2011

Are We Becoming Superhuman Cyborgs? How Technomorphism Influences Our Perceptions Of The World Around Us

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ARE WE BECOMING SUPERHUMAN CYBORGS? HOW TECHNOMORPHISM INFLUENCES OUR PERCEPTIONS OF THE WORLD AROUND US

by

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A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in Applied Experimental and Human Factors Psychology
in the Department of Psychology
in the College of Sciences
at the University of Central Florida
Orlando, Florida

Summer Term
2011

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ABSTRACT

Although traditionally researchers have focused on making robotics more user-friendly from a human perspective, a new theory has begun to take shape in which humans take on the perspective of a robotic entity. The following set of studies examined the concept of technomorphism defined as the attribution of technological characteristics to humans. This concept has been mentioned anecdotally and studied indirectly, but there is nothing currently available to tap in to the various forms that technomorphism may take. Therefore, one goal of this dissertation was to develop a scale to fill that purpose. The results of the Technomorphic Tendencies Scale (TTS) indicated that there are marked differences between those who technomorphize and those who do not. Further, the wording of the TTS items may have influenced an individual's propensity to respond in a technomorphic way. It may also be that, since technology is so new from an evolutionary perspective, it was difficult for humans to have the adequate verbiage to express their feelings about it.

The other goal of this dissertation was to examine where the individual differences may lie in the tendency to technomorphize. During the scale validation process, the Technomorphic Tendencies Scale was used alongside other scales, including those measuring anthropomorphism, acceptance of technology, perceptions of robots, and personality characteristics to determine what characteristics helped determine in what contexts people technomorphize. The results indicated that there were indeed individual differences between those who do and do not technomorphize as it relates to other constructs.

An examination of the individual differences also was performed by capturing the low level and more objective differences that may have existed. To do this, the researcher utilized an eye tracker to examine exactly what the participant focuses on while viewing the model pictures. There were indeed differences in the self reported and attentive level scores between those who fell in the different ranges of technomorphism.

The results of both the scale validation and individual differences component of this dissertation suggested that technomorphism does indeed exist. Furthermore, it may be related to how we see each other. Through the study of technomorphism, researchers have come slightly closer to the question of how technology is influencing our perceptions of what it means to be human. The findings from this work should help fuel the desire of others in the field to think about the potential influences of technomorphism during the design and implementation of new devices as well as in how technology may be related to how we perceive each other.

ACKNOWLEDGMENTS

First and foremost, I would like to thank my advisor, Dr. Valerie Sims, who has been instrumental in not only this dissertation, but also my graduate career. She has always been a source of inspiration and guidance and I appreciate all of her time and support. She also has grown to be a close personal friend and I hope to stay in communication for years to come. This sentiment should also be resonated to Dr. Matthew Chin who has worked closely with me these past five years. I also would like to thank my other dissertation committee members for their support and great ideas to make my topic even stronger. Further, the Applied Cognition and Technology (ACAT) Lab has been my home, and I need to thank all of the graduate and undergraduate lab members who have grown to be like family.

I wouldn't be where I am today without the love of my family. They have always believed in me, even when I didn't believe in myself. Thank you so much, especially to my father, Timothy, step-mother, Anne, step-sister, Brenda, and my Aunt Carol. Additionally, I am sure that, if my mother were here today, she would be very proud of my accomplishments. I would, of course, also like to thank my extended family as well along with all of my close friends including Rachel, Matt, and Andi who have consoled me during my dark times and helped me laugh and take life a little less seriously.

Of course, I need to mention my amazing animals. They are the source of inspiration for me daily. When I see the wagging tail of Kudo and the licking tongue of my scruff-ball Pickles, I can't help but smile. My cats, Nala and Purr Button, always seem to know when I want to work and do everything they can to distract me, while my little devil of a cat, Nibbles, is the most unique and interesting creature I have ever met.

And last, but certainly not least, in any stretch of the imagination, I am forever indebted to my amazing husband, Shane. In addition to supporting me through this process, he also has been instrumental in helping implement the studies of this dissertation. I would not have been able to accomplish a tenth of what I have, without him. I am incredibly lucky to have him in my life and to snag him up when I did.

Thank you to everyone in my life that has helped me to get to this point and those I have yet to meet in the future!

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CHAPTER ONE: INTRODUCTION

What makes us human? That is a philosophical question with many intricate pieces. In this paper, there will be a focus on one of those small pieces. More specifically, how has technology influenced our perceptions of what makes each other human or not? As Brian Christian exclaimed in his book *The Most Human Human*, "in the mid-twentieth century, a piece of cutting edge mathematical gadgetry was 'like a computer.' In the twenty-first century, it is the human math whiz that is 'like a computer.' An odd twist: we're like the thing that used to be like us" (p. 11). Christian later asks a question which is the crux of the current work: "Does the fact that computers are so good at mathematics take away an arena of human activity, or does it free us from having to do a nonhuman activity, liberating us into a more human life?" (p. 13). So again the question of what makes us human is raised and how technology has changed the definition of humanity and the perception of other humans comes to the forefront.

Recently, operators working on the Mars rover were asked about their interactions with the distant robot. One engineer described how she used her knowledge of the robot's vision to help move the rover by "cupping her hands around her face like the head of the Rover's mast" (Moroney, 2010, p. 23). The engineer goes on to say that "I have frequently tried to put myself in the Rover's head and say, what do I know about the world…?" (Vertesi, 2008, p. 281). Although traditionally researchers have focused on how to make robotics more user-friendly from a human perspective, a new theory has begun to take shape in which the human makes decisions based on how a robot would. This type of thinking has enabled those working on the Mars rover to use their knowledge of how the robot viewed this strange world to go beyond the limitations of what a human would see. This concept, termed technomorphism, is the focus of this paper and includes the theoretical underpinnings as well as a scale creation designed to measure this evolving construct.

Defining Technomorphism

The concept of technomorphism (first termed mechanomorphism) was mentioned initially in passing by Caporael (1986) as a “schema (albeit an elaboration of anthropomorphism) used by the scientific community, especially by researchers in artificial intelligence and cognitive science” to explain their field and understand complex concepts (p. 216). This term has since been expanded upon to define the attribution of technological characteristics to humans. In considering and perceiving a problem, a typical inclination is to consider the situation in an anthropomorphic way (Nowak & Bloca, 2003). Anthropomorphism involves the attribution of human-like characteristics to non-human entities that may be organic such as an animal, or inorganic, such as a robot or other object (Aggarwal & McGill, 2007). Although it is common to anthropomorphize as a way to understand and relate to non-human entities, perhaps equally as important is an examination of how we use those non-human entities to understand more about ourselves as human beings. Yet, only a handful of studies have even mentioned technomorphism in any form. It has been seen in the science fiction genre with countless characters in movies and books that are described in terms of their mechanical nature. For example, a series of commercials have been produced for the Droid cell phone in which a human using the phone is transformed into a cyborg while using the device. From a scientific perspective, however, technomorphism is something that researchers have been slow to investigate.

It should be noted that technonomorphism may have been employed, at least anecdotally, for many years. As Caporeal mentioned, computer scientists and those in similar fields have used technomorphism to explain how the human brain works by breaking it down into computer terms. For example, in explaining how human memory works, it is common to describe the human memory system by using RAM as a symbol of working memory, whereas a computer hard drive can be considered a long-term memory structure. Thinking in technomorphic terms can help us understand a complex structure such as the brain in much simpler concrete and relatable ways. Because the construct of technonomorphism would not be present without the presence of technology, so next will be a discussion of how the world has changed in the wake of technology's presence.

Technology in Our Society

Technology has become ever more present in our society and has enabled such objects as computers and robots to be more relatable to the average person (Osborne, Simon, & Collins, 2003). People born between 1982 and 1998 have been surrounded by and use technology like no other generation in history, with college-aged students now experiencing their academic years more "wired in" than their predecessors (McBride & Nief, 2010). Similarly, technology and robotics companies are now beginning to utilize cutting edge equipment to turn humans into "super humans." For example, the Raytheon Sarcos has created an exoskeleton, which allows a human user to increase his or her strength beyond normal human limits with minimal effort (Jacobsen, 2010). Other researchers, like Kevin Warwick from the University of Reading, have gone one step further by implanting a RFI chip into the body. This chip has rewired his brain in a way that allows him to move robots and devices with his mere thoughts (Warwick et al., 2010). Exposure to this constant wave of technological devices may have caused a shift in our thinking from an organic view to a more technological one.

Technology shapes our society in a multitude of ways. It has changed how we communicate with each other, both face to face as well as remotely. Even human-human relationships have been formed through online connections. In 2010, one in six people who got married began his or her relationship online. This is “more than twice the number of people who met at bars, clubs, and other social events combined” (Koford, 2010, p. 1). With regard to television usage, the Nielsen group reports that the average American watches approximately 153 hours of television every month at home and at least 131 million watch on their mobile devices (Nielsen Company, 2009). An even more astounding statistic relates to today’s youth and their online usage. According to the New York Times (Lewin, 2010), those between the ages of eight and eighteen years spend more than seven and a half hours a day using a smart phone, computer, television or other electronic devices. According to one 14 year old, “I feel like my days would be boring without it” (Lewin, 2010, p. 1). Businesses have been impacted equally by technology. Where would we be without the instant access to information via the Internet? The ability to send and receive information via email (over 294 billion sent every day or 2.8 million every second) has forever changed how we work and play (Tschabitscher, 2011).

Given that modern Western society has instant access to nearly anything we can think of, even our perception of time is evolving. As one researcher at UC Berkeley explains, “Because of the ability to instantaneously respond to others, our perception of time has been altered. No longer do we feel like we have enough time in the day. Many find themselves spending their entire work time and even personal time replying to e-mails. Though data proves otherwise, we now feel like there is less than 24 hours in a day. When we are bored, we find ourselves spending our whole time chatting online. By the end of the day, we discover that we have spent hours on the internet" (Meng, 2009, p. 1). We also are facing certain threats that people less than 20 years ago seldom thought about: identity theft and computer viruses. Last year, the FTC estimates that as many as 9 million Americans had their identities stolen, and the primary way of gaining that information was through the internet (Federal Trade Commission, 2011). With this influx of technology in our personal and professional lives, it is clear that we are fundamentally altering what is important to us as well as well as how we interact with each other. For centuries, face to face communication was the only way to interact and learn about each other and the world. But, now we can talk to each other over the phone or online and gain access to any information we want. As stated before, it is all almost instantaneous. These characteristics may cause a shift in the way we think and concepts such as technomorphism and anthropomorphism are becoming ever more important areas to study in this regard.

Technomorphism and Anthropomorphism Intertwined

Technomorphism and anthropomorphism are intertwined in both definition and concept. If technomorphism involves the attribution of machine-like characteristics of humans, anthropomorphism can be considered the opposite, such that it is the attribution of human-like characteristics to non-human entities (Aggarwal & McGill, 2007). Different theories exist for why it may be beneficial to view the world in an anthropomorphic way. Guthrie (1993) has postulated three explanations for this behavior. The first describes the comfort-based idea that when one views human-like characteristics in others, it is a way of providing or extending relationships or companionship. The second involves the idea that by anthropomorphizing, it allows people to make better sense of the world around them. In the first two explanations, there is a more practical standpoint, whereas the third may be considered more theoretical. It involves the assumption that a person has evolved to think this way because it has an evolutionary benefit that has outweighed any risks associated with it.

Additionally, anthropomorphism can be thought of in terms of three main types or forms in which anthropomorphism is exhibited. These forms include the literal, accidental, and partial (Guthrie, 2003). In literal anthropomorphism, individuals actually believe an object or animal is human-like. This is usually considered a result of mistaken perception such as the case of a child seeing a monster in a shadow or an individual perceiving an object that is dimly lit as a human. Accidental anthropomorphism may occur when someone sees some element of a human in an object but does not consider the object to be human at all. This may include seeing a human shape in the clouds and similar instances (Guthrie, 1993). The most common form of anthropomorphism, and the one that this work has focused on, concerns individuals seeing objects or events as having some human characteristics but not considering the entire object's form actually to be human. This is termed partial anthropomorphism and this form is the one most described in the literature and most experienced by many consumers (Guthrie, 2003). Indeed, many individuals have noted that they saw their pet smiling at them or yelled at their computer for defying or angering them. Although many speak of this in terms of the human characteristics involved, most realize that the object or being is not human in all respects and still holds its own inherent features.

The current body of literature has examined anthropomorphism in the context of what is and what is not usually classified in an anthropomorphic way. Many have looked at the physical features of the object, including its shape, color, form, size, and movement to name a few (Graham & Poulin-Dubois 1999; Morewedge, Preston, & Wegner 2007; Tremoulet, Leslie, & Hall, 2000). It is important also to look at anthropomorphism as it relates to technology and specifically to robotics. Robots have been created that encompass many anthropomorphic features, either intentionally or not. For instance, Sony Aibo, a robotic dog, was created as a companion, and has many of the same physical characteristics and mannerisms as a live dog. Additionally, the design of Roomba, a personal robotic vacuum, is very appealing because it is rounded and returns to its “home” when it needs to charge. Rounded surfaces are more organic and found more readily in nature than straight lines and shapes (Riek, 2009). In considering perceptions of robotic heads, designers account for the shape and dimensions of key features like the eyes, nose, and mouth (DiSalvo, Gemperle, Forlizzi, & Kiedler, 2002; Goetz, Kiesler, & Powers, 2003).

Even something as simple as the color and position of a set of dots inside of a box can elicit different anthropomorphic perceptions. In a study by Sims et al. (2006) participants viewed different patterns of circles and squares inside of a square box and made attributions about the emotional tone of the figure. The participants rated the object “faces” on attributions of aggression, friendliness, intelligence, trustworthiness, and degree of animation. They found that object “faces” that had round features as well as eyes with discernable pupils were rated most positively. This suggests that objects with round features, even those with minimal features, evoke “humanness”. The concept of anthropomorphism can be found in everyday life, from an American Express commercial that shows objects with “happy” or “sad” faces, to the local grocery store that has boxes of snacks with animals expressing a smiling face beckoning someone to buy them. The concepts of both technomorphism and anthropomorphism come down to the idea of how we perceive other humans, beings, and objects. This perception develops, in part, through the use of schemas, which will be discussed in the next section.

Schemas and Technomorphism

When an individual technomorphizes, anthropomorphizes, or for that matter, makes a judgment about any object, they are likely doing so through the use of a schema. A schema is a mental structure that is used to organize and simplify knowledge and make better sense of novel objects and events (Baldwin, 1992). Through the use of schemas, individuals can use their past experiences to form opinions and make judgments of an unfamiliar object. Though traditionally looked at in the Psychology field, even those in the engineering world have utilized schemas as a way to represent motor function in robots (Arkin, 1989). In this example, researchers created a motor schema that they implemented into their robot. This schema allowed said robot to operate in a concurrent and independent manner, while at the same time communicating to produce paths that reflected the uncertainty in the detection of objects and cope with conflicting or changing information.

In order to for an individual to use a technomorphic schema, he or she must make use of knowledge from a well-known domain and make analogies to apply that knowledge to another domain (Clement & Gentner, 1991; Spellman & Holyoak, 1996). It is this ability to use analogical reasoning that is a core feature of human cognition (Holyoak & Thagard, 1997). Humans construct and convey understanding of things through the use of terms previously reserved for other things, on the basis of some perceived or conjectured similarity between them (Leary, 1992).

It is the use of these schemas that allow humans to quickly perceive and produce an action in response. The use of schemas is also present in the assessment of what makes us human or not. For example, the Turing Test is a theoretical and applied concept from the 1950s that requires a human to judge whether another being with whom they are interacting is human or if it is a computer program (Turing, 1950). The Turing Test also has a human component to it as well. In his book, *The Most Human Human*, Brian Christian talks about his experiences as a confederate in the Turing Test. In addition to awarding a prize for the programming team that can fool participants into thinking the entity on the other side is human, there is also a “side” reward called the Loebner Prize for the confederate that participants thought was the “most human-like.” Mr. Christian goes on to describe how he was instructed to just “be himself” and that will be considered enough to be considered human. But given the complex nature of what it means to be human, he found it difficult not to prepare and do all he could to have the winning edge, especially given that many of the nature cues that humans use to interact with each other (such as nonverbal communication) would be stripped when interacting via computer screen.

Interestingly, we used a version of a reverse Turing Test on a regular basis. It has been created to allow a computer program to recognize whether the being on the other side of the screen is a human or another computer program. Many have experienced this “test” when trying to register for a new email account, commented on a website forum, or tried purchasing tickets at an online vendor. A computer program called “Completely Automated Public Turing Test to Tell Computers and Humans Apart" or “CAPTCHA” has created a “test” that prompts users to enter a series of numbers and letters in a distorted, wavy image (von Ahn, Blum, & Langford, 2004). By using these security features, websites are protected against bots by generating and grading tests that humans can pass, but current computer programs cannot. It protects both companies and users from comments, spam in blogs, website registration, and online polls from being “spammed,” etc. Up to this point, most human users can answer this prompt with little difficulty, whereas most computer programs lack the capability to perform a “CAPTCHA.”

Through the Turing Test and CAPTCHA examples above, we can see that there are certain inherent human and computer characteristics that can be put to the test. These and other programs are examples of organizations trying to utilize the distinctions between what humans can do and what computers can do. In order to bridge the gap between research that focuses on aspects of humans that can be designed in computers, and aspects of computers that can help us understand ourselves better as humans, the conceptualization of technomorphism needs to be fleshed out and understood better.

CHAPTER TWO: A THEORETICAL AND EMPIRICAL INVESTIGATION OF TECHNOMORPHISM

In the previous chapter, technomorphism was defined and shown to be interlinked with other concepts, such as anthropomorphism, technology, schema formation, and perceptions of other humans. However, technomorphism as a scientifically measured construct is lacking and many of the studies that are out there are adjacent to or otherwise not empirically studied. Instead, technomorphism for the most part, has been mentioned in passing as a possible cause for many results. Therefore, the goal of this section is to de-compact what it is to technomorphize and what has been done in the past to theoretically and empirically study this phenomenon.

Search for Literature on Technomorphism

In order to determine the number and types of research that are out there, a literature search was performed. A total of 12 databases was sampled within EBSCOhost. For the search term “technomorphism”, 0 articles were returned, whereas “mechanomorphism” returned 11 articles, five of which were relevant to this paper. When the search was expanded to other related terms, the return rate was increased significantly. When searching for “anthropomorphism,” 809 articles were found. When the search also added the term “human”, that number was reduced to 387 articles. There were 1775 articles with the search terms “perceptions of using technology” + “human,” 2989 on “acceptance of technology”, and 433 on “wearing technology.” However, most of these articles were tangential to the topics of this paper and were not referenced here. The bulk of the articles that were used were found in the computer science, robotics, and technology disciplines. Most spoke of technomorphism only in passing and without empirically investigating this phenomenon. When casting a wider net outside of academic articles, the search yielded five book references and 16 news or internet sources. As detailed above and described more below, technomorphism is an understudied subject. Given how fast technology is impacting and changing us, however, it is extremely important topic to examine.

Theoretical and Empirical Evidence for Technomorphism

Technomorphism has been studied, at least indirectly, in a small number of studies. In a recent study by Reiser, Parlit, and Klein (2009), technomorphism was examined in the design and implementation of a new robot butler. Although technomorphism in this context referred to designing a robot to look more “tech” like, the same basic principle can be applied to humans. As humans use more and more technological devices, they too can potentially look more “tech” like. The authors go on to mention the uncanny valley as one possible reason why a more technomorphic robot would be preferable to a human-like model. The uncanny valley can be thought of as the “strange” feeling that individuals get when viewing a robot or other non-human entity that looks and acts almost like an actual human. It also can be expanded to humans that look “too perfect” in appearance There is a point at which a human replica can look “too much like a human” (Mori, 2005). However, other research has summarized the opposite when it comes to the appearance of a robot. In the matching hypothesis, it is predicted that the most successful human-robot interaction will occur when the robot’s appearance matches its role in the interaction (Goetz, Kiesler, & Powers, 2003). There is some evidence to support the idea that robots whose features, both visually and behaviorally, mimic our own are more comforting to us. Indeed, people may be turned off by a robot whose appearance does not match its purpose

(Duffy, 2003). Duffy describes several examples of this idea, including robots in factories that humans prefer to look less human-like as well as service robots that humans prefer to look and act more like humans in general. Conversely, there are others that believe that we too are becoming more robotic-like, as we try to design robots that are more human-like. Those like Andy Clark (2004) believe that we are becoming more and more like natural-born cyborgs. Indeed, many people would fall under Clarks description of "human-technology symbionts: whose thinking and reasoning systems whose minds and selves are spread across biological brain and non-biological circuitry" (p. 230). The current work seeks to test Clark's theory in a more empirical fashion.

In a study by Shamp (1991), technomorphism was examined in conversations with communication partners on a computer. Researchers hypothesized that perceptions of communication partners would become more computer-like when little personal information was exchanged and when small amounts of communication took place between computer communication partners. Their results suggested that their first hypothesis was supported but the second was not. As the participants interacted with each other via a computer interface, the content and tone of their conversation became much less conversational, and much more rote and computer-like with short, direct questions and answers between the two humans. In this case, technomorphism was studied through communication and interaction between humans, instead of through the study of the physical appearance of an individual. Therefore, it is important to study many facets of technomorphism, which include, but are not limited to appearance, interactions with others, our process for understanding the world, and how we perceive each other.

Technomorphism as a concept has been around for over 50 years. Waters defined and described it (then termed mechanomorphism) back in 1948. He explains it through the mention of mechanical advances that were taking place and how that brought about questions of what it meant to be human. This is, of course, a tricky question that brings about more questions than answers. After all, human to human interaction is a complex web of communication cues, social norms, and previous experience, as well as many other cues. Indeed, at Stanley Stark (1963) stated in his work " even if Armageddon never comes, we may still never learn whether metal brains can do everything human brains can do; the reason being that scientists may never agree what human brains can do" (p. 160). There has been slow advancement in answering this question nearly half a century later. There has been a plethora of research within the past two decades relating to how robots and other entities may interact with humans including how the robot should look, sound, and act. However, there is a decided lack of empirical work on what it means to be a human and even less on how technology has impacted how the definition of "humanness" is changed. This work seeks to fill that gap through the design, validation, and implementation of a technomorphic scale to begin to examine these key questions. This is further described in the section below as well as in the four studies described throughout the rest of this paper.

Current Study

Through the empirical studies described in the following chapters, the researcher wanted to produce a proof of concept for how and when technomorphism is used and where the overlap may lie. As stated above, little is known about technomorphism from an empirical standpoint, so this work is meant to lay down the framework for this type of study. A large component of this includes the creation of a scale to measure the concept of technomorphism. It has been mentioned anecdotally and studied indirectly, but there is nothing currently available to tap into the various forms that technomorphism may take. Therefore, the scale that was created here serves to fill that purpose. This scale includes two main types of technomorphism, as determined through the theoretical literature. The first is a set of items which are meant to capture the problem solving or schema driven form of technomorphism. So, as humans try to "figure out" the world, do we use more concrete and definable objects in order to understand it better? These questions were developed out of the basic premise that, as technology is becoming more and more accessible it also may be causing a shift in the way we think and solve about problems. For instance, using the computer to model how the brain works, as described above, would fall in to this question type. The second type of items to be developed pertain to perceptions of others that may be eliciting a technomorphic features. This is further broken down into features that may be physical in nature such as the use of a Bluetooth, prosthesis, or other device, as well as those internal or non-physical features such as the way an individual acts, reasons, or emotes. The process of creating and validating a scale of this kind is a multi-step process and is described in depth in Studies 1A, 1B, and 2 below.

The other goal of these studies is to examine where individual differences may lie in the tendency to technomorphize. During the scale validation process, the Technomorphic Tendencies Scale was used alongside other scales including ones measuring anthropomorphism, acceptance of technology, perceptions of robots, and personality characteristics to determine what individual differences help determine in what contexts do individuals technomorphize. It was hypothesized that subscales of these measures would indeed predict differences in the tendency to technomorphize. Since there is little empirical evidence, this will be largely exploratory in nature. More specifically, the researcher believed that those individuals who have a tendency to technomorphize also would anthropomorphize and have a higher acceptance of technology. Those who do not technomorphize will be more likely to have a negative attitude towards robots and have less openness to experience and also fall on the higher end of the neuroticism spectrum.

An examination also was made of what high level cognitive structures and lower level attentive features may be related to individuals' tendency to view someone else in a technomorphic way. The higher cognitive level was accomplished through the use of pictures of models wearing certain devices and attributions and first impressions made for each. Also, to capture the low level differences that may exist, the researcher also used an eye tracker to examine exactly what the participant focuses on while viewing these pictures. In Study 2, the attributions was examined and are based on previous research (Halse, Lum, Sims, & Chin, 2011; Lum, Sims, Chin, & Lagattuta, 2009). In Study 3, participants will view the pictures in-person while equipped with the eye tracker to capture exactly where they are looking. However, it should be noted again that there has been no examination of such individual differences, so the results will be exploratory. The researcher suspects that there will be differences in those who score in different ranges of technomorphism such that those who score higher on the tendency to technomorphize may make different attributions or focus on different features of the models than those in the medium or lower range. Further, although individuals may not be able to voice whether they technomorphize, either through the scale or by expressing their opinions, individuals who technomorphize will have different eye tracking patterns than those who do not. So, those who technomorphize may focus on different things from an attentive level. Through the study of the topic of technomorphism, we may become at least slightly closer to understanding how technology is related to our perceptions of what it means to be human.

CHAPTER THREE: STUDY 1A AND 1B

The following set of studies served to examine the concept of technomorphism through the creation and validation of a Technomorphic Tendencies Scale. This was described in detail in Studies 1A, 1B, and 2. In addition, this scale was then used to examine the individual differences that may lie between those who do and do not technomorphize. In Study 3, the researcher designed an experiment to measure what people were focusing on with regards to technology and our perceptions of each other at both a higher subjective level and lower attentive level.

STUDY 1A

In this first study, the initial creation and validation process of a scale to measure technomorphism began. Because no one has ever measured empirically technomorphism, this scale was the first of its kind in both concept and execution. Additionally, other individual difference measures was examined in conjunction with the newly formed technomorphism scale in order to see whether those individuals who technomorphize also had a tendency to anthropomorphize, accept technology, have particular attitudes toward robots, and be more open to experience.

The researcher hypothesized that the result of the scale creation would be a dichotomous scale that captured the two main types on technomorphism based on the theoretical literature. This would namely be the use of a technomorphic schema to problem solve while the second subscale would focus on the technomorphic features of other individuals. Additionally, this study measured the individual differences that existed with regard to a person's tendency to technomorphize. It was hypothesized that there is a positive relationship between technomorphism and the tendency to anthropomorphize in an extreme manner as well as by individuals who are optimistic and innovative about technology. Individuals who technomorphized would also be open to experience and be conscientious. However, the researcher expected a negative relationship between those who technomorphized and those who were insecure and uncomfortable with technology, and have a negative attitude toward robots. These individuals would also be high on extraversion and agreeableness.

Method

Participants

Seven hundred and eighty undergraduate students at a large state university located in the southeastern U.S. participated in this study. Of those recruited, a total of 119 were excluded from further analyses due to incomplete or insufficient data. The final set of participants consisted of a total of 661 participants, 280 males and 381 females (Age M=19.89 years, SD =3.44, range= 18-27 years). Of the 661 participants, 453 were Caucasian/White, 57 were African American/Black, 127 were Hispanic/Non-White, 39 were Asian/Pacific Islander, 18 were American Indian/Alaskan Native, and 24 classified themselves as other. An examination of the participants' majors revealed that 160 were from Psychology, 89 from Engineering or Computer Science, 123 from Life Sciences, 28 from Health Sciences, 42 from Business, 38 from English or Communications, and the remainder were undeclared or did not answer the question.

Participants voluntarily signed up through an extra credit psychology research program and their participation was in accordance with all regulations from the university's Institutional Review Board (see Appendix D.1 for a copy of the IRB outcome letter). Participants completed the study via an online secure website with restricted access to only research participants. The study took approximately 45 minutes to complete.

The researcher chose to sample at least 620 participants due to the nature of the analyses needed to execute on the data. These included an Exploratory Factor Analysis on the newly created Technomorphic Tendencies Scale (TTS). Because the survey included 62 items, and the accepted ratio of participants to items is between seven and ten to one, the number of participants chosen allowed for an accepted minimum needed for this study (Gorsuch, 1983). In this study, the final participant to item ratio was 10.99:1.

Measures & Apparatus

Technomorphic Tendencies Scale (TTS)

The TTS was designed to measure the degree to which an individual technomorphizes. The scale was comprised of 62 items that were broken down into two main sections. The first set of questions related to individuals' tendency to use a technomorphic schema to solve a problem. In essence, those questions were trying to capture if and when individuals think in a technomorphic way when viewing the world. The second set of questions focused on how participants perceived others who were eliciting technomorphic features. This was further delineated into questions about viewing others exhibiting mental or internal technomorphic features, such as a smart or calculating individual with whom to you might come in contact, and those who may be exhibiting physical technomorphic features such as an individual wearing a Bluetooth device or a prosthetic. Further, these questions were separated into two forms of the same question. The first set of questions used the word "mechanical" as the target word, whereas the second set used the word “computer” as the target word. This was done because the researcher wanted a more general term as well as a specific term in order to determine if there were any noticeable differences. For a list of the original 62 items, see Appendix A.1. Participants rated all items using a 5-point Likert scale (1=“Strongly Disagree” and 5 = “Strongly Agree”).

Anthropomorphic Tendencies Scale (ATS)

This 78 item scale was created to tap an individual’s tendency to anthropomorphize, with four major factors including “extreme” anthropomorphism, anthropomorphism of pets, anthropomorphism of a god or higher power, and “negative” anthropomorphism directed toward machines (Chin et al., 2005). Because it was hypothesized that anthropomorphism was related closely to technomorphism, this scale served as a template for how to create and administer the TTS.

Technology Readiness Index (TRI)

The Technology Readiness Index is a scale that was developed by Parasuraman (2000) and was meant to measure and classify individuals by their propensity to embrace technology. There are three versions of the scale, including a full version with 36 items that captures all four factors in the scale, including optimism, innovativeness, discomfort, and insecurity. The other two versions are abridged versions of the full scale. It was decided to use the full version because individual differences with experience and propensity to use technology are large components of what will be looked at in this study.

Negative Attitudes Toward Robots Scale (NARS)

The Negative Attitudes Toward Robots Scale was developed by Nomura (2006) and serves to measure individuals; perspectives on robots. It includes 14 items and encompasses three subscales on negative attitude towards situations of interaction with robots, negative attitude toward social influence of robots, and negative attitude towards emotions in interaction with robots.

Personality Measure (Mini-IPIP)

The Big Five scale has been a popular measure of personality and has been shown to predict outcomes and ways of thinking (Barrick & Mount, 1991). For this study, the experimenter chose to use a shortened version of the personality measure titled the Mini-IPIP by Donnellan, Oswald, Baird, and Lucas (2006). This is a 20-item scale that quickly and reliably measures the personality traits of extroversion, conscientiousness, openness to experience, neuroticism, and agreeableness using a 5-point Likert scale.

Procedure

Participants where directed to a secure website, where they read the informed consent. After consenting to the study, they were directed to the next page where they responded to the Technomorphic Tendencies Scale. After completing that portion of the study, they then completed the Anthropomorphic Tendencies Scale, Negative Attitudes Toward Robots, Technology Readiness Index, and the Personality measure. At the conclusion of this study, participants filled out the demographic portion of the survey and then viewed a post participation form explaining the purpose of the study. An example of the scales can be found in Appendix A and the, informed consent and post participation forms can be found in Appendix B.1 and B.2.

Results

Item-Item and Item-Total Correlation

In order to determine the reliability and relevance of the of the TTS questions, item-item and item-total correlations were calculated. This analysis included the examination of the inter-correlation between the 62 items. Six scales that had a Cronbach's Alpha less than .13 were dropped from further analyses. A summary of the inter-correlations can be found in Appendix C.1. Through the use of this analysis, the researcher determined the importance of the items within the scale as well as across question types.

Exploratory Factor Analysis

A Principal Component Analysis (Quartimax rotation with Kaiser Normalization) was then run to determine the factor structure of the Technomorphic Tendencies Scale. A Quartimax rotation was used because it maximizes the variance of the squared factor loadings in each variable which was appropriate in this instance. Based on the results of a parallel analysis (PA) and minimum average partial (MAP) test, a six factor solution was retained. After rotation, the variance accounted for was 43.20% ($\lambda 1 = 22.25$, $\lambda 2 = 7.48$, $\lambda 3 = 4.74$, $\lambda 4 = 3.18$, $\lambda 5 = 3.08$, $\lambda 6 = 2.48$). Next, items with loadings of less than .4 were dropped (Gorsuch, 1983), resulting in Factor 1 having 9 items, Factor 2 having 7 items, Factor 3 having 7 items, Factor 4 having 5 items, Factor 5 having 4 items, and Factor 6 having 4 items. The factor loadings of the items that fall within each of the six factors can be found in Appendix C.2.

Factor Labels

An examination of the items on each of the factors suggested the following labels: Factor 1 items seemed to concern "how concepts work" (*e.g.*, "When I am trying to understand a concept such as how the human brain works, I use an analogy about how a machine works to try and figure it out."). Factor 2 items concerned using technomorphism in order to understand abstract concepts (*e.g.*, "When I am trying to understand a complex concept such as how a business works, I try to break the concept down into concrete machine-like parts"), Factor 3 items focused on understanding complex concepts (*e.g.,* "When I am trying to understand a complex concept such as how the human body operates, I DO NOT try to break the concept down into concrete machine-like parts.").

Factor 4 items dealt with perceptions of physical technomorphism (*e.g.*, "A person that is wearing a Bluetooth device can be thought of as computer-like"). Factor 5 items dealt with negative physical technomorphism (*e.g.,* "A person that has an artificial heart cannot be thought of as machine-like."). Finally, Factor 6 items dealt with judgments of individuals' personality and mannerism (e.g., "A person who uses logic to answer the majority of their questions can be thought of as being computer-like"). Again, a full list of the items that fell within each of these factors can be found in Appendix C.2.

Endorsement of TTS Items

To assess the degree to which participants tended to display technomorphism, items that were worded negatively were reverse-scored, such that higher numbers indicated a greater endorsement of technomorphism. Average scores then were calculated for each participant across all of the items on each of the six factors. These average scores then were used as the dependent variables in a series of one-sample t-tests to see if there was a significant deviation from the neutral point of three on the five-point scale.

There was significant agreement with Factor 1 items [M=3.35, SD=1.31; $t(660)$=9.72, p<.001], Factor 5 items [M=3.41, SD=1.09; $t(660)$=5.46, p<.001], and Factor 6 items [M=3.39, SD=0.99; $t(660)$=9.21, p<.001]. Results showed that participants displayed significant disagreement for Factor 2 items [M=2.48, SD=1.08; $t(660)$=-26.22, p<.001], Factor 3 items [M=2.13, SD=1.06; $t(660)$=-16.94, p<.001], and Factor 4 items [M=2.42, SD=0.97; $t(660)$=-14.98, p<.001]. This means that participants were likely to endorse Factors 1, 5, and 6 and likely to not endorse Factors 2, 3, and 4.

Individual Differences

In order to examine the individual differences that may have influenced the participants' responses on the TTS, a multiple linear regression analysis was conducted. The predictor variables included in the analysis were the Anthropomorphic Tendencies Scale, Negative Attitudes Toward Robots, Technology Readiness Index, and the Personality Measure. The dependent variable was the summed score of the items for each factor. A total of six linear regression analyses were conducted; one for each of the factors.

For Factor 1, "how concepts work," the overall regression model was significant [$F(16, 644)$=4.68, p<.001]. In this instance, there was a positive relationship between technomorphism and the Extreme subscale of the Anthropomorphic Tendencies Scale, as well as the Innovative subscale of the Technology Readiness Index. Individuals, who used a technomorphic schema to determine how concepts worked, were also more likely to anthropomorphize in an extreme way and be a proponent of technology as an innovation. However, there was a negative relationship between technomorphism and extraversion and agreeableness. Individuals that technomorphized by problem solving were not extraverted or high on agreeableness.

For Factor 2, which was understanding abstract concepts, the overall regression model was significant [$F(16, 644)=3.61$, $p<.001$]. Similar to the last factor, there was a positive relationship between technomorphizing abstract concepts and anthropomorphizing in an extreme way as well as endorsing innovation of technology. There was also a negative relationship between Factor 2 and Agreeableness. Factor 3 did not yield a significant overall regression model.

Factor 4 concerning perceptions of physical technomorphism did yield a significant regression model [$F(16, 644)=3.61$, $p<.001$]. There was a positive relationship between this factor and ATS Extreme and Conscientiousness. So those who endorsed physical technomorphism also endorsed extreme anthropomorphism and were considered conscientious. There was a negative relationship between physical technomorphism and negative attitudes towards robots for social purposes. In this instance, those technomorphized did not agree with or endorse negative attitudes toward social robots. There was not a significant regression model for either Factor 5 or Factor 6. A table of the findings is in Table 1 below.

Table 1: *Study 1A Linear Regression Analysis for TTS Subscales (N = 661)*

	Variable	*B*	*SE B*	*β*	*t*
Factor 1	ATS Extreme	0.130	0.062	*0.095	2.096
	TRI Innovation	1.984	1.052	*0.092	1.887
	Big5 Extraversion	-0.031	0.791	*-0.002	-1.267
	Big5 Agreeableness	-1.273	0.924	*0.061	-1.378
R^2			0.034		
F for change in R^2			1.830		
Factor 2	ATS Extreme	0.010	0.028	**0.017	5.179
	TRI Innovation	0.154	0.476	*0.324	1.416
	Big5 Agreeableness	-0.880	0.418	**-0.093	-2.104
R^2			0.023		
F for change in R^2			1.968		
Factor 3	No Significant Finding				
Factor 4	ATS Extreme	0.035	0.021	*0.077	1.708
	Big5 Conscientiousness	0.063	0.281	*-.009	2.210
	NARS Social	-0.150	0.068	*-.108	-1.195
R^2			0.029		
F for change in R^2			1.207		
Factor 5	No Significant Finding				
Factor 5	No Significant Finding				

*$p < .05$. **$p < .01$

Discussion

Summary of Findings

In this study, the initial version of the Technomorphic Tendencies Scale was developed and tested. The results of the Exploratory Factor Analysis suggested a total of six factors with endorsement of three of those factors. The TTS was designed to capture two main components within technomorphism: the use of analytic technomorphic schemas to solve problems and perceptions of others eliciting technomorphic features. In an examination of the items that fell into the first three factors, the technomorphic schema does come out. Further, the latter three factors did fall into the context of perceiving others with technomorphic features. Although it did not fall into a strictly dichotomous factor structure, the overall hypotheses did hold.

Also, this study demonstrated that there are measurable individual differences in technomorphism, and that this construct was multi-dimensional in nature. In particular, participants were likely to report the use of technomorphism for physical aspects of a human, such as presence of technological devices. Those who anthropomorphized in an extreme manner and considered technology in an innovative light were also more likely to use an analytic technomorphic schema to solve problems. However, those who had negative attitudes toward robots in a social context and those who fell in the agreeable spectrum of the Big Five were not. When viewing other individuals, those who anthropomorphized objects and were innovative with technology, were more likely to see others in a technomorphic light, whereas those who were considered neurotic did not. There were instances where the individual differences that were hypothesized were not found, but overall these findings supported the hypotheses.

This study was the first of its kind to study technomorphism in this manner. It showed that there were instances when we may technomorphize and that it is a key topic to continue to investigate. There is little doubt that this construct is important to study, especially as technology continues to be at the forefront of our society. When Caporeal (1986) mentioned technonomorphism over 25 years ago, it was in the abstract. Since then, little has been done to move technomorphism forward as a measureable empirical subject. This study was designed to remedy this fact. Do people technomorphize? Do they view others in a technomorphic way? Although there were limitations to this study, which will be described below, this first study was able to answer these questions with a resounding "yes."

Limitations of Current Study and Future Studies

This preliminary study was an important first step in discovering in what contexts individuals technomorphize. One limitation of this work involved the population that was sampled for this study. Due to convenience, a college psychology population was sampled. Although the scope was limited to those students who were actively taking courses in Psychology and were in the age range of 18 to 27, it should be noted that the majors listed by the participants varied across all disciplines. Since the General Psychology course is a general education requirement, all majors are responsible for taking it. Also, although the sample was chosen because of the access to participants, the age range was in line with those who have grown up with and have access to technology in a way that those in generations past did not. So they may be more likely to technomorphize any way.

In future studies, the scale should be examined in older populations that have had less access to technology to see how this may change how they perceive the world. Further, other majors or careers should be sampled as well. Since individuals in computer science, engineering, and bio-mechanics work with technology very closely, they may be more likely than the average psychology student to technomorphize. The other limitation of this study involved the inconsistent wording of the items, which may have lead to the low endorsement of three of the six technomorphic subscales. It may be that the participants answered the questions in the manner in which they did due to a real effect or as an artifact of the wording. Therefore, the wording of the items was revised accordingly and will be re-examined in Study 1B. The individual differences also will be re-examined to determine if they are still present after rewording the questions. Although there were certain limitations to this study, it is an important gateway to empirically test the concept of technomorphism and finding out if people do indeed view the world in a technomorphic way.

STUDY 1B

Study 1B was an extension of the previous study. Because the wording of the questions may have influenced the results more so than the concepts themselves, one goal of this study was to make the wording clearer and more similar throughout. Also, the relationship between the individual differences, such as anthropomorphism, acceptance of technology, personality characteristics, was re-examined with this revised version of the Technomorphic Tendencies Scale.

The researcher hypothesized that by revising the wording of the TTS, the scale would fall into a dichotomous scale, with items pertaining to using a technomorphic schema in one, and the other referring to perceiving technomorphism in other individuals. Further, there would be a similar relationship as there was in Study 1A between those who technomorphize and the other individual differences. More specifically, there would be a positive relationship between technomorphism and anthropomorphism, acceptance of technology, and the conscientiousness and openness to experience portions of the Mini IPIP. There would be a negative relationship between technomorphism and the subscales of the Negative Attitudes Toward Robots, and also the extraversion subscale of the Mini IPIP.

Method

Participants

Six hundred and forty-nine participants from the general Psychology pool at a large metropolitan university took part in this study. Of those, 117 participants were excluded from further analysis due to incomplete or insufficient data. This lead to a final data set of 533 participants, 226 males and 307 females (Age *M*=20.29, *SD* =2.84, range= 18-34 years). Of the 533 participants, 304 were Caucasian/White, 42 were African American/Black, 101 were Hispanic/Non-White, 15 were Asian/Pacific Islander, 7 were American Indian/Alaskan Native, and 64 classified themselves as other. An examination of the participants' majors revealed that 132 were from Psychology, 65 from Engineering or Computer Science, 98 from Life Sciences, 24 from Health Sciences, 32 from Business, 28 from English or Communications, and the remainder were undeclared or did not answer the question.

Participants received extra credit points for participating in this study and it was in accordance with the university's Institutional Review Board. The outcome and application materials that were approved by the IRB can be found in Appendix D.2, B.3, and B.4. As with the previous study, the number of participants recruited was due to the nature of the analyses performed which included an exploratory factor analysis. In order to fulfill a minimum accepted ratio of participants to items (between seven and ten to one), a minimum of 434 participants needed to be sampled (Gorsuch, 1983). The final ratio for this study was 8.60:1 which is in agreement with the accepted minimum requirement.

Measures and Apparatus

Technomorphic Tendencies Scale

The revised version of the TTS was given to the participants. There was a total of 62 items as was the case in the original iteration of the TTS. However, the questions were modified to be more consistent across items in order to rule out any effects that may have been present due to the wording. Again, there were two main questions types; those that focused on an individual’s propensity to use a technomorphic schema to problem solve and those that examined someone’s view of others who may be eliciting physical or mental technomorphic features. For a full list of the revised questions, see Appendix A.2.

Other Measures

The measures that were used in Study 1A also were utilized for this study. These included the Anthropomorphic Tendency Scale, Negative Attitudes Toward Robots, Technology Readiness Index, and the Personality measure. These also were accompanied by a demographic measure as well. For a description of these measures, see Study 1A above.

Procedure

This study was run in a similar manner as Study 1A. It was run entirely online through a secure website. Participants signed up through the university’s Psychology pool site and were directed to an external link where this study was found. They read the informed consent. If the participants agreed to participate, they advanced to the next screen where they took the revised Technomorphic Tendencies Scale. This was followed by the other measures including the Anthropomorphic Tendencies Scale, Technology Readiness Index, Negative Attitudes Toward Robots, the Personality measure, and a demographics survey. At the end of the study, participants viewed a post participation form with information about the purpose of the study as well as contact information of the researchers in case they needed further clarification.

Results

Item-Item and Item-Total Correlation

As was the case in Study 1A, item-item and item-total correlations were performed in order to determine the reliability and relevance of the of the TTS questions. The results of this analysis yielded three items below the minimum Cronbach's Alpha less of .13. A summary of the inter-correlations can be found in Appendix C.3.

Exploratory Factor Analysis

The factor structure of the revised Technomorphic Tendencies Scale was examined through a Principal Component Analysis (Quartimax Rotation with Kaiser Normalization). A 5 factor solution was retained based on the results of a parallel analysis (PA) and minimum average partial (MAP) test. After rotation, the variance accounted for was 49.93% ($\lambda1$= 32.49, $\lambda2$= 6.13, $\lambda3$= 4.71, $\lambda4$= 4.32, and $\lambda5$= 2.29). Items with loadings of less than .4 were dropped (Gorsuch, 1983, p. 332), resulting in Factor 1 having 37 items, Factor 2 having 7 items, Factor 3 having 4 items, Factor 4 having 4 items, and Factor 5 having 6 items.

The researcher then chose to examine the negatively phrased items, in order to determine if there was a certain subgroup of respondents who endorsed both positively and negatively phrased items to the same degree after recoding. This was determined by using the standard deviation value of 3 as a cutoff to examine the differences between participant endorsements of the positively and negatively phrased items. It can be argued that participants with standard deviations above this cutoff either had too strong of a response set to give consistent responses or did not pay attention to the questions. After this was performed, a total of 12 participants were excluded from analyses and the Principal Component Analysis (Quartimax with Kaiser Rotation) was re-conducted resulting in a 3 factor structure. After rotation, the variance accounted for was 43.33% ($\lambda 1$= 32.49, $\lambda 2$= 6.13, and $\lambda 3$= 4.71). Items with loadings of less than .4 were dropped resulting in Factor 1 having 37 items, Factor 2 having 7 items, Factor 3 having 4 items.

Upon further investigation from other sources, it was discovered that the use of a large number of negatively worded items, as was the case in this study, may have caused participant response problems (DiStefano & Motl, 2009). In particular, respondents were less likely to endorse disagreement with negatively worded items to the same degree as they endorsed agreement with positively worded items. Although the intention in this study was to use a large number of negatively worded items to detect respondents with response sets or lack of attention, this effect was largely obscured by the method variance that using negatively worded items introduced. Therefore, the researcher chose to then look only at the factor structure of the positively worded items. After performing the Principal Component Analysis (Quartimax Rotation with Kaiser Normalization) again, the result was a uni-dimensional scale. There were a total of three factors after the matrix was rotated. However, the items that fell on Factors 2 and 3 also loaded stronger on Factor 1 and so Factors 2 and 3 were dropped. This resulted in the total variance accounted for of 41.88%. For a table of the factor loadings, see Appendix C.4.

Factor Label

The final version of the scale included the 30 positively-worded items. Because it was uni-dimensional in nature, the final label for the factor was "Technomorphism" including both the technomorphic schema and perceptions of other individual items. This version of the scale was used in all subsequent analyses, in this and following studies.

Endorsement of TTS Items

Similar to Study 1A, it was then necessary to assess the degree to which participants tended to display technomorphism. Because the remaining scale only included positively worded items, it was not necessary reverse score and of the items. Average scores were calculated for each participant across all of the items on the factor score. These average scores then were used as the dependent variables a one-sample t-test to see if there was a significant deviation from the neutral point of three on the five-point scale. Results indicated that there was significant endorsement for the factor [M=3.42, SD=1.12; $t(521)=23.40$, $p<.001$]. The results of this analysis indicated that most individuals do technomorphize as described in the TTS questions, at least for the positively worded items.

Individual Differences

A multiple linear regression analysis was then run in order to examine the individual differences that were related to participants' responses on the TTS. The predictor variables included in the analysis were the Anthropomorphic Tendencies Scale, Negative Attitudes Toward Robots, Technology Readiness Index, and the Personality measure. The dependent variable was the summed score for the technomorphic factor determined in the Exploratory Factor Analysis.

For Factor 1, the overall regression model was significant [$F(16, 504)=30.47$, $p<.001$]. The Extreme subscale of the ATS as well as the Innovative subscale of the TRI and Openness to

Experience portion of the Mini IPIP had a positive relationship with the TTS. So those who technomorphize also anthropomorphize in an extreme way, view technology in an innovative fashion, and are open to experience. However, there was a negative relationship between the TTS and the Discomfort subscale of the TRI, and the emotional aspect of robots in the NARS. This suggests that those who technomorphize are not uncomfortable with technology nor robots having emotions. A summary of these results can be found in Table 2 below.

Table 2: *Study 1B Linear Regression Analysis for TTS (N = 520)*

	Variable	*B*	*SE B*	*β*	*t*
Factor 1	ATS Extreme	0.309	0.022	**0.62	12.758
	TRI Innovation	2.024	0.837	*0.101	2.418
	Big5 Openness to Experience	1.421	0.659	*0.074	2.155
	TRI Discomfort	-3.844	1.285	*-0.133	-2.991
	NARS Emotions	-0.572	0.191	*-0.107	-2.997
R^2			0.492		
F for change in R^2			30.429		

*p < .05. **p < .01

Discussion

Summary of Findings

The results of the Factor Analysis uncovered issues with the negatively worded items and there items were dropped from the final scale. Response bias concerns have motivated researchers to use both positively and negatively worded items on a survey (e.g., DeVellis, 1991), as was done in this and the Study 1A. This practice was intended to reduce agreement bias, but it has been found in other studies, as well as this one, to introduce systematic biases such as method effects (Horan, DiStefano, & Motl, 2003; Marsh, 1996; Motl & DiStefano, 2002;

Tomás & Oliver, 1999). In this case, responses systematically differed based on the direction of the item wording, resulting in confounding results by a method effect caused by the mechanism used to collect the information. Again, in order to remedy this problem, the negatively worded items were dropped from the measure. The resulting scale with only positively worded items was uni-dimensional in nature. The endorsement of the items suggested that individuals were technomorphizing across the two hypothesized models. Namely, because the scale was uni-dimensional, the hypothesized separation between items focusing on using and technomorphic schema and those focusing on perceiving technomorphism in other individuals was not found. Instead, these items were brought together as one form of technomorphism. Additionally, individual differences were found in this study, in a similar fashion to Study 1A. It was found that those who technomorphized also anthropomorphized in an extreme way, viewed technology in an innovative fashion, and were open to experience. However, those who technomorphize are not uncomfortable with technology nor by robots having emotions.

With this version of the scale, the concept of technomorphism is setting firmly in the ground of both theory and application. From a theory standpoint, technomorphism as a concept of study was more apparent. Perhaps there is some difference between those who technomorphize and those who do not with regards to viewing the world and interacting with others. This has implications for consumer, research, and military fields, as well as many other fields. When hiring for a position where a human has to not only interact with, but also take on the perspective of a robot, as was the case with the Mars rover, it may be beneficial to use an instrument like the Technomorphic Tendencies Scale to determine a candidate's propensity to technomorphize. Although there are limitations of the scale, it is an important first step to empirically measuring technomorphism and this opens the gate for other researchers to study this construct further.

Limitations of Current Study and Future Studies

Since this study looked only at technomorphism from a self-reported scale in a generic context, a goal of the next two studies was to look at the use of technomorphism from different angles. More specifically, Study 2 examined how individuals technomorphize when viewing pictures of other individuals who may be portraying technomorphic features. This was coupled in Study 3 by an examination of differences in eye movements between those who technomorphize those pictures and those who do not. Do people technomorphize others who are using technology? Also, because technomorphism was intertwined with other individual difference measures, most notably anthropomorphism, the distinct variance that technomorphism accounts for was examined in the next study. The next series of studies examined these potential differences more closely and in different contexts.

CHAPTER FOUR: STUDY 2

The goal of Study 2 was to examine the internal consistency, reliability and overall structure of the Technomorphic Tendencies Scale. The other goal of this study was to determine if there were differences in the ratings of attributions as a function of technomorphism, gender, and type of picture shown to participants.

It was hypothesized that the structure of the TTS would be similar to that of Study 1B such that it would remain uni-dimensional and the 30 positively worded items would fall in the factor. The Extreme subscale of the ATS and the Innovative subscale of the TRI would result in a positive relationship with the TTS while the NARS Emotions and Discomfort subscale of the TRI would result in a negative relationship. Further, there would be marked differences between those who were high and low on technomorphism in how they respond to the attributions of the pictures of models wearing items that could be considered technomorphic.

Method

Participants

A total of seven hundred and forty-four undergraduate students took part in this study. Of those recruited, 103 were excluded from further analyses due to incomplete or insufficient data. Therefore, the final data set included a total of 641 participants; 274 males and 367 females (Age *M*=20.02, *SD* =4.18, range= 18-32 years). Of the 641 participants, 321 were Caucasian/White, 75 were African American/Black, 152 were Hispanic/Non-White, 44 were Asian/Pacific Islander, 9 were American Indian/Alaskan Native, and 40 classified themselves as other. An examination of the participants' majors revealed that 176 were from Psychology, 95 from Engineering or

Computer Science, 118 from Life Sciences, 52 from Health Sciences, 29 from Business, 32 from English or Communications, and the remainder were undeclared or did not answer the question.

Participants voluntarily signed up in a similar manner to the previous studies and were awarded extra credit in the psychology course of their choice. The study was in full accordance with the university's Institutional Review Board (see Appendix D.3 for a copy of the IRB outcome letter and B.5 and B.6 for the other application materials). Participants completed the study via an online secure website with restricted access to only research participants. The study took approximately 30-45 minutes to complete. Because the analyses of this study included a Factor Analysis, among others, it was decided that a minimum of 240 students were needed. Since the final participant total exceeded this minimum, the power and critical *F* was adjusted to account for any spurious effects that may have been found.

Measures and Apparatus

Revised Technomorphic Tendencies Scale (TTS)

The final version of the TTS was used in this study. As a result of the Exploratory Factor Analysis performed in Study 1B, this version included 30 positively worded items. These items captured both the schema and problem solving aspects of technomorphism as well as perceptions of others that may be portraying technomorphic tendencies. In order to account for any order effects, the items were randomized as was the case in the previous studies.

Other Individual Difference Measures

In this study, the researcher also chose to use the Anthropomorphic Tendencies Scale, Technology Readiness Index, Negative Attitudes Toward Robots, Personality Measure, and a demographics survey. Since components of these measures were predictive in the previous study, it was important to include these here as well.

Model Pictures and Attributions

In addition to the scales mentioned above, the participants also viewed images of models and were asked to rate those images on several attributes. In a previous study, several pictures of different models were tested and it was determined that the two people used in that study as well as this one were perceived to be of average appearance, intelligence, friendliness, and other attributions (Halse, Lum, Sims, & Chin, 2011). Also, in order to account for possible gender effects, both a male and female model were used. The pictures were taken in front of a white backdrop with the models wearing the same colored shirt and both were instructed to give a neutral expression. Further, the images were presented to participants in black and white to account for possible perceptions of color or other variables. Participants viewed one of 14 images in a between-subjects design. For each model, there was a total of seven pictures taken. These included a control picture, two images of the model wearing different types of eye tracking equipment, a Bluetooth device, a headset, a bike helmet, and a military helmet. For a summary of these pictures, please see Appendix A.10 and A.11.

The models were rated on 10 different attributions on a five-point scale ranging from extreme disagreement to extreme agreement. The attributions included attractiveness, friendliness, trustworthiness, aggressiveness, intelligence, honesty, dependability, independence, competitiveness, and the ability to be hard-working. These particular attributions were chosen because, in previous studies (Halse, Lum, Sims, & Chin, 2011; Lum**,** Sims, Chin, & Lagattuta, 2009), they had been predictive and were meant to capture a varying range of perceptions.

Procedure

In a similar fashion to the previous two studies, this study was completed entirely online. Participants first went to a secure website, where they read the informed consent. After consenting to the study, they were directed to the next page where they responded to the Technomorphic Tendencies Scale. This was followed by the portion of the study where participants viewed one of 14 pictures of the models and rated them on the ten attributions. The pictures were randomized between participants, and the attributions also were randomized within-the study. After completing that portion of the study, they then completed the Anthropomorphic Tendencies Scale, Negative Attitudes Toward Robots Scale, Technology Readiness Index, and the Personality measure. At the conclusion of this study, participants filled out the demographic portion of the survey and then viewed a post participation form explaining the purpose of the study.

Results

Factor Analysis

The researcher had access to the participant's answers on all 62 of the items, although only the positively worded items were used for the analyses following this. Therefore, the researcher chose to examine the negatively phrased items, in order to determine if there was a certain subgroup of respondents who endorsed both positively and negatively phrased items to the same degree after recoding. This was determined by using the standard deviation value of 3 as a cutoff to examine the differences between participant endorsements of the positively and negatively phrased items. As was the case in Study 1B, it was argued that participants with standard deviations above this cutoff either had too strong of a response set to give consistent responses or did not pay attention to the questions. After this was performed, a total of 38 participants were excluded from analyses.

In order to determine if the item structure within each of the four factors in Study 1B showed a similar result in this data set, a Principal Component Analysis (Quartimax Rotation with Kaiser Normalization) was performed on the remaining 603 participants. Instead of using the parallel analysis (PA) and minimum average partial (MAP) test as was conducted in the previous studies, the researcher chose to use a fixed number of factors method. The number of factors chosen to be extracted was one since that was found in Study 1B. After rotation, the variance accounted for was 39.56% compared to 41.88% of the last study. Items with loadings of less than .4 were dropped (Gorsuch, 1983, p. 332). The items in the factor was then examined and found to load on the same factor as was found in the previous study.

Endorsement of TTS Items

In order to determine if the endorsement of the TTS items fell along the same pattern as Study 1B, average scores were calculated for each participant. These average scores then were used as the dependent variables in a one-sample t-test to see if there was a significant deviation from the neutral point of three on the five-point scale. The same pattern did indeed exist as was the case in Study 1B. Results indicated that there was significant endorsement of the Factor 1 items [M=3.58, SD=1.14; $t(603)=9.751$, $p<.001$].

Prediction of TTS for Acceptance of Technology

In order to determine whether the Technomorphic Tendencies Scale predicted, above and beyond, the established Anthropomorphic Tendencies Scale, a hierarchical regression was performed for the overall acceptance of technology. The dependent variable was the total Technology Readiness Index score because that scale was meant to measure overall acceptance of technology. The independent variables were the TTS summed score and ATS Extreme subscale. The ATS Extreme subscale was used because it was predictive in the previous two studies while the other subscales were not.

For Model 1, with the ATS score inputted, the overall regression model was significant [$F(1, 602)=8.53$, $p=.004$]. For this model, the ATS positively predicted the propensity to accept technology ($B=.017$, $SEB=.006$, $\beta=.127$, $t=2.920$). When Model 2 was examined with both the ATS and TTS, the overall model was still predictive [$F(2, 602)=10.40$, $p<.001$]. The ΔR^2 for Model 1 was .161 and ΔR^2 for Model 2 was .223. When the TTS was added ($B=.012$, $SEB=.003$, $\beta=.150$, $t=3.477$), it accounted for 6.20% unique variance above and beyond the ATS ($B=.017$, $SEB=.006$, $\beta=.130$, $t=3.026$).

Individual Differences

An examination of the individual differences that may have existed, was performed by running a multiple linear regression analysis. The dependent variable was the overall Technomorphic Tendencies Scale score with the predictor variables, including the Anthropomorphic Tendencies Scale, Negative Attitudes Toward Robots, Technology Readiness Index, and the Personality Measure. The overall regression model was significant [*F*(16, 587)=1.535, p<.001]. In this instance, the ATS Negative subscale, the TRI Innovative Subscale, and the TRI Optimism subscale positively predicted the TTS score. However, the TRI Discomfort and TRI Insecure subscales negatively predicted the TTS. So, in this instance, those who scored high on the TTS also tended to anthropomorphize in a negative way as well as to agree with questions about using the innovation and optimism of technology However, those who were both insecure and uncomfortable about technology tended to not technomorphize. A summary of these findings can be found in Table 3 below.

Table 3: *Study 2 Linear Regression Analysis for TTS (N = 587)*

	Variable	*B*	*SE B*	*β*	*t*
Factor 1	ATS Extreme	0.053	0.086	*0.32	2.906
	TRI Innovation	0.703	0.146	*0.024	2.223
	Big5 Openness to Experience	1.490	1.858	*0.039	1.390
	TRI Discomfort	-0.471	2.261	*-0.012	-1.011
	NARS Emotions	-0.188	0.333	*-0.026	2.353
R^2			0.322		
F for change in R^2			1.535		

*p < .05. **p < .01

Attribution Ratings

Canonical Correlation

A canonical correlation analysis was conducted using TTS score, picture type, sex of model, and sex of participant as predictors of the attributions made (attractiveness, intelligence, friendliness, aggressiveness, dependability, honesty, independence, trustworthiness, competitiveness, hardworking) to evaluate the relationship between the two variable sets (i.e., technomorphism related to attributions made). The analysis produced four functions with squared canonical correlations (Rc^2) of 0.114, 0.036, 0.015, and 0.008 for each successive function. The full model across all functions was significant (Wilks'λ = 0.835 criterion; $F(40, 2307.32) = 2.80$, $p < 0.001$). The effect size was found by examining 1-λ, which provides an indication of the effect size as a percentage of variance explained (r^2) (Sherry & Henson, 2005). In this study, a medium effect size was found (0.3632), which meant the full model explained 36.32% of the variance shared between the variable sets. The results of the dimensional reduction analyses showed that only the full model was significant (Functions 1 to 4). Also, given the RC^2 effects for each function, only the first function was considered noteworthy because it explained 26.4% of shared variance. In contrast, Functions 2 through 5 accounted for only 9.9% of the remaining variance in the variable set after the extraction of the first function.

The standardized canonical function coefficients, the structure coefficients, and the squared structure coefficients for Function 1 can be found in Table 4. An examination of the canonical loadings (i.e., structure coefficients) shows that only TTS Score and Picture Type were primary contributors to the predictor synthetic variable. This conclusion is supported by the squared structure coefficients and the standardized canonical function coefficients. In Table 4, an examination of the canonical loadings also reveals the relevant criterion variables to be Attractiveness and Intelligence.

Table 4: *Study 2 Canonical Correlation (N = 587)*

	Function 1		
Variable	**Coefficient**	r_s	r_s^2 (%)
Attractiveness	-0.793	**-0.807**	65.08
Intelligence	0.231	**0.742**	55.11
Friendliness	-0.077	0.307	9.45
Aggressiveness	-0.021	-0.210	4.40
Dependibility	-0.046	0.351	12.30
Honesty	-0.046	-0.188	3.54
Independence	-0.191	-0.293	8.57
Trustworthiness	-0.142	-0.262	6.85
Competitiveness	0.011	0.145	2.10
Hardworking	-0.164	-0.241	5.81
R_c^2			11.40
TTS	0.701	**0.722**	52.13
Picture Type	0.587	**0.684**	46.79
Sex of Model	-0.228	-0.296	8.76
Sex of Participant	-0.198	-0.211	4.45

Note: Structure coefficients (r_s) greater than |0.45| are in bold. Coefficient=standardized canonical function coefficient: structure coefficient; r_s^2 =squared structure coefficient

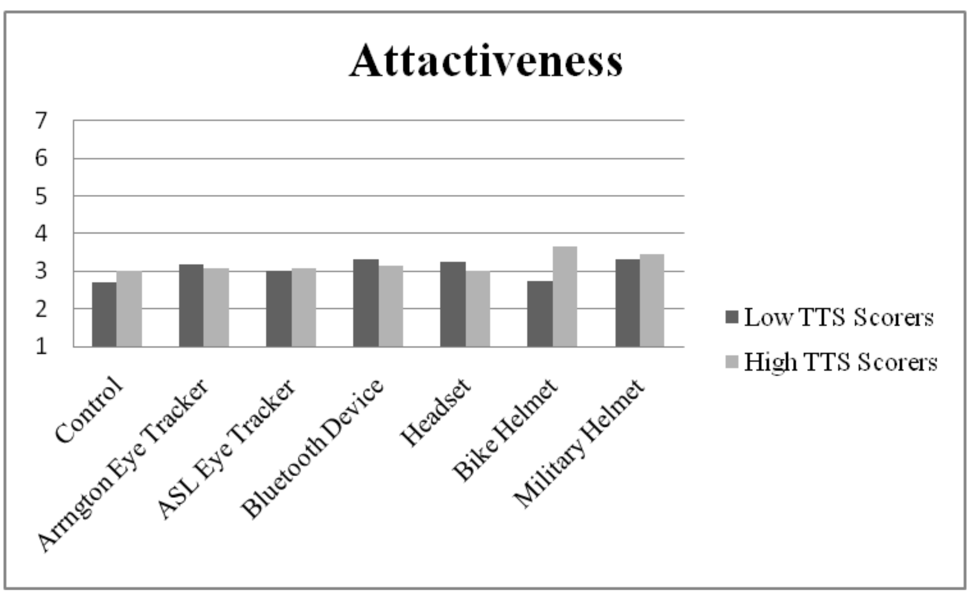
Attribution Analysis of Variance

The results of the canonical correlation were then used to aid in the analysis of where the differences were for the predictor variables of TTS score and Picture Type. A 2 (low or high TTS score) x 7 (picture type) ANOVA was performed for the two attributions that were significant in the canonical correlation (attractiveness and intelligence). The low TTS scorers were determined by choosing those participants who received a combined score on the TTS below 60. The high TTS scorers were determined by choosing participants with a combined score above 120. This allowed the researcher to only examine those participants with extreme low scores (those who overall scored 2 or below on each of the 30 questions) and extreme high scores (those who overall scored 4 or higher on each of the 30 questions). After removing those participants with scores higher than 60 and lower than 120, 209 participants remained in the analysis (132 low TTS Scorers and 77 high TTS Scorers).

Attractiveness

For the rating of attractiveness, there was a main effect for TTS Score [$F(1,195)=.309$, $p=.003$, $\eta p^2=.060$], such that the low TTS Scorers ($M=3.78$, $SD=.091$) rated the models more attractive than the high TTS Scorers ($M=2.99$, $SD=.070$). There also was an interaction effect for TTS Score by Picture Type [$F(6,195)=2.631$, $p=.004$, $\eta p^2=.037$]. Post-hoc analyses showed that the low TTS Scorers reported significantly lower scores ($M=2.72$, $SD=.102$) for the Bike Helmet than high TTS Scorers ($M=3.67$, $SD=.093$). A pictorial summary of these findings can be found in Figure 1 below.

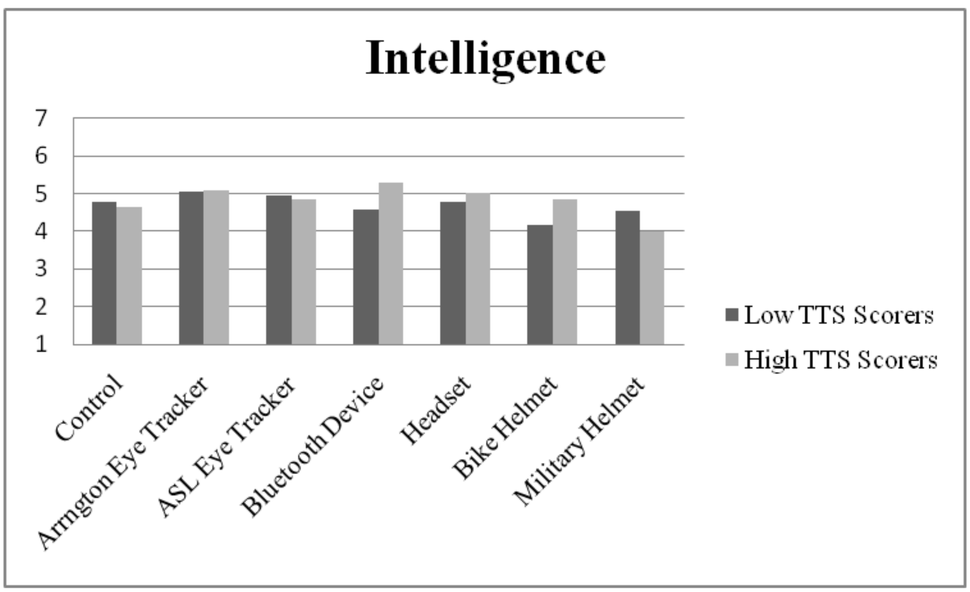
Figure 1: *Study 2 Attractiveness Interaction*



Intelligence

For the attribution of intelligence, there was an interaction between TTS Score and Picture Type [$F(6,195)=2.65$, $p=.002$, $\eta_p^2=.040$]. Post-Hoc analyses revealed that there were significant differences for the Bluetooth Device, Bike Helmet, and Military Helmet. Low TTS Scorers (*M*=4.56, *SD*=.265) considered models with the Bluetooth Devices as less intelligent than high TTS Scorers (*M*=5.29, *SD*=.481). Similarly, low TTS Scorers (*M*=4.17, *SD*=.300) rated models with the Bike Helmet as less intelligent than high TTS Scorers (*M*=4.83, *SD*=.368). However, the opposite was true for the Military Helmet such that the low TTS Scorers (*M*=4.53, *SD*=.292) rated the models in this picture type as more intelligent than high TTS Scorers (*M*=4.00, *SD*=.353). Figure 2 is a pictorial summary of these findings.

Figure 2: *Study 2 Intelligence Interaction*



Discussion

Summary of Findings

In Study 2, the internal consistency of the TTS was examined and found to be high for the uni-dimensional scale. Most importantly, the factor structure and items within the factor held constant between Study 1B and this one. This suggests that the TTS is a reliable scale and might be useful to measure technomorphism. This was also found based on the high endorsement for the items in this and the previous administration of the scale. Additionally, technomorphism was positively related to other individual difference measures such as extreme anthropomorphism, technology innovation, and openness to experience. Technomorphism was negatively related to emotions in robots and insecurity with technology. The results of the individual difference measures were consistent with Study 1B. Because it was hypothesized that there was an inter-relationship between technomorphism and anthropomorphism, a separate analysis was performed to determine if technomorphism predicted attitudes toward technology above and beyond anthropomorphism. The results indicated this was indeed the case, as technomorphism accounted for nearly 7% of the variance over anthropomorphism.

The second and more primary goal of this study was to use the TTS to predict attributions of pictures where models were wearing different devices and to verify the use and utility of the TTS. The results of the canonical correlation and subsequent ANOVA analysis suggest that the TTS can be used to determine perceptions of others who may be different from what is considered the norm. For instance, low TTS Scorers rated the models more attractive than the high TTS Scorers across picture types. This suggests that those who do technomorphize view others differently than those who do not technomorphize. Also, the results of the interactions between technomorphism score and picture type for both the attractiveness and intelligence attributions lends itself to the conclusion that it does matter how technomorphic a person as well as who or what they are looking at. The results of this study suggest that there are differences in perceptions of people who exhibit physical technomorphic features as were seen in the model pictures shown to the participants. Picture type and most importantly TTS score were predictive which furthers the evidence that we do indeed attribute different characteristics to people.

From a theoretical standpoint, these findings support the idea that technology is changing or adapting our view of the world. The creation of the Technomorphic Tendencies Scale will allow researchers to not only focus on creating products that fit to a human mold, but also how technology can shape how we have changed fundamentally as human beings. This has further implications for application. When designing consumer and military products, consideration of how people perceive those wearing the products should be taken into account. If a company designs a Bluetooth device but users are perceived as more aggressive or less friendly or similarly if a soldier walks in to an unfamiliar village and is seen in a negative light due to the gear he is wearing, this has implications for how others will perceive and subsequently interact with that person.

Limitations of Current Study and Future Studies

This study is limited by the types of attributions used as well as the pictures shown. Due to practical reasons, only ten attributions and fourteen pictures were used in this study. Future studies should examine how other characteristics and types of objects may affect how people are perceived. Also, although the models in the pictures were pre-tested for attractiveness, the findings may be limited in scope since multiple models were not used. Age, race, and ethnicity also may play a role in shaping perceptions and should be examined in more depth in future studies. Lastly, the TTS has shown to have internal consistency, although endorsement was low for the subscales. It may be that people just are not using technomorphic schemas in certain instances or that the scale itself failing to capture some of the relevant topics. However, when the scale was examined further, it was determined that there are differences in endorsement between those who fall in the low and high TTS extremes. A future study should break out the levels even further between those who fall in the even more extreme high and low spectrums of the scale. Potential studies should look at how people in these ranges differ on other key characteristics as well. Since the TTS was given at one point in time, this scale also will be tested in the next study across time to determine whether this can be considered a state or trait measure. Furthermore, because the perceptions of the pictures were completed at a higher and more subjective level of assessment, the next study will determine if individual differences exist at a lower level also.

CHAPTER FIVE: STUDY 3

In previous studies, the concept of technomorphism was looked at through the guise of higher level individual differences that may be related to individuals' perceptions. In this study, researchers took this one step further by not only looking at technomorphism at a high level but also at a lower level through the examination of eye gaze patterns of participants. It was hypothesized that there would be a difference in both the duration and number of fixations on the model pictures for individuals who were high and low on technomorphism. Finally, there would be a difference on what the first word spoken by the participants when viewing the models as delineated by low and high technomorphism.

Method

Participants

There were two components to this study. In the first part, a total of 232 participants (98 males, and 134 females) responded to a series of scales online including the Technomorphic Tendencies Scale. At the end of the study, the participants had the option of giving their contact information to take part in the second part of the study in-person. The researcher asked 98 participants to come in. Of those, a total of 43 undergraduate students responded (Age *M*=19.32, *SD* =3.88, range 18-26 years) and came in for the second part. Of the 43 participants, 24 were Caucasian/White, 8 were African American/Black, 6 were Hispanic/Non-White, 2 were Asian/Pacific Islander, 1 were American Indian/Alaskan Native, and 2 classified themselves as other. An examination of the participants' majors revealed that 13 were from Psychology, 5 from Engineering or Computer Science, 3 from Life Sciences, 2 from Health Sciences, 1 from

Business, 2 from English or Communications, and the remainder were undeclared or did not answer the question. Of those 43, one participant was excluded from further analyses due to incomplete data.

Participants voluntarily signed up in a similar manner to the previous studies and were awarded extra credit in the psychology course of their choice. The study was in full accordance with the university's Institutional Review Board (see Appendix D.4 for a copy of the IRB outcome letter). The online portion of the study took approximately 30 minutes to complete and the in-person portion took 30-45 minutes.

Measures and Apparatus

Technomorphic Tendencies Scale (TTS)

The final version of the TTS was used in this study which included the 30 positively worded items. These items captured both the schema and problem solving aspects of technomorphism as well as perceptions of others that may be portraying technomorphic tendencies. In order to account for any order effects, the items were randomized as was the case in the previous studies.

Individual Difference Measures

The participant completed the Anthropomorphic Tendencies Scale, Technology Readiness Index, and Negative Attitudes Toward Robots online. In-person, the participants also responded to the Personality Measure, and a demographics survey.

Model Pictures & Attributions

The same pictures that were shown in Study 2 also were used here. The pictures of the models also were rated on ten different attributions on a five-point scale. However, the participants viewed and responded to all 14 images as a within-subjects design, whereas the participants only saw one image in Study 2.

Eye Tracking

The participants were eye tracked while viewing images of the models. An eye tracker is a device that measures eye movements, pupil size, focus, and other characteristics of one or both eyes while engaged in a given task. An eye tracker records eye gaze information so a researcher can identify what an individual is viewing at any given time as well as their eye movement patterns across a span of time (Poole & Ball, 2006). Participants were equipped with a lightweight goggle eye tracker developed by Arrington Research that utilized a scene camera to record the direction in which the participant is looking and a second camera pointed at the participant's eye. The information from the eye camera was recorded and later processed based on the number of fixations, average duration of fixations, and part of the screen that the participant focused on when they first viewed each picture. A fixation indicates a period of time, usually 200-400 milliseconds, in which eye movement is relatively stable (Jacob & Karn, 2003). For this particular study, a fixation was defined at the 700-millisecond level due to the potential for high velocity eye movement and the short time period that the participants had to view each image. Each picture was shown for five seconds, and the order of the pictures was randomized for each participant.

First Impressions

After each picture was shown, the participant was asked an opened question: “What is the first word that comes to your mind when viewing this image?” The first question was coded for word and schema type. It was broken down into eight categories: 1) words relating to a person, 2) words about the device or object the model had on them, 3) words about the model’s expression, 4) words about the model’s facial features, 5) irrelevant or indistinguishable words, 5) participant gave no response or didn’t know what to say, 6) participant referred to themselves, and 8) word referring to a machine or technology.

Procedure

In the first part of this study, participants went to a secure website where they viewed the informed consent. If they consented, they took the TTS followed by the ATS, TRI, and NARS. At the end of the study, the participants were given the option to enter their contact information if they would like to come in for part two of the study. This was followed by a post-participation page, explaining the purpose of the study.

The TTS scores were calculated for those who gave their contact information to come in for the second part of the study. Those who fell in to the low, medium, and high ranges as described in the participant section of this study, then were emailed and asked to sign up for this in-person study. Those participants who signed up for part two, came in and read an informed consent. The participants were given verbal explanation of the study, what they would see, and also information about the three questions they would be asked after every picture. They then were directed to sit in front of a screen and an eye tracking device was placed on them. After calibration, they then saw the 14 images in a randomized fashion. After every picture, they were asked the *First Impression* question. The researcher wrote down the answers to the questions after ever picture. When this was completed, the eye tracker was removed, and the participants were directed to a second computer where they answered the attribution questions for all 14 images. This was followed by the second administration of the TTS, the Personality Measure and demographics survey. At the end, participants received a copy of the post-participation form and had a chance to answer any questions they might have. The informed consent, post participation form, and the scales for both parts of this study can be found in Appendix B.7, B.8, B.9, and B.10.

Results

The researcher was interested in the difference in first impression and eye tracking for those who were low and high TTS scorers. This was done by splitting the participants into those who scored a 4 or above or a 2 and below on the 30 TTS. This was done in the same manner as Study 2. This resulted in a total of 24 participants remaining from the original 42 that were run. 14 participants were considered low TTS Scorers and 10 were considered high TTS Scorers. This subset of participants were used in all subsequent analyses in this study.

Technomorphism Related to Viewing Pictures

First Impressions

A qualitative assessment was conducted for the first impression questions that participants gave after seeing the images of the models. The answers that participants gave for the "first word that comes to mind when viewing this picture" was coded for word type as described in the method section above.

For the control picture, the low (33.3%), and high (33.3%) TTS Scorers tended to focus on the facial features of the model. The participants commented that the models in this instance looked "normal" or referred to them as "man" and "woman". When the Arrington eye tracker pictures were viewed, the bulk of participants in both the high and low TTS score ranges commented about the device (low: 38.2% and high 45.2%) with the most frequently used words including "goggles" and "camera" For the ASL eye tracker pictures, those low TTS scorers (30.8%) commented on the facial features of the model using words like "headset" and "headpiece", whereas the high TTS Scorers (20.0% for each) were split evenly between commenting on the eye tracker, the expression of the model, and referring to the machine or technology. The high TTS Scorer answers included things like "futuristic," "optical," and "smart".

When it comes to viewing the pictures of the model wearing the Bluetooth device, the words about the object were the highest across TTS Scorers (low: 32.5% and high 58.5%). The bulk of the participants knew what a Bluetooth was and responded superficially with the word "Bluetooth" when the question was prompted. With regard to the headset, the low TTS Scorers (33.3% for each) were divided evenly between using words relating to the object and words that focused on the models' expression, whereas the high TTS Scorers (40.0%) focused mostly on the object. These included words like "xbox," "telecommuting," and "professional." Across both TTS score types (low: 46.2%, and high 66.7%), when participants viewed the pictures of the model wearing the bike helmet, they responded with words regarding the object with the bulk specifically saying "bicycle" or "bike." Finally, when responding to the pictures with the models wearing a military helmet, the low TTS Scorers tended to focus on either the helmet itself or the models' expression such as "serious" and "silly" (28.6% for each). However, thigh TTS Scorers (40.0%) responded by giving words relating to the person such as "soldier" or "marine". A summary of these findings can be found in the table below.

Table 5: *Study 3 Summary of First Impression Responses by TTS Scorers*

	TTS Scorers		
Picture Type	**Low**	**High**	**Response Examples**
Control	facial features (33.3%)	facial features (33.3%)	normal, man, woman
Arrington Eye Tracker	device (38.2%)	device (45.2%)	goggles, camera
ASL Eye Tracker	facial features (30.8%)	device, model expression, and technology (20.0% each)	headset, headpiece, futuristic, optical
Bluetooth Device	device (32.5%)	device (58.5%)	bluetooth
Headset	device, model expression (33.3% each)	device (40.0%)	focused, attentive, xbox, telecommuting
Bike Helmet	device (46.2%)	device (66.7%)	bicycle, bike
Military Helmet	model expression (28.6%)	person (40.0%)	serious, silly, soldier, marine

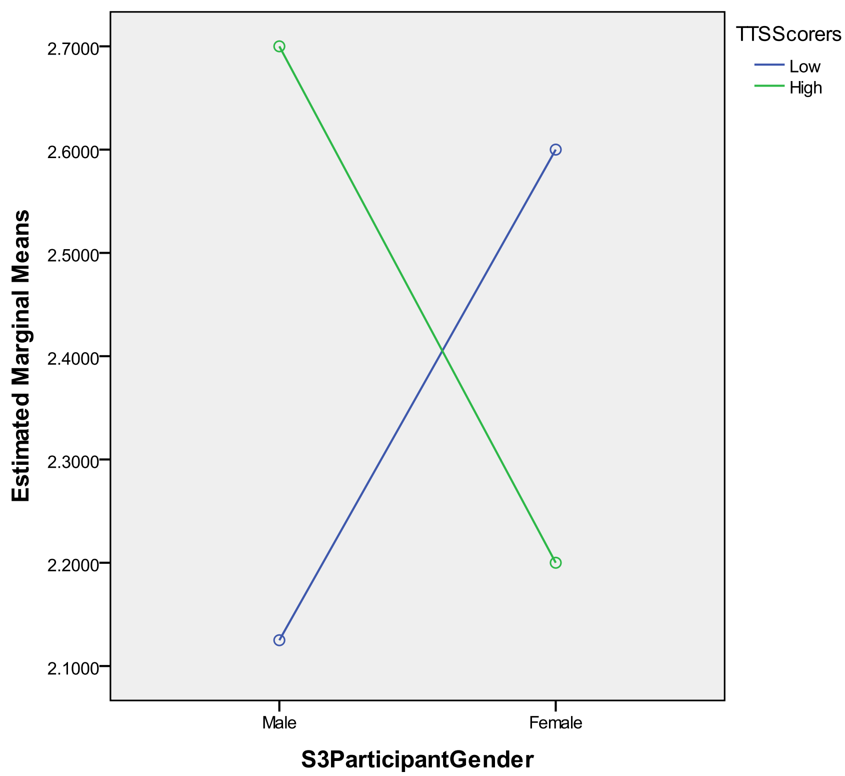
Eye Tracking

After examining what the participants said and thought about the pictures, the researcher then wanted to dig deeper and focus not only on the self-reported perceptions, but also on the more objective, attentive measures. This was done by studying the eye tracking patterns at the global level through the duration and number of fixations the participants had. This was collapsed by model gender since this was not the main focus of this study.

Number of Fixations

A MANOVA was run with the number of fixations for each picture types serving as the dependent variables and the TTS Scorers (low and high) and the participant gender serving as the independent variables. For the control picture, there was an interaction effect for the TTS score and participant gender [$F(1,20)=6.054$, $p=.023$, $\eta p^2=.232$]. Tukey HSD post-hoc analysis revealed that male low TTS Scorers ($M=2.12$, $SD=.479$) had significantly less number of fixations than male high TTS Scorers ($M=2.70$, $SD=.274$). The opposite effect was found for females such that female low TTS Scorers ($M=2.60$, $SD=.642$) had higher number of fixations than female high TTS Scorers ($M=2.19$, $SD=.434$). See Figure 3 below for a graphical representation of this effect.

Figure 3: *Study 3 Summary of Number of Fixations by TTS Scorers*



For the Arrington Eye Tracker, there was a significant main effect for participant gender [$F(1,20)=4.475$, $p=.047$, $\eta p^2=.183$]. According to the post-hoc test (Tukey HSD), male participants (*M*=4.83, *SD*=.823) had significantly fewer number of fixations than female participants (*M*=5.10, *SD*= .928). There was also a main effect of TTS Score for the ASL Eye Tracker [*f* (1,20)=2.276, *p*=.004, η p^2=.127]. According to the post-hoc test (Tukey HSD), low TTS Scorers (*M*=3.72, *SD*=.916) had significantly fewer number of fixations than high TTS Scorers (*M*=4.92, *SD*= .824). Finally, there was a main effect of TTS Score for the bike helmet [*f* (1,20)=3.804, *p*=.023, η p^2=.230]. According to the post-hoc test (Tukey HSD), low TTS Scorers (*M*=4.65 *SD*=.878) had significantly fewer number of fixations than high TTS Scorers (*M*=5.76, *SD*= .820).

Duration of Fixations

A MANOVA was run with the duration of fixations for each picture types as the dependent variables and the TTS Scorers (low and high) and the participant gender as the independent variables. For the ASL Eye Tracker, there was a significant main effect for TTS Score [*F*(1,20)=3.865, *p*=.003, η p^2=.391]. Post-hoc analysis revealed that low TTS Scorers (*M*=2.10, *SD*=.049) had significantly higher duration of fixations than high TTS Scorers (*M*=.99, *SD*=.058). There was also a main effect of TTS Score for the Headset [*f* (1,20)=4.092, *p*=.036, η p^2=.129]. According to the post-hoc test (Tukey HSD), low TTS Scorers (*M*=1.76, *SD*=.067) had significantly higher duration of fixations than high TTS Scorers (*M*=0.92, *SD*=.049). Finally, there was a main effect of TTS Score for the military helmet [*f* (1,20)=1.679, *p*=.008, η p^2=.284]. In this case, low TTS Scorers (*M*=1.89 *SD*=.096) had significantly higher duration of fixations than high TTS Scorers (*M*=.96, *SD*= .014).

Discussion

Summary of Findings

Qualitative assessment of the first impressions of the pictures revealed that it does indeed matter what objects you use. When by themselves, the models were considered “normal” by many participants. However, when introducing such items as the eye trackers and consumer technology, the focus shifted to the objects. Further, those in the low and high TTS score ranges differed in what they focused on, such that high TTS Scorers tended to focus more on the technology or object than low TTS Scorers So it may be that those who are highly technomorphic see technology, and specifically those wearing technology, differently than those who do not technomorphize. This was demonstrated even more clearly when examining the eye tracking patterns both at a global level. When viewing the objects, those who were in the low and high TTS ranges had contrasting number and duration of fixations. More specifically, high TTS Scorers tended to have more fixations and for a shorter duration of time when compared with the low TTS Scorers. Although examined only at the global level and not at specific zones over the time period, it can be concluded by the eye tracking and first impressions, that there is clearly a differences in what is focused on or attended to by those who technomorphize and those who do not.

These findings suggest that there are individual differences at play here. This is seen not only at the conscious, subjective level through the attributions given to others, but also at a lower more objective one with the eye tracking patterns. Those who technomorphize see the world and attribute others in a different way than those who do not. As technology becomes ever more present, this may indeed be causing a change in how we perceive each other and ultimately interact with each other. Moreover, the TTS has proven itself to be a reliable measure by which to study this phenomenon. Although there are still many hurdles to overcome and more testing to be done before we can recognize technomorphism as an empirically testable construct, there is evidence in this and the previous studies to support the idea that technomorphism does exist and can influence how we see the world.

Limitations of Current Study and Future Studies

The results of this study are limited by the pictures chosen in the same manner described in the discussion of Study 2. There was an effect for certain picture types and not for others. To gain better internal and external validity, future studies should investigate different types of objects and people in the pictures, different age groups, races, and ethnicities of participants, as well as how different cultures both view technology and subsequently technomorphize. Also, as stated above, the eye tracking results were only examined at the global level. Further, coding is needed to differentiate exactly what and where participants were looking at and how the construct of technomorphism may have influenced what was being attended to. The results of this and previous studies are largely exploratory. Although it has broken ground in the area of technomorphism, there is much further to go before we can gain a true grasp of the concept and how it may be impacting our perceptions and interactions with each other.

CHAPTER SIX: GENERAL DISCUSSION & CONCLUSIONS

Summary of Findings

Overall, the results of the Study 1, 2, and 3 indicated that technomorphism could be reliably measured, and that strong individual differences did exist. In Study 1A, there were concerns about the influence of wording on the outcome of the Factor Analysis. Therefore, in Study 1B, the items were reworded and re-analyzed. As stated in the discussion section of Study 1B, the results of the Factor Analysis uncovered issues with the negatively worded items and there items were dropped from the final scale. Although the use of negatively worded items was intended to reduce agreement bias, in this case, it introduced systematic biases such as method effects (Horan, DiStefano, & Motl, 2003; Marsh, 1996; Motl & DiStefano, 2002; Tomás & Oliver, 1999). Responses differed systematically based on the direction of the item wording, resulting in confounding results by a method effect caused by the mechanism used to collect the information. As such, the negatively worded items were dropped from the measure, resulting in a uni-dimensional scale with 30 items that were all positively worded. The results of the factor analyses suggested that the TTS assesses technomorphic tendencies across analytic and positive technomorphism of others. The results from Study 2 and 3 showed that the TTS has predictive validity. Scores on the TTS predicted both individuals' attributions of and eye tracking patterns with people and objects. Although the validity of the TTS was only evaluated in a limited context, the results from Study 3 do suggest that technomorphic tendencies, as measured by the TTS, could impact peoples' perceptions of others.

These studies also demonstrate that there are identifiable individual differences between those who technomorphize and those who do not. This has influence over how a person perceives others at a higher and more subjective level as evidenced in Study 2 and 3 with the attributions and first impressions made of the models. In study 3, the models were considered “normal” by many participants but the introduction of items as the eye trackers and consumer technology shifted the focus from the model to the object. Further, those in the low and high TTS score ranges differed in what they focused on, such that high TTS Scorers tended to focus more on the technology or object than low TTS Scorers. So it may be that those who are highly technomorphic see technology, and specifically those wearing technology, differently than those who do not technomorphize.

This was demonstrated even more clearly when examining the eye tracking patterns both at a global level. When viewing the objects, those who were in the low and high TTS ranges had contrasting number and duration of fixations. More specifically, high TTS Scorers tended to have more fixations and for a shorter duration of time when compared with the low TTS Scorers. Although examined only at the global level and not at specific zones over the time period, it can be concluded by the eye tracking and first impressions, that there is clearly a differences in what is focused on or attended to by those who technomorphize and those who do not. There is clearly something at play here, and what technology we use may influence how we are seen by others.

Through these series of studies, the construct of technomorphism has begun to take shape. Although mostly exploratory in nature, these studies have shown that there is indeed something going on here and that technology may play a bigger role than we just thought in shaping our perceptions of each other and of the world as a whole. As stated previously, the creation of the Technomorphic Tendencies Scale will allow researchers to not only focus on creating products that fit to a human mold but also how technology can shape how we have changed fundamentally as human beings.

The TTS has the potential for numerous scientific and applied uses. For example, it could be used to predict individual differences in interactions with other humans, avatars, robots, and many others. Similarly, the military, NASA, and many other government agencies could use this scale to determine who is qualified uniquely to think about problems in a technomorphic way or can work with and use robots and be able to take on the robot's point of view. These results suggest that individuals may perceive others more positively on a number of attributes when they fit expectations for what people naturally look like. When designing consumer and military products, consideration of how people perceive those wearing the products should be taken into account.

Limitations of Current Study and Future Studies

Future research will be needed to determine if there are additional technomorphic tendencies that are not measured by the TTS or if the two types found in the present research represent a full range of possible types of technomorphism. Also, a more heterogeneous pool of participants should be sampled in order to measure the validity of this measure within different populations. This includes different age groups, races, ethnicities, and cultures. There also should be special attention to those who do and do not work with technology on a regular basis and how this may influence how much and what types of technomorphism they utilize. Furthermore, factors that were not assessed in the current studies may be correlated with technomorphic tendencies. Use and acceptance of technology, anthropomorphism, and personality characteristics were all predictive of tendency to technomorphize. However, other individual differences such as exposure to technology at a certain age, socio-economic status, and other factors may play into a person's propensity to technomorphize.

Technomorphic tendencies appear to be measurable, and this individual difference, along with other variables, may be used to further understand humans' interactions with each other. This study may be the very first of its kind to look at how we perceive technomorphic attributes in humans rather than how to humanize a robot or computer. The results of this study may serve as a stepping stone into a more introspective view of ourselves as humans within the larger context of a technologically driven society. The findings from this and future work should allow robotics developers, computer scientists, military agencies, and even advertisers to better understand the underlying tendencies that exist within many individuals, in order to create better, more engaging products. It is through an understanding of how technology is fundamentally changing us as human beings through the viewpoint of mechanomorphism, which can be important to the future of our interactions with and perceptions of other human beings.

Although it is difficult to measure every form of technology and the potential negative implications of it, there may still be some importance in researching the social implications of technology in our society. If the social context in which we use technology is fundamentally changing the way that we perceive each other, that is a philosophical as well as practical question that should be addressed now, as we continue to move forward with ever more complex and intricate machines designed to further augment us. This is particularly important in light of the ever-increasing amount of technology that is being utilized by everyone including soldiers, school teachers, and everyday consumers.

APPENDIX A: EXPERIMENTAL SCALES & MEASURES

A.1 First Iteration of the Technomorphic Tendencies Scale

TTS

Please read each statement carefully. Indicate the strength of your agreement with each statement by clicking on the button which corresponds with your opinion on the following 5-point scale. There are no right or wrong answers to any of these statements. We are interested in your honest reactions and opinions.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

1. When I am trying to understand a concept such as how the human brain works, I DO NOT use an analogy about how a machine works to try and figure it out.
2. When I look at how the human body moves, I DO NOT tend to think of a machine with moving parts working in conjunction with one another.
3. When I look at how people dance, I tend to think of a machine with moving parts working in conjunction with one another.
4. When I exercise (or practice for sports), I DO NOT think of my body as a machine which needs to become calibrated by repeated movements and training.
5. When I eat, I think of the food as fuel that my body converts to energy in order to work as an effective machine.
6. When I am trying to understand a concept such as how the human brain works, I DO NOT use an analogy about how a computer works to try and figure it out.
7. When I look at how the human body moves, I tend to think of a computer with moving parts working in conjunction with one another.
8. When I look at how people dance, I DO NOT tend to think of a computer with moving parts working in conjunction with one another.
9. When I exercise (or practice for sports), I DO NOT think of my body as a computer which needs to become calibrated by repeated movements and training.
10. When I eat, I think of the food as fuel that my body converts to energy in order to work as an effective computer.

11. When I am trying to understand an abstract concept such as respect, I DO NOT use an analogy about how a machine works to figure it out.
12. When I am trying to understand an abstract concept such as hatred, I DO NOT tend to think of it as a machine with moving parts working in conjunction with one another.
13. When I am trying to understand an abstract concept such as how other people's emotions work, I DO NOT use an analogy about how a machine works to try and figure it out.
14. When I am trying to understand an abstract concept such as how love works, I tend to think of it as a machine with moving parts working in conjunction with one another.
15. When I am trying to understand an abstract concept such as tiredness, I use an analogy about how a machine works to figure it out.
16. When I am trying to understand an abstract concept such as respect, I DO NOT use an analogy about how a computer works to figure it out.
17. When I am trying to understand an abstract concept such as hatred, I tend to think of it as a computer with moving parts working in conjunction with one another.
18. When I am trying to understand an abstract concept such as how other people's emotions work, I DO NOT use an analogy about how a computer works to try and figure it out.
19. When I am trying to understand an abstract concept such as how love works, I tend to think of it as a computer with moving parts working in conjunction with one another.
20. When I am trying to understand an abstract concept such as tiredness, I DO NOT use an analogy about how a computer works to figure it out.
21. When I am trying to understand a complex concept such as how the universe works, I DO NOT try to break the concept down into concrete machine-like parts.
22. When I am trying to understand a complex concept such as how memory works, I try to break the concept down into concrete machine-like parts.
23. When I am trying to understand a complex concept such as how the human body operates, I DO NOT try to break the concept down into concrete machine-like parts.
24. When I am trying to understand a complex concept such as how an ecosystem works, I try to break the concept down into concrete machine-like parts.
25. When I am trying to understand a complex concept such as how a business works, I try to break the concept down into concrete machine-like parts

26. When I am trying to understand a complex concept such as how the universe works, I DO NOT try to break the concept down into concrete computer-like parts.
27. When I am trying to understand a complex concept such as how memory works, I DO NOT try to break the concept down into concrete computer-like parts.
28. When I am trying to understand a complex concept such as how the human body operates, I try to break the concept down into concrete computer-like parts.
29. When I am trying to understand a complex concept such as how an ecosystem works, I DO NOT try to break the concept down into concrete computer-like parts.
30. When I am trying to understand a complex concept such as how a business works, I try to break the concept down into concrete computer-like parts.
31. A person that is wearing a Bluetooth device can be thought of as machine-like.
32. A person that has an artificial heart or CANNOT be thought of as machine-like.
33. A person that is using a cochlear implant (hearing aid) can be thought of as machine-like.
34. A person that has prosthesis CANNOT be thought of as machine-like.
35. A person who is using multiple technological devices at once can be thought of as machine-like.
36. A person who is using a computer CANNOT be thought of as machine-like.
37. A person that is wearing a Bluetooth device can be thought of as computer-like.
38. A person that has an artificial heart or can be thought of as computer-like.
39. A person that is using a cochlear implant (hearing aid) CANNOT be thought of as computer-like.
40. A person that has prosthesis can be thought of as computer-like.
41. A person who is using multiple technological devices at once can be thought of as computer-like.
42. A person who is using a computer CANNOT be thought of as computer-like.
43. A person with exceptional math skills can be thought of as being machine-like
44. A person who uses logic to answer the majority of their questions CANNOT be thought of as being machine-like.

45. A person who seems detached during emotional class discussions can be thought of as being machine-like.

46. A person who often uses precise vocabulary in casual situations can be thought of as being machine-like.

47. A person who is extremely organized CANNOT be thought of as being machine-like.

48. A person with exceptional math skills CANNOT be thought of as being computer-like

49. A person who uses logic to answer the majority of their questions can be thought of as being computer-like.

50. A person who seems detached during emotional class discussions CANNOT be thought of as being computer-like.

51. A person who often uses precise vocabulary in casual situations can be thought of as being computer-like.

52. A person who is NOT extremely organized can be thought of as being computer-like.

53. A person who acts machine-like is NOT able to solve complex problems better.

54. A person who acts machine-like is able to use his/her skills to improve negative situations.

55. A person who acts l machine-like is able to understand human emotions as well.

56. A person who acts machine-like is NOT able to make more rational decisions.

57. A person who acts machine-like is able to empathize with others.

58. A person who acts computer-like is able to solve complex problems better.

59. A person who acts computer-like is NOT able to use his/her skills to improve negative situations.

60. A person who acts l computer-like is NOT able to understand human emotions as well.

61. A person who acts computer-like is able to make more rational decisions.

62. A person who acts computer-like is NOT able to empathize with others.

A.2 Second Iteration of the Technomorphic Tendencies Scale

TTS

Please read each statement carefully. Indicate the strength of your agreement with each statement by clicking on the button which corresponds with your opinion on the following 5-point scale. There are no right or wrong answers to any of these statements. We are interested in your honest reactions and opinions.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

1. I DO NOT use an analogy about how a machine works to try to understand how the human brain works
2. I DO NOT think of a machine with moving parts working in conjunction with one another when looking at how the human body moves.
3. I think of a machine with moving parts working in conjunction with one another when looking at how people dance.
4. I DO NOT think of my body as a machine which needs to become calibrated by repeated movements and training.
5. I think of food as fuel that my body converts to energy in order to work as an effective machine.
6. I DO NOT use an analogy about how a computer works to try to understand how the human brain works
7. I think of a computer with moving parts working in conjunction with one another when looking at how the human body moves.
8. I DO NOT think of a computer with moving parts working in conjunction with one another when looking at how people dance.
9. I DO NOT think of my body as a computer which needs to become calibrated by repeated movements and training.
10. I think of food as fuel that my body converts to energy in order to work as an effective computer.

11. I DO NOT use an analogy about how a machine works to understand a concept such as respect.
12. I DO NOT think of a machine with moving parts working in conjunction with one another to understand a concept such as hatred.
13. I DO NOT use an analogy about how a machine works to understand a concept such as how other people's emotions work.
14. I think of a machine with moving parts working in conjunction with one another to understand a concept such as how love works.
15. I use an analogy about how a machine works to understand a concept such as tiredness.
16. I DO NOT use an analogy about how a computer works to understand a concept such as respect.
17. I think of a computer with moving parts working in conjunction with one another to understand a concept such as hatred.
18. I DO NOT use an analogy about how a computer works to understand a concept such as how other people's emotions work.
19. I think of a computer with moving parts working in conjunction with one another to understand a concept such as how love works.
20. I DO NOT use an analogy about how a computer works to understand a concept such as tiredness.
21. I DO NOT break down the concept into machine-like parts when I am trying to understand how the universe works.
22. I break down the concept into machine-like parts when I am trying to understand how memory works.
23. I DO NOT break down the concept into machine-like parts when I am trying to understand how the human body operates.
24. I break down the concept into machine-like parts when I am trying to understand how an ecosystem works.
25. I break down the concept into machine-like parts when I am trying to understand how a business works.
26. I DO NOT break down the concept into computer-like parts when I am trying to understand how the universe works.

27. I DO NOT break down the concept into computer-like parts when I am trying to understand how memory works.

28. I break down the concept into computer-like parts when I am trying to understand how the human body operates.

29. I DO NOT break down the concept into computer-like parts when I am trying to understand how an ecosystem works.

30. I break down the concept into computer-like parts when I am trying to understand how a business works.

31. I think that a person who is wearing a Bluetooth device is machine-like.

32. I DO NOT think that a person who has an artificial heart is machine-like.

33. I think that a person who is using a cochlear implant (hearing aid) is machine-like.

34. I DO NOT think that a person who has prosthesis is machine-like.

35. I think that a person who is using multiple technological devices at once is machine-like.

36. I DO NOT think that a person who is using a computer is machine-like.

37. I think that a person who is wearing a Bluetooth device is computer-like.

38. I think that a person who has an artificial heart is computer-like.

39. I DO NOT think that a person who is using a cochlear implant (hearing aid) is computer-like.

40. I think that a person who has prosthesis is computer-like.

41. I think that a person who is using multiple technological devices at once is computer-like.

42. I DO NOT think that a person who is using a computer is computer-like.

43. I think that a person who has exceptional math skills is machine-like.

44. I DO NOT think that a person who uses logic to answer questions is machine-like.

45. I think that a person who is detached during emotional discussions is machine-like.

46. I think that a person who uses precise vocabulary in casual situations is machine-like.

47. I DO NOT think that a person who is extremely organized is machine-like.

48. I DO NOT think that a person with exceptional math skills is computer-like.

49. I think that a person who uses logic to answer questions is computer-like.
50. I DO NOT think that a person who is detached during emotional discussions is computer-like.
51. I think that a person who uses precise vocabulary in casual situations is computer-like.
52. I DO NOT think that a person who is extremely organized is computer-like.
53. I DO NOT think that a person who solves complex problems is machine-like.
54. I think that a person who uses his/her skills to improve negative situations is machine-like.
55. I think that a person who understands human emotions is machine like.
56. I DO NOT think that a person who makes rational decisions is machine-like.
57. I think that a person who empathizes with others is machine-like.
58. I think that a person who solves complex problems is computer-like.
59. I DO NOT think that a person who uses his/her skills to improve negative situations is computer-like.
60. I think that a person who understands human emotions is computer-like.
61. I think that a person who makes rational decisions is computer-like.
62. I DO NOT think that a person who empathizes with others is computer-like.

A.3 Final Iteration of the Technomorphic Tendencies Scale

TTS

Please read each statement carefully. Indicate the strength of your agreement with each statement by clicking on the button which corresponds with your opinion on the following 5-point scale. There are no right or wrong answers to any of these statements. We are interested in your honest reactions and opinions.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

1. I think of a machine with moving parts working in conjunction with one another when looking at how people dance.
2. I think of food as fuel that my body converts to energy in order to work as an effective machine.
3. I think of a computer with moving parts working in conjunction with one another when looking at how the human body moves.
4. I think of food as fuel that my body converts to energy in order to work as an effective computer.
5. I think of a machine with moving parts working in conjunction with one another to understand a concept such as how love works.
6. I use an analogy about how a machine works to understand a concept such as tiredness.
7. I think of a computer with moving parts working in conjunction with one another to understand a concept such as hatred.
8. I think of a computer with moving parts working in conjunction with one another to understand a concept such as how love works.
9. I break down the concept into machine-like parts when I am trying to understand how memory works.
10. I break down the concept into machine-like parts when I am trying to understand how an ecosystem works.
11. I break down the concept into machine-like parts when I am trying to understand how a business works.

12. I break down the concept into computer-like parts when I am trying to understand how the human body operates.
13. I break down the concept into computer-like parts when I am trying to understand how a business works.
14. I think that a person who is wearing a Bluetooth device is machine-like.
15. I think that a person who is using a cochlear implant (hearing aid) is machine-like.
16. I think that a person who is using multiple technological devices at once is machine-like.
17. I think that a person who is wearing a Bluetooth device is computer-like.
18. I think that a person who has an artificial heart is computer-like.
19. I think that a person who has prosthesis is computer-like.
20. I think that a person who is using multiple technological devices at once is computer-like.
21. I think that a person who has exceptional math skills is machine-like.
22. I think that a person who is detached during emotional discussions is machine-like.
23. I think that a person who uses precise vocabulary in casual situations is machine-like.
24. I think that a person who uses logic to answer questions is computer-like.
25. I think that a person who uses precise vocabulary in casual situations is computer-like.
26. I think that a person who uses his/her skills to improve negative situations is machine-like.
27. I think that a person who understands human emotions is machine like.
28. I think that a person who empathizes with others is machine-like.
29. I think that a person who solves complex problems is computer-like.
30. I think that a person who understands human emotions is computer-like.

A.4 Anthropomorphic Tendencies Scale (78 item version)

Please read each statement carefully. Indicate the strength of your agreement with each statement by filling in the blank using the following 5-point scale. There are no right or wrong answers to any of these statements. We are interested in your honest reactions and opinions.

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

1. When I am clearly upset, a COMPUTER does not know.
2. I do not act as if a COMPUTER has a spirit or life-force like people do.
3. A STUFFED TOY cannot communicate with people.
4. A COMPUTER does not have a personality like a person has a personality.
5. A MICROWAVE does not do things just to annoy me.
6. I would not praise a MICROWAVE when it does something I like.
7. When I am clearly upset, a MICROWAVE does not know.
8. An OCEAN does not do things just to annoy me.
9. I would not apologize to a BACKPACK for neglecting it.
10. I would not buy a present for a BACKPACK.
11. When I am clearly upset, a CAR does not know.
12. When I talk to a BACKPACK, I do not believe it understands me.
13. A STOMACH does not have a personality like a person has a personality.
14. An OCEAN does not have a personality like a person has a personality.
15. I do not act as if a MICROWAVE has a spirit or life-force like people do.
16. A STUFFED TOY does not have a personality like a person has a personality.
17. A MICROWAVE has a spirit or life-force like people do.

18. I would not apologize to a COMPUTER for neglecting it.
19. I do not act as if a CAR has a spirit or life-force like people do.
20. When I talk to a HOUSE PLANT, I do not believe it understands me.
21. A MICROWAVE likes certain people better than others.
22. I do not act as if a HOUSE PLANT has a spirit or life-force like people do.
23. When I talk to a CAR, I do not believe it understands me.
24. I would not buy a present for a HOUSE PLANT.
25. I do not act as if LUCK has a spirit or life-force like people do.
26. I would not praise a STOMACH when it does something I like.
27. A STUFFED TOY is intelligent like a human is intelligent.
28. I do not act as if a STOMACH has a spirit or life-force like people do.
29. A BACKPACK does not do things just to annoy me.
30. I treat a MICROWAVE like a human.
31. If I were to get rid of a MICROWAVE, it would feel abandoned.
32. A MICROWAVE is intelligent like a human is intelligent.
33. A COMPUTER does not do things just to annoy me.
34. I would not praise a HOUSE PLANT when it does something I like.
35. If a HOUSE PLANT were to be destroyed, I would not mourn it like I would mourn the loss of a human.
36. If I were to get rid of a COMPUTER, it would feel abandoned.
37. I would not praise an INSECT when it does something I like.
38. A COMPUTER has a spirit or life-force like people do.
39. I would talk to a BACKPACK.

40. If a MICROWAVE were to be destroyed, I would not mourn it like I would mourn the loss of a human.
41. I treat a HOUSE PLANT like a human.
42. LUCK is intelligent like a human is intelligent.
43. An OCEAN cannot communicate with people.
44. When I talk to LUCK, I do not believe it understands me.
45. I would name a STOMACH.
46. I treat a COMPUTER like a human.
47. If a BACKPACK were to be destroyed, I would not mourn it like I would mourn the loss of a human.
48. A HOUSE PLANT does not have a personality like a person has a personality.
49. A CAR has a spirit or life-force like people do.
50. If a COMPUTER were to be destroyed, I would not mourn it like I would mourn the loss of a human.
51. A CAR does not do things just to annoy me.
52. LUCK cannot communicate with people.
53. I treat a BACKPACK like a human.
54. If I were to get rid of a BACKPACK, it would feel abandoned.
55. If I were to get rid of an INSECT, it would feel abandoned.
56. I would not apologize to an INSECT for neglecting it.
57. If I were to get rid of a HOUSE PLANT, it would feel abandoned.
58. A BACKPACK does not have a personality like a person has a personality.
59. LUCK does not have a personality like a person has a personality.
60. When I am clearly upset, a GOD OR HIGHER POWER does not know.

61. A GOD OR HIGHER POWER cannot communicate with people.

62. When I talk to a GOD OR HIGHER POWER, I do not believe it understands me.

63. I do not act as if a GOD OR HIGHER POWER has a spirit or life-force like people do.

64. I would not apologize to a GOD OR HIGHER POWER for neglecting it.

65. I would talk to a GOD OR HIGHER POWER.

66. I would not praise a GOD OR HIGHER POWER when it does something I like.

67. I would apologize to a GOD OR HIGHER POWER for accidentally hurting it.

68. A GOD OR HIGHER POWER has a spirit or life-force like people do.

69. A GOD OR HIGHER POWER is intelligent like a human is intelligent.

70. A GOD OR HIGHER POWER does not have a personality like a person has a personality.

71. I treat a GOD OR HIGHER POWER like a human.

72. I treat a PET like a human.

73. A MICROWAVE does not do things just to annoy me.

74. I do not act as if LUCK has a spirit or life-force like people do.

75. I would not buy a present for a BACKPACK.

76. If I were to get rid of a HOUSE PLANT, it would feel abandoned.

77. When I talk to a CAR, I do not believe it understands me.

78. I treat a MICROWAVE like a human.

A.5 Technology Readiness Index

36 Item Scale

The following are some statements about peoples' beliefs about technology For each one, please indicate whether you "strongly agree," "somewhat agree," are "neutral," "somewhat disagree," or "strongly disagree."

5 Strongly Agree
4 Somewhat Agree
3 Neutral
2 Somewhat Disagree
1 Strongly Disagree

OPTIMISM STATEMENTS

a. Technology gives people more control over their daily lives

b. Products and services that use the newest technologies are much more convenient to use

c. You like the idea of doing business via computers because you are not limited to regular business hours

d. You prefer to use the most advanced technology available

e. You like computer progrLAMS that allow you to tailor things to fit your own needs

f. Technology makes you more efficient in your occupation

g. You find new technologies to be mentally stimulating

h. Technology gives you more freedom of mobility

i. Learning about technology can be as rewarding as the technology itself

j. You feel confident that machines will follow through with what you instructed them to do

INNOVATIVE STATEMENTS

k. Other people come to you for advice on new technologies

l. It seems your friends are learning more about the newest technologies than you are

m. In general, you are among the first in your circle of friends to acquire new technology when it appears

n. You can usually figure out new high-tech products and services without help from others

o. You keep up with the latest technological developments in your areas of interest

p. You enjoy the challenge of figuring out high-tech gadgets

q. You find you have fewer problems than other people in making technology work for you

INSECURE STATEMENTS

r. The human touch is very important when doing business with a company

s. When you call a business, you prefer to talk to a person rather than a machine

t. If you provide information to a machine or over the Internet, you can never be sure it really gets to the right place

u. You do not consider it safe giving out a credit card number over a computer

v. You do not consider it safe to do any kind of financial business online

w. You worry that information you send over the Internet will be seen by other people

x. You do not feel confident doing business with a place that can only be reached online

y. Any business transaction you do electronically should be confirmed later with something in writing

z. Whenever something gets automated, you need to check carefully that the machine or computer is not making mistakes

DISCOMFORT STATEMENTS

aa. Technical support lines are not helpful because they don’t explain things in terms you understand

bb. Sometimes, you think that technology systems are not designed for use by ordinary people cc. There is no such thing as a manual for a high-tech product or service that's written in plain language

dd. When you get technical support from a provider of a high-tech product or service, you sometimes feel as if you are being taken advantage of by someone who knows more than you do

ee. If you buy a high-tech product or service, you prefer to have the basic model over one with a lot of extra features

ff. It is embarrassing when you have trouble with a high-tech gadget while people are watching

gg. There should be caution in replacing important people-tasks with technology because new technology can break-down or get disconnected

hh. Many new technologies have health or safety risks that are not discovered until after people have used them

ii. New technology makes it too easy for governments and companies to spy on people

jj. Technology always seems to fail at the worst possible time

A.6 Negative Attitudes Toward Robots Scale

All the questionnaire items and subscales in the NARS:

1. I would feel uneasy if robots really had emotions S2

2. Something bad might happen if robots developed into living beings S2

3. I would feel relaxed talking with robots a S3

4. I would feel uneasy if I was given a job where I had to use robots S1

5. If robots had emotions, I would be able to make friends with them a S3

6. I feel comforted being with robots that have emotions a S3

7. The word ‘‘robot’’ means nothing to me S1

8. I would feel nervous operating a robot in front of other people S1

9. I would hate the idea that robots or artificial intelligences were making judgments about things S1

10. I would feel very nervous just standing in front of a robot S1

11. I feel that if I depend on robots too much, something bad might happen S2

12. I would feel paranoid talking with a robot S1

13. I am concerned that robots would be a bad influence on children S2

14. I feel that in the future society will be dominated by robots S2

Index Subscales

S1 Negative attitude toward situations of interaction with robots

S2 Negative attitude toward social influence of robots

S3 Negative attitude toward emotions in interaction with robots (a=Reversed item)

A.7 Personality Mini Big 5 Measure

Please indicate how well each statement describes you on a 5 point scale:

1. Am the life of the party. (Extraversion)
2. Sympathize with others' feelings. (Agreeableness)
3. Get chores done right away. (Conscientiousness)
4. Have a vivid imagination. (Intellectual/Imaginative)
5. Don't talk a lot. (reverse coded) (Extraversion)
6. Am not interested in other people's problems. (reverse coded) (Agreeableness)
7. Often forget to put things back in their proper place. (reverse coded) (Conscientiousness)
8. Am not interested in abstract ideas. (reverse coded) (Intellectual/Imaginative)
9. Talk to a lot of different people at parties. (Extraversion)
10. Feel others' emotions. (Agreeableness)
11. Like order. (Conscientiousness)
12. Have difficulty understanding abstract ideas. (reverse coded) (Intellectual/Imaginative)
13. Keep in the background. (reverse coded) (Extraversion)
14. Am not really interested in others. (reverse coded) (Agreeableness)
15. Make a mess of things. (reverse coded) (Conscientiousness)
16. Do not have a good imagination. (reverse coded) (Intellectual/Imaginative)
17. Have frequent mood swings. (neuroticism)
18. Am relaxed most of the time. (reverse coded) (neuroticism)
19. Get upset easily. (neuroticism)
20. Seldom feel blue. (reverse coded) (neuroticism)

A.8 Demographics Survey

Gender:
  1-male
  2-female
Race (you may choose more than one):
  1-American Indian/ Alaskan Native
  2-Asian/ Pacific Islander
  3-African American/ Black
  4-Caucasian/ White
  5-Hispanic/ non-White
  6-Other

Highest level of education:
  1-Grade School
  2-Some High School
  3-High School Diploma or Equivalent
  4-Associate's Degree
  5-Bachelor's Degree
  6-Master's Degree
  7-Ph D.
  8-Professional Degree

Major:

Minor:

Have you taken any of the following types of classes (you may choose more than one)?

- Computer science
- Engineering
- Computer Programming

Technology Questions

Do you own a computer?   Yes   No

If Yes, how many desktop computers do you own? _____

How many laptop computers do you own? ______

Do you primarily use a Windows-Based PC or Macintosh Computer (Please indicate one)

How many hours per week do you spend using your home computer for:

____ School

____ Work

____ Entertainment/Personal

What programs do you use on your computer? (Check all that apply)

____ Email

____ Word Processing

____ Photo/Graphic

____ Presentation

____ Video

____ Other (Please Specify) ____________________________

Do you have internet access at home?   Yes   No

If Yes, what type of connection do you have? (Check all that apply)

____ Dial-up

____ Broadband (DSL, Cable, or T1)

Do you own any gaming consoles? Yes   No

If Yes, please indicate which ones you currently own?

How many hours per week do you spend playing video games (including console games and computer-based games)? ___

Do you own a television?   Yes   No

If Yes, how many do you own? ____

How many hours per week do you spend watching television? _______

Do you own or use a blue tooth headset?

Do you own an ipod/mp3 player?

If yes, How often do you use your ipod/mp3 player?

Do you consider yourself to be computer savvy?

Not at all Very

1 2 3 4 5 6 7

Do you consider yourself to be technology savvy?

Not at all Very

1 2 3 4 5 6 7

Please indicate your level of agreement with these questions:

When I don't understand something new, I use an analogy from my real life to figure it out.

Never Always

1 2 3 4 5 6 7

I think "outside the box".

Never Always

1 2 3 4 5 6 7

I am an organized person.

Never Always

1 2 3 4 5 6 7

I have a vivid imagination.

Never Always

1 2 3 4 5 6 7

I am a sentimental person.

Never Always

1 2 3 4 5 6 7

I am a creative person.

Never						Always
1	2	3	4	5	6	7

When I am working on a project, I like to think of all the possible approaches before moving forward.

Never						Always
1	2	3	4	5	6	7

When I am working on a project, I like to think of all the possible outcomes before moving forward.

Never						Always
1	2	3	4	5	6	7

When I am trying to teach someone else, I use an analogy to help explain the concept to them.

Never						Always
1	2	3	4	5	6	7

I keep up with the current trends in technology.

Never						Always
1	2	3	4	5	6	7

I think humans act like machines.

Never						Always
1	2	3	4	5	6	7

Please Indicated Religious Affiliation

- ☐ Protestant
- ☐ Catholic
- ☐ Mormon
- ☐ Jehovah's Witness
- ☐ Orthodox
- ☐ Jewish
- ☐ Buddhist
- ☐ Muslim
- ☐ Hindu
- ☐ Unitarians and other liberal faiths
- ☐ New Age (Includes Wiccan and Pagan)
- ☐ Agnostic
- ☐ Atheist
- ☐ Don't know
- ☐ None of the above
- ☐ Prefer not to answer

Do you consider yourself to be religious?

Not at all						Very
1	2	3	4	5	6	7

Where do you fall on the political spectrum?

Conservative						Liberal
1	2	3	4	5	6	7

A.9 Attributes Used in Study 2 & 3

Attributes used with each picture. Participants responded to their agreement with these attributes on a 7 point scale:

1. Attractive
2. Intelligent
3. Friendly
4. Aggressive
5. Dependable
6. Honest
7. Independent
8. Trusting
9. Competitive
10. Hard working

A.10 Pictures of the Male Model Used in Study 2 & 3

In order of the pictures from left to right and top to bottom:

1. Control
2. Arrington Eye Tracker
3. ASL Eye Tracker
4. BlueTooth Device
5. Headset
6. Bicycle Helmet
7. Military Helmet

A.11 Pictures of the Female Model Used in Study 2 & 3

In order of the pictures from left to right and top to bottom:

1. Control
2. Arrington Eye Tracker
3. ASL Eye Tracker
4. BlueTooth Device
5. Headset
6. Bicycle Helmet
7. Military Helmet

APPENDIX B: IRB MATERIALS

B.1 Study 1A Informed Consent

EXPLANATION OF RESEARCH

Title of Project: A Mechanomorphism Study
Principal Investigators: Heather C. Lum, M.A.
Faculty Supervisor: Valerie K, Sims, PhD.
Other Investigators: Shane Halse, B.S.

You are being invited to take part in a research study. Whether you take part is up to you.

Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being invited to take part in a research study which will include about 400 people online at UCF. You have been asked to take part in this research study because you are a student in a psychology class. You must be 18 years of age or older to be included in the research study and sign this form. You can read this form and agree to take part right now, or take the form home with you to study before you decide. The person doing this research is a graduate student in Psychology. Because the researcher is a graduate student, she is being guided by Valerie Sims, a UCF associate professor.

Purpose of the research study: The purpose of this study is to examine student opinions of mechanomorphism and related topics.

What you will be asked to do in the study: During this study, you will be given an opinion based survey where you will rate how much you agree/disagree with the opinions stated. You will also answer demographics and other survey related questions

Location: This study is entirely online and all data will be saved in a secure database.

Time required: We expect that you will be in this research study for approximately 45-60 minutes.

You must be 18 years of age or older to take part in this research study.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints talk to Heather Lum, Graduate Student, Psychology Program, College of Sciences, 407-443-8045, email address: hlum@knights.ucf.edu or Dr. Valerie Sims, Assistant Professor, Psychology at 407-823-0343.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901.

B.2 Study 1A Post Participation Form

University of Central Florida

Post Study Information Statement

Thank you very much for participating.

The goal of this study is to examine student opinions of mechanomorphism and related topics. Mechanomorphism can be thought of as the attribution of mechanical or robotic like attributions to humans. The results of this study will lead to a validation of a Mechanomorphic Tendency Scale and a deeper understanding of the concept of mechanomorphism as it relates to other concepts like anthropomorphism and attitudes toward technology.

All of the information you provided will be used for research purposes only. It is very important to the goals of the project that you do your best to provide complete and accurate information.

If you have any questions, please contact the principal investigator or research assistant at the Applied Cognition & Technology lab:

Principal Investigators:
Heather Lum, M.A.
hlum@knights.ucf.edu

Faculty Advisor:
Dr. Valerie Sims, PhD.
vsims@ucf.edu

Undergraduate Research Assistant:
Shane Halse, B.S.
ShaneHalse@knights.ucf.edu

B.3 Study 1B Informed Consent

EXPLANATION OF RESEARCH

Title of Project: A Mechanomorphism Study
Principal Investigators: Heather C. Lum, M.A.
Faculty Supervisor: Valerie K, Sims, PhD.
Other Investigators: Shane Halse, B.S.

You are being invited to take part in a research study. Whether you take part is up to you.

Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being invited to take part in a research study which will include about 400 people online at UCF. You have been asked to take part in this research study because you are a student in a psychology class. You must be 18 years of age or older to be included in the research study and sign this form. You can read this form and agree to take part right now, or take the form home with you to study before you decide. The person doing this research is a graduate student in Psychology. Because the researcher is a graduate student, she is being guided by Valerie Sims, a UCF associate professor.

Purpose of the research study: The purpose of this study is to examine student opinions of mechanomorphism and related topics.

What you will be asked to do in the study: During this study, you will be given an opinion based survey where you will rate how much you agree/disagree with the opinions stated. You will also answer demographics and other survey related questions

Location: This study is entirely online and all data will be saved in a secure database.

Time required: We expect that you will be in this research study for approximately 45-60 minutes.

You must be 18 years of age or older to take part in this research study.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints talk to Heather Lum, Graduate Student, Psychology Program, College of Sciences, 407-443-8045, email address: hlum@knights.ucf.edu or Dr. Valerie Sims, Assistant Professor, Psychology at 407-823-0343.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901.

B.4 Study 1B Post Participation Form

University of Central Florida

Post Study Information Statement

Thank you very much for participating.

The goal of this study is to examine student opinions of mechanomorphism and related topics. Mechanomorphism can be thought of as the attribution of mechanical or robotic like attributions to humans. The results of this study will lead to a validation of a Mechanomorphic Tendency Scale and a deeper understanding of the concept of mechanomorphism as it relates to other concepts like anthropomorphism and attitudes toward technology.

All of the information you provided will be used for research purposes only. It is very important to the goals of the project that you do your best to provide complete and accurate information.

If you have any questions, please contact the principal investigator or research assistant at the Applied Cognition & Technology lab:

Principal Investigators:
Heather Lum, M.A.
hlum@knights.ucf.edu

Faculty Advisor:
Dr. Valerie Sims, PhD.
vsims@ucf.edu

Undergraduate Research Assistant:
Shane Halse, B.S.
ShaneHalse@knights.ucf.edu

B.5 Study 2 Informed Consent

University of Central Florida

EXPLANATION OF RESEARCH

Title of Project: A Study of Perceptions in Mechanomorphism
Principal Investigators: Heather C. Lum, M.A.
Faculty Supervisor: Valerie K, Sims, PhD.

Other Investigators: Shane Halse, B.S.

You are being invited to take part in a research study. Whether you take part is up to you.

Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being invited to take part in a research study which will include about 400 people online at UCF. You have been asked to take part in this research study because you are a student in a psychology class. You must be 18 years of age or older to be included in the research study and sign this form. You can read this form and agree to take part right now, or take the form home with you to study before you decide. The person doing this research is a graduate student in Psychology. Because the researcher is a graduate student, she is being guided by Valerie Sims, a UCF associate professor.

Purpose of the research study: The purpose of this study is to examine student opinions of mechanomorphism and related topics.

What you will be asked to do in the study: During this study, you will be given an opinion based survey where you will rate how much you agree/disagree with the opinions stated. You will also view pictures of models and make attributions of them and answer basic demographics and other survey related questions

Location: This study is entirely online and all data will be saved in a secure database.

Time required: We expect that you will be in this research study for approximately 45-60 minutes.

You must be 18 years of age or older to take part in this research study.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints talk to Heather Lum, Graduate Student, Psychology Program, College of Sciences, 407-443-8045, email address: hlum@knights.ucf.edu or Dr. Valerie Sims, Assistant Professor, Psychology at 407-823-0343.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901.

B.6 Study 2 Post Participation Form

Post Study Information Statement

Thank you very much for participating.

The goal of this study is to examine student opinions of mechanomorphism and related topics. Mechanomorphism can be thought of as the attribution of mechanical or robotic like attributions to humans. The results of this study will lead to a validation of a Mechanomorphic Tendency Scale and a deeper understanding of the concept of mechanomorphism as it relates to other concepts like anthropomorphism and attitudes toward technology.

All of the information you provided will be used for research purposes only. It is very important to the goals of the project that you do your best to provide complete and accurate information.

If you have any questions, please contact the principal investigator or research assistant at the Applied Cognition & Technology lab:

Principal Investigators:
Heather Lum, M.A.
hlum@knights.ucf.edu

Faculty Advisor:
Dr. Valerie Sims, PhD.
vsims@ucf.edu

Undergraduate Research Assistant:
Shane Halse, B.S.
ShaneHalse@knights.ucf.edu

B.7 Study 3 Part 1 Informed Consent

EXPLANATION OF RESEARCH

A Study of Attributes Relating to Technomorphism Part 1

Informed Consent

Principal Investigators: Heather C. Lum, M.A.

Faculty Supervisor: Valerie K, Sims, PhD.

Other Investigators: Shane Halse, B.S.

Investigational Site(s): UCF Psychology Department

Introduction: Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being invited to take part in a research study which will include about 250 people online at UCF. You have been asked to take part in this research study because you are a student in a psychology class. You must be 18 years of age or older to be included in the research study and sign this form. You can read this form and agree to take part or decline participation and exit this website. The person doing this research is a graduate student in Psychology. Because the researcher is a graduate student, she is being guided by Valerie Sims, a UCF associate professor.

What you should know about a research study:

- A research study is something you volunteer for.
- Whether or not you take part is up to you.
- You should take part in this study only because you want to.
- You can choose not to take part in the research study.
- You can agree to take part now and later change your mind.
- Whatever you decide it will not be held against you.
- Feel free to ask all the questions you want before you decide.

Purpose of the research study: The purpose of this study is to examine student opinions of technomorphism and related topics.

What you will be asked to do in the study: During this study, you will be given an opinion based survey where you will rate how much you agree/disagree with the opinions stated. This is the first part of a two-part study. At the end of this study, you will be asked if you would like to include your contact information. If you choose to include that information and fit the criteria for further study, you will be contacted via email to come in for the second part of the study which is in the laboratory. That study will involve viewing pictures of models while you are wearing an eye tracker. You will also respond to additional surveys.

Location: This study is entirely online and all data will be saved in a secure database. If you decide to take part in the second part of the study, that will be located in-person in a laboratory in the Psychology Dep.

Time required: We expect that you will be in this research study for 30 minutes online. If you provide your contact information to take part in the second part of the study, you will be contacted within 72 hours of the completion of part 1. You will then be able to sign up for the study in Sona to come in. We expect part 2 of the study will also take approximately 30 minutes to complete in-person.

Risks: There is a slight risk of breach of confidentiality if your information or your identity is obtained by someone other than the investigators, but precautions will be taken to prevent this from happening.

Benefits: We cannot promise any benefits to you or others from your taking part in this research. However, possible benefits include learning more about the research process.

Compensation or payment: There is no monetary compensation for taking part in this study or the second part of the study. However, you will receive .25 Sona extra credit points for part 1 and .5 Sona extra credit points if you are chosen and decide to come in for part 2. If you choose not to participate, you may notify your instructor and ask for an alternative assignment of equal effort for equal credit. There will be no penalty.

Confidentiality: If you decide to give your contact information including your name and email address to come in for part 2 of the study, that information is considered confidential. We will limit your personal data collected in this study to people who have a need to review this information. We cannot promise complete secrecy.

Study contact for questions about the study or to report a problem: : If you have questions, concerns, or complaints talk to Heather Lum, Graduate Student, Psychology Program, College of Sciences, 407-443-8045, email address: hlum@knights.ucf.edu or Dr. Valerie Sims, Assistant Professor, Psychology at 407-823-0343.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901. You may also talk to them for any of the following:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You want to get information or provide input about this research.

B.8 Study 3 Part 1 Post Participation Form

Post Study Information Statement

Thank you very much for participating.

The goal of this study is to examine student opinions of technomorphism and related topics. Technomorphism can be thought of as the attribution of mechanical or robotic like attributions to humans. The results of this study will lead to a validation of a Technomorphic Tendency Scale and a deeper understanding of the concept of technomorphism as it relates to other concepts like anthropomorphism and attitudes toward technology.

All of the information you provided will be used for research purposes only. It is very important to the goals of the project that you do your best to provide complete and accurate information.

If you provided contact information, you may receive an email to come in for the second part of the study within a week of completion of this study.

If you have any questions, please contact the Principal Investigator or research assistant at the Applied Cognition & Technology lab:

Principal Investigators:
Heather Lum, M.A.
hlum@knights.ucf.edu

Faculty Advisor:
Dr. Valerie Sims, PhD.
vsims@mail.ucf.edu

Undergraduate Research Assistant:
Shane Halse, B.S.
ShaneHalse@knights.ucf.edu

B.9 Study 3 Part 2 Informed Consent

EXPLANATION OF RESEARCH

A Study of Attributes Relating to Technomorphism Part 2

Informed Consent

Principal Investigators: Heather C. Lum, M.A.
Faculty Supervisor: Valerie K, Sims, PhD.
Other Investigators: Shane Halse, B.S.
Investigational Site(s): UCF Psychology Department

Introduction: Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being invited to take part in a research study which will include about 250 people online at UCF. You have been asked to take part in this research study because you are a student in a psychology class. You must be 18 years of age or older to be included in the research study and sign this form. You can read this form and agree to take part or decline participation and exit this website. The person doing this research is a graduate student in Psychology. Because the researcher is a graduate student, she is being guided by Valerie Sims, a UCF associate professor.

What you should know about a research study:

- Someone will explain this research study to you.
- A research study is something you volunteer for.
- Whether or not you take part is up to you.
- You should take part in this study only because you want to.
- You can choose not to take part in the research study.
- You can agree to take part now and later change your mind.
- Whatever you decide it will not be held against you.

- Feel free to ask all the questions you want before you decide.

Purpose of the research study: The purpose of this study is to examine student opinions of technomorphism and related topics.

What you will be asked to do in the study: During this study, you will view pictures of models and be asked to rate them on a number of different items. While viewing these pictures, you will also be equipped with an eye tracker so that researchers can examine where you are looking on the screen. You will also be given a series of opinion based surveys where you will rate how much you agree/disagree with the opinions stated. This study will take approximately 30 minutes to complete. The contact information you gave for part 1 (the online) study will be matched with your answers to this study. Your contact information will be analyzed and kept confidential to protect your privacy. There is a slight risk of breach of confidentiality if your information or your identity is obtained by someone other than the investigators, but precautions will be taken to prevent this from happening.

Location: This study takes place in the Psychology Dept. room 207C. All of your survey data will be kept on a secure website. Additionally, your eye tracking data will be kept on a password protected hard drive which will further be secured in a locked cabinet when not in use.

Time required: We expect that you will be in this research study for 30 minutes.

Eye Tracking Recording:

An eye tracker is a non-invasive head mounted optical device that automatically follows the gaze of the participant and records the coordinates in a computer program. You will be asked to wear a head mounted devices that looks similar to safety goggles. On that device, there are two cameras; one that looks out in the direction that your head is pointed. The other is capturing your eye movements. When analyzed, the data will show exactly where on the screen you were looking at. The eye movements are recorded as both a text file and video file. This information will be saved on a password encrypted external hard drive that will be secured in a locked cabinet when not in use. The information will be saved for a minimum of 3 years.

Risks: There is a small risk that people who take part will develop what is ordinarily referred to as computer sickness. It occurs once in awhile to people who are exposed to prolonged continuous testing in a computer environment. Symptoms consist of nausea and a feeling of being light- headed. The risk is minimized as a result of the short duration of each session in the simulator. If you experience any of the symptoms mentioned, please tell the researcher and remain seated until the symptoms disappear.

Additionally, there is a slight risk of breach of confidentiality if your information or your identity is obtained by someone other than the investigators, but precautions will be taken to prevent this from happening. In addition, no direct contact information will be saved in this part of the study and instead you will be assigned a participant number that is used for your survey and eye tracking data.

Benefits: We cannot promise any benefits to you or others from your taking part in this research. However, possible benefits include learning more about the research process.

Compensation or payment: There is no monetary compensation for taking part in this study or the second part of the study. However, you will receive .5 Sona extra credit for this portion of the study. If you choose not to participate, you may notify your instructor and ask for an alternative assignment of equal effort for equal credit. There will be no penalty.

Confidentiality: We will limit your personal data collected in this study to people who have a need to review this information. We cannot promise complete secrecy.

Study contact for questions about the study or to report a problem: : If you have questions, concerns, or complaints talk to Heather Lum, Graduate Student, Psychology Program, College of Sciences, 407-443-8045, email address: hlum@knights.ucf.edu or Dr. Valerie Sims, Assistant Professor, Psychology at 407-823-0343.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901. You may also talk to them for any of the following:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You want to get information or provide input about this research.

B.10 Study 3 Part 2 Post Participation Form

Post Study Information Statement

Thank you very much for participating.

The goal of this study is to examine student opinions of technomorphism and related topics. Technomorphism can be thought of as the attribution of mechanical or robotic like attributions to humans. The results of this study will lead to a validation of a Technomorphic Tendency Scale and a deeper understanding of the concept of technomorphism as it relates to other concepts like anthropomorphism and attitudes toward technology.

All of the information you provided will be used for research purposes only. It is very important to the goals of the project that you do your best to provide complete and accurate information.

If you have any questions, please contact the Principal Investigator or research assistant at the Applied Cognition & Technology lab:

Principal Investigators:
Heather Lum, M.A.
hlum@knights.ucf.edu

Faculty Advisor:
Dr. Valerie Sims, PhD.
vsims@mail.ucf.edu

Undergraduate Research Assistant:
Shane Halse, B.S.
ShaneHalse@knights.ucf.edu

APPENDIX C: TABLES AND FIGURES

C.1 Inter-Item Correlations for First Iteration of TTS

Table 6: *Study 1A Summary of Inter-Correlation Results for the TTS*

Item	Inter-Correlation	Item	Inter-Correlation
TTS1	0.27	TTS32	0.16
TTS2	0.26	TTS33	0.29
TTS3	0.26	TTS34	0.19
TTS4	0.17	TTS35	0.41
TTS5	0.35	TTS36	0.23
TTS6	0.28	TTS37	0.33
TTS7	0.37	TTS38	0.30
TTS8	0.19	TTS39	0.24
TTS9	0.22	TTS40	0.28
TTS10	0.33	TTS41	0.41
TTS11	0.16	TTS42	0.23
TTS12	0.13	TTS43	0.36
TTS13	0.19	TTS44	0.21
TTS14	0.21	TTS45	0.30
TTS15	0.28	TTS46	0.41
TTS16	0.16	TTS47	*0.10
TTS17	0.27	TTS48	0.14
TTS18	0.15	TTS49	0.39
TTS19	0.20	TTS50	*0.12
TTS20	0.19	TTS51	0.39
TTS21	0.28	TTS52	0.14
TTS22	0.37	TTS53	*0.03
TTS23	0.28	TTS54	0.30
TTS24	0.39	TTS55	0.17
TTS25	0.35	TTS56	*0.04
TTS26	0.22	TTS57	0.15
TTS27	0.32	TTS58	0.34
TTS28	0.40	TTS59	*0.01
TTS29	0.31	TTS60	*0.06
TTS30	0.40	TTS61	0.31
TTS31	0.31	TTS62	*0.06

Note: Items less than .13 were dropped from further analysis

C.2 Factor Loadings for First Iteration of TTS

Table 7: *Study 1A Factor Loadings*

Summary of Exploratory Factor Analysis Results for the Technomorphic Tendency Scale (N=661)

	Factor Loadings					
Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
7. When I look at how the human body moves, I tend to think of a computer with moving parts working in conjunction with one another.	0.614					
10. When I eat, I think of the food as fuel that my body converts to energy in order to work as an effective computer.	0.532					
15. When I am trying to understand an abstract concept such as tiredness, I use an analogy about how a machine works to figure it out.	0.562					
17. When I am trying to understand an abstract concept such as hatred, I tend to think of it as a computer with moving parts working in conjunction with one another.	0.526					
22. When I am trying to understand a complex concept such as how the universe works, I DO NOT try to break the concept down into concrete machine-like parts.	0.688					
24. When I am trying to understand a complex concept such as how the human body operates, I DO NOT try to break the concept down into concrete machine-like parts.	0.730					
25. When I am trying to understand a complex concept such as how an ecosystem works, I try to break the concept down into concrete machine-like parts.	0.661					
28. When I am trying to understand a complex concept such as how memory works, I DO NOT try to break the concept down into concrete computer-like parts.	0.692					
30. When I am trying to understand a complex concept such as how an ecosystem works, I DO NOT try to break the concept down into concrete computer-like parts.	0.692					
8. When I look at how people dance, I DO NOT tend to think of a computer with moving parts working in conjunction with one another.		0.607				
11. When I am trying to understand an abstract concept such as respect, I DO NOT use an analogy about how a machine works to figure it out.		0.717				
12. When I am trying to understand an abstract concept such as hatred, I DO NOT tend to think of it as a machine with moving parts working in conjunction with one another.		0.636				
13. When I am trying to understand an abstract concept such as how other people's emotions work, I DO NOT use an analogy about how a machine works to try and figure it out.		0.694				
16. When I am trying to understand an abstract concept such as respect, I DO NOT tend to think of it as a computer with moving parts working in conjunction with one another.		0.712				
18. When I am trying to understand an abstract concept such as hatred, I tend to think of it as a computer with moving parts working in conjunction with one another.		0.744				
20. When I am trying to understand an abstract concept such as how love works, I tend to think of it as a computer with moving parts working in conjunction with one another.		0.596				
1. When I am trying to understand a concept such as how the human brain works, I DO NOT use an analogy about how a machine works to try and figure it out.			0.703			
6. When I am trying to understand a concept such as how the human brain works, I DO NOT use an analogy about how a computer works to try and figure it out.			0.681			
21. When I am trying to understand an abstract concept such as tiredness, I DO NOT use an analogy about how a computer works to figure it out.			0.646			
23. When I am trying to understand a complex concept such as how memory works, I try to break the concept down into concrete machine-like parts.			0.614			
26. When I am trying to understand a complex concept such as how a business works, I try to break the concept down into concrete machine-like parts.			0.658			
27. When I am trying to understand a complex concept such as how the universe works, I DO NOT try to break the concept down into concrete computer-like parts.			0.698			
29. When I am trying to understand a complex concept such as how the human body operates, I try to break the concept down into concrete computer-like parts.			0.673			
32. A person that is wearing a Bluetooth device can be thought of as machine-like.				0.700		
34. A person that is using a cochlear implant (hearing aid) can be thought of as machine-like.				0.695		
36. A person who is using multiple technological devices at once can be thought of as machine-like.				0.645		
39. A person that has an artificial heart or can be thought of as computer-like.				0.695		
42. A person who is using multiple technological devices at once can be thought of as computer-like.				0.689		
33. A person that has an artificial heart or CANNOT be thought of as machine-like.					0.530	
37. A person who is using a computer CANNOT be thought of as machine-like.					0.685	
38. A person that is wearing a Bluetooth device can be thought of as computer-like.					0.547	
41. A person that has prosthesis can be thought of as computer-like.					0.614	
43. A person who is using a computer CANNOT be thought of as computer-like.						0.561
46. A person who seems detached during emotional class discussions can be thought of as being machine-like.						0.652
49. A person with exceptional math skills CANNOT be thought of as being computer-like						0.572
51. A person who seems detached during emotional class discussions CANNOT be thought of as being computer-like.						0.684
Eigenvalues	22.25	7.48	4.74	3.18	3.08	2.48
Total % of Variance 43.20						

Note: Factor loadings below .40 were dropped from the analysis

C.3 Inter-Item Correlations for Second Iteration of TTS

Table 8: *Study 1B Summary of Inter-Correlation Results for the TTS*

Item	Inter-Correlation	Item	Inter-Correlation
TTS1	0.37	TTS32	0.21
TTS2	0.35	TTS33	0.35
TTS3	0.22	TTS34	0.27
TTS4	0.29	TTS35	0.47
TTS5	0.35	TTS36	0.28
TTS6	0.37	TTS37	0.38
TTS7	0.33	TTS38	0.36
TTS8	0.31	TTS39	0.27
TTS9	0.35	TTS40	0.32
TTS10	0.33	TTS41	0.50
TTS11	0.28	TTS42	0.31
TTS12	0.25	TTS43	0.45
TTS13	0.30	TTS44	0.21
TTS14	0.17	TTS45	0.36
TTS15	0.25	TTS46	0.46
TTS16	0.29	TTS47	0.17
TTS17	0.23	TTS48	0.23
TTS18	0.28	TTS49	0.44
TTS19	0.15	TTS50	0.19
TTS20	0.30	TTS51	0.47
TTS21	0.38	TTS52	*0.10
TTS22	0.36	TTS53	0.13
TTS23	0.36	TTS54	0.35
TTS24	0.39	TTS55	0.16
TTS25	0.35	TTS56	*0.03
TTS26	0.32	TTS57	0.22
TTS27	0.43	TTS58	0.36
TTS28	0.38	TTS59	*0.08
TTS29	0.44	TTS60	0.14
TTS30	0.40	TTS61	0.34
TTS31	0.39	TTS62	*0.03

Note: Items less than .13 were dropped from further analysis

C.4 Factor Loadings for Second Iteration of TTS

Table 9: *Study 1B Factor Loadings*

	Factor Loadings
Item	Factor 1
1. I think of a machine with moving parts working in conjunction with one another when looking at how people dance.	0.625
2. I think of food as fuel that my body converts to energy in order to work as an effective machine.	0.562
3. I think of a computer with moving parts working in conjunction with one another when looking at how the human body moves.	0.699
4. I think of food as fuel that my body converts to energy in order to work as an effective computer.	0.608
5. I think of a machine with moving parts working in conjunction with one another to understand a concept such as how love works.	0.599
6. I use an analogy about how a machine works to understand a concept such as tiredness.	0.614
7. I think of a computer with moving parts working in conjunction with one another to understand a concept such as hatred.	0.599
8. I think of a computer with moving parts working in conjunction with one another to understand a concept such as how love works.	0.586
9. I break down the concept into machine-like parts when I am trying to understand how memory works.	0.608
10. I break down the concept into machine-like parts when I am trying to understand how an ecosystem works.	0.467
11. I break down the concept into machine-like parts when I am trying to understand how a business works.	0.696
12. I break down the concept into computer-like parts when I am trying to understand how the human body operates.	0.673
13. I break down the concept into computer-like parts when I am trying to understand how a business works.	0.679
14. I think that a person who is wearing a Bluetooth device is machine-like.	0.630
15. I think that a person who is using a cochlear implant (hearing aid) is machine-like.	0.515
16. I think that a person who is using multiple technological devices at once is machine-like.	0.530
17. I think that a person who is wearing a Bluetooth device is computer-like.	0.647
18. I think that a person who has an artificial heart is computer-like.	0.690
19. I think that a person who has prosthesis is computer-like.	0.665
20. I think that a person who is using multiple technological devices at once is computer-like.	0.683
21. I think that a person who has exceptional math skills is machine-like.	0.527
22. I think that a person who is detached during emotional discussions is machine-like.	0.710
23. I think that a person who uses precise vocabulary in casual situations is machine-like.	0.651
24. I think that a person who uses logic to answer questions is computer-like.	0.609
25. I think that a person who uses precise vocabulary in casual situations is computer-like.	0.627
26. I think that a person who uses his/her skills to improve negative situations is machine-like.	0.515
27. I think that a person who understands human emotions is machine like.	0.580
28. I think that a person who empathizes with others is machine-like.	0.446
29. I think that a person who solves complex problems is computer-like.	0.438
30. I think that a person who understands human emotions is computer-like.	0.438
Total % of Vairance	41.88%

Note: Factor loadings below .40 were dropped from the analysis

APPENDIX D: IRB HUMAN SUBJECTS PERMISSION LETTER

D.1 Study 1A IRB Human Subjects Permission Letter

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Heather C. Lum**

Date: **November 16, 2010**

Dear Researcher:

On 11/16/2010, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Project Title:	A Mechanomorphism Study
Investigator:	Heather C Lum
IRB Number:	SBE-10-07241
Funding Agency:	
Grant Title:	
Research ID:	N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Joseph Bielitzki, DVM, UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 11/16/2010 04:42:04 PM EST

IRB Coordinator

D.2 Study 1B IRB Human Subjects Permission Letter

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Heather C. Lum**

Date: **January 04, 2011**

Dear Researcher:

On 01/04/2011, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Addendum/Modification Request Form
Modification Type:	Revised MTS Scale submitted
Project Title:	A Mechanomorphism Study
Investigator:	Heather C Lum
IRB Number:	SBE-10-07241
Funding Agency:	None

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Joseph Bielitzki, DVM, UCF IRB Chair, this letter is signed by:

Signature applied by Janice Turchin on 01/04/2011 04:40:58 PM EST

IRB Coordinator

D.3 Study 2 IRB Human Subjects Permission Letter

University of Central Florida

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Heather C. Lum**

Date: **January 04, 2011**

Dear Researcher:

On 01/04/2011, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Addendum/Modification Request Form
Modification Type:	Revised MTS Scale submitted
Project Title:	A Mechanomorphism Study
Investigator:	Heather C Lum
IRB Number:	SBE-10-07241
Funding Agency:	None

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Joseph Bielitzki, DVM, UCF IRB Chair, this letter is signed by:

Signature applied by Janice Turchin on 01/04/2011 04:40:58 PM EST

IRB Coordinator

D.4 Study 3 IRB Human Subjects Permission Letter

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Heather C. Lum** and Co-PI: **Valerie K. Sims**

Date: **March 15, 2011**

Dear Researcher:

On 3/15/2011, the IRB approved the following human participant research until 3/14/2012 inclusive: Type

of Review: UCF Initial Review Submission Form
Project Title: A Study of Attributes Relating to Technomorphism Part 1 & 2
Investigator: Heather C Lum
IRB Number: SBE-11-07540
Funding Agency:
Grant Title:
Research ID: N/A

The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

If continuing review approval is not granted before the expiration date of 3/14/2012, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual. On

behalf of Joseph Bielitzki, DVM, UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 03/15/2011 02:27:07 PM EST
IRB Coordinator

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