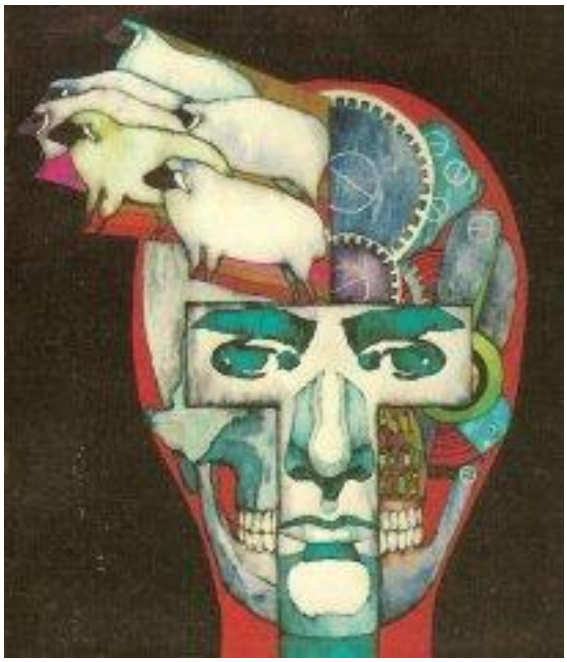
Do geeks dream of electric sheep?

A study of the relationship between Geekism and anthropomorphization of robotic agents



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Abstract

The following study aims at researching the relationship between people with high Geekism and anthropomorphic tendencies concerning robotic agents. On basis of literature analysis of three sub aspects, namely Geekism, Anthropomorphism and Human-Robot Interaction, this study's main question " Do technological interested people have a lesser tendency towards anthropomorphic behavior than other people?" was formulated. A combination of explicit and implicit measurement tools was used to gather data about several personality traits of the participants, and furthermore to measure their Anthropomorphism. The analysis was conducted by using a combination of Pearson-correlation analysis and the mixed effect model, to account for repeated measures that were done in this study. In order to have a reference point for our analysis the three-factor approach of Epley, et al., 2007 is used to compare our data and verify our findings. The result of our study indicate that there is no distinct relationship between technological interest and anthropomorphic behavior, but also show that the three-factor approach by Epley, et al., 2007 is not applicable to every participant group as suggested. The usage of the Stroop task to assess anthropomorphic tendencies was rendered insufficient due to lack of significant results, which indicates that other implicit measuring tool must be considered to measure Anthropomorphism. Following studies can use this study as framework to form a basis of Geekism as well as Anthropomorphism and their relationship.

Summary

Het doel van de volgende studie is het analyseren van de relatie tussen mensen met een tendentie voor Geekism en antropomorfisch gedrag tegenover robotic agents. Op basis van een literatuur analyse van de drie factoren die voor deze relatie een rol spelen, namelijk Geekism, Antropomorfisme en Mens-Robot Interactie, werd de hoofdvraag van deze studie geformuleerd:" Hebben mensen met een technologisch interesse minder tendenties voor het antropomorfiseren van robots." Een combinatie van expliciete en impliciete meetinstrumenten werd gebruikt om een aantal persoonlijkheid eigenschappen van de deelnemers te meten en verder hun antropomofiserende tendenties te onderzoeken. De analyse van de data werd gedaan met behulp van een Pearson-Correlatie analyse in combinatie met een mixed effect model, oom herhaalde metingen in de data analyse te integreren. Om een vergelijking met andere studies te kunnen maken, werd de driefactoor aanpak van Epley, et al., 2007 op onze deelnemer groep toegepast. De resultaten van onze studie laten echter geen relatie tussen Geekism en Antropomorfisme zien, maar tonen wel aan dat de driefactoor aanpak van Epley, et al., 2007 niet geschikte is om antropomorfisme bij elke deelnemer groep te meten. Het gebruiken van de Stroop-Task oom antropomorfisme te meten werd door deze studie als onvoldoende uit gevonden, wat betekend dat andere impliciete meetinstrumenten nodig zijn om antropomorfisme te meten. Toekomstige studies kunnen deze studie als basis voor hun analyse of zowel Geekism en Antropomorfisme als ook de relatie van de twee gebruiken.

1. Introduction

“Pretty soon we'll have robots in our society, you're going to have a lot of automated processes that used to be done by people - this is happening. Society and technology is changing so fast, and the impact of the change on society and technology is global, not local. (Jose Padihla)”. The 20th century was one of increased development in scientific areas of computer science and robotics, which affected not only the world of science, but also daily life in several different manners. Several experts assume that in the future more and more processes that are now managed by human beings, will in fact be managed by robots completely (de Graaf & Allouch, 2013). This assumption is however not verifiable. Therefore it is crucial to understand the connection between the human part and the robot part of this symbiosis, in order to guarantee that no problems will emerge out of the increased usage of robots in daily life.

How do people interact with robots? How do they perceive robots? How do they handle robots? All these questions and many more must be analyzed to create a deeper understanding of human-robot interaction (HRI). Epley, Waytz, & Cacioppo, 2007 therefore designed a three dimensional theory to access Anthropomorphism, which can essentially be described as the tendency to assign humanlike characteristics, emotions and a consciousness to a non-human agents like an animal or robot. Due to the “rise of the machines” Anthropomorphism has come more into focus, because it gives an explanation on how to change the appearance and working behavior of robots, in order for the human counter agent to interact as smoothly as possible with the robotic agent (Waytz, Morewedge, Epley, Monteleone, Gao & Cacioppo, 2010). But the increased usage of computers and robots has not only affected Anthropomorphism but has made space for the development of new subcultures, that have interest in technology, and especially in computer science and robots, the so called “geeks” (McArthur, 2008).

People who score high on the personality trait Geekism seem to have a special relationship with their object of interest (McArthur, 2008). The basis of Geekism seems to be the urge and the need to understand and master the functioning of computer and robots, which make these people an important factor in the development of new technology and also a crucial target group for research and interventions (O’Brian, 2007). But how are the two concepts (Anthropomorphism and Geekism) connected? Do the special abilities and characteristics of geeks prone them to have a higher or lower tendency to Anthropomorphism and if so, why do they have this tendency and what are the implications for the future

development of new robots and computers? Aim of this paper is to answer these questions by thoroughly analyzing the two concepts of Anthropomorphism and Geekism, and their interaction on an explicit and an implicit dimension by the usage of several different measuring tools. In order to do so we first need a general definition of Geekism as well as Anthropomorphism.

1.1 Geekism

The term "geek" was first used in the late 19th century for carnival sideshow freaks en therefore mostly used for a negative purpose (McArthur, 2008). After the rise of technology in the 19th and 20th century a group of people evolved that had better understanding of technology and a deeper bond with technology itself than the rest of humanity (O'Brian, 2007). Due to mistrust and misunderstanding of this group, the term geek was used in a negative way to describe these people as intellectual outcast that were socially awkward, who focused on technological and academical endeavor and a group where other people were embarrassed to be around (McArthur, 2008).

This negative stereotype and stigmatizing associated with the word geek persisted until a change in society from a mechanical base to an information age occurred and the usage of computer and robots got more important every year (Cross, 2005). McArthur, 2008 conducted an interview study on people with high Geekism and characterized that the increased importance and power of these people in modern society led to a reinvention of the term "geek" from a negative stigmatization to a term of admiration and jealousy by other people. Important people in computer and robot science of the 20th and 21th century like Bill Gates and Mark Zuckerberg, who would have been considered as intellectual outcast 50 years ago, are now considered as innovators and open-minded geniuses (McArthur, 2008). But aside from the change of the definition, stays the questions what makes a person have a high score on Geekism. The basis for Geekism is the acquisition of knowledge concerning one area of expertise, but what is the motivation to acquire this kind of knowledge?

The first and obvious extrinsic motivation of people with a high Geekism to become an expert in one area of expertise could be that it promotes their status on the job-market which would be associated with an improvement of life standards and financial possibilities (Bitzer, Schrettl & Schröder 2006).

Schmettow, Noordzij & Mundt, 2013 also identified two intrinsic motivators that people with technological experience and interest show, and described these in their study of implicit associations that people with high Geekism show. The first factor that can be used to characterize the term Geekism is technological enthusiasm. Technology enthusiasm means the urge to understand and change the inner workings of technologies, like robots or computers, which is why people with a high score on Geekism mainly use non mainstream technology like Linux instead of Windows or "spends more time on customizing a smart phone than using it" (Schmettow, Noordzij & Mundt, 2013).

Schmettow and Passlick, 2013 also used the term of technological enthusiasm in their interview study, and found that people with high Geekism show an "intense enthusiasm for the progress of technology". Therefore can the term technological enthusiasm be described as the wish and desire to acquire expert knowledge and make new experiences concerning technological advancement, in order to be able to make a contribution to the development of new technology (Schmettow and Passlick, 2013).

Another very important intrinsic motivator of Geekism was described by Schmettow and Passlick, 2013 and Schmettow, Noordzij & Mundt, 2013 as the need to engage in intellectual and effortful endeavors in order to satisfy the by Cacioppo, 1984 described "need for cognition". A high score on "need for cognition" is characterized by the appreciation of idea exchange and discussions, flexible cognitive abilities and a high motivation for intellectual challenging tasks (Schmettow, Noordzij & Mundt, 2013). This implicates that there may be a positive correlation between people with high technological enthusiasm and a high score on "need for cognition", because they not only try to understand the functioning of technology, but they also maneuver themselves into positions where they are mentally challenged. This could ultimately lead to the acquisition of even more expert knowledge which would in return associate them even more with the construct of Geekism.

Now that we have described all the motivational factors that may or may not motivate people with a high score on Geekism to pursue their interests in technology, we have to analyze how they do that and what they value the most when interacting with technology. However there is not much research done that analyzes the specific interaction of humans with high Geekism and robots, but there is extensive knowledge about how people in general perceive technology, and how they interact with latter. One sort of interaction between robots and humans is anthropomorphization of robots by the human counter agent.

1.2 Anthropomorphism

Anthropomorphism is the term given to the process of assigning human-like characteristics and emotion to non-human agents like animals, computer or in our case robots. Epley, Waytz, Cacioppo and Akalis, 2008, define Anthropomorphism as "Perceiving humanlike characteristics in either real or imagined nonhuman agents […]. These humanlike characteristics may include physical appearance, emotional states perceived to be uniquely human , or inner mental states and motivations."

But why do humans try to anthropomorphize non-human agents? Research suggests that there are mainly two reasons for humans to anthropomorphize non-human agents, namely for work purposes and for social purposes (Epley, Waytz & Cacioppo, 2007), but more research is necessary in order to determine one overall reason for humans to anthropomorphize non-human agents.

Epley et al., 2007 propose a three dimensional construct of Anthropomorphism, which tries to give a better insight in the reasons of people to anthropomorphize technology/robots. According to their research can Anthropomorphism be explained by the use of three psychological determinants, namely the accessibility and applicability of anthropogenic knowledge, the motivation to understand the behavior of non-human agents (in our case robots) and the desire for sociality and affiliation (Epley, et al., 2007).

A requirement of Anthropomorphism is according to Epley, et al., 2007 the general knowledge about oneself and humans in general, which is formed in early years, and the basis for development to a mature human being. On top of that does every human being posses this kind of knowledge, because otherwise we would not be able to make a distinction between human and non-human being. Epley, et al., 2007 state that with an increase of knowledge about the non-human agent (knowledge about the robot), the usage of the general human knowledge to recognize the agent decreases. Therefore are humans that acquire expert knowledge about robots, less likely to use human knowledge to understand the robot and it's behavior, and ultimately their tendency to anthropomorphize will decrease (Sims et al., 2005).

The second determinant that was found by Epley et al., 2007 is a motivational factor that seems to have an influence on Anthropomorphism. Motivation to understand behavior of non-human agents or effectance motivation consist out of two constructs that are crucial for anthropomorphic behavior, namely the need for control (Burger, 1995) and the need for cognitive closure (Kruglanski & Webster, 1994). In general can effectance motivation be seen as the wish to be able to predict the behavior of non-human agents in order to decrease the disambiguation in future situations (Epley et al., 2008). This can, according to Epley, et al.,

2008 only be achieved by having a high need for closure in combination with a high need for control.

Need for closure, as identified by Kruglanski and Webster, 1994 can be seen as a measure to access the wish of a person, to clarify an ambiguous situation, in order to avoid future uncertainties. On the other hand does a high need for closure suggest that people tend to be narrow minded, focus on primary information, form a quick impression and do not change their opinion later on (Epley et al., 2007). But all these results of a high need for closure also suggest that people form a first impression of a non-human agent, which is done by using human-like comparison, and after that stick to that impression. That leaves a lot of implication for the usage of need for closure in the assessment of Anthropomorphism, because if the first impression of the non-human agent is anthropomorphic, then people that have a high need for closure, are more likely to use this anthropomorphic impression to describe and interact with the non-human agent (Epley, et al., 2007). If we apply this concept to our research of Geekism, we get two important statements. On the one hand is a high score on Geekism associated with a high need for cognition, which implies that people associated with Geekism tend to enjoy situations that are difficult and demanding, in order to increase their cognitive horizon (Schmettow, Noordzij & Mundt, 2013). Therefore will people with high Geekism have a lower tendency to anthropomorphize robotic agents, than other people with a lower need for cognition. On the other hand will people with a high Geekism try to decrease the ambiguity of a situation in order to make it more accessible and predictable, which will increase the amount of knowledge they may acquire by solving the problem at hand (Epley, et al., 2007; Kruglanski and Webster, 1994). They therefore will have a higher need for closure, which according to Epley et al., 2007 leads to an increase in Anthropomorphism.

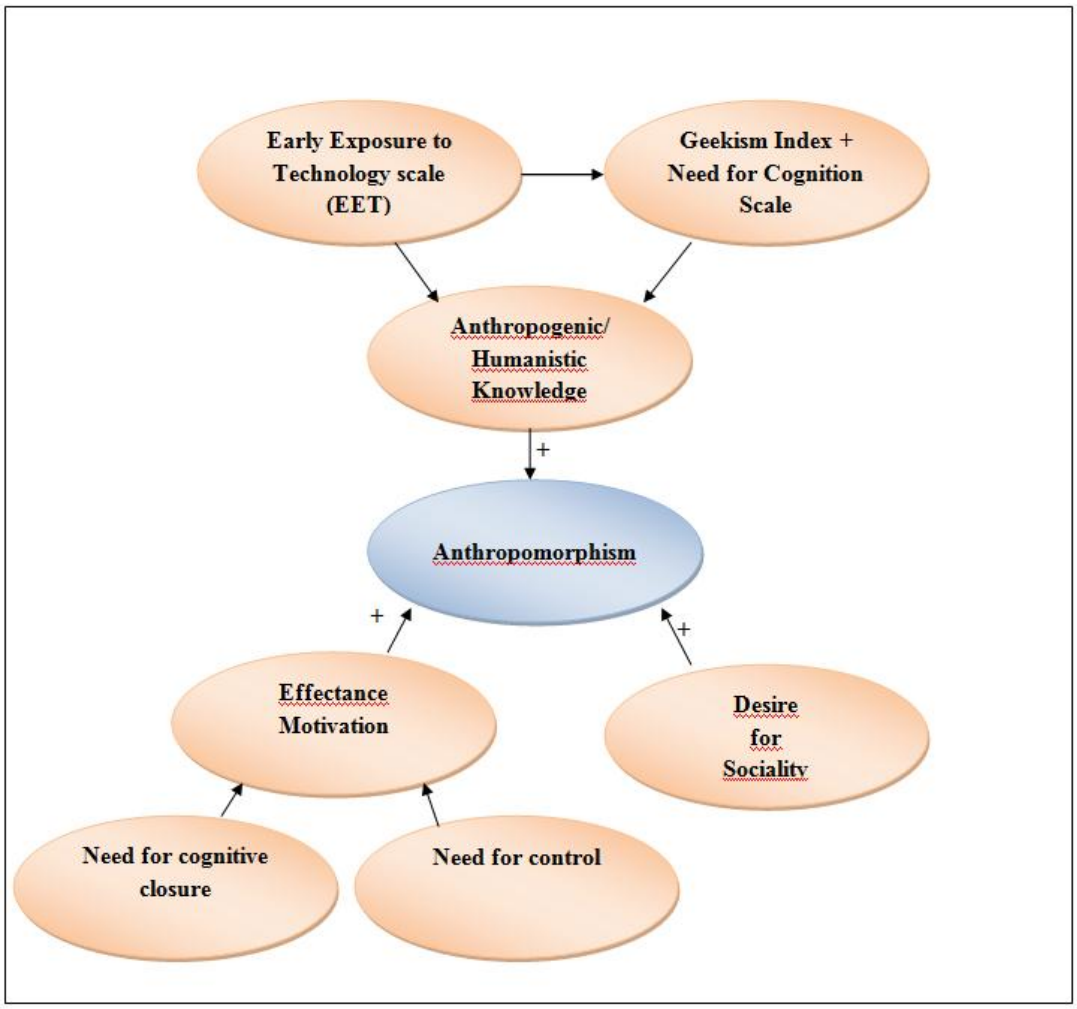
But how do these two constructs fit together? Epley, et al., 2008 describe a solution for the combination of the two. They state that the interaction between the knowledge and need for cognition aspect, and the aspect of effectance motivation would presumably lead to a decrease in anthropomorphic behavior, because effectance motivation, or even more precisely need for closure, implies that there is a situation of uncertainty which tries to be avoided by the person in the situation (Kruglanski and Webster, 1994). People with a high Geekism score on the other hand have extensive expert knowledge and can think of a great amount of solutions to solve a problematic situation (O'Brian, 2007), which means that people with high Geekism gain insight, and predictability about the non-human agent and his characteristics, and therefore tend to anthropomorphize less. Due to their expert knowledge they simply have other solutions than Anthropomorphism to make a situation predictable. This leads to the

conclusion that people with high Geekism tend to have lower tendency towards Anthropomorphism due to the fact that their need for cognition opposes their high need for cognitive closure.

The third aspect of the three dimensional construct of Epley, et al., 2007 is the sociality of the person in question. They state that the urge of social contact is a predictor for increased anthropomorphic behavior. However for this research we will mainly focus on the first two aspects of their theory.

Now that we have outlined the two main constructs of this paper, we give a short introduction of Anthropomorphism in Human-Robot Interaction, because it will provide important information on how people tend to interact with non-human agents, which will on the other hand give implications to analyze the relationship between Geekism and Anthropomorphism.

Figure 1:Model to access Anthropomorphism by Epley, et al., 2007 in combination with Geekism



1.3 Anthropomorphism in Human Robot Interaction (HRI)

Robots of today can have a broad set of applications in daily life. Fong, Nourbakhsh & Dautenham, 2003 make a distinction between work related robots and social robots, however human-robot interaction (HRI) exist on several other levels ranging from HRI for fun by using robots as toys, to HRI in the elderly care, by using robots as support for elderly people that have physical or mental handicaps (Powers, Kiesler & Goetz, 2003).

Fong, Nourbakhsh & Dautenham, 2003, suggest that humans use robots in four different manners namely HRI as a toy, HRI as an assistant, HRI as a companion and HRI as a substitute pet. Our research population, people with a high score on Geekism, use robots mainly as learning project and for fun (O'Brian, 2007). The four HRI patterns are characterized by several different factors that can have a positive of negative effect on the effectiveness of HRI. The first and maybe most important factors that can have an impact on HRI is the perception of the human user (Sims, Chin, Sushil, Barber, Ballion, Clark, Garfield Dolezal, Shumaker & Finkelstein, 2005). This perception is formed by the first impression, which is always formed fast and automatic by using the robots stimuli and cues (Sims et al., 2005). The other important aspect that influences human perception of robots are the attitudes towards the robot, which are mainly influenced by prior knowledge and prior exposure to robots (Sekmen & Challa, 2013). Furthermore is knowledge about the robots purpose and its behavior essential to create a positive attitude towards robots and guarantee effective HRI (Sims et al., 2005). In order to increase the trust and positive attitudes that humans associate with robots, factors like human-like design and human-like characteristics become more and more important (Ellis, Sims, Chin, Pepe, Owens, Dolezal, Shumaker & Finkelstein, 2005). Robots that have more human characteristics are easier accepted by humans because they can identify themselves with the robots (Ellis et al., 2005). Therefore a combination of experience, knowledge and human characteristics can possibly have a positive impact on the effectiveness of HRI in all the four categorize described above (Fong, Nourbakhsh & Dautenham, 2003).

Now that we have discussed the most important constructs that can ultimately be used to answer this papers main question, it is time to formulate hypothesis that we are going to test with this paper.

1.4 Hypothesis

This sections purpose is the development of hypotheses concerning the connection between humans that are associated with Geekism and their tendencies to anthropomorphize. To do so we will use the theory of Epley, et al., 2007 and their tri-factor approach of psychological determinants. We will also try to adapt this tri-factor model to persons with technological experience that score high on Geekism. We will however leave out the last aspect of Epleys et al., 2007 theory of sociability due to limitations of this research.

As a conclusion of the literature analysis that we conducted above, this papers main hypothesis is

People with technological experience tend to have a lower tendency towards anthropomorphization

In order to fully analyze all possible theories that this main hypothesis implies, we have to consider all the aspects that we have analyzed so far, and have to form a number of sub hypothesis to answer our main hypothesis.

1. *A high technological enthusiasm is positively correlated with a high need for cognition*
2. *A high need for cognition is negatively correlated with a high need for cognitive closure*
3. *A high technological enthusiasm leads to a lower tendency towards anthropomorphic behavior*
4. *A high need for cognition leads to a lower tendency towards anthropomorphic behavior*
5. *The combination of a high need for cognition and a high need for cognitive closure leads to a lower tendency towards anthropomorphic behavior.*

Finally this research will focus on how expertise and knowledge is acquired by people associated with Geekism. According to Gleitman, Gross and Reisberg, 2011 is knowledge a combination of experiences and understanding. Therefore they suggest that in order to acquire expert knowledge on a subject, the person in question needs to have experiences with the subject. If we translate this theory onto our research of the combination between Geekism and Anthropomorphism, then we can suggest that people associated with Geekism, must have a great amount of experience with their subject of interest, in our case technology, in order to

acquire the knowledge needed to be called a “geek”. We can also suggest that these experiences must have their roots in the youth of people associated with Geekism, due to the fact that there is no age requirement to be a “geek”. This is in agreement with the research conducted by Schmettow and Passlick 2013, who state that high Geekism may be a result of past events, experiences and furthermore influences by the father to make certain technological experiences.
The two hypothesis that arise out of these theories are therefore

Humans that have a high score Geekism have made experiences with technology by being exposed to technology in their youth.

And

Humans that have self reported experience with technology have a higher score on Geekism

To test this hypothesis we will make use of implicit and explicit measures which are described in detail in the following section

2. **Method**

In the following section I will explain all the methods that were used while conducting this research. On top of that I am going to give insight in our research sample as well as explaining the different parts of our data analysis.

2.1 Participants

In order to determine general differences between participant groups we conducted the experiment on N = 60 students of the University Twente in Enschede. The age of the participants varied from 19 to a maximum age of 29. In order to create a great variety of participants we asked Dutch as well as German and other students to take part in our research. Furthermore did we choose participants gender independently, which led to n=33 female participants and n=27 male students who took part in our study.
Due to time issues did only one third, therefore 20 students, take part in the implicit Stroop task measure and the rest only conducted a survey study, on top of an explicit perceived humanness measure.

Due to our research of the relationship between humans with high Geekism and Anthropomorphism, we needed to conduct the research with as many technological interested respondents as possible. Therefore we mainly tried to reach technological interested student by asking respondents that follow a technical study at the University of Twente to participate in our research. Studies that we aimed to find participates in include, electrical engineering, informatica, wiskunde, biomedische techniek and werktuigbouwkunde.

As a reward, we offered psychology and other student of the behavioral science a part of their bachelor fulfillment at the University of Twente. In order to interest the technical student in our research, we offered every participant a financial reward of 12,50€ for participating in our study.

2.2 Material

In this study we tried to assess the concept of Anthropomorphism by using explicit as well as implicit measurement tools. The explicit measurement tools consisted out of several questionnaires that were all presented by the usage of one big survey, were we randomized all the items out of the four used personality scales. We also used a consistent answer structure of a 7-point likkert scale for all items asked with the exception of the EET items which required an objective answer structure. The possible answers ranged from (1) completely disagree to (7) completely agree

2.3 Explicit measuring tools

In total did we use 4 different questionnaires, namely the Geekism Index (GEX), the need for cognition scale (NCS), the need for cognitive closure scale (NCCR) and the Early Exposure to Technology scale (EET). On top of that did we use the perceived humanness scale by Ho and MacDorman, 2010, in order to be able to analyze how much every participant tends to anthropomorphize.

2.3.1 Geekism Index (GEX)

The GEX was developed by Sander and Schmettow, 2013 and was mainly used to identify people that had a high score on Geekism, and who could be associated as ‘geeks’. The survey consists of 32 statements that had to be answered by the use of a 5 point- likkert scale. To increase the precision of our research we changed the answer structure to a 7 point- likkert scale. Later research rendered 17 of the 32 items insufficient to access the construct Geekism, which left the Geekism Index with 15 items (Schmettow & Drees, 2014). This study however

used the full extent of the Geekism Index in order to access the personality trait Geekism. The Geekism Index covers important area of Geekism like "understanding technology, need for being in control of devices, preference for versatility, motivation to repurpose devices, and privacy concerns." (Schmettow & Drees 2014).
According to Schmettow and Drees, 2014, does the GEX have an excellent reliability with Cronbachs alpha of .96 and a test-retest reliability of .96. On top of that does the GEX show good correlations with other explicit (need for cognition) as well as implicit measuring tools, which makes it usable for this researches purpose.

2.3.2 Need for cognition scale

According to Schmettow, Noordzij & Mundt, 2013, is the need for cognition assumed to be a crucial part of being a geek which is why we thought that integrating the need for cognition scale is unavoidable if you want to get a whole picture of Geekism and Anthropomorphism. The need for cognition scale consist of 18 items (Cacioppo, Petty, Kao, 1984) and after a validating factor analysis Cacioppo, Petty and Kao determined that the need for cognition scaled is a one factor measure and therefore unidimensional.
The answer structure of the need for cognition scale was originally designed to be a 7 point-likkert scale, so we did not have to change anything, and the reliability of the need for cognition scale was with a theta score of .90 sufficient.

2.3.3 Need for cognitive closure

Other than the need for cognition scale is the construct of need for cognitive closure, which was developed by Kruglanski and Webster, 1994, not directly associated with Geekism. It is however a crucial factor to analyze ones tendency to anthropomorphize a non-human agent, due to its contribution to the construct of effectance motivation (Epley, et al., 2007). Therefore the integration of the need for closure scale into our research is a necessary, because it gives us the possibility to make an assessment of the extent of anthropomorphic behavior of the people associated with Geekism.

The need for closure scale was developed by Kruglanski and Webster in 1994 which consisted out of 5 different subscales that measured different aspect, which indicates that the need for closure scale is not a homogenous construct. Reason for the development of the NCCR was to try to assess if people tend to avoid or even seek predictable and controllable situations (Avoidance or seeking of ambiguity/disambiguation). After a statement of Neuberg, Judice and West, 1997, that the need for cognitive closure scale should actually be a multi-

dimensional scale, did Roets and van Hielen, 2007 a detailed analysis of the scale and revised it to form the NFCS-R which consists of 41 items and which shows a sufficient reliability, with a Cronbachs alpha of .85-.87 in sample 1 and .82-.85 in sample 2. Therefore we decided to integrate the need for cognitive closure scale in our study.

2.3.4 Early Exposure to technology scale

In order to determine to what extend the respondents had been exposed to technology in their youth and if that may or may not have an influence on their Geekism score, we had to create a new survey which we called Early Exposure to Technology scale (EET). Due to its objectivity did we not do a pilot test or reliability analysis to determine the usefulness of the scale. The answer structure consisted of simple yes/no answers as well as estimated age answers. The intention behind the development of the items was on one hand to investigate the relationship of self-reported experience and their influence on the Geekism score of the participant. On the other hand was a purpose of the EET to analyze to what extent the participants were exposed to technology in their youth and if this exposure had any influence on their Geekism Index score. Therefore 3 items asked the respondent to describe his or her own experiences with technological devices and 4 items asked the respondent to estimate his or her age of first exposure to a technological device. In order to make the survey accessible for every participant, we chose to integrate only 4 of the main technological devices that the majority of humans are exposed to during their early life, namely television, computer, mobile phone and MP3-player. The items about self-reported experience were meant to give an overall general picture about, how the participant rates his own experience with technological devices. All items used in this survey can be found in table 1 below. The second reason for the development of the EET was the validation of the Gex scale by Schmettow and Passlick, 2013. As mentioned above does the Gex scale try to measure technological enthusiasm which is seen as a crucial base factor for Geekism (Schmettow & Drees, 2014). Therefore should people who score high on the Geekism Index also describe themselves as technological experienced, which was assessed by the EET.

Table 1: Items used in the EET

Item Number	Item
Age of first exposure	
1	At what age did you first get access to a television?
2	At what age did you first get access to a mobile phone?
3	At what age did you first get access to a computer?
4	At what age did you first get access to a MP3 player/iPod?
Self reported experience	
5	Would you state that you have experience with technology?
6	Did you ever fix an electronic devise (Computer, Mp3 player, television)?
7	Did you ever try to understand how an electronic devise works?

2.3.5 Perceived Humanness Scale

In this study we make use of the perceived humanness scale, which was developed as an answer to the Godspeed questionnaire and is supposed to determine the extent to which the respondent anthropomorphizes a non-human agent (Ho & MacDorman, 2010). The scale consists of the subscales perceived humanness, warmth, eeriness, and attractiveness, but this study only uses the sub concept of perceived humanness because it is the most convenient scale for our purpose. As suggested by MacDorman, Coram, Ho and Patel, 2010, the aspect of humanness includes the factors, "human photorealism of the character's morphology, skin texture, motion quality, or other formal property". This means that the perceived humanness scale measures all the important aspects to assess the anthropomorphic tendencies of, in this study, humans associated with Geekism.

First reliability analysis showed that the Cronbachs alpha of the subscale perceived humanness was sufficient with a value of α=.92. The subscale consists of 6 items namely, *artificial–natural, human-made– humanlike, without definite lifespan–mortal, inanimate–living, mechanical movement–biological movement, and synthetic–real.* We used the perceived humanness scale in combination with N=20 different short clips of moving robots, which were supposed to prime the respondent to complete the perceived humanness scale.

2.3.6 Video Clips

As an addition to the perceived humanness scale by Ho and MacDorman, 20010, we also used 20 short video clips that were handpicked by the researchers. The main topic of all the video clips was robots, so that we could analyze how the respondent perceives robots and if he or she has a tendency to anthropomorphize these robots.

Each video clips was cut to a length of 5 second with a resolution of 1920x1080 pixel. The video clips were shown on a standard 16" laptop, in form of a Microsoft Office Power Point presentation to guarantee the right order of the video clips in every experimental trial. The guidelines for the video clips were as followed:

- No humans may been seen in the clip
- The robot must stand focus
- The video clips must have the same length
- The movement pattern of the robots must be the same
- The sort robot must diversify

In order to achieve these guidelines we used 9 robots that were rolling or flying and 11 robots that show some kind of walking behavior. Furthermore did we not only use humanistic robots but also animalistic robots and robots that had nothing to do we either of these two categories.

2.4 Implicit measuring tools

Due to the limitations of the explicit measuring tools that were mentioned above, we decided to integrate an implicit measuring tool, namely the Stroop task. Basis of the Stroop task is the suggestions that people, when confronted with words, are not able to ignore the meaning of them. Therefore people are not able to not read a word, if they see it.

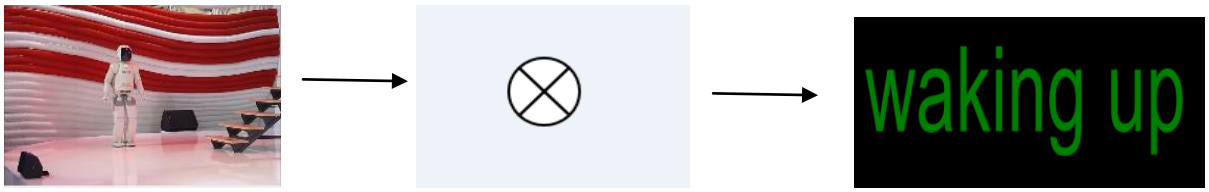
Schmettow, Noordzij and Mundt, 2013 also added a new component to the Stroop task, namely a priming effect. The priming of the respondent by using pictures of video clips in combination with neutral words, which may or may not be congruent with the priming lead to an association effect between the word and the priming stimulus. In our case we used the 20 video clips that were mentioned in section 2.3.6 and played them prior to every Stroop trial. The words that we used during the experiment were 41 verbs in the present progressive form that concerned the topic of robotics. We also tried to find corresponding human words, so that we were able to determine the difference between human-like and robot-like associations. On top of that did we integrate some neutral words that had no connections to either humanlike of robotic target words, to have a control sample for later analysis.
Examples of these word pairs can be found in table 2 below.

Table 2: Target words used in Stroop Experiment

Humanlike words	Robotic words	Neutral words
Walking	Rolling	Raining
Eating	Recharging	Flashing
Forgetting	Deleting	Happening

Furthermore did the Stroop task consist of 3 different sequences that were repeated in every trial, and which consisted of the same time frames. The first sequences contained the priming stimulus, in our case the video clip of about 5 seconds. The second sequence consisted of a fixation cross that was shown for about 1 second, to focus the respondents attention to the center of the screen were the third sequence, namely the target word was shown. The time that the target word was shown was dependent on the respondents reaction time (RT). The whole sequence is shown in figure 2.

Figure 2: Sequence of a Stroop priming trial



Prime (5 Seconds) Fixation Cross (~1Second) Target word (Reaction Time/RT)

2.5 Procedure

The experiment took place in a standardized environment in the research lab of the Cubicus. We invited two participation groups, the first group did only the explicit measures (sub-samples A) and the second group also participated in the Stroop experiment on top of the explicit measuring (sub-sample B).

In order to prevent conscious or unconscious biases, we asked the participants first to take part in the Stroop task. We gave them the necessary instructions and started the Stroop task for them. After they finished we would begin with the second phase namely with completing the perceived humanness scale, which we did by starting a Microsoft PowerPoint presentation that contained all the video clips that were used to as primes for the perceived humanness scale. We explained how everything worked and asked the participant if he or she had any more questions, and if that was not the cased we leaved the room again. After finishing the perceived humanness scale, the first part of the study was finished and we asked

the participant to fill in our questionnaire at home and return it to us in 2-3 days.

Condition A underwent the same procedure, but started with the perceived humanness scale instead of the Stroop task. After they completed the perceived humanness they were also asked to complete the questionnaire at home in order to prevent concentration and bias issues.

The precise distribution of respondents can be found in table 3.

Table 3: Distribution of respondents into the two conditions

	Condition A	**Condition B**
Male Respondents	14	13
Female Respondents	24	9
Total	38	22

2.6 Data Analysis

We integrated the datasets into the computer program PASW Statistics 20 which was used to conduct every analysis that will be mentioned below.

First we had to calculate the total score of the NCS, the NCCR, the Gex, according to the scale developer's intentions. Furthermore did we integrate every score on every prime of the perceived humanness scale, in order to acquire a dataset which could ultimately be used to test our hypothesis concerning anthropomorphic tendencies. After the completion of the main dataset, we integrated the Stroop experiment scores (the reaction time) into SPSS which we did by adding several categories (word category, word theme and target word) to describe the trial as precisely as possible. The factor word category, which described the three different categorizations that the target words could by classified in, human, neutral or system words, which was necessary in order to test if there are any fluctuations concerning the reaction times, when different word categories were involved. The factor of word theme was not used in this study, but could ultimately be analyzed to determine if the respondents show more associations with target words that concern cognition, or for example show more association with a target word out of the theme energy.

After all the datasets were prepared we started our overall analysis by determine the demographics at hand. After all demographics were determined we started testing our hypothesis, as mentioned in the section 1.4 Hypothesis.

2.6.1 Main Hypothesis

Due to the two dimensional construct of Geekism (combination of Gex and NCS score), we had to use an interaction analysis with repeated measures in order to test our main hypothesis, that there is a relation between Geekism and Anthropomorphism. Therefore we used a mixed-effect model consisting of random effects and fixed effects (for a detailed overview see table 4). As dependent variable we chose the scores on the perceived humanness scale as an indicator for anthropomorphic behavior. Our covariates were in case of the main hypothesis the scores of the respondent on the Need for cognition scale (NCS) and the Geekism Index scale (Gex), which if combined gave an reference point of the respondents Geekism score. However due to repeated measurements on the same item, the same prime and within the same subject we also had to integrate random effects into our analysis to account for possible influences of these factors.

Table 4: Overview of effect of the mixed effects model

Effects	Variables
Fixed/Main Effects	Gex, NCS, NCCR
Interaction Effects	Gex*NCS, Gex*NCCR, NCCR*NCS, Gex*NCS*NCCR
Random Effects	Participant, Item, Prime
Dependent Variable	Score on perceived humanness scale

2.6.2 Sub-hypothesis

Firstly in order to get deeper insight in the data we also used the mixed-effect model of our main hypothesis to test our sub hypothesis (Table 4). We also added a correlation analysis of the different scale scores, which we did by developing a correlation table of the three subscale NCS, Gex, and NCCR to get a better understanding of the connections between the sub scales, and how that might influence our main hypothesis. To categorize the correlation strengths we make use of the graduation system by Dancey and Reidy, 2004, who state that all correlation with a value of 0.3 or higher can be seen as moderate and strong correlations.

Secondly, we used a mixed-effect model with the score on Stroop experiment (RT) as dependent variable and the scores on the perceived humanness scale plus the word category as covariate in order to validate if the Stroop task is appropriate to measure anthropomorphic tendencies. We also included the factors respondent, the used prime and the target word as random effects in order to account for repeated measurements.

Thirdly, to test the hypothesis that a basis for Geekism and expert knowledge is prior experience with technology, we used the scores on our self developed scale (Early Exposure to Technology) and calculated the total age of exposure, which was the result of the addition of the four items that concerned age of exposure. The second step in our analysis was to calculate the score of self reported experience by the respondents. This was done by using the three items and adding the total score of all three items. Due to the items binary structure, the maximum score of self reported experience was 3, which indicated a high degree of self reported experience and a minimum score of 0 which indicated no self reported experience with technology at all. On basis of these two measures, were we able to conduct a correlation analysis in order to determine if, and how strong, the two factors (Exposure age, and self reported experience) influence the respondents Geekism score. The construct Geekism was measured by using the Gex and NCS scores of the respondents

3. **Results**

Purpose of this section is to give an overview of the results that we found while analyzing the data as described in section 2.6. In order to do so we will mention every hypothesis that form the basis of this paper, and give relevant data that we found in our analysis, which can be used to form a theory concerning the hypothesis. We will start with a short overview of the descriptive data that were gathered during our experimental trials.

3.1 Descriptives

Purpose of this section is to give an overview of the descriptive statistics of the personality scales (Gex, NCS, and NCCR) and the perceived humanness scale. Participants scored on the Geekism Index with a mean score of μ=-0.081, which equals about a 4 on the 7-point likkert scale that was used to conduct our research. The scores on the NCS had a mean score of μ=0.222, and on the NCCR did the participants score a mean of μ=0.095. The scores on the perceived humanness scale had a mean of μ=3.021 and were the only ones that were not recoded into a different variable. Therefore the mean score of the perceived humanness scale is identical to a 3.021 on a likkert scale, which is pretty much a 3. This indicates that people tend to score lower than the neutral 4, which means that they anthropomorphize most of the robotic primes below average.

For a detailed overview of the mean scores and the standard deviation by gender see table 5.

Table 5: Descriptive statistics

	Mean score	Std. Deviation	Mean score Male	Mean score Female
Gex	-0.081	0.488	0.149	-0.256
NCS	0.222	0.273	0.249	0.202
NCCR	0.095	0.197	0.003	0.161
Perceived Humanness	3.021	1.377	2.880	3.174

Table 5 indicates that male participants tend to score higher on Gex and NCS than female participants but lower on the perceived humanness scale, which suggests that they tend to score higher on Geekism but also lower on Anthropomorphism. For female participants, it is the complete opposite, they tend to score lower on Geekism but higher on Anthropomorphism. We can however not make a general statement about the relationship between Geekism and Anthropomorphism without further analysis.

Table 6: Correlation analysis of NCS, Gex and NCCR, Self reported experience and total age of first exposure with subscales

	Gex	NCS	NCCR	Self reported experience	Total age of first exposure	Age of first exposure to television	Age of first exposure to computer	Age of first exposure to mobile phone	Age of first exposure to MP3-Player
Gex	1	0.456	-0.208	0.760	-0.278	-0.411	-0.450	-0.014	0.072
Sig. (2-tailed)		0.000	0.120	0.000	0.042	0.002	0.001	0.917	0.600
N	60	60	57	57	54	55	56	56	55
NCS		1	-0.273	0.230	-0.031	-0.155	-0.118	-0.013	0.142
Sig. (2-tailed)			0.040	0.086	0.822	0.259	0.388	0.922	0.300
N		60	57	57	54	55	56	56	55
NCCR			1	-0.208	0.182	0.147	0.299	0.070	0.016
Sig. (2-tailed)				0.120	0.202	0.298	0.030	0.619	0.908
N			57	57	51	52	53	53	52
Self reported experience				1	-0.335	-0.342	-0.492	-0.138	-0.056
Sig. (2-tailed)					0.013	0.011	0.000	0.310	0.687
N				57	54	55	56	56	55
Total age of first exposure					1	0.821	0.813	0.780	0.759
Sig. (2-tailed)						0.000	0.000	0.000	0.000
N					54	54	54	54	54

3.2 Hypothesis testing

This paper tries to investigate the assumption that a high score on Geekism is based on youth experience with technology as a result to early exposure to technological devices. We analyzed these assumptions by using the data we gathered with our self developed questionnaire over Early Exposure to Technology (EET), and compared the results with data gathered by the NCS and Gex scale.
The detailed averages of every age of exposure to technological devices can be found in table 7 below.

Table 7: Summary of average age of exposure to technological devices

	Mean	**Maximum**	**Minimum**
Age Computer	10 years	22 years	3 years
Age Television	5.6 years	22 years	1 years
Age Mobile Phone	12.3years	22 years	8 years
Age MP3-Player	13.1 years	22 years	4 years

The distribution of the total self reported experience can be found in table 8.

Table 8: Distribution of total self reported experience score

	0	**1**	**2**	**3**	**Mean**
Frequency	12	11	9	25	1,82

A correlation analysis of the factors, age of exposure and all underlying subscales, self reported experience, technological enthusiasm and need for cognition was used to analyze the hypothesis if there is indeed a influence of early exposure and experience with technology and the degree of which respondents show a high score on Geekism. Table 6 shows that there is a positive correlation between the score on the Gex and self reported experience with a score of r=0.760 and also a positive correlation between NCS and self reported experience with a correlation coefficient of r=0.230. This indicates that the assumption, that people with a higher score of self reported experience tend to have a higher Geekism, can be proven, due to the fact that the self reported experience score correlates strongly with the Geekism Index scores and modest with the scores on the need for cognition scale, which both are assumed to form the basis of the construct Geekism. The difference between the two correlations which is rather large can be explained by outlining that the Geekism Index scale was partly developed by an interview study by O'Brian, 2007 with self-declared geeks who reported extensive self

reported experience. Therefore do the questions about self-reported experience of the EET strongly correlate with the Geekism Index, due to the fact that they partly measure the same construct. NCS on the other hand does not fully rely on self-reported experience, due to the fact that it tries to access several other aspects, which are independent of self-reported traits. The correlation between NCS and EET is therefore lower, but still positive. Therefore do the results show that the extent to which people report self experience with technology, is a clear indicator of their score on Geekism. The age of first exposure to technological devices on the other hand, shows an overall significant negative correlation with NCS (r=-0.031) as well as Gex (r=-0.278). This indicates that the assumption that an early exposure to technology lead to a higher Geekism might be verifiable, due to the fact that the lower the age of first exposure, the higher the scores on the Geekism Index and need for cognition scale which is assumed to give an estimate of having a high Geekism. A detailed analysis of the underlying subscales of the first exposure to technology scale shows that only the items first exposure to television (r=-0.411) and first exposure to computer (r=-0.450) show correlation to the Geekism Index that are statically significant and can be seen as having an influence on later scores on Geekism of the participant. The correlation of first exposure to a mobile phone (r=-0.014) and first exposure to an MP3-player (r=0.072) on the other hand are too weak to have a relevant influence on the Gex score and can therefore not be used as an explanatory variable for Geekism (see table 6). A visualization of these findings can be found in the figures below.

Figure 3: Correlation between NCS and self-reported experience

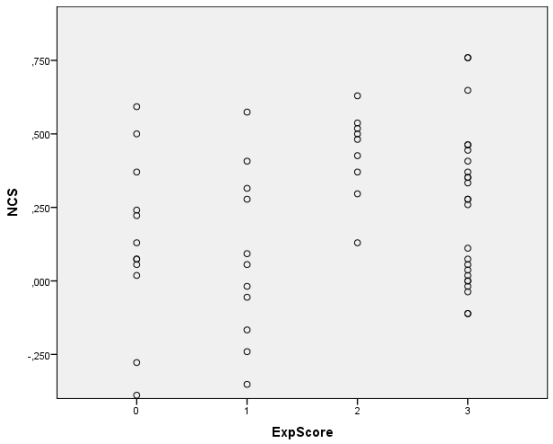


Figure 4: Correlation between Gex and self-reported experience

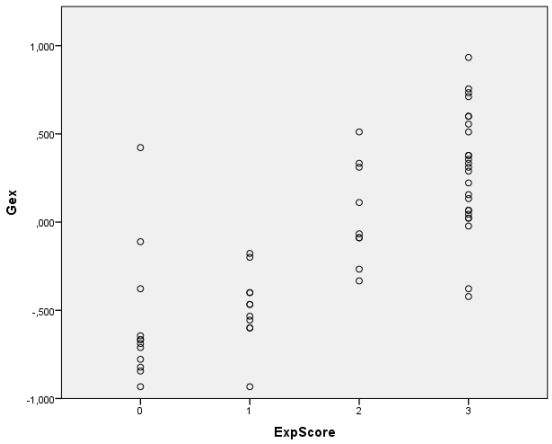


Figure 5: Correlation between NCS and total age of first exposure

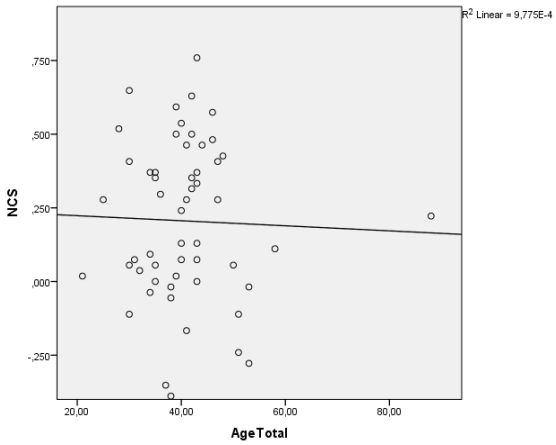
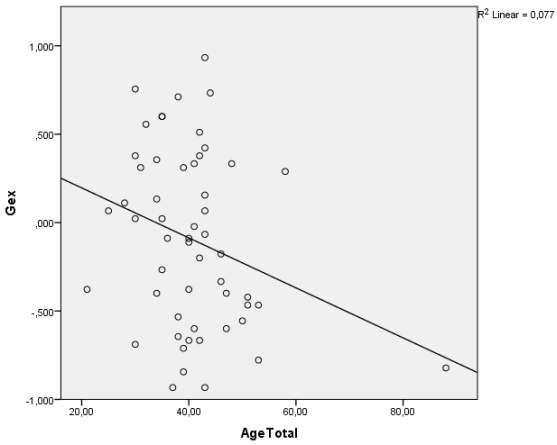


Figure 6: Correlation between Gex and total age of first exposure



In order to answer this papers main hypothesis, we first have to analyze the underlying sub hypothesis, to make the relationship between the different constructs clear. We therefore start by analyzing sub hypothesis 1

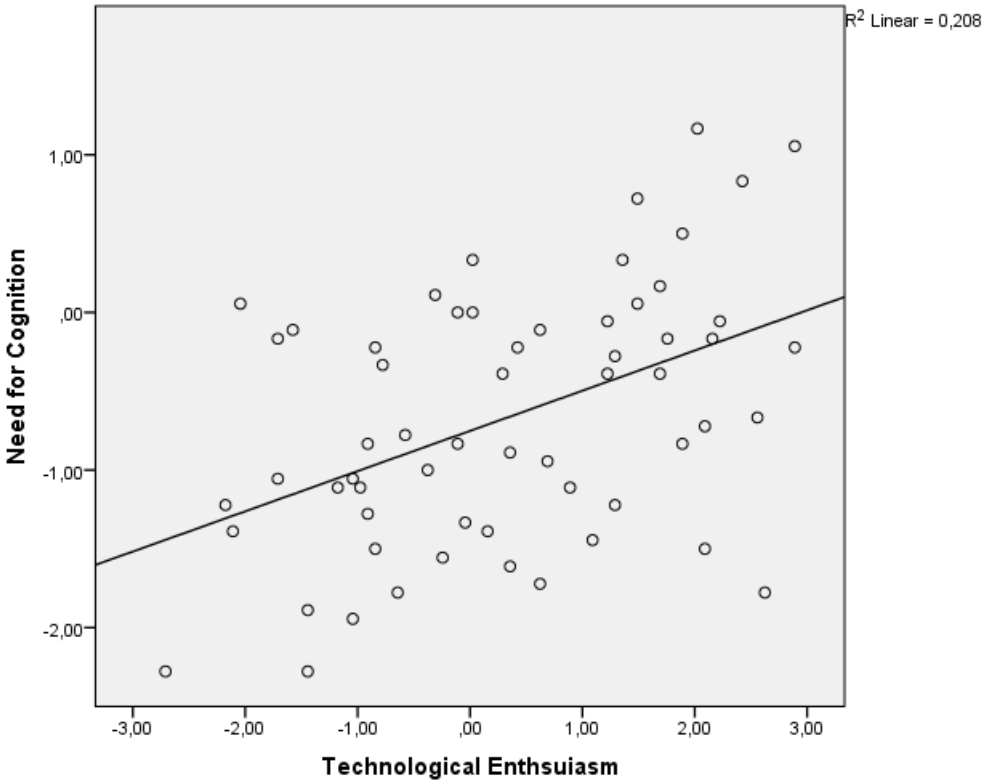
"Geekism consists of the constructs technological enthusiasm and the need for cognition"

For this hypothesis to be true we must see a positive correlation between need for cognition (NCS) and technological enthusiasm (Gex).

As can be seen in table 6 does the correlation analysis shows that there is indeed a positive correlation of r=0.456 with a statistical significance. This means that people who score high

on technological enthusiasm also show the tendency to score high on need for cognition (figure 7)

Figure 7: Correlation between technological enthusiasm (Gex) and need for cognition (NCS)



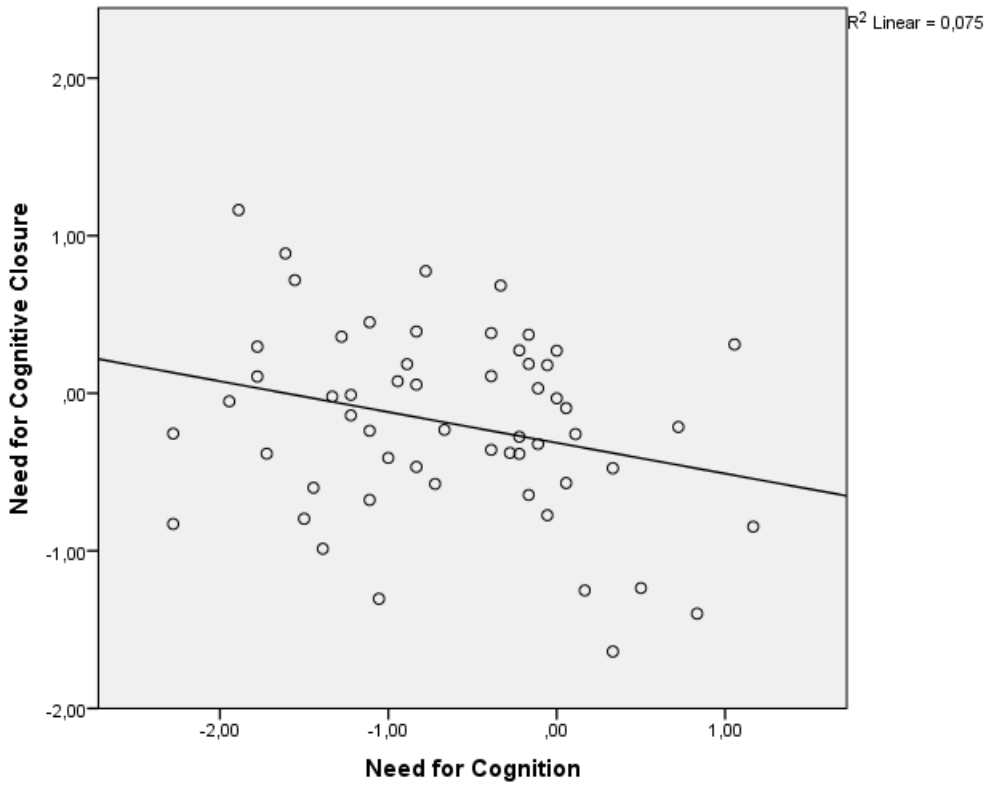
This papers hypothesis that,

"A high need for cognition is negatively correlated with a high need for cognitive closure"

can also be answered by looking at the findings of the correlation analysis which we summarized in table 6. The correlation analysis shows that the need for cognition scale (NCS) and the need for cognitive closure scale (NCCR) show a distinct negative relationship of r= -.273, which is statistical significant (Table 6).

The relationship between the need for cognition and the need for cognitive closure is visualized in figure 8 below.

Figure 8: Correlation between Need for cognition (NCS) and Need for cognitive closure (NCCR)



To test our third hypothesis we needed to choose a different approach than a correlation analysis, due to the fact the we wanted to analyze anthropomorphic behavior which was observed by the use of repeated measurements within the respondent, the items and the primes that we used. We therefore had to do a mixed effects analysis with random and fixed factors as described in section 2.6.

The mixed effects analysis showed that there is a slight negative interaction between technological enthusiasm and the tendency towards anthropomorphic behavior ($F(1;48)= 0.075$) but that this interaction is so small that it could be seen as practically not present (see table 7).

This means that technological enthusiasm on its own has no considerable influence on the tendency to anthropomorphize.

Table 7: Interaction effect of GEX, NCS, NCCR and the tendency to anthropomorphic behavior

	Estimates β	F	Sig	Lower Bound (95%)	Higher Bound (95%)
Intercept	3.054	117.007	0.000	2.483	3.624
Gex	0.023	0.075	0.785	-0.146	0.192
NCS	0.029	0.050	0.824	-0.233	0.291
NCCR	0.084	0.079	0.780	-0.515	0.683
NCS * NCCR	0.086	0.121	0.730	-0.414	0.586
NCS * Gex	-0.087	1.541	0.220	-0.227	0.054

Dependent Variable: Response Perceived Humanness Scale

To test our fourth hypothesis we chose the same approach as we used with hypothesis three due to the same circumstances.
The mixed effect analysis showed that there is a slight negative interaction effect between the construct need for cognition and the tendency to anthropomorphic behavior, measured by the perceived humanness scale, but that the interaction is not statistically significant ($F(1;48)= 0.050$, $p= 0.824$, see table 7). The confidence interval further showed an almost symmetrical range [-0.233; 0.291] around 0 which indicated that there is no significant effect at all. This means that the need for cognition, just like the technological enthusiasm, has on its own no influencing effect on the tendency towards anthropomorphic behavior.

Our fifth hypothesis concerned the interacting effect of the need for cognition and the need for cognitive closure on the tendency towards anthropomorphic behavior. We therefore analyzed if the combination of the two decreases anthropomorphic tendencies. We also did this by the usage of a mixed effects analysis with a two way interaction as covariant and the scores on the perceived humanness scale as dependent variable. The results (table 7) indicate that the interacting effect of NCS and NCCR has no statistically significant influence on the tendency towards anthropomorphic behavior ($F(1;48)= 0.121$, $p=0.730$). The estimates however showed a slight positive influence, which would indicate that people with a combination of need for cognition and need for cognitive closure would ultimately have a higher tendency towards anthropomorphic behavior. Due to the fact that the confidence interval showed an almost symmetrical distribution [-0.586; 0.414] around 0 we can assume that the effect is

practically not present which would render our assumption of a slight positive influence irrelevant. We can therefore conclude that there is no interacting effect of NCS and NCCR on anthropomorphic tendencies.

Now that we have answered all the underlying sub hypothesis, we now have to analyze the results of our main hypothesis

People with technological experience tend to have a lower tendency to anthropomorphization

In sub hypothesis one we found that people with technological experience scoreed high on technological enthusiasm as well as need for cognition. Therefore we tried to analyze if the interacting effect of Gex and NCS may or may not have influence on the anthropomorphic tendencies of a person. The mixed effect analysis that we conducted shows that the combination of Gex and NCS shows a slight negative relation with the anthropomorphic tendencies (β= -,087) but that these negative tendencies are not statistically significant ($F(1;48)=1.541$, $p=.220$, see table 7).

These results indicate that our main hypothesis, that people with a a high score on Geekism tend to anthropomorphize less, cannot be verified, which means that there is no evidence for a different anthropomorphic behavior of people that have a predisposition to Geekism.

4. Discussion

The main goal of this study was to investigate the relationship of Geekism and Anthropomorphism, and furthermore, if people who score high on Geekism have a different tendency towards anthropomorphic behavior. We tried to do so by applying the theory of Epley, et al., 2007 about the three determinants of Anthropomorphism to our theory about the combination of constructs that lead to Geekism. On basis of this theory we formulated several hypothesis that this paper tries to answers. Although we confirmed that the two sub constructs, technological enthusiasm and the need for cognition show a moderate correlation, which indicates that they may be basic factors of Geekism as described by Schmettow and Drees, 20014, we were not able to find any statistically significant connection between technological enthusiasm and anthropomorphic tendencies, nor between need for cognition and Anthropomorphism. We were however able to find several effects that stand opposing to the theory of Epley et al., 2007, which indicates that their suggestion about general

application of their three dimensional theory of Anthropomorphism is not statistically verifiable in our study.

4.1 Technological Enthusiasm and Anthropomorphism

Schmettow and Passlick, 2013 assumed that the aspect of technological enthusiasm is based on expert knowledge that an individual acquires on a specified subject, for example robotics. Therefore in order to have high Geekism, a person must study and learn, to become an expert. If we apply these facts onto the theory of Epley, et al., 2007 we can state that people not only acquire expert, but anthropogenic knowledge as well, which means that they have alternate knowledge opposed to humanistic knowledge which is needed to recognize human like behavior and characteristics (Epley, et al., 2008). Our results however show that there is no difference in anthropomorphic behavior between people with high technological enthusiasm and low technological enthusiasm, which indicates that the theory of Epley, et al., 2007 may not account for anthropomorphic tendencies of people with high Geekism. This could indicate that expert knowledge may not have the predicted influence on Anthropomorphism as suggested by Epley et al., 2007 and that there are other important factors that may decrease or increase anthropomorphic tendencies of people with technological knowledge. One of these factors could be prior experience which leads to an automatic forming of an impression, and due to the frequent exposure to technology of people with high Geekism, they may be more prone to form a technological impression instead of a human impression. This is however not verifiable by this research and could be topic of future research concerning the relationship between Geekism and Anthropomorphism.

4.2 Need for cognition and Anthropomorphism

The second aspect of Geekism as assumed by Schmettow and Passlick, 2013 is a high need for cognition as identified by Cacioppo, 1984. Need for cognition is also part of the theory of Epley et al., 2007 due to the fact that it promotes the urge to acquire alternative knowledge, which would according to them ultimately decrease an individual's Anthropomorphism. The results however show practically zero relationship between need for cognition and anthropomorphic behavior, which indicates that our hypothesis cannot be confirmed by our findings. Therefore we are once again not able to confirm the theory of Epley et al., 2007 concerning expert knowledge which decreases the anthropomorphic tendencies of the participants. In order to make a general statement about the application of Epley's theory onto our participant group we also have to investigate the theory's hypothesis about the need for closure.

4.3 Need for cognitive closure and Anthropomorphism

According to Epley, et al., 2007 does a high need for cognitive closure lead to an increase in anthropomorphic tendencies which could be part of Geekism due to their desire to create an ambiguous situation. On the other hand does this papers main hypothesis state that high Geekism leads to a lesser Anthropomorphism. Epley, et al., 2007 give a explanation for this paradox, by pointing out that the factor of need for cognitive closure, can be overruled by expert and alternative knowledge which is assumed to be present in people with a high score on Geekism. Our results reinforce the findings of Epley, et al., 2007 because the correlation of the two constructs is slightly negative and furthermore statistically significant. The correlation coefficient of the two constructs can however only be accounted as weak, according to the categorization system of Dancey and Reidy, 2004. The results of our mixed effects analysis of the interaction effect between NCS and NCCRS could however not verify the hypothesis of Epley, et al., 2007 due to the fact that we were not able to find any relationship between the two aspects. We can therefore not conclude that neither need for cognitive closure on its own nor in combination with need for cognition has any significant effect on the participant's tendency towards anthropomorphic behavior. Cognitive closure is furthermore partly based on automatic cognitive processes which could lead to higher Anthropomorphism. We used video clips of 5 seconds, which do not leave room for cognitive processes other than automatic perception forming (Wilson, Turner, Emerson & Scheuer, 1999), which could lead to a adulteration of our data. Future research must determine if the length of the priming videos could have a possible influence on Anthropomorphism and how these influences stand in combination to the need for cognitive closure.

4.4 Construct Geekism and Anthropomorphism

To answer our main hypothesis we have to connect all three constructs into one and investigate if there is a relationship between Geekism and Anthropomorphism. Therefore people who tend to score high on need for cognition and technological enthusiasm, and low on need for cognitive closure would show a lower tendency towards Anthropomorphism than other people. The first two aspects define the groups as having a high Geekism, and the last factor, namely need for cognitive closure is according to Epley et al., 2007 an important moderating factor in the assessment of Anthropomorphism and should be seen within our participant group. The results however do not indicate an influence of either technological enthusiasm, need for cognition or need for cognitive closure on the tendency to Anthropomorphism, which means that neither of the points of Epley, et al., 2007 could be verified by our findings. We did not include the aspect of Sociality into our study, which is

according to Epley, et al., 2007 the third determinant that is responsible for someone's anthropomorphic tendencies, which might be an drawback if we want to evaluate the applicability of their theory onto every person. We did however show that neither of their first two key determinant seemed to influence the anthropomorphic tendencies of our participant group in ways that were predicted by Epley et al., 2007. This means that we were not able to find any connection between the two constructs of Geekism and Anthropomorphism, which leaves us with the conclusion that there may be several different factors of the two constructs that interact in way that promote Anthropomorphism. These factors are however not part of this research and might be accessed in future analysis.

4.5 Motivational factors for Geekism

Another purpose of this study was to identify, where the knowledge and motivation to become a person with a tendency to Geekism comes from. We therefore analyzed the past experience of the participant to determine if there are any factors that may or may not increase the participant's motivation to become a geek. We expected people who scored high on need for cognition as well as technological enthusiasm, to show that they were exposed to technology pretty early in their life (about 8-9 years and younger). The result indeed show a distinct correlation between early exposure and the scores on the Geekism Index and the need for cognition scale, which means that people who are early exposed to technology, tend to have a higher score on Geekism than people who are exposed to technology later on. These findings also verify the results of Schmettow and Passlick, 2013 that so called "geeks" begin to gather experience early on, and that they are introduced to technology by their fathers. These findings also agree with the theory of Colley, Gale and Harris, 1994 that experiences that are formed in early years of a person's life, can have a major influence on their interest development. Therefore are we able conclude that in order to have a preference and interest into subject that would be counted as characteristic for Geekism, people have to make early experience with computer science as well as other forms of technology. The distinct analysis of each of the four technological devices in question however revealed that only television and computer show a relationship with scores on the Geekism index as well as the need for cognition scale, which indicates that the experiences, as described by Colley, Gale and Harris, 1994 must be selective. Technological devices that are of lower importance or acquired later in life, like a MP3-Player or a mobile phone, show no significant influence on Geekism. Therefore in order to make a clear assessment about Geekism, the qualitative aspect of exposure, for example the device that the person is exposed to and the severity of exposure must be considered as well.

Furthermore does this study aimed to support theories about Geekism by analyzing if self reported experience with technological devices might be an indicator of a high Geekism later on. We therefore asked participants about their prior experiences with technology and how they would rate themselves (as experienced or inexperienced with technology). We expected to see a highly positive correlation between the scores on the sub constructs of Geekism, need for cognition and technological enthusiasm and the scores on the self reported experience. The result indeed show a strong positive relationship between the two aspects. This indicates that people who report experience with technological devices tend to score much higher on Geekism than people who report no or just slight experience with technological devices. McArthur, 2008 did extensive research on Geekism using interviews and observations of online communities and found that the aspect of self reported experiences is one of the major indicators for a high Geekism. These findings stand accord with our results under consideration of potential limitations that occurred in our study and that will be discussed in detail in section 4.1. However this study shows that the basis of Geekism begins in early years of someone's life with the combination of frequent exposure to technological devices, which could be initiated in several ways, and the acquisition of experience concerning technological devices. The quality of exposure and the way of acquiring technological experience however seem to influence later tendencies to a great amount. This means that frequent exposure of one's child to technology, and the initiation of experience gathering trough parents, cannot necessarily be seen as a means end for a child to have a high score on Geekism. There are still several other factors that influence the development and motivation of people that are not accounted in this study.

On top of these findings can our results be seen as a validation of the Gex scale by Sander, 2013 due to the fact that it is based on technological interest and experience which is also measured by the EET scale. The EET is therefore not only a tool to access motivations for becoming a geek, but can also be used as a validation tool for other experience based scale for Geekism which could have important implications for the future, due to the fact that Geekism is a subject that is not yet fully researched, and which needs future questionnaires to fully understand every sub construct of the trait Geekism.

4.6 Limitations

The results of this study could be ascribed to some limitations that were confronted during the experimental trial of our research. Purpose of this section is to name these limitations and explain in what way they might have affected our results.

Purpose of this study was to gather a great variety of people that show different scores on Geekism by trying to reach as many technological interested students as possible. This was done by asking students of technical studies to participate in our research which ultimately lead to 21 participants that could be ascribed to technical studies. The other 39 participants however do not follow a technological study, which might lead to a participant sample that score below average on the trait Geekism, which could alter our findings concerning their tendencies to anthropomorphize robotic agents.

Another aspect that we have to point out as a possible limitation of our findings concerning the relationship of knowledge and anthropomorphic behavior is our way of measuring latter. We used primes that were shown for about 5 seconds, after which the participant had to make an assessment of the humanlike characteristics that he or she would ascribe to the robot. This time might be on one hand to long to form an automatic cognitive perception of the robot, but too short to get a clear view of all the characteristics that are needed to show Anthropomorphism.

Epley et al., 2008 furthermore used animals in their study to measure the extent of Anthropomorphism, by combining video material with questionnaires and added the factor that the animal could actually be introduced to the participant, which increased according to them the anthropomorphic tendencies of the sample. The aspect that the participant may actually be able to interact with the robot could maybe have an influence on anthropomorphic tendencies of our participant sample, which might indicate that our form of measuring Anthropomorphism is not suited to account for every aspect of the theory of Epley, et al., 2007

Another limitation that arises when we compare our findings to the findings of Epley, is that we did not integrate the need for control in our measuring of effectance motivation, which is according to Epley et al., 2008 a crucial factor in assessing anthropomorphic tendencies.

We also have to consider some limitations that we may have occurred during our personality measurements. First of all did we translate the different scales into German and

Dutch, so that every participant could answer the questionnaires in his or her mother language. This could however indicate that the meaning of some questions may have been altered during the process of translation, which could ultimately change the meaning of the questions. Secondly did this study only measure the two sub constructs of technological enthusiasm and need for cognition to access Geekism, but maybe there are still several other factors that are important in the assessment of Geekism and that were not considered in this study.

The second part of this study, namely the investigation of the influence of age of exposure and self reported experience on Geekism, could also be prone to some limitations. First the questions about age and self experience are objective self report questions where the participant has to give an estimated answer about himself. The limitation to these sort questions is that people are maybe not able to remember the first time they used a computer or television, because on one hand it is a pretty trivial action which usually leaves no imprint in a person's memory (Watts & Weems, 2006), and is forgotten pretty soon, and on the other hand may some people encounter technological devices on an early point in their life so that the memory simply doesn't exist anymore (Craik & Lockhart, 1972). The estimates could therefore be wrong or not accurate enough in order for us to make a general statement about their influences on technological enthusiasm and need for cognition. The number of items that were used to access self-reported experience with technology was rather low, with only 3 items, which could imply that people were not able to show the full extent of their experience. That could ultimately lead to a less precise categorization of people's experience. Furthermore is the EET a self-developed questionnaire, and its reliability has not been analyzed yet. Therefore it might be possible that the items show a low reliability which would indicate that our results are not suited to be compared to the Gex and the NCS.

This study also concerned itself with implicit measuring tools like the Stroop task, which are according to De Houwer, Teige-Mocigemba, Spruyt and Moors, 2009, a strong upcoming factor in psychological research. They also state that due to its unpredictability, implicit measures like the Stroop task cannot be used in every research conducted. This study indeed discovered that the Stroop task is not suited to identify anthropomorphic tendencies due to the fact that although we used a valid and reliable version of the Stroop task, we did not find any statically relevant results. Therefore we can conclude that future research has to adapt the Stroop task, and other implicit measuring tools in order to make them able to assess anthropomorphic tendencies in general. These findings agree with the idea of Fazio and

Olson, 2003 that although they are necessary to make general psychological assessment, implicit measures are still not developed enough to be applicable for every internal aspect of human beings.

Lastly we have to mention that the sample of participants with whom we conducted the Stroop task, was with only 20 participants not sufficient due to the fact that it was a too small sample. This lead to no results that could make a contribution to our study, which rendered the Stroop task unnecessary.

4.7 Implications for the future

Aim of this study was the analysis of the relationship between Geekism and Anthropomorphism and although we did not find any significant proof of the relationship, did this study provide us with the opportunity to verify some already existing hypothesis about Geekism as a construct and Anthropomorphism as combination of several psychological determinants.

There are however still several aspect that need to be analyzed in order to form a general model of Anthropomorphism that is applicable to every culture and every human. This research gave however indication that theories by Epley, et al., 2008, Cacioppo 1984, Schmettow, Noordzij and Mundt 2013 and Schmettow and Passlick, 2013, already cover some important aspects of Anthropomorphism as well as Geekism and can be used as ground stone for further research, even though they were to some extent not adaptable to our participant sample. This research might however lay the foundation for this research because we investigate how people with technological knowledge interact with robots which could ultimately be used to have reference point for the investigation of HRI by people that do not have technological knowledge (Lee, Peng, Jin & Yan, 2006). The fact that we did not find any statistically significant results must therefore not be seen as failure but rather as framework for future research that can build on our results.

Another aspect that might be crucial for future research to analyze is the aspect of sociality which arises in theories around Geekism as well as Anthropomorphism. Epley, et al., 2007 describe Anthropomorphism as arising out of two reasons, namely for work purpose and for social purposes. Therefore it might be important to analyze if the sociality of people with a high score on Geekism, as described by McArthur, 2008 also influence their anthropomorphic tendencies.

This study furthermore discovered several motivational factors that may influence people to have a higher or lower Geekism in later life. These factors could have an influence on future research on Geekism, because the Early Exposure to Technology scale can be used as a validation tool for questionnaires concerning Geekism and furthermore can the two factors self-reported experience and age of exposure to technological devices be crucial in a better understanding of Geekism as well as the sub culture of geeks.

5. Conclusion

In summary has this research successful verified the theory of Schmettow and Passlick, 2013 that Geekism consist of two factors namely, need for cognition and technological enthusiasm. The main hypothesis of this study, that there is a distinct relationship between Geekism and Anthropomorphism could not be proven due to a lack of statistically significant results that were acquired by a combination of explicit and implicit measures.

The readjustment of the theory of Epley, et al., 2007 onto our participant group of people with a high score on Geekism was not successful, although their theory is described as a general approach for "when people are likely to anthropomorphize and when they are not". If their theory is correct than our study would have shown that the anthropomorphic tendencies of our participant group, should be higher due to their score on Geekism, but this is not the case which indicates that the three determinant theory is not applicable to every participant group and needs to be revised in order to make an overall general assessment about the anthropomorphic tendencies of people.

This studies second aim was to identify how expert knowledge and motivation is acquired. The results show that first age of exposure to a technological device and second self reported experience may be seen as an important factor in forming a high Geekism in later life, which indicates that children who are regularly exposed to technology have a higher affinity with Geekism due to their early acquisition of technological experience.

These findings are an important contribution to future Geekism as well as Anthropomorphism research because they provide a general framework of the relationship between the two constructs and furthermore give a better insight into Geekism and its sub constructs and motivations.

References

Burger, J.M., (1995) Need for Control and Self-Esteem. Two Routes To A High Desire For Control. *Springer Science+Business Behavior 1995*, 2, 217-233. Doi: 10.1007/978-1-4899-1280-0_11

Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, *11*(6), 671–684. doi:10.1016/S0022-5371(72)80001-X

Cacioppo, J. T., Petty, R. E., & Kao, C. F. (1984). The efficient assessment of need for cognition. *Journal of Personality Assessment*, *48*(3), 306–7. doi:10.1207/s15327752jpa4803_13

Colley, A.M., Gale, M.T., & Harris, T.A. (1994). Effects of Gender Role Identity and Experience on Computer Attitude Components. *Journal of Educational Computing Research, 10*(2), 129-137. Doi:10.2190/8NA7-DAEY-GM8P-EUN5

Cross, T. L. (2005). Nerds and Geeks: Society's Evolving Stereotypes of Our Students With Gifts and Talents, *28*(4), 26–65.

Dancey, C. P., Reidy, J., (2007) Statistics without Maths for Psychology. *Pearson Education Limited, 4*(1), 168-212 ISBN: 978-0-132-05160-6

De Graaf, M. M. a., & Ben Allouch, S. (2013). The relation between people's attitude and anxiety towards robots in human-robot interaction. *2013 Ieee Ro-Man*, 632–637. doi:10.1109/ROMAN.2013.6628419

De Houwer, J., Teige-Mocigemba, S., Spruyt, A., & Moors, A. (2009). Implicit measures: A normative analysis and review. *Psychological Bulletin*, *135*(3), 347–68. doi:10.1037/a0014211

Ellis, L. U., Sims, V. K., Chin, M. G., Pepe, a. a., Owens, C. W., Dolezal, M. J., … Finkelstein, N. (2005). Those A-Maze-Ing Robots: Attributions of Ability are Based on Form, not Behavior. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *49*(3), 598–601. doi:10.1177/154193120504900382

Epley, N., Akalis, S., Waytz, A., & Cacioppo, J. T. (2008). Creating social connection through inferential reproduction: loneliness and perceived agency in gadgets, gods, and greyhounds. *Psychological Science*, *19*(2), 114–20. doi:10.1111/j.1467-9280.2008.02056.x

Epley, N., Waytz, A., Akalis, S., & Cacioppo, J. T. (2008). When We Need A Human: Motivational Determinants of Anthropomorphism. *Social Cognition*, *26*(2), 143–155. doi:10.1521/soco.2008.26.2.143

Epley, N., Waytz, A., & Cacioppo, J. T. (2007). On seeing human: a three-factor theory of Anthropomorphism. *Psychological Review*, *114*(4), 864–86. doi:10.1037/0033-295X.114.4.864

Fong, T., Nourbakhsh, I., & Dautenhahn, K. (2003). A survey of socially interactive robots. *Robotics and Autonomous Systems*, *42*(3-4), 143–166. doi:10.1016/S0921-8890(02)00372-X

Goetz, J., Kiesler, S., & Powers, a. (2003). Matching robot appearance and behavior to tasks to improve human-robot cooperation. *The 12th IEEE International Workshop on Robot and Human Interactive Communication, 2003. Proceedings. ROMAN 2003.*, 55–60. doi:10.1109/ROMAN.2003.1251796

Guangmin, W., Zeyan, L., (2008) Typical Features and Training Policy Recommendations on Innovational Science and Technology Geniuses. *Science & Technology Progress and Policy*, *7*(1)

Guerrero, C. R., Fraile Marinero, J. C., Turiel, J. P., & Muñoz, V. (2013). Using "human state aware" robots to enhance physical human-robot interaction in a cooperative scenario. *Computer Methods and Programs in Biomedicine*, *112*(2), 250–9. doi:10.1016/j.cmpb.2013.02.003

Ho, C.-C., & MacDorman, K. F. (2010). Revisiting the uncanny valley theory: Developing and validating an alternative to the Godspeed indices. *Computers in Human Behavior*, *26*(6), 1508–1518. doi:10.1016/j.chb.2010.05.015

Kruglanski, a W., & Webster, D. M. (1996). Motivated closing of the mind: "seizing" and "freezing". *Psychological Review*, *103*(2), 263–83. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/8637961

Kwak, S., Kim, Y., Kim, E., Shin, C., & Cho, K. (2013). What makes people empathize with an emotional robot?: The impact of agency and physical embodiment on human empathy for a robot. *RO-MAN, 2013 IEEE*, *745*. Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6628441

Lee, K. M., Peng, W., Jin, S.-A., & Yan, C. (2006). Can Robots Manifest Personality?: An Empirical Test of Personality Recognition, Social Responses, and Social Presence in Human?Robot Interaction. *Journal of Communication*, *56*(4), 754–772. doi:10.1111/j.1460-2466.2006.00318.x

MacDorman, K., Coram, J., Ho, C., & Patel, H. (2010). Gender differences in the impact of presentational factors in human character animation on decisions in ethical dilemmas. *… : Teleoperators and Virtual …*, *19*(3), 213–229. Retrieved from http://www.mitpressjournals.org/doi/abs/10.1162/pres.19.3.213

McArthur, J. a. (2008). Digital Subculture: A Geek Meaning of Style. *Journal of Communication Inquiry*, *33*(1), 58–70. doi:10.1177/0196859908325676

Neuberg, S. L., Judice, T. N., & West, S. G. (1997). What the Need for Closure Scale measures and what it does not: Toward differentiating among related epistemic motives. *Journal of Personality and Social Psychology*, *72*(6), 1396–1412. doi:10.1037//0022-3514.72.6.1396

O'Brien, B. (2007). *Gifted geeks: The emergence and development of computer technology talent*. University of Kansas. Retrieved from http://gradworks.umi.com/32/67/3267198.html

Roets, A., & Van Hiel, A. (2007). Separating ability from need: clarifying the dimensional structure of the Need for Closure Scale. *Personality & Social Psychology Bulletin*, *33*(2), 266–80. doi:10.1177/0146167206294744

Sander, N. (2013). The Construction and Evaluation of a Questionnaire Measuring Geekism. Retrieved from http://essay.utwente.nl/64149/

Schmettow, M., Noordzij, M., & Mundt, M. (2013). An implicit test of UX: individuals differ in what they associate with computers. *... on Human Factors in Computing ...*, 2039–2048. Retrieved from http://dl.acm.org/citation.cfm?id=2468722

Sekmen, A., & Challa, P. (2013). Assessment of adaptive human–robot interactions. *Knowledge-Based Systems*, *42*, 49–59. doi:10.1016/j.knosys.2013.01.003

Sims, V. K., Chin, M. G., Sushil, D. J., Barber, D. J., Ballion, T., Clark, B. R., … Finkelstein, N. (2005). Anthropomorphism of Robotic Forms: A Response to Affordances? *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *49*(3), 602–605. doi:10.1177/154193120504900383

Sreenivasa, M. (2012). Walking to grasp: Modeling of human movements as invariants and an application to humanoid robotics. *... A: Systems and Humans, ...*, *42*(4), 880–893. Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6133339

Watts, S. E., & Weems, C. F. (2006). Associations among selective attention, memory bias, cognitive errors and symptoms of anxiety in youth. *Journal of Abnormal Child Psychology*, *34*(6), 841–52. doi:10.1007/s10802-006-9066-3

Waytz, A., Morewedge, C. K., Epley, N., Monteleone, G., Gao, J.-H., & Cacioppo, J. T. (2010). Making sense by making sentient: effectance motivation increases Anthropomorphism. *Journal of Personality and Social Psychology*, *99*(3), 410–35. doi:10.1037/a0020240

Webster, D. M., & Kruglanski, A. W. (1994). Individual differences in need for cognitive closure. *Journal of Personality and Social Psychology*, *67*(6), 1049–1062. doi:10.1037/0022-3514.67.6.1049

Wright, J., Sanders, T., & Hancock, P. a. (2013). Identifying the Role of Attributions in Human Perceptions of Robots. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *57*(1), 1288–1292. doi:10.1177/1541931213571285

Wilson, S. B., Turner, C. a, Emerson, R. G., & Scheuer, M. L. (1999). Spike detection II: automatic, perception-based detection and clustering. *Clinical Neurophysiology : Official Journal of the International Federation of Clinical Neurophysiology*, *110*(3), 404–11. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10363762

Appendix:

Questionnaire Gex, NCS, NCCR, Age of exposure, Self-reported Experience:

We will start with a few general questions. Please try to answer the answers as precisely as possible. There are no right or wrong answers.

Nationality:

Gender: female O

male O

Age:

Study:

In the following you will find a number of statements. We would like to know to what extend you agree with these statements. Therefore we are asking you to mark but one of the seven circles that come per statement. The left circle stands for 'completely disagree' and the right circle stands for 'completely agree'. Of course you may also make use of the digits in between. There is no right or wrong answer, as long as it represents your own opinion.

If you do not understand the question, if you don't want to answer it or if you cannot answer is please feel free to leave the question out, by not filling in one of the circles

I usually end up deliberating about issues even when they do not affect me personally.	completely disagree	O---O---O---O---O---O---O	completely agree
I don't like to be with people who are capable of unexpected actions.	completely disagree	O---O---O---O---O---O---O	completely agree
I find satisfaction in deliberating hard and for long hours.	completely disagree	O---O---O---O---O---O---O	completely agree
I think it is fun to change my plans at the last minute.	completely disagree	O---O---O---O---O---O---O	completely agree
Thinking is not my idea of fun.	completely	O---O---O---O---O---O---O	completely

	disagree		agree
Controlling devices exactly the way I want appeals to me.	completely disagree	O---O---O---O---O---O---O	completely agree
I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.	completely disagree	O---O---O---O---O---O---O	completely agree
The notion of thinking abstractly is appealing to me.	completely disagree	O---O---O---O---O---O---O	completely agree
I try to approach things in a scientific manner.	completely disagree	O---O---O---O---O---O---O	completely agree
In my spare time I don't invest more time to computers or technical devices than other people do.	completely disagree	O---O---O---O---O---O---O	completely agree
I like acquiring more knowledge of technical devices (hardware/software).	completely disagree	O---O---O---O---O---O---O	completely agree
I prefer to think about small daily projects to long term ones.	completely disagree	O---O---O---O---O---O---O	completely agree
I prefer complex to simple problems.	completely disagree	O---O---O---O---O---O---O	completely agree
I think that having clear rules and order at work is essential for success.	completely disagree	O---O---O---O---O---O---O	completely agree
I don't like to go into a situation without knowing what I can expect from it.	completely disagree	O---O---O---O---O---O---O	completely agree
I hate to change my plans at the last minute.	completely disagree	O---O---O---O---O---O---O	completely agree
I always see so many possible solutions to problems I face.	completely disagree	O---O---O---O---O---O---O	completely agree
I prefer my life to be filled with puzzles I must solve.	completely disagree	O---O---O---O---O---O---O	completely agree
I avoid the advanced settings of my technical devices.	completely disagree	O---O---O---O---O---O---O	completely agree
Privacy settings on computers and the internet are important to me.	completely disagree	O---O---O---O---O---O---O	completely agree
I feel relief rather than satisfaction after completing a task that requires a lot of mental effort.	completely disagree	O---O---O---O---O---O---O	completely agree

I like to have friends who are unpredictable.	completely disagree	O---O---O---O---O---O---O	completely agree
I prefer to socialize with familiar friends because I know what to expect from them.	completely disagree	O---O---O---O---O---O---O	completely agree
I like to know what people are thinking all the time.	completely disagree	O---O---O---O---O---O---O	completely agree
I like tasks that require little thought once I've learned them.	completely disagree	O---O---O---O---O---O---O	completely agree
I would rather do something that requires little thought than something that is sure to challenge my thinking abilities.	completely disagree	O---O---O---O---O---O---O	completely agree
When I have made a decision, I feel relieved.	completely disagree	O---O---O---O---O---O---O	completely agree
It appeals to me that computer users help each other, for example on web forums.	completely disagree	O---O---O---O---O---O---O	completely agree
I prefer interacting with people whose opinions are very different from my own.	completely disagree	O---O---O---O---O---O---O	completely agree
I dislike it when a person's statement could mean many different things.	completely disagree	O---O---O---O---O---O---O	completely agree
Usually I need help when having trouble with a technical device.	completely disagree	O---O---O---O---O---O---O	completely agree
I almost always feel hurried to reach a decision, even when there is no reason to do so.	completely disagree	O---O---O---O---O---O---O	completely agree
I have or I would make a project or work of mine publicly available on the internet.	completely disagree	O---O---O---O---O---O---O	completely agree
I like sharing ideas and projects with others.	completely disagree	O---O---O---O---O---O---O	completely agree
I am interested in technical products that are versatile.	completely disagree	O---O---O---O---O---O---O	completely agree
Sometimes I use technical devices different to what they were intended for.	completely disagree	O---O---O---O---O---O---O	completely agree
I try to anticipate and avoid situations where there is a likely chance I will have to think in depth about something.	completely disagree	O---O---O---O---O---O---O	completely agree
I find that a well-ordered life with regular hours suits my temperament.	completely disagree	O---O---O---O---O---O---O	completely agree

Objectivity is important to me.	completely disagree	O---O---O---O---O---O---O	completely agree
Even if I get a lot of time to make a decision, I still feel compelled to decide quickly.	completely disagree	O---O---O---O---O---O---O	completely agree
I believe that orderliness and organization are among the most important characteristics of a good student.	completely disagree	O---O---O---O---O---O---O	completely agree
When considering most conflict situations, I can usually see how both sides could be right.	completely disagree	O---O---O---O---O---O---O	completely agree
I invest a lot of time and effort to explore computing devices.	completely disagree	O---O---O---O---O---O---O	completely agree
Learning new ways to think doesn't excite me very much.	completely disagree	O---O---O---O---O---O---O	completely agree
It's annoying to listen to someone who cannot seem to make up his or her mind.	completely disagree	O---O---O---O---O---O---O	completely agree
I only think as hard as I have to.	completely disagree	O---O---O---O---O---O---O	completely agree
I find that establishing a consistent routine enables me to enjoy life more.	completely disagree	O---O---O---O---O---O---O	completely agree
I dislike unpredictable situations.	completely disagree	O---O---O---O---O---O---O	completely agree
I enjoy the uncertainty of going into a new situation without knowing what might happen.	completely disagree	O---O---O---O---O---O---O	completely agree
I think that I would learn best in a class that lacks clearly stated objectives and requirements.	completely disagree	O---O---O---O---O---O---O	completely agree
I feel uncomfortable when I don't understand why an event occurred in my life.	completely disagree	O---O---O---O---O---O---O	completely agree
I feel irritated when one person disagrees with what everyone else in a group believes.	completely disagree	O---O---O---O---O---O---O	completely agree
I dislike the routine aspects of my work (studies).	completely disagree	O---O---O---O---O---O---O	completely agree
I have sometimes modified a technical device or diverted it from its intended purpose.	completely disagree	O---O---O---O---O---O---O	completely agree
The idea of relying on thought to make my way to the top appeals to me.	completely disagree	O---O---O---O---O---O---O	completely agree

When buying a new computing device performance matters more to me than outside appearance.	completely disagree	O---O---O---O---O---O---O	completely agree
It's enough for me that something gets the job done; I don't care how or why it works.	completely disagree	O---O---O---O---O---O---O	completely agree
I am motivated to optimize technical devices or configure them to my requirements.	completely disagree	O---O---O---O---O---O---O	completely agree
Some people would call me a computer freak.	completely disagree	O---O---O---O---O---O---O	completely agree
I like to have the responsibility of handling a situation that requires a lot of thinking.	completely disagree	O---O---O---O---O---O---O	completely agree
I enjoy having a clear and structured mode of life.	completely disagree	O---O---O---O---O---O---O	completely agree
I'd rather know bad news than stay in a state of uncertainty.	completely disagree	O---O---O---O---O---O---O	completely agree
I would rather make a decision quickly than sleep over it.	completely disagree	O---O---O---O---O---O---O	completely agree
I dislike questions which could be answered in many different ways.	completely disagree	O---O---O---O---O---O---O	completely agree
I don't feel I have much control over my technical devices	completely disagree	O---O---O---O---O---O---O	completely agree
I like technical devices that have many features.	completely disagree	O---O---O---O---O---O---O	completely agree
I would quickly become impatient and irritated if I would not find a solution to a problem immediately.	completely disagree	O---O---O---O---O---O---O	completely agree
When dining out, I like to go to places where I have been before so that I know what to expect.	completely disagree	O---O---O---O---O---O---O	completely agree
In most social conflicts, I can easily see which side is right and which is wrong.	completely disagree	O---O---O---O---O---O---O	completely agree
I really enjoy a task that involves coming up with new solutions to problems.	completely disagree	O---O---O---O---O---O---O	completely agree
I take care about privacy regarding my personal data.	completely disagree	O---O---O---O---O---O---O	completely agree
When thinking about a problem, I consider as many different opinions on the issue as possible.	completely disagree	O---O---O---O---O---O---O	completely agree

Complex procedures with technical devices put me off.	completely disagree	O---O---O---O---O---O---O	completely agree
I would choose a technical product that looks nice.	completely disagree	O---O---O---O---O---O---O	completely agree
My personal space is usually messy and disorganized.	completely disagree	O---O---O---O---O---O---O	completely agree
I do not usually consult many different opinions before forming my own view.	completely disagree	O---O---O---O---O---O---O	completely agree
It is important that everybody cares for what they upload to the internet.	completely disagree	O---O---O---O---O---O---O	completely agree
It puts me off when technical devices have too many settings options.	completely disagree	O---O---O---O---O---O---O	completely agree
I want to understand how computer parts and software work.	completely disagree	O---O---O---O---O---O---O	completely agree
I like to have a place for everything and everything in its place.	completely disagree	O---O---O---O---O---O---O	completely agree
I don't like situations that are uncertain.	completely disagree	O---O---O---O---O---O---O	completely agree
Even after I've made up my mind about something, I am always eager to consider a different opinion.	completely disagree	O---O---O---O---O---O---O	completely agree
I not am interested in the inner working or coding of software.	completely disagree	O---O---O---O---O---O---O	completely agree
When someone needs help with a computer I try to help as good as possible.	completely disagree	O---O---O---O---O---O---O	completely agree
Challenging tasks with technical devices appeal to me.	completely disagree	O---O---O---O---O---O---O	completely agree
When I am confronted with a problem, I'm dying to reach a solution very quickly.	completely disagree	O---O---O---O---O---O---O	completely agree
It is important to me that people have free access to my projects and works.	completely disagree	O---O---O---O---O---O---O	completely agree
I feel uncomfortable when someone's meaning or intention is unclear to me.	completely disagree	O---O---O---O---O---O---O	completely agree
When I am confused about an important issue, I feel very upset.	completely disagree	O---O---O---O---O---O---O	completely agree

I have good knowledge of computing devices (hardware/software).	completely disagree	O---O---O---O---O---O---O	completely agree
I have more than once opened technical devices to see their insides.	completely disagree	O---O---O---O---O---O---O	completely agree
Would you state that you have experience with technology?	Yes		No
Did you ever fix an electronic devise (Computer, Mp3 player, television)?	Yes		No
Did you ever try to understand how an electronic devise works?	Yes		No
At what age did you first get access to a television?	Age		
At what age did you first get access to a mobile phone?	Age		
At what age did you first get access to a computer?	Age		
At what age did you first get access to a mp 3 player/ipod?	Age		

Perceived Humanness Scale:

Student ID: _____

In the following you find a number of word pairs. We would like to know what impression you have received from the robot/robots. Therefore we are asking you to mark but **one** of the seven digits that stand between the words. The procedure can be explained best through the following example:

What impression gave you the robot?

The Robot is/was: Fast 1 2 3 4 5 6 7 Slow

When you think that the robot is/was for example fast, than you mark digit 1. When you think that the robot is/was slow you mark digit 7. Of course, you may also make use of the digits in between. There is no right or wrong answer, as long as your answers represent the impressions you have received from the robot/robots.

The digits in this example mean the following:

1: fast

2: rather fast

3: a bit fast

4: a bit of both

5: a bit slow

6: rather slow

7: slow

Robot 1

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Robot 2

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Robot 3

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Robot 4

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Robot 5

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Robot 6

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Robot 7

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Robot 8

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Robot 9

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Robot 10

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Robot 11

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Robot 12

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Robot 13

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Robot 14

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Robot 15

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Robot 16

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Robot 17

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Robot 18

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Robot 19

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Robot 20

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

Syntax Correlation NCS, Gex, NCCR:

```
GET
  FILE='C:\Users\Marc\Desktop\D4.sav'.
DATASET NAME DataSet1 WINDOW=FRONT.
CORRELATIONS
  /VARIABLES=Gex NCS NCCR
  /PRINT=TWOTAIL NOSIG
  /MISSING=PAIRWISE.
```

Syntax Analysis Main Hypothesis:

```
GET
  STATA FILE='C:\Users\Marc\Desktop\D2.dta'.
DATASET NAME DataSet1 WINDOW=FRONT.
GET
  STATA FILE='C:\Users\Marc\Desktop\D3.dta'.
DATASET NAME DataSet2 WINDOW=FRONT.
```

```
MIXED response WITH Gex NCS NCCR
  /CRITERIA=CIN(95) MXITER(100) MXSTEP(10) SCORING(1)
SINGULAR(0.000000000001) HCONVERGE(0, ABSOLUTE) LCONVERGE(0,
ABSOLUTE) PCONVERGE(0.000001, ABSOLUTE)
  /FIXED=Gex NCS NCCR Gex*NCS Gex*NCCR NCS*NCCR Gex*NCS*NCCR |
SSTYPE(3)
  /METHOD=REML
  /PRINT=SOLUTION
  /RANDOM=INTERCEPT | SUBJECT(participant) COVTYPE(VC)
  /RANDOM=INTERCEPT | SUBJECT(prime) COVTYPE(VC)
  /RANDOM=INTERCEPT | SUBJECT(item) COVTYPE(VC).
```

Syntax Analysis Stroop Task

```
MIXED RT BY wordCat WITH score Gex NCS
  /CRITERIA=CIN(95) MXITER(100) MXSTEP(10) SCORING(1)
SINGULAR(0.000000000001) HCONVERGE(0, ABSOLUTE) LCONVERGE(0,
ABSOLUTE) PCONVERGE(0.000001, ABSOLUTE)
  /FIXED=wordCat score wordCat*score wordCat*Gex wordCat*NCS wordCat*Gex*NCS |
SSTYPE(3)
  /METHOD=REML
  /PRINT=SOLUTION
  /RANDOM=INTERCEPT | SUBJECT(participant) COVTYPE(VC)
  /RANDOM=INTERCEPT | SUBJECT(targetWord) COVTYPE(VC)
  /RANDOM=INTERCEPT | SUBJECT(prime) COVTYPE(VC).
```

Syntax Analysis Age exposure + self reported experience:

1.
```
COMPUTE AgeTotal=AgeTelevision + AgeMobilephone + AgeComputer +
AgeMP3.
EXECUTE.
```

2.
```
CORRELATIONS
 /VARIABLES=Gex NCS ExpScore AgeTotal
  /PRINT=TWOTAIL NOSIG
  /MISSING=PAIRWISE.
```

3.
```
UNIANOVA Gex WITH ExpScore AgeTotal
  /METHOD=SSTYPE(3)
  /INTERCEPT=INCLUDE
  /PRINT=DESCRIPTIVE
  /CRITERIA=ALPHA(.05)
  /DESIGN=AgeTotal*ExpScore ExpScore AgeTotal.
```

Demographics tables

Table: Participants Age Distribution

Participants Age	Frequency
19	3
20	9
21	5
22	17
23	16
24	5
25	1
26	1
29	2

Table: Participants Study Distribution

Participants Study	Frequency
Applied Mathematic	1
Biomedical Technology	3
Civiele Technick	3
Computer Science	1
Creative Technology	1
Communication Science	3
Electrical Engineering	1
International Business Administration	2
Informatics	1
Industrial Design	1
Mechanical Engineering	1
Psychology	33
Technical Informatics	2
Technical Nature Science	1
Technical Medical Science	1
Technical Mathematics	1
Werktuigbouwkunde	3
Economical Informatics	1