those done on the entire group of subjects but still acceptable. The Cronbach's alpha and standardised alpha were 0.79, the skewness was 0.41 and the kurtosis was 0.41. As is the case with employees, the internal-consistency reliability is good and the distribution of items is skewed slightly to the left and leptokurtic. The average inter-item correlation was 0.21 and the item-total statistics can be viewed in Appendix 10.

The scholar group of subjects achieved the lowest reliability scores but they were still at an acceptable level. The Cronbach's alpha was 0.74 and the standardised alpha was 0.75. The scale had a skewness of 0.69, a kurtosis of 0.96 (therefore marginally skewed to the left and leptokurtic) and the average inter-item correlation was 0.17. The item-total statistics appear in Appendix 11.

In looking at Appendix 11, item 7 has a negative item-total correlation which suggests that it should be removed from the scale or reworded. This is also reflected in Table 5 with the reliability statistics of the entire subject group. However, the removal of the item will only increase the reliability of the scale for the entire population by a negligible amount so it should not be removed.

Therefore the Anthropomorphism Scale seems to be a reliable measure across all the subjects, the employee group of subjects and the

student subjects. The Anthropomorphism Scale is marginally less reliable in the case of scholars although it's alpha levels are still at an acceptable level for this group of subjects.

Computer Attitude Scale

The mean score of subjects on the Computer Attitude Scale was 70.86 with a standard deviation of 10.43. The Computer Attitude Scale did not give as reliable results a mentioned in the literature. LaLomia and Sidowski (1991) give a Cronbach's alpha level of 0.81 for this measure. In this study however, it was found that the Cronbach's alpha was 0.72 and the standard alpha was 0.79. As this is not the main focus of the study and is needed only to establish the relationship between attitudes, anthropocentrism and anthropomorphism towards computers, the reliability of the computer Attitude Scale is acceptable for the purpose it will be used. The reliability of the scale on each of the subgroups of subjects was not explored for the reason noted above.

Validity Studies and Independence of the Constructs

In order to establish a bit more than face validity for the scales, an item was put into each scale that closely resembles the definition of the construct. In the case of the Anthropocentrism Scale this was item 1 ("The primary value of computers is to serve humanity.") and in the case of the anthropomorphism it was item 2 of the Anthropomorphism Scale ("The similarities between humans and computers are more numerous than the differences."). These two items were then correlated with the sum of the remaining items in the respective scales to see if the scales had some form of criterion validity.

In the case of the Anthropocentrism Scale, the correlation between item 1 and the rest of the scale was $r=0.423$ which was highly significant ($p<0.001$). In the case of the student and employee groups of the subjects the correlations between item 1 and the rest of the Anthropocentrism Scale remained significant. For the students, the correlation was $r=0.345$ ($p=0.004$) and for the employee

group of subjects, the correlation was r=0.603 (p<0.001). However, in the case of the scholars, the correlation between item 1 of the Anthropocentrism Scale and the rest of the scale turned out to be non-significant at r=0.222 (p=0.152). This adds to the evidence that the Anthropocentrism Scale may not be suitable to people who are below the age of 18.

The correlation between item 2 of the Anthropomorphism Scale and the sum of the rest of the scale also turned out to be a highly significant r=0.418 (p<0.001). Significant correlations were also found for the employee and scholar groups of subjects but not for the student group of subjects. The employee group had a correlation of r=0.542 which had a p-level less than 0.001 and the scholars had a correlation of r=0.405 with a p-level of 0.007. In the case of the student group, the correlation between item 2 and the rest of the Anthropomorphism Scale was r=0.200 which had a p-level of 0.105.

Therefore both scales both seem to show some degree of criterion validity. However further validity studies need to be undertaken on the scales and especially in the case of the Anthropomorphism Scale on students. Once more there is evidence that the Anthropocentrism Scale may not be suitable for younger subjects at the school going age.

The study also set out to explore whether or not anthropocentrism, anthropomorphism and attitudes towards computers are independent constructs or not. In order to do this, the scores of all three measures were correlated in order to explore the relationships between the constructs and factor analyses were performed to see if the items in the scales belonged to their respective scales or were aspects of another construct.

Table 6 shows the correlations between anthropocentrism, anthropomorphism and attitudes towards computers for the entire group of subjects. It can be seen this table that all three constructs are significantly related to one another. Anthropocentrism and

Table 6:
Correlations Between Anthropocentrism, Anthropomorphism and Attitudes Towards Computers for All Subjects

Variables	Correlation	p-level
Anthropocentrism & Anthropomorphism	-.199	.007 **
Anthropocentrism & Computer Attitudes	.233	.002 **
Anthropomorphism & Computer Attitudes	-.418	.000 ***

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

anthropomorphism are negatively related (r=-0.199, p-level=0.007), anthropocentrism and attitudes towards computers are positively related (r=0.233, p-level=0.002), and anthropomorphism and attitudes towards computers are strongly negatively related (r=-0.418, p-level <0.001).

Correlations were also performed between anthropocentrism, anthropomorphism and attitudes towards computers for each of the subgroups of subjects in the sample. These correlations can be seen in Table 7 (Employees), Table 8 (Students) and Table 9 (Scholars). These tables generally reflect the correlations shown in Table 6. In the case of the correlations between anthropocentrism and anthropomorphism, a significant negative relationship can be seen in the case of the employee group of subjects (r=-0.236, p-level=0.041) as well as in the case of students (r=-0.259, p-level=0.035). However, in the case of scholars, the relationship between anthropomorphism and anthropocentrism is a non significant positive one (r=0.059, p-level=0.716). This could be due to the fact that the Anthropocentrism Scale is not reliable for this group of subjects.

The relationship between anthropocentrism and attitudes towards computers was positive in each of the three groups and this relationship was significant in the case of scholars and employees.

Table 7:
Correlations Between Anthropocentrism, Anthropomorphism and Attitudes Towards Computers for the Employee Group of Subjects

Variables	Correlation	p-level
Anthropocentrism & Anthropomorphism	-.236	.041 *
Anthropocentrism & Computer Attitudes	.307	.007 **
Anthropomorphism & Computer Attitudes	-.562	.000 ***

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

Table 8:
Correlations Between Anthropocentrism, Anthropomorphism and Attitudes Towards Computers for the Student Group of Subjects

Variables	Correlation	p-level
Anthropocentrism & Anthropomorphism	-.259	.035 *
Anthropocentrism & Computer Attitudes	.174	.160
Anthropomorphism & Computer Attitudes	-.143	.250

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

Table 9:
Correlations Between Anthropocentrism, Anthropomorphism and Attitudes Towards Computers for the Scholar Group of Subjects

Variables	Correlation	p-level
Anthropocentrism & Anthropomorphism	.059	.716
Anthropocentrism & Computer Attitudes	.309	.050 *
Anthropomorphism & Computer Attitudes	-.187	.241

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

For scholars, the correlation was r=0.309 (p-level=0.050) and for employees it was r=0.307 (p-level=0.007). In the case of students, the correlation between anthropocentrism and attitudes towards computers was weak at a level of r=0.174 (p-level=0.160).

The correlations between anthropomorphism and attitudes towards computers were negative in all three cases, however the relationship is only significant in the case of employees (r=-0.562, p-level<0.001). For students and scholars the correlations were r=-0.143 and r=-0.187 with p-levels of 0.249 and 0.241 respectively.

The correlations done on each of the three groups generally seem to support the correlations between anthropocentrism, anthropomorphism and attitudes towards computers performed on the entire sample although not all the correlations done on these three groups of subjects were statistically significant. There was found to be a significant negative relationship between anthropocentrism and anthropomorphism, a significant positive relationship between anthropocentrism and attitudes towards computers, and a significant negative relationship between anthropomorphism and attitudes towards computers in the overall sample of subjects.

Since these constructs are all related, it is necessary to perform factor analyses to see if the scales are not in fact measuring the same thing (or the same thing in reverse with respect to anthropomorphism). Four factor analyses were performed; the first to see if anthropocentrism and anthropomorphism fitted well into two factors, the second to explore if there was more than one factor in either the Anthropocentrism or Anthropomorphism Scale and if the scales were independent of one another, the third was to see if anthropocentrism was independent of computer attitudes, and the fourth was to see if anthropomorphism was independent of computer attitudes.

Table 10 shows the eigenvalues for a factor analysis with the Anthropocentrism and Anthropomorphism scales. From Table 10 it can

be seen that three factors explain 40% of the variance. However, it was decided firstly to choose two factors to see if the Anthropocentrism and Anthropomorphism Scales are independent. Raw varimax rotation was performed with two factors and the normalised factor loadings for this rotation appear on Table 11. From Table 11, it can be seen that all the items in the Anthropomorphism Scale with the exception of item 7 have strong loadings on Factor 1 (ranging from 0.453 to 0.750) and all the items in the Anthropocentrism Scale are low or negative on this factor. All the items from the Anthropocentrism Scale with the exception of item 6 are strongly loaded on Factor 2. With the exception of item 6, factor loadings range from 0.413 to 0.668. All the items in the Anthropomorphism Scale have negative or low loadings in Factor 2. Item 6 in the Anthropocentrism Scale and item 7 in the Anthropomorphism Scale thus do not fit in well with their respective scales. Item 7 on the Anthropocentrism Scale is not strongly loaded on either factor. In the case of item 6 in the Anthropocentrism scale, it is strongly negatively loaded on Factor 1 (the anthropomorphism factor). This suggests that maybe it could be a reverse scored item on the Anthropocentrism Scale, but when looking at it ("Computers are superior to humans in all important ways."), it does not seem that it would have face validity for this scale.

As was mentioned, Table 10 suggests that there are three factors in the factor analysis with the Anthropocentrism and Anthropomorphism scales. Table 12 shows the normalised factor loadings for the raw varimax rotation of three factors. From this table it can be seen that all the items in the anthropocentrism scale with the exception of item 6 again are strongly loaded on Factor 2 (the factor loadings range from 0.398 to 0.627). There seem to be 2 factors for the Anthropomorphism Scale as items 5, 6, 9, 11, 12, 13, 14, and 15 strongly loaded on Factor 1 (the factor loadings range from 0.491 to 0.726) and items 1, 2, 3, 4, 6, 8, and 10 are strongly loaded on Factor 3 (the factor loadings range from 0.404 to 0.610). Looking at these items, Factor 1 can thus be described as an affective aspect of anthropomorphism towards computers while factor 3 can be described as

Table 10:
Eigenvalues for the Factor Analysis on the Anthropocentrism and Anthropomorphism Scales

Standard Mode	Eigenvalue	Cumulative Eigenvalue	Variance	Cumulative Variance
Factor 1	5.436	5.436	.209	.209
Factor 2	3.139	8.575	.121	.330
Factor 3	1.843	10.418	.071	.401
Factor 4	1.510	11.928	.058	.459
Factor 5	1.282	13.210	.049	.508
Factor 6	1.107	14.317	.043	.551
Factor 7	1.013	15.330	.039	.590
Factor 8	.954	16.283	.037	.626
Factor 9	.900	17.184	.035	.661
Factor 10	.844	18.027	.032	.693
Factor 11	.787	18.814	.030	.724
Factor 12	.748	19.563	.029	.752
Factor 13	.672	20.235	.026	.778
Factor 14	.638	20.873	.025	.803
Factor 15	.625	21.498	.024	.827
Factor 16	.590	22.088	.023	.850
Factor 17	.554	22.643	.021	.871
Factor 18	.502	23.144	.019	.890
Factor 19	.482	23.627	.019	.909
Factor 20	.434	24.061	.017	.925
Factor 21	.396	24.457	.015	.941
Factor 22	.383	24.839	.015	.955
Factor 23	.353	25.192	.014	.969
Factor 24	.299	25.491	.012	.980
Factor 25	.281	25.772	.011	.991
Factor 26	.228	26.000	.009	1.000

Table 11:
Normalised Factor Loadings for the Raw Varimax Rotation on the Anthropocentrism and Anthropomorphism Scales

Test Item	Factor 1	Factor 2
Anthropocentrism Scale		
Item 1	-.121	.534
Item 2	.117	.464
Item 3	.069	.615
Item 4	-.132	.539
Item 5	-.199	.560
Item 6	-.539	.176
Item 7	.073	.413
Item 8	.050	.540
Item 9	-.062	.599
Item 10	.127	.562
Item 11	-.243	.668
Anthropomorphism Scale		
Item 1	.453	.149
Item 2	.539	.217
Item 3	.599	.036
Item 4	.574	-.048
Item 5	.594	-.015
Item 6	.750	.035
Item 7	.122	-.082
Item 8	.537	-.083
Item 9	.713	-.017
Item 10	.503	-.208
Item 11	.603	-.208
Item 12	.403	-.123
Item 13	.543	-.020
Item 14	.552	-.327
Item 15	.639	-.127

Table 12:
Normalised Factor Loadings for the Raw Varimax Rotation on the Anthropocentrism and Anthropomorphism Scales

Test Item	Factor 1	Factor 2	Factor 3
Anthropocentrism Scale			
Item 1	.056	.576	-.269
Item 2	-.113	.421	.326
Item 3	.051	.622	.042
Item 4	-.028	.563	-.181
Item 5	-.030	.596	-.286
Item 6	-.382	.184	-.388
Item 7	-.027	.398	.147
Item 8	.082	.557	-.028
Item 9	-.228	.563	.182
Item 10	.109	.571	.062
Item 11	-.388	.627	.092
Anthropomorphism Scale			
Item 1	-.012	.066	.741
Item 2	.336	.202	.441
Item 3	.287	-.004	.601
Item 4	.247	-.094	.610
Item 5	.750	.056	.012
Item 6	.581	.038	.475
Item 7	.281	-.038	-.157
Item 8	.215	-.131	.593
Item 9	.726	.027	.234
Item 10	.322	-.225	.404
Item 11	.491	-.203	.354
Item 12	.609	-.052	-.118
Item 13	.559	.014	.170
Item 14	.625	-.282	.104
Item 15	.618	-.097	.251

a cognitive aspect of anthropomorphism towards computers. Item 6 ("I sometimes feel that computers are alive.") comes up in both dimensions and this seems normal as a being that is considered to be alive can have both affective and cognitive aspect. Once more, item 7 of the Anthropomorphism Scale does not load heavily on any of the factors and none of the items in the Anthropomorphism Scale come up in Factor 2 which is the anthropocentrism factor. Therefore, anthropocentrism and anthropomorphism seem to be independent

constructs and anthropomorphism seems to have the two predicted dimensions.

In order to check for the independence between anthropocentrism and attitudes towards computers, another factor analysis was performed containing the items of the Anthropocentrism Scale and the Computer Attitude Scale. Table 13 shows the eigenvalues for this factor analysis. From Table 13, it can be seen that the first four factors explain 45% of the variance. Table 14 shows the normalised factor loading of the raw varimax rotation performed on these four factors. All the items of the Anthropocentrism Scale with the exception of item 6 came up on Factor 4 with loadings ranging from -0.360 to -0.660. The only item in the Computer Attitude Scale to weigh heavily on this factor was item 14 which is "The use of computers is enhancing our standard of living". This item obviously ties in strongly with the concept of anthropocentrism. Apart from item 14 of the Computer Attitude Scale, none of the items on the scale weigh heavily on Factor 4 nor did any of the items from the Anthropocentrism Scale weigh heavily on any of the other factors with the exception of item 6 that had a strong loading on Factor 3 (0.459) and items 3 and 5 which came up in Factor 2. Items 1, 5, 11, 13, 14, 19, and 20 of the Computer Attitude Scale are also heavily loaded on Factor 2 which seems to denote a "usefulness and ease" description of computers; a description which seems to be related to anthropocentrism. Anthropocentrism did not feature in Factor 1 which seems to describe an intimidation dimension of computers nor on Factor 3 (with the exception of item 6) which seems to describe a dimension of computers controlling humans. Items 2, 4, 6, 7, 8, 10, 12, 16, and 20 of the Computer Attitude Scale were strongly loaded on Factor 1 and items 3, 6, 15, 17, and 18 of the Computer Attitude Scale were strongly loaded on Factor 3. Therefore, it seems that anthropocentrism can be considered independent from computer attitudes but related to that dimension of computer attitudes that focus on the ease and usefulness of computers (ie. Factor 2 in Table 14).

Table 13:
Eigenvalues for the Factor Analysis on the Anthropocentrism and Computer Attitude Scales

Standard Mode	Eigenvalue	Cumulative Eigenvalue	Variance	Cumulative Variance
Factor 1	5.485	5.484	.177	.177
Factor 2	4.715	10.200	.152	.329
Factor 3	1.968	12.168	.063	.393
Factor 4	1.805	13.972	.058	.451
Factor 5	1.649	15.621	.053	.504
Factor 6	1.303	16.924	.042	.546
Factor 7	1.143	18.067	.037	.583
Factor 8	1.005	19.072	.032	.615
Factor 9	.966	20.038	.031	.646
Factor 10	.890	20.928	.029	.675
Factor 11	.853	21.781	.028	.703
Factor 12	.783	22.563	.025	.728
Factor 13	.769	23.333	.025	.753
Factor 14	.712	24.045	.023	.776
Factor 15	.673	24.718	.022	.797
Factor 16	.654	25.372	.021	.818
Factor 17	.591	25.963	.019	.838
Factor 18	.561	26.523	.018	.856
Factor 19	.548	27.071	.018	.873
Factor 20	.521	27.593	.017	.890
Factor 21	.471	28.064	.015	.905
Factor 22	.452	28.516	.015	.920
Factor 23	.422	28.938	.014	.933
Factor 24	.370	29.308	.012	.945
Factor 25	.329	29.637	.011	.956
Factor 26	.293	29.930	.009	.965
Factor 27	.257	30.188	.008	.974
Factor 28	.240	30.428	.008	.982
Factor 29	.229	30.656	.007	.989
Factor 30	.199	30.856	.006	.995
Factor 31	.144	31.000	.005	1.000

Table 14:
Normalised Factor Loadings for the Raw Varimax Rotation on the Anthropocentrism and Computer Attitude Scales

Test Item	Factor 1	Factor 2	Factor 3	Factor 4
Anthropocentrism Scale				
Item 1	.282	.212	-.099	-.497
Item 2	-.085	-.052	-.072	-.486
Item 3	.181	.512	-.283	-.367
Item 4	.079	.235	-.038	-.542
Item 5	.141	.378	.074	-.537
Item 6	.064	.276	.459	-.101
Item 7	.127	.123	-.062	-.359
Item 8	-.195	.027	.021	-.660
Item 9	.020	.205	.023	-.514
Item 10	-.223	.058	-.119	-.625
Item 11	-.012	.442	.097	-.446
Computer Attitude Scale				
Item 1	.001	.463	.115	-.054
Item 2	.650	.332	.157	.173
Item 3	.102	.266	-.481	-.108
Item 4	.652	-.131	.206	-.014
Item 5	.006	.610	.112	-.070
Item 6	.406	-.019	.599	.127
Item 7	.706	.285	.321	.067
Item 8	.661	-.113	-.060	-.206
Item 9	.083	.180	-.378	.049
Item 10	.684	-.061	-.007	-.251
Item 11	.051	.692	-.216	-.109
Item 12	.658	-.013	.115	.078
Item 13	-.021	.722	.063	-.086
Item 14	.072	.453	-.242	-.407
Item 15	.331	-.101	.579	.087
Item 16	.650	.212	.333	.169
Item 17	.127	-.015	.740	-.109
Item 18	.232	.011	.807	.073
Item 19	.163	.748	-.032	-.129
Item 20	.508	.466	.185	.152

The final factor analysis was done to see if anthropomorphism and attitudes towards computers were independent of one another. Table 15 shows the eigenvalues for this factor analysis. From Table 15 it can be seen that the first 4 factors explain 45.6% of the variance. Table 16 shows the normalised factor loading for the four factors.

Table 15:
Eigenvalues for the Factor Analysis on the Anthropomorphism and Computer Attitude Scales

Standard Mode	Eigenvalue	Cumulative Eigenvalue	Variance	Cumulative Variance
Factor 1	7.681	7.681	.219	.219
Factor 2	3.384	11.065	.097	.316
Factor 3	3.170	14.235	.091	.407
Factor 4	1.730	15.964	.049	.456
Factor 5	1.552	17.516	.044	.500
Factor 6	1.393	18.910	.040	.540
Factor 7	1.225	20.135	.035	.575
Factor 8	1.030	21.165	.029	.605
Factor 9	1.002	22.167	.029	.633
Factor 10	.943	23.110	.027	.660
Factor 11	.912	24.021	.026	.686
Factor 12	.821	24.842	.024	.710
Factor 13	.790	25.632	.023	.732
Factor 14	.752	26.384	.021	.754
Factor 15	.728	27.112	.021	.775
Factor 16	.662	27.775	.019	.794
Factor 17	.638	28.413	.018	.812
Factor 18	.620	29.033	.018	.830
Factor 19	.580	29.613	.017	.846
Factor 20	.536	30.149	.015	.861
Factor 21	.504	30.653	.014	.876
Factor 22	.481	31.133	.014	.890
Factor 23	.464	31.597	.013	.903
Factor 24	.451	32.047	.013	.916
Factor 25	.394	32.441	.011	.927
Factor 26	.386	32.827	.011	.938
Factor 27	.330	33.157	.009	.947
Factor 28	.302	33.460	.009	.956
Factor 29	.286	33.746	.008	.964
Factor 30	.260	34.006	.007	.972
Factor 31	.247	34.253	.007	.979
Factor 32	.230	34.483	.007	.985
Factor 33	.196	34.679	.006	.991
Factor 34	.176	34.855	.005	.996
Factor 35	.145	35.000	.004	1.000

Table 16:
Normalised Factor Loadings for the Raw Varimax Rotation on the Anthropomorphism and Computer Attitude Scales

Test Item	Factor 1	Factor 2	Factor 3	Factor 4
Anthropomorphism Scale				
Item 1	-.066	.102	-.364	-.666
Item 2	-.473	-.246	-.169	-.156
Item 3	-.399	.141	-.009	-.609
Item 4	-.344	.042	-.324	-.468
Item 5	-.729	-.019	.030	.107
Item 6	-.648	-.053	-.203	-.341
Item 7	-.294	-.087	.065	.453
Item 8	-.354	.013	-.352	-.353
Item 9	-.751	-.016	-.070	-.079
Item 10	-.438	.106	-.097	-.181
Item 11	-.587	.191	-.084	-.101
Item 12	-.528	.111	-.055	.139
Item 13	-.592	.054	.010	-.136
Item 14	-.630	.172	-.159	-.025
Item 15	-.664	.148	-.207	-.097
Computer Attitude Scale				
Item 1	.292	-.297	.192	-.501
Item 2	-.055	-.199	.780	.042
Item 3	-.291	-.467	-.069	.078
Item 4	.140	.163	.594	.147
Item 5	.187	-.604	.019	.220
Item 6	.301	.241	.536	.262
Item 7	.198	-.123	.815	.075
Item 8	-.128	-.027	.531	.154
Item 9	-.108	-.277	-.039	-.167
Item 10	-.006	-.025	.621	-.098
Item 11	-.050	-.730	.049	.015
Item 12	.154	.086	.618	-.029
Item 13	.279	-.672	.061	-.074
Item 14	-.086	-.644	.003	-.024
Item 15	.350	.287	.416	.246
Item 16	.087	-.027	.774	.093
Item 17	.294	.165	.269	.478
Item 18	.452	.254	.375	.352
Item 19	.085	-.703	.248	-.018
Item 20	.056	-.352	.592	.217

Factor 1 consists of high loadings for most of the items in the Anthropomorphism Scale, the only exceptions being items 1 and 7. The items in the Anthropomorphism Scale do not feature on Factor 2 at

all. Items 4 and 8 are moderately weighted on Factor 3 and items 1, 3, 4, 6 and 8 of the Anthropomorphism Scale also come up in Factor 4. With respect to the Computer Attitude Scale, items 6 ("Soon our lives will be controlled by computers.") and 18 ("Soon our world will be completely run by computers".) also weigh heavily in Factor 1. This makes sense as these two items imply that computers are able to "dominate" in the same way some humans do. On Factor 4, where some items in the Anthropomorphism Scale weigh heavily, items 1 and 17 also come up. There seems no way to describe this factor as all the items which weigh heavily in this factor are all very different. Factor 2 seems to denote the "usefulness and ease of computers" dimension described in the previous factor analysis and Factor 3 seems to denote a dimension of computers devaluating humans. Items 2, 4, 6, 7, 8, 10, 12, 16, and 20 of the Computer Attitude Scale load heavily of Factor 3. Therefore it seems that anthropomorphism is a construct independent of attitudes towards computers but that it is related slightly to the dimension of computers being dehumanising to society (Factor 3).

Therefore from the factor analyses performed, it seems that anthropocentrism, anthropomorphism and attitudes towards computers are independent but related constructs. Anthropocentrism seems to consist of one factor and is related to the "usefulness and ease" factor of computer attitudes. Anthropocentrism seems to consist of two factors which have been termed affective and cognitive anthropocentrism. Anthropomorphism also seems to be related to the dimension in computer attitudes that computers devalue humans.

Some Exploratory Studies

The final aim of the study was to briefly explore the relationships between anthropocentrism (CENTRIC), anthropomorphism (MORPHIC) and attitudes towards computers (ATTITUDE) with respect to age (AGE), gender (GENDER), race (RACE), education level (EDUC), and experience with computers. Since there is no existing measure of people's experiences with computers, this variable was operationalised in a group of variables including whether or not the person has access to

a computer in their home (HOME?), how long the person has used computers for (L_USE), how many hours per week the person uses a computer (HPW_USE), and how many different computer applications the person has used in the past year (APP_USE). The words in the brackets denote the names given to all the variables and will be used in the tables in this section.

Age

Table 17 shows the correlations between age and anthropocentrism, anthropomorphism and attitudes towards computers. Only with respect to computer attitudes is there a significant positive correlation (r=0.16, p-level=0.050). Thus it seems that as a person gets older, his/her attitudes towards computers improves.

Table 17:
Correlations Between Age and the Dependent Variables

Variables	Correlation	p-level
Anthropocentrism & AGE	.036	.663
Anthropomorphism & AGE	-.107	.193
Computer Attitudes & AGE	.160	.049 *

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

Gender

Table 18 shows various Anovas performed between females and males for anthropocentrism, anthropomorphism, computer attitudes, and various indicators of experience with computers. Males have a significantly higher level of anthropocentrism than do females (p-level=0.05) with males scoring an average of 44.121 and females scoring an average of 42.134 on the scale. Additionally, females tend to significantly anthropomorphise computers more than males (p-level=0.002) with an average score of 35.042 on this scale as opposed to the males' average score of 30.455. Males were shown to have more positive

Table 18:
Anovas for Anthropocentrism, Anthropomorphism, Computer Attitudes, and Experience with Computers Across Gender

Effect	df Effect	MS Effect	df Error	MS Error	F	P-level
CENTRIC	1	167.58	183	37.42	4.479	.036 *
MORPHIC	1	893.44	183	89.71	9.959	.002 **
ATTITUDE	1	2683.57	181	92.48	29.017	.000 ***
L_USE	1	187.66	168	17.00	11.038	.001 **
HPW_USE	1	10548.13	169	252.64	41.752	.000 ***
APP_USE	1	141.13	183	3.52	40.141	.000 ***

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

attitudes towards computers with an average score of 75.864 on the Computer Attitude Scale as opposed to the females mean score of 67,889. The p-level was less than 0.001.

Finally, females seem to have had less experience with computers than males with significant differences on all of the variables measuring this construct. 62% of females had access to a computer in their homes while 82% of males had access to a computer in their homes. Females had used computers for a significantly shorter time than males with an average of 5.433 years as opposed to the males' average of 7.601 years (p-level=0.001). Females also tended to use computers fewer hours per week (mean=9.575) than males (mean=25.805). The p-level in this case was less than 0.001. Finally, females had used significantly less applications this year than males had. The mean number of applications used by females was 3.025 and the mean for males was 4.848 with a p-level of less than 0.001.

Therefore, statistics show that females have a lower degree of anthropocentrism towards computers, a higher degree of

anthropomorphism towards computers, less positive attitudes towards computers and less experience with computers than do males.

Racial Group

The Anova for the effects of race on anthropocentrism, anthropomorphism and attitudes towards computers as well as on the various measures of computer experience are shown on Table 19. There are no significant differences in anthropocentrism with respect to race (p-level=0.338) or in attitudes towards computers (p-level=0.156). However, according to the Anova in Table 19 there is a significant difference between racial groups with respect to anthropomorphism (p-level<0.001). Looking at the LSD Post-Hoc Test on Table 20, it can be seen that Africans have a significantly greater level of anthropomorphism towards computers than whites and Asian people. The mean score for Africans was 39.152 as opposed to 31.104 for whites and 32.737 for Asians. The difference between Africans and whites is significant at the 0.001 level while that between Asians and Africans is significant at the 0.05 level. The difference in anthropomorphism between whites and Asians is non significant (p-level=0.471).

Table 19:
Anovas for Anthropocentrism, Anthropomorphism, Computer Attitudes, and Experience with Computers Across Race

Effect	df Effect	MS Effect	df Error	MS Error	F	p-level
CENTRIC	2	39.77	177	36.48	1.090	.338
MORPHIC	2	1067.82	177	83.43	12.800	.000 ***
ATTITUDE	2	199.78	175	106.34	1.879	.156
L_USE	2	200.60	163	15.95	12.573	.000 ***
HPW_USE	2	2551.76	163	291.95	8.741	.000 ***
APP_USE	2	32.16	177	4.00	8.034	.000 ***

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

With respect to experience with computers, white people had scored higher on all the measures than their Asian and African counterparts. 85% of whites had access to a computer in their home as opposed to 68% of the Asians and 29% of the Africans. There is no need to do an Anova on this to see that the differences are highly significant. As can be seen from Table 19, there is a significant difference between the races with respect to how long the person has used a computer (p-level<0.001), hours per week spent using a computer (p-level<0.001) and number of applications used (p-level<0.001).

The LSD Post-Hoc Test on Table 21 shows that whites have used computers for a significantly longer time than both Asians and Africans with p-levels of 0.018 between whites and Asians and less than 0.001 between whites and Africans. The mean length of use for whites was 7.345 years as opposed to 4.971 years for Asians and 3.684 years for Africans. There were no significant differences in the mean time that Africans and Asians have been using a computer (p-level=0.257).

A similar result can be seen with hours per week spent using a computer. Whites spent an average of 19.778 hours per week using a computer as opposed to 14.806 hours for Asians and 6.787 hours per week for Africans. The LSD Post-Hoc Test on Table 22 shows that whites spend significantly more hours per week using a computer than do Africans (p-level<0.001). There are no significant differences in hours per week spent using a computer between whites and Asians (p-level=0.255) and Asians and Africans (p-level=0.098).

These results are echoed with respect to the different applications used on computers during the year 1996. Whites used an average of 4.130 applications, Asians used an average of 3.526 applications and Africans used an average of 2.739 different applications. The LSD Post-Hoc Test on Table 23 shows that whites used significantly more types of applications than did Africans (p-level<0.001). As with hours per week, there were no significant differences between Africans and Asians (p-level=0.151) and between Asians and whites (p-

Table 20:
LSD Post-Hoc Test across Race with respect to Anthropomorphism

Race	Asian	African	White
Mean	32.737	39.152	31.104
Asian	---	.011	.471
African	.011 *	---	.000 ***
White	.471	.000 ***	---

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

Table 21:
LSD Post-Hoc Test across Race with respect to L_USE

Race	Asian	African	White
Mean	4.971	3.684	7.345
Asian	---	.257	.018 *
African	.257	---	.000 ***
White	.018 *	.000 ***	---

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

Table 22:
LSD Post-Hoc Test across Race with respect to HPW_USE

Race	Asian	African	White
Mean	14.806	6.787	19.778
Asian	---	.098	.255
African	.098	---	.000 ***
White	.255	.000 ***	---

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

Table 23:
LSD Post-Hoc Test across Race with respect to APP_USE

Race	Asian	African	White
Mean	3.526	2.739	4.130
Asian	---	.151	.224
African	.151	---	.000 ***
White	.224	.000 ***	---

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

level=0.224) with respect to the number of applications used.

In sum, there seem to be no racial differences with respect to anthropocentrism and attitudes towards computers. However, statistics show that Africans have a greater degree of anthropomorphism towards computers and much less experience with computers than do their white and Asian counterparts.

Table 24:
Anovas for Anthropocentrism, Anthropomorphism, Computer Attitudes, and Experience with Computers Across Education Level

Effect	df Effect	MS Effect	df Error	MS Error	F	P-level
CENTRIC	4	43.58	179	38.16	1.142	.338
MORPHIC	4	176.52	179	92.59	1.907	.111
ATTITUDE	4	509.69	177	98.17	5.192	.001 ***
L_USE	4	154.27	164	14.66	10.524	.000 ***
HPW_USE	4	3719.88	165	232.06	16.030	.000 ***
APP_USE	4	52.67	179	3.20	16.442	.000 ***

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

Educational Level

As can be seen from Table 24, education level does not seem to affect anthropocentrism nor anthropomorphism towards computers. The p-levels for the differences in education for anthropocentrism and anthropomorphism towards computers are 0.338 and 0.111 respectively. In doing LSD Post-Hoc Tests on these two constructs with respect to education level, the only significant difference found was that subjects with a postgraduate degree have a significantly lower level of anthropomorphism than subjects with a matric (p-level=0.017) and subjects with a degree (p-level=0.021). These Post-Hoc Tests can be seen in Appendix 12.

There were however significant differences between the different education levels and attitudes towards computers (p-level=0.001). As can be seen from the LSD Post-Hoc Test in Table 25, postgraduate subjects had a significantly more positive attitude towards computers than those subjects with a standard 8 (p-level=0.009), those subjects with a matric (p-level=0.023), and those subjects with an undergraduate degree (p-level<0.001). Subjects with an undergraduate

Table 25:
LSD Post-Hoc Test across Educational Level with respect to Computer Attitudes

Highest Level-	Std 8 or lower	Matric	Diploma	Under Graduate	Post Graduate
Mean	70.500	70.640	73.429	67.456	76.600
Std 8 or lower	---	.956	.342	.125	.009 **
Matric	.956	---	.400	.171	.023 *
Diploma	.342	.400	---	.041 *	.313
Under Graduate	.125	.171	.041 *	---	.000 ***
Post Graduate	.009 **	.023 *	.313	.000 ***	---

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

Table 26:
LSD Post-Hoc Test across Educational Level with respect to L_USE

Highest Level-	Std 8 or lower	Matric	Diploma	Under Graduate	Post Graduate
Mean	6.402	5.922	6.677	4.250	9.608
Std 8 or lower	---	.629	.822	.006 **	.000 ***
Matric	.629	---	.571	.079	.000 ***
Diploma	.822	.571	---	.041 *	.020 *
Under Graduate	.006 **	.079	.041 *	---	.000 ***
Post Graduate	.000 ***	.000 ***	.020 *	.000 ***	---

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

Table 27:
LSD Post-Hoc Test across Educational Level with respect to HPW_USE

Highest Level-	Std 8 or lower	Matric	Diploma	Under Graduate	Post Graduate
Mean	6.650	20.391	23.143	9.225	30.714
Std 8 or lower	---	.001 ***	.001 ***	.412	.000 ***
Matric	.001 ***	---	.595	.003 **	.013 *
Diploma	.001 ***	.595	---	.003 **	.118
Under Graduate	.412	.003 **	.003 **	---	.000 ***
Post Graduate	.000 ***	.013 *	.118	.000 ***	---

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

Table 28:
LSD Post-Hoc Test across Educational Level with respect to APP_USE

Highest Level-	Std 8 or lower	Matric	Diploma	Under Graduate	Post Graduate
Mean	3.952	3.160	3.214	2.765	5.686
Std 8 or lower	---	.081	.183	..001 ***	.000 ***
Matric	.081	---	.928	.346	.000 ***
Diploma	.183	.928	---	.393	.000 ***
Under Graduate	.001 ***	.346	.393	---	.000 ***
Post Graduate	.000 ***	.000 ***	.000 ***	.000 ***	---

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

degree had less positive attitudes towards computers than subjects with a diploma (p-level=0.041). There were no other significant differences across the education levels.

There were also significant differences across the education level with respect to experience with computers as can be seen in Table 24. 86% of postgraduate subjects, 60% of subjects with an undergraduate degree, 71% of those subjects with a diploma, 64% of subjects with a matric, and 71% of subjects with a standard 8 had access to a computer in their homes. From Table 24 it can be seen that there are significant differences between education level with respect to the length of time subjects had used computers for (p-level<0.001). In the LSD Post Hoc Test on Table 26 it can be seen that subjects with a postgraduate degree had used computers for a significantly longer period of time than those subjects with an undergraduate degree (p-level<0.001), those subjects with a diploma (p-level=0.020), those with a matric (p-level<0.001), and those with a standard 8 (p-level<0.001). Subjects with an undergraduate degree had been using computers for a shorter period of time than any of the other education groups. There are significant differences between these subjects and those with a diploma (p-level<0.001) and those with a standard 8 (p-level=0.006). There are no other significant differences. With respect to hours per week spent using a computer, there were also significant differences across the education groups. From Table 24 it can be seen that the significance level is less than 0.001. The LSD Post-Hoc Test on Table 27 shows that subjects with a postgraduate degree spend significantly longer periods of time working on a computer than subjects with an undergraduate degree (p-level<0.001), those with a matric (p-level=0.013) and those with a standard 8 (p-level<0.001). Subjects with a diploma use computers slightly fewer hours per week than those subjects with a postgraduate degree but significantly longer than those subjects with an undergraduate degree (p-level=0.003) and those with a standard 8 (p-level=0.001). Finally, subjects with a matric use computers significantly more every week than those with a standard 8 (p-level=0.001) and those subjects with an undergraduate degree (p-

level=0.003). The last Anova on Table 24 shows a significant difference between education groups with respect to the number of applications used in the past year (p-level<0.001). The LSD Post-Hoc Test on Table 28 shows that subjects with a postgraduate degree used significantly more applications than all the other education groups of subjects. The p-levels for this were all less than 0.001. The only other significant difference seen on this table is that subjects with a standard 8 have also used significantly more applications than those subjects with an undergraduate degree (p-level=0.001).

In sum, there are no significant differences between the education groups with respect to anthropocentrism and anthropomorphism towards computers. Subjects with a postgraduate degree and those with a diploma tend to have more positive attitudes towards computers than the rest of the subjects and in general, tend to have had more experience with computers. The undergraduate subjects in this sample tended to have the least experience with computers on all but one of the measures of experience towards computers (the HPW_USE variable) as well as the least favourable attitudes towards computers.

Experience With Computers

Table 29 shows the correlations between anthropocentrism and the variables used to operationalise subjects' experience with computers. All the correlations are negative which implies that anthropocentrism towards computers decreases as a person's experience with computers increases; however, none of these correlations are significant.

As can be seen from Table 30, subjects' anthropomorphism with respect to computers also decrease as experience with computers increase. All the correlations in this table are negative and significant.

The correlations between attitudes towards computers and all the variables of experience with computers are also significant and positive as can be seen in Table 31.

Table 29:
Correlations between Anthropomorphism and the Experience with Computers Variables

Variables	Correlation	p-level
Anthropocentrism & L_USE	-.001	.994
Anthropocentrism & HPW_USE	-.091	.264
Anthropocentrism & APP_USE	-.002	.980

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

Table 30:
Correlations between Anthropomorphism and the Experience with Computers Variables

Variables	Correlation	p-level
Anthropomorphism & L_USE	-.294	.000 ***
Anthropomorphism & HPW_USE	-.205	.011 *
Anthropomorphism & APP_USE	-.223	.006 **

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

Table 31:
Correlations between Computer Attitudes and the Experience with Computers Variables

Variables	Correlation	p-level
Computer Attitudes & L_USE	.424	.000 ***
Computer Attitudes & HPW_USE	.493	.000 ***
Computer Attitudes & APP_USE	.412	.000 ***

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

Table 32 contains Anovas which show the differences in anthropocentrism, anthropomorphism and attitudes towards computers with respect to whether or not subjects have a computer. The results of these Anovas more or less echo the results of the correlations. There are no significant differences in anthropocentrism whether or not one has access to a computer in their home (p-level=0.351). Subjects with computers in their homes had a significantly lower level of anthropomorphism than those subjects who do not have access to a computer in their homes (p-level<0.001). The mean anthropomorphism score was 31.457 for those with computers in their homes and 37.298 for those who do not. Subjects with computers in their homes also had better attitudes towards computers (mean=71.977) than those who do not (mean=68.196). The p-level in this case was 0.022.

Therefore, anthropocentrism is not related to any of the measures of experience with computers while anthropomorphism is negatively related to all these measures at a significant level. Attitudes towards computers are positively related to all the measures of experience with computers at a significant level.

Table 32:
Anovas for Anthropocentrism, Anthropomorphism and Computer Attitudes Across the Variable HOME?

Effect	df Effect	MS Effect	df Error	MS Error	F	P-level
CENTRIC	1	33.54	182	38.35	.875	.351
MORPHIC	1	1342.51	182	84.12	15.960	.000 ***
ATTITUDE	1	553.88	180	104.40	5.305	.022 *

* denotes significance at the .05 level.
** denotes significance at the .01 level.
*** denotes significance at the .001 level.

CHAPTER 6: DISCUSSION

This study set out to achieve three broad aims. The first aim was to define anthropocentrism and anthropomorphism with respect to computers and to develop two scales that are valid and reliable to measure these constructs. The second broad aim was to establish that anthropocentrism, anthropomorphism and attitudes towards computers are distinct constructs as well as to explore the relationship between these three constructs. It was hypothesised that the three constructs would be related but distinct. The final aim of the present study was to explore certain possible predictors of anthropocentrism and anthropomorphism. These predictors included age, gender, culture, educational level, and experience with computers.

Definitions and Measures of Anthropocentrism and Anthropomorphism

Based on the literature, anthropocentrism with respect to computers was defined as a value in which people perceive humanity to be the most significant of all entities and in which computers are perceived as valuable to the extent that they are able to maintain or enhance the quality of life of humans or provide benefits to them. Anthropomorphism with respect to computers was broadly defined as the extent to which an individual believes that computers have the same capabilities and characteristics that humans have. Anthropomorphism is considered to be made up of three dimensions: physical, affective and cognitive anthropomorphism. Physical anthropomorphism is defined as the extent to which an individual believes that computers have the same physical capabilities and characteristics as humans (for example walk and hear); affective anthropocentrism refers to the extent to which an individual believes that computers have the same emotional characteristics and capabilities as humans have (that is, they have feelings); and cognitive anthropomorphism refers to the degree to which an individual believes that computers have the same cognitive capabilities and characteristics as humans (for example they are able to think and make decisions). These definitions of anthropomorphism

are virtually identical to those given by Nass et al. (1995) with the exception that their conceptualisation of psychological anthropomorphism was further divided into cognitive and affective anthropomorphism in the present study. Due to the fact that physical anthropomorphism is an objective rather than subjective factor since a "true" level of physical anthropomorphism can be agreed upon, physical anthropomorphism was not included in the questionnaires which focused on subjects' subjective anthropomorphic beliefs.

Two scales were designed to measure anthropocentrism and anthropomorphism. The scales measuring anthropocentrism and anthropomorphism can be seen in Appendices 3 and 4 respectively. The Anthropocentrism Scale yielded a Cronbach's alpha value of 0.74 over the entire sample of subjects indicating that it does have internal consistency. Additionally, the scale yielded similar reliabilities for employees and students. However, the Anthropocentrism Scale does not seem suitable for scholars as it's internal-consistency reliability was 0.47. It is therefore advised that this scale not be used for subjects who are still at school. A possible explanation for the Anthropocentrism Scale's lack of reliability for scholars is that their values have not had the time to develop fully. Most of the scholars tested were 14 to 16 years old and according to the development theories (such as Erickson's stages theory), individuals start to develop their values around the age of 13 and values only become more stable around the age of 18 to 20 (Weiten, 1992). Therefore the scholars tested were still in the process of forming and determining their values and because of this, the Anthropocentrism Scale would not be a very reliable measure.

Another problem with the Anthropocentrism Scale is that item 6 ("Computers are superior to humans in all important ways." - reversed) does not seem suitable for the measure. This is evident in the item-total statistics for the employee and scholar groups of subjects. Further evidence for this comes from all the factor analyses containing the Anthropocentrism Scale in which item 6 does

not weigh heavily on any of the factors that the other items do. Therefore, item 6 should be removed from the Anthropocentrism Scale.

As mentioned, the Anthropocentrism Scale has face validity. Criterion validity was tested by correlating item 1 in the Anthropocentrism Scale ("Humans are superior to computers in all important respects.") with the sum of the rest of the items in the scale. Over the entire sample of subjects, this correlation was highly significant. In the same procedure undertaken for scholars, students and employees, the correlations were significant for both students and employees. Given these results, the Anthropocentrism Scale shows good criterion validity over students and employees but it is not valid in the case of scholars. Therefore this is further evidence that the Anthropocentrism Scale should not be used on subjects at the school going age.

In sum, the Anthropocentrism Scale is a valid and reliable measure of anthropocentrism with respect to computers for all people older than the school going age. The final scale consists of 10 items and can be viewed in Appendix 13 (this is the same as the scale in Appendix 3 except that item 6 has been removed).

The Anthropomorphism Scale had a high internal-consistency reliability across all the subjects with a Cronbach's alpha of 0.83. The Cronbach's alpha levels were slightly lower for students and scholars and higher for employees, but they were acceptable in all three cases. In the case of the scholars and to a lesser degree employees, item 7 of the Anthropomorphism Scale ("Computers and humans think in totally different ways." - reversed) seemed to pose a bit of a problem. Many subjects said that computers don't think at all and hence answered the question with a "1" on the Likert scale which would indicate a high level of anthropomorphism when their beliefs are in fact to the contrary. Item 7 also seemed to be a problem in all the factor analyses involving anthropomorphism. The question does not seem to be an invalid one so it is proposed that

item 7 of the Anthropomorphism Scale be changed to "Computers are not able to think in the same way that a human does." (reversed).

Criterion validity was tested for the Anthropomorphism Scale in the same way as in the Anthropocentrism Scale. Item 2 of the scale ("The similarities between humans and computers are more numerous than the differences.") was correlated with the sum of the rest of the scale. Over the entire group of subjects, this correlation was highly significant. The same applies for scholars and employees, however, the correlation was not significant for the student group of subjects. Given these results, the Anthropomorphism Scale seems to have some degree of criterion validity.

Therefore, the Anthropomorphism Scale is a reliable and valid measure of anthropomorphism with respect to computers. However, further validity studies should be conducted on the scale in order to ensure its validity. The reliability of the Anthropomorphism Scale should also be re-valuated since item 7 has been slightly changed. The final scale consists of 15 items and can be viewed in Appendix 14 (this is the same as the scale in Appendix 4 except that item 7 has been reworded).

Finally, the present study found that Nickell and Pinto's (1986) Computer Attitude Scale is reliable for a South African population. It showed a Cronbach's alpha of 0.73 and standard alpha of 0.79; and therefore has an acceptable internal-consistency reliability.

Distinctiveness of and Relationships between Anthropocentrism, Anthropomorphism, and Attitudes towards Computers

Results support the hypotheses that anthropocentrism, anthropomorphism and attitudes towards computers are distinct constructs. This goes against Nass et al.'s (1995) view that anthropomorphism is a dimension of anthropocentrism. Results also support the hypotheses that anthropocentrism and anthropomorphism are negatively related to one another, anthropocentrism and attitudes

towards computers are positively related to one another, and anthropomorphism and attitudes towards computers are negatively related to one another.

The correlations between anthropocentrism and anthropomorphism were all negative and significant. Therefore, people with a high level of anthropocentrism with respect to computers will tend to have a low degree of anthropomorphism with respect to computers. This supports the view by Nass et al. (1995) that highly anthropocentric individuals will make numerous distinctions between themselves and computers.

The correlations between anthropocentrism and attitudes towards computers were all positive and significant with the exception of scholars. This latter discrepancy is probably due to the fact that the Anthropocentrism Scale is neither valid nor reliable for people at the school going age. Therefore individuals with a high level of anthropocentrism will tend to have favourable attitudes towards computers. In other words, those individuals who value computers for the benefits they can provide to humanity and to the extent that they maintain or enhance the quality of life for humans will tend to have a good attitude towards computers. Although the correlations were not very strong (they were around 0.23 to 0.31), there is evidence to support the notion that anthropocentrism does play a part as a value in determining an individual's attitudes towards computers.

Anthropomorphism was significantly and negatively correlated to attitudes towards computers over the entire sample of subjects. The negative correlation between these two constructs was especially strong in the case of employees but not significant in the case of students and scholars (although the relationship stayed negative). Therefore, individuals high in anthropomorphism will tend to have negative attitudes towards computers. As is the case with anthropocentrism, this provides evidence that anthropomorphism as a belief has some impact on a person's attitudes towards computers.

There is a possible explanation as to why the negative relationship between anthropomorphism and attitudes towards computers was not significant for the student and scholar groups of subjects but significant for the employee group of subjects. Employees in the sample tended to be older than students and scholars in the sample. Younger people have grown up in a society of computers and due to this, computers are a fact of life to many of these people. Conversely, many of older people have had to come to terms with computers at a later time in their lives and may see the complexity of computers as threatening. Therefore in the case of older people, if they anthropomorphised computers, they would have negative attitudes similar to the "autonomous entity" concept described by Lee (1970) and Cancro and Slotnik (1970). There are also likely to be younger people high in anthropomorphism that also have negative attitudes towards computers for the same reason but at the same time, some younger people who anthropomorphise computers may do so in a positive way; in other words, form an emotional bond with the computer as suggested by Weizenbaum (1976). Older people would be less inclined to form an emotional bond with a computer due to the fact that it is a relatively new invention and not yet worthy of trust.

In addition to being related, anthropocentrism, anthropomorphism and attitudes towards computers are also distinct. From the factor analyses performed in the study, a number of interesting points also came up. From the first factor analysis consisting of two factors on Table 11, it can be seen that all the items from the Anthropocentrism Scale fall into Factor 2 and all the items from the Anthropomorphism Scale fall into Factor 1. The exceptions are item 6 of the Anthropocentrism Scale and item 7 of the Anthropomorphism Scale which was discussed earlier. From this factor analysis, it can be seen that anthropocentrism and anthropomorphism are totally distinct constructs since none of the items of the Anthropocentrism Scale are heavily loaded on the anthropomorphism factor and vice versa.

The second factor analysis with three factors on Table 12 reflects the distinctiveness of these two constructs that was shown in the first factor analysis. The only exception is that anthropomorphism is shown to consist of two factors (in Factors 1 and 3) and thus seems to be bi-dimensional. The items that are loaded on Factor 1 reflect the affective aspect of anthropomorphism exploring the emotional ties that an individual has with a computer. This factor consists of items that ask about computers evoking emotions from the individual and computers being able to communicate like humans. Although communication is also a cognitive process, one could argue that it often involves emotions as well. The example given of a person swearing at a vending machine that does not deliver is a good one highlighting the emotional aspect of communication. The items that are loaded on Factor 2 reflect cognitive anthropomorphism with items that ask about the decision making abilities and the ability to think of computers. It is interesting to note that item 6 of the Anthropomorphism Scale ("I sometimes feel that computers are alive.") is heavily loaded on both the affective and cognitive anthropomorphism factors. The factor analysis also showed anthropocentrism as a uni-dimensional construct.

The third factor analysis (on Table 14) showed the distinctiveness of anthropocentrism from attitudes towards computers as well as its uni-dimensionality. All the items of the Anthropocentrism are well loaded in factor 4. Also loaded in factor 4 is item 14 of the Computer Attitude Scale ("The use of computers is enhancing our standard of living."). This provides evidence that the value of anthropocentrism is related to this aspect of attitudes towards computers. Further evidence for this appears in Factor 2 where some of the items from the Anthropocentrism Scale are well loaded and many of the others moderately loaded. This factor consists of items in the Computer Attitude Scale that reflect the dimension that computers are useful tools to be used (eg. "Computers can eliminate a lot of tedious work for people." and "Computers are a fast and efficient means of gathering information.").

The final factor analysis shown in Table 16 shows that anthropomorphism is a distinct construct from attitudes towards computers. As is the case with anthropocentrism, anthropomorphism seems to affect certain aspects of attitudes towards computers. Item 18 of the Computer Attitude Scale ("Soon our world will be completely run by computers.") is the only item which loads on the factor with most of the anthropomorphism items. Some of the items in the Anthropomorphism Scale also weigh heavily on the fourth factor. The computer attitude items that weigh on this factor generally reflect the fact that computers devalue humans (eg. "Computers will never replace human life." and "Computers replace the need for working beings."). In addition to this, some of the items from the Anthropomorphism Scale weigh moderately on the third factor. This factor contains items in the Computer Attitude Scale that reflect the dimensions of computers intimidating and devaluing people (eg. "Computers intimidate me because they seem so complex" and "Computers are dehumanising to society."). Therefore, there is evidence that anthropomorphism as a belief affects those aspects of computer attitudes that computers are intimidating, devalue humans, are going to take over the world, or are going to replace people.

To sum up, anthropocentrism, anthropomorphism and attitudes towards computers are all distinct constructs. Anthropocentrism is a uni-dimensional construct while psychological anthropomorphism consists of two dimensions : affective and cognitive anthropomorphism. Anthropocentrism is negatively related to anthropomorphism and positively related to attitudes towards computers. The relationship between anthropomorphism and attitudes towards computers is more difficult to ascertain because it may conceivably run either way. A high level of anthropomorphism may cause either a positive attitude towards computers in that an emotional bond with the computer is formed or a negative attitude towards computers in that computers are viewed as threatening entities. However, the evidence suggests that anthropomorphism is more often than not negatively related to attitudes towards computers. Anthropocentrism seems to underlie that aspect of attitudes towards computers that perceives computers to be

useful tools or not. Based on the definition of anthropocentrism, this makes perfect sense. Similarly, anthropomorphism as a belief seems to underlie those dimensions of attitudes towards computers that perceive computers to be autonomous entities are going to take over the world or that intimidate, devalue, or replace humans. Again this is to be expected given the definition of anthropomorphism.

Predictors of Anthropocentrism and Anthropomorphism

Age

Results show that there are no significant relationships between anthropocentrism and age and anthropomorphism and age. Therefore the hypotheses that age is related to anthropocentrism and anthropomorphism are rejected. The study did however find a significant positive relationship between age and attitudes towards computers. Therefore as one gets older, one's attitudes towards computers improves.

Experience With Computers

Experience with computers does not seem to have any effect on anthropocentrism. In none of the measures of experience with computers was there a significant relationship with anthropocentrism. Therefore the hypothesis that experience with computers is positively related to anthropocentrism is rejected.

Experience with computers does however have an effect on anthropomorphism. There was a significant negative relationship between all the measures of experience with computers and anthropomorphism. Also, people who have access to a computer in their homes tend to have a lower degree of anthropomorphism than those who do not. Therefore, the hypothesis that experience with computers is negatively related to anthropomorphism holds. Due to the fact that most of the measures of experience with computers were correlated to anthropomorphism, causality is difficult to establish. It could be argued that people with a low level of anthropomorphism are more willing to use computers or that the more a person uses a

computer, the lower his/her anthropomorphism levels become due to learning more about what to expect from a computer. The relationship between anthropomorphism and experience with computers goes against Weizenbaum's (1976) notion that anthropomorphism comes as a result of an emotional tie with a machine. If this were the case, anthropomorphism and experience with computers would be positively related. However, Weizenbaum's (1976) notion may hold for a few younger people as was put forward earlier.

The study supports findings by Loyd and Gressard (1984), Koohang (1987) and many other researchers that attitudes towards computers are positively related to experience with computers. All the measures of experience with computers correlated significantly with the subjects' scores on the Computer Attitude Scale and people who have access to a computer at home are more likely to have positive attitudes towards computers.

Gender

Males tend to have a higher degree of anthropocentrism with respect to computers than females. Females, on the other hand tend to have a higher level of anthropomorphism with respect to computers. Therefore the hypotheses put forward with respect to the differences in gender for anthropocentrism and anthropomorphism hold true. The reason for this could be due to the fact that males tend to have more favourable attitudes towards computers than females. Since anthropocentrism is significantly positively related to attitudes towards computers, and anthropomorphism is significantly negatively related to computers, the differences in these constructs between males and females could be due to their differences in attitude towards computers.

An alternative explanation could be that the differences in anthropocentrism and anthropomorphism between males and females cause the differences in their attitudes towards computers, but the present study cannot prove this. This latter explanation also seems unreliable given findings by Chen (1986), Chambers and Clarke (1987),

and Campbell (1989) that the differences between males and females with respect to attitudes towards computers are reduced when experience with computers is controlled. This view is supported in the present study with respect to anthropomorphism because males have been shown to have significantly more experience with computers than females on all the measures of computer experience used. Thus given the significant relationship between experience with computers and anthropomorphism, it seems that the reason females have a higher level of anthropomorphism than males is because of the fact that they have less experience with computers. For now, however, gender can be considered to be a good predictor of anthropocentrism and anthropomorphism.

Culture

There were no differences in anthropocentrism nor attitudes towards computers between Africans, Asians and whites thus the hypothesis that Africans and Asians have a lower degree of anthropocentrism than whites is rejected. However, Africans tend to have a higher degree of anthropomorphism towards computers than Asians and whites, thereby supporting the hypothesis that there are differences between cultures with respect to anthropomorphism. This could be due to cultural factors as suggested by Caporael (1987). However, a more reasonable explanation is that Africans in the present study have had significantly less experience with computers than whites have had in all the measures used; and therefore for the same reason as the differences in gender for anthropomorphism, Africans could have a higher degree of anthropomorphism than whites due to the fact that they have had less experience with computers. This explanation does not hold for the significant differences between Africans and Asians however. Although Asians have had more experience with computers than Africans have had, these differences were not significant. Therefore the fact that Africans have a significantly higher degree of anthropomorphism than Asians suggests that cultural factors may be a determinant of anthropomorphism. As with gender, for now culture can still be considered a predictor of anthropomorphism.

Educational Level

There were no differences in anthropocentrism and no overall differences in anthropomorphism with respect to educational level. Therefore the hypotheses that education level has an effect on anthropocentrism and anthropomorphism are rejected. The only differences found in anthropomorphism was that people with a postgraduate degree had a lower level of anthropomorphism than people with or undertaking a degree or matric. This is probably due to the fact that subjects with or undertaking a degree or matric had significantly less experience with computers than subjects with a postgraduate degree. Therefore, educational level fails as a predictor of both anthropocentrism and anthropomorphism.

The study provides some support for Rogers' (1983) view that individuals with a higher level of education tend to be more willing to accept computers. With the exception of those subjects with or undertaking a degree (who had the poorest attitudes towards computers), attitudes towards computers tends to increase with increasing educational level. This could be due to the fact that as one gets more educated, there is a higher chance that one will have more contact experience with computers. A possible reason that subjects with or undertaking a degree have the lowest attitudes towards computers is that most of the African subjects fell into this education category. Due to the fact that most Africans have been disadvantaged in the past, they would have had less experience with computers and hence a less positive attitude towards computers; hence dropping the overall attitude scores of this education category.

CHAPTER 7: LIMITATIONS OF THE STUDY

There are two major limitations to the study. The first lies in the fact that although both the Anthropocentrism Scale and the Anthropomorphism Scale have been shown to have face validity and some degree of criterion validity, they need to undergo further validity studies. Until this is done, none of the exploratory work on age, gender, culture, education, and experience with computers can be considered true without question. Test-retest reliability studies on the two scales should also be performed in order to strengthen their reliabilities.

The second limitation is the fact that the scales were designed using a white collar sample of employees from an estate agency, accounting firm and computer company, and from an urban school and university. The results of this study may or may not apply to other populations such as blue collar workers or people working in other industries. Therefore further studies have to be conducted using other samples in order to establish the generalisability of the findings in the present study. On the topic of generalisability, it should be noted that the present study looked at anthropocentrism and anthropomorphism with respect to computers only and thus the results only apply to the domain of computers. The present results may not apply to anthropocentrism and anthropomorphism with respect to other machines.

CHAPTER 8: IMPLICATIONS FOR FUTURE RESEARCH

The first thing that would need to be done in future research would be to further validate the two scales in the study on different samples of people. Future research could also set about exploring the relationships between anthropocentrism, anthropomorphism and the various predictors explored in the study and perhaps designing a model that would predict anthropocentrism and anthropomorphism with respect to computers. With a lot of the relationships described in the exploratory study, causality has to be established and the relationships need to be further explained (for example, does experience with computers mediate the differences in anthropocentrism and anthropomorphism between males and females or the differences in anthropomorphism between different cultures).

Now that anthropocentrism and anthropomorphism have been linked to attitudes towards computers, this should be taken a step further to see if anthropocentrism and anthropomorphism affect behaviours towards computers. Since anthropocentrism and anthropomorphism underlie attitudes towards computers, it seems logical that they may affect people's behaviour towards computers as well. Finally, since anthropocentrism and anthropomorphism have been shown to be tied in with one's attitudes towards computers and hence probably to one's behaviour towards computers, it should be explored how anthropocentrism and anthropomorphism can be changed in people in order for them to improve their attitudes towards computers.

CHAPTER 9: CONCLUSION

The present study defined and explored anthropocentrism and anthropomorphism with respect to computers. Anthropocentrism was defined as a value or motive in which people perceive humanity to be the most significant of all entities and in which computers are seen as valuable to the extent that they are able to maintain or enhance the quality of life of humans or provide benefits to them. Anthropomorphism was defined as the extent to which an individual believes that computers have the same capabilities and characteristics as humans. Two scales were developed to measure anthropocentrism and anthropomorphism and their reliabilities and validities were established. Anthropocentrism and anthropomorphism were found to be distinct constructs inversely related to one another. Anthropocentrism was found to be uni-dimensional and positively related to attitudes to computers while anthropomorphism was found to be bi-dimensional and inversely related to attitudes towards computers. Differences in anthropocentrism were found according to gender and differences in anthropomorphism were found according to gender, culture, and experience with computers.

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APPENDIX 1: Anthropocentrism Pilot Scale

1) Humans are superior to computers in all important respects.
2) The primary value of computers is to serve humanity.
3) Governments should adopt policies which ensure good living standards for humans over advancement in computer technology.
4) One of the best things about computers is that they make our lives easier.
5) Humankind should control computers for its own benefit as much as possible.
6) Computers can be adapted to perform most jobs better than humans.*
7) Humans are the most significant entities on the planet.
8) Humans should show more respect toward computer technology.*
9) Computers were made to serve humans.
10) Advancements in computer technology are more important than ensuring that humans have a high quality of life.*
11) If a computer is able to do a job better than a human, then it should do so even at the expense of a person's job.*
12) Humans are more intellectually advanced than computers.
13) Computers are more advanced than most people would like to believe.*
14) Computers are superior to humans in all important ways.*
15) The most important use of computers is to make our lives more pleasant.
16) Advancements in computer technology are good only if a high quality of life is preserved.
17) No matter how one defines superiority, it seems that humans are to be considered superior to all computers.
18) Computers would be useless if they did not improve our living standards.

(Items marked with a * are reverse scored)

APPENDIX 2: Anthropomorphism Pilot Scale

1) Computers are unpredictable.
2) The similarities between humans and computers are more numerous than the differences.
3) When a computer breaks down, I tend to think of it as "sick".
4) I sometimes think that computers have a mind of their own.
5) When a computer program/application does not work, it is usually because I have done something incorrectly.*
6) User-friendly computers give me a "warm" feeling.
7) Computers can communicate with me as well as humans can.
8) Computers don't have feelings.*
9) I sometimes feel that computers are alive.
10) When I succeed on doing something on a computer it is because of my own efforts.*
11) Computers and humans think in totally different ways.*
12) Computers make me feel that machines are smarter than humans.
13) I sometimes see a computer as someone to "talk" to.
14) Computers are able to make better decisions than humans.
15) Computers are not that different from humans.
16) Computers sometimes evoke strong emotions in me.
17) Computers are merely inanimate machines.*
18) I sometimes catch myself talking to a computer when I am using it.
19) A computer will always only do what it is programmed to do.*
20) I sometimes feel bad when I switch off a computer that I have been using.
21) When I succeed on doing something on a computer it is because the computer allowed me to do so.
22) I sometimes feel that computers are emotionally affected by the commands that I give.

(Items marked with a * are reverse scored)

APPENDIX 3: Anthropocentrism Scale used in the Main Study

1) The primary value of computers is to serve humanity.
2) Governments should adopt policies which ensure good living standards for humans over advancement in computer technology.
3) One of the best things about computers is that they make our lives easier.
4) Humankind should control computers for its own benefit as much as possible.
5) Computers were made to serve humans.
6) Computers are superior to humans in all important ways.*
7) The most important use of computers is to make our lives more pleasant.
8) Advancements in computer technology are good only if a high quality of life is preserved.
9) No matter how superiority is defined, humans are to be considered superior to computers.
10) Computers would be useless if they did not improve our living standards.
11) Humans are more important than computers.

(Items marked with a * are reverse scored)

APPENDIX 4: Anthropocentrism Scale used in the Main Study

1) Computers are unpredictable.
2) The similarities between humans and computers are more numerous than the differences.
3) When a computer breaks down, I tend to think of it as "sick".
4) I sometimes think that computers have a mind of their own.
5) Computers can communicate with me as well as humans can.
6) I sometimes feel that computers are alive.
7) Computers and humans think in totally different ways.*
8) Computers make me feel that machines are smarter than humans.
9) I sometimes see a computer as someone to "talk" to.
10) Computers are able to make better decisions than humans.
11) Computers are not that different from humans.
12) Computers sometimes evoke strong emotions in me.
13) I sometimes catch myself talking to a computer when I am using it.
14) I sometimes feel bad when I switch off a computer that I have been using.
15) I sometimes feel that computers are emotionally affected by the commands that I give.

(Items marked with a * are reverse scored)

APPENDIX 5: Nickell & Pinto's (1986) Computer Attitude Scale

1) Computers will never replace human life.
2) Computers make me uncomfortable because I do not understand them.*
3) Computers are responsible for many of the good things we enjoy.
4) People are becoming slaves to computers.*
5) There are unlimited possibilities of computer applications that haven't even been thought of yet.
6) Soon our lives will be controlled by computers.*
7) I feel intimidated by computers.*
8) The over-use of computers may be harmful and damaging to humans.*
9) Computers are bringing us into a bright new era.
10) Computers are dehumanising to society.*
11) Life will be easier and faster with computers.
12) Computers turn people into just another number.*
13) Computers can eliminate a lot of tedious work for people.
14) The use of computers is enhancing our standard of living.
15) Computers are lessening the importance of too many jobs now done by humans.*
16) Computers intimidate me because they seem so complex.*
17) Computers replace the need for working human beings.*
18) Soon our world will be completely run by computers.*
19) Computers are a fast and efficient means of gathering information.
20) Computers are difficult to understand and frustrating to work with.*

(Items marked with a * are reverse scored)

APPENDIX 6: Item-Total Statistics for the Anthropocentrism Scale on Employees

Test Item	Item-Total Correlation	Alpha if deleted
Item 1	.634	.728
Item 2	.286	.768
Item 3	.329	.763
Item 4	.590	.733
Item 5	.524	.740
Item 6	.098	.786
Item 7	.289	.769
Item 8	.452	.749
Item 9	.419	.753
Item 10	.498	.743
Item 11	.524	.743

APPENDIX 7: Item-Total Statistics for the Anthropocentrism Scale on Students

Test Item	Item-Total Correlation	Alpha if deleted
Item 1	.347	.798
Item 2	.375	.795
Item 3	.654	.768
Item 4	.347	.797
Item 5	.524	.779
Item 6	.335	.798
Item 7	.255	.806
Item 8	.468	.785
Item 9	.609	.769
Item 10	.506	.782
Item 11	.641	.766

APPENDIX 8: Item-Total Statistics for the Anthropocentrism Scale on Scholars

Test Item	Item-Total Correlation	Alpha if deleted
Item 1	.206	.439
Item 2	.208	.438
Item 3	.259	.425
Item 4	.414	.367
Item 5	.190	.443
Item 6	-.105	.553
Item 7	.334	.409
Item 8	.138	.459
Item 9	.213	.436
Item 10	.106	.481
Item 11	.377	.429

APPENDIX 9: Item-Total Statistics for the Anthropomorphism Scale on Employees

Test Item	Item-Total Correlation	Alpha if deleted
Item 1	.392	.873
Item 2	.567	.864
Item 3	.515	.866
Item 4	.604	.861
Item 5	.498	.867
Item 6	.736	.856
Item 7	.189	.882
Item 8	.633	.861
Item 9	.726	.857
Item 10	.514	.866
Item 11	.676	.860
Item 12	.442	.870
Item 13	.433	.871
Item 14	.514	.866
Item 15	.667	.862

APPENDIX 10: Item-Total Statistics for the Anthropomorphism Scale on Students

Test Item	Item-Total Correlation	Alpha if deleted
Item 1	.206	.800
Item 2	.203	.796
Item 3	.488	.777
Item 4	.424	.782
Item 5	.516	.773
Item 6	.635	.764
Item 7	.198	.799
Item 8	.172	.800
Item 9	.657	.762
Item 10	.329	.788
Item 11	.439	.781
Item 12	.303	.791
Item 13	.542	.771
Item 14	.425	.781
Item 15	.489	.777

APPENDIX 11: Item-Total Statistics for the Anthropomorphism Scale on Scholars

Test Item	Item-Total Correlation	Alpha if deleted
Item 1	.248	.735
Item 2	.465	.715
Item 3	.404	.718
Item 4	.312	.729
Item 5	.230	.735
Item 6	.583	.701
Item 7	-.162	.773
Item 8	.460	.712
Item 9	.438	.715
Item 10	.389	.719
Item 11	.316	.727
Item 12	.259	.732
Item 13	.434	.714
Item 14	.438	.715
Item 15	.429	.719

APPENDIX 12: LSD Post-Hoc Analyses across the Education Levels for the Anthropocentrism and Anthropomorphism Scales

Anthropocentrism Scale

Highest Level-	Std 8 or lower	Matric	Diploma	Under Graduate	Post Graduate
Mean	42.429	42.960	44.857	43.412	41.257
Std 8 or lower	---	.734	.204	.418	.408
Matric	.734	---	.359	.755	.294
Diploma	.204	.359	---	.426	.067
Under Graduate	.418	.755	.426	---	.095
Post Graduate	.408	.294	.067	.095	---

Anthropomorphism Scale

Highest Level-	Std 8 or lower	Matric	Diploma	Under Graduate	Post Graduate
Mean	33.143	35.720	34.714	34.294	29.657
Std 8 or lower	---	.290	.597	.543	.115
Matric	.290	---	.755	.527	.017 *
Diploma	.597	.755	---	.882	.098
Under Graduate	.543	.527	.882	---	.022 *
Post Graduate	.115	.017 *	.098	.022 *	---

* denotes significance at the 0.05 level.

APPENDIX 13: Final Anthropocentrism Scale

1) The primary value of computers is to serve humanity.
2) Governments should adopt policies which ensure good living standards for humans over advancement in computer technology.
3) One of the best things about computers is that they make our lives easier.
4) Humankind should control computers for its own benefit as much as possible.
5) Computers were made to serve humans.
6) The most important use of computers is to make our lives more pleasant.
7) Advancements in computer technology are good only if a high quality of life is preserved.
8) No matter how superiority is defined, humans are to be considered superior to computers.
9) Computers would be useless if they did not improve our living standards.
10) Humans are more important than computers.

APPENDIX 14: Final Anthropomorphism Scale

1) Computers are unpredictable.
2) The similarities between humans and computers are more numerous than the differences.
3) When a computer breaks down, I tend to think of it as "sick".
4) I sometimes think that computers have a mind of their own.
5) Computers can communicate with me as well as humans can.
6) I sometimes feel that computers are alive.
7) Computers are not able to think in the same way a human does.*
8) Computers make me feel that machines are smarter than humans.
9) I sometimes see a computer as someone to "talk" to.
10) Computers are able to make better decisions than humans.
11) Computers are not that different from humans.
12) Computers sometimes evoke strong emotions in me.
13) I sometimes catch myself talking to a computer when I am using it.
14) I sometimes feel bad when I switch off a computer that I have been using.
15) I sometimes feel that computers are emotionally affected by the commands that I give.

(Items marked with a * are reverse scored)