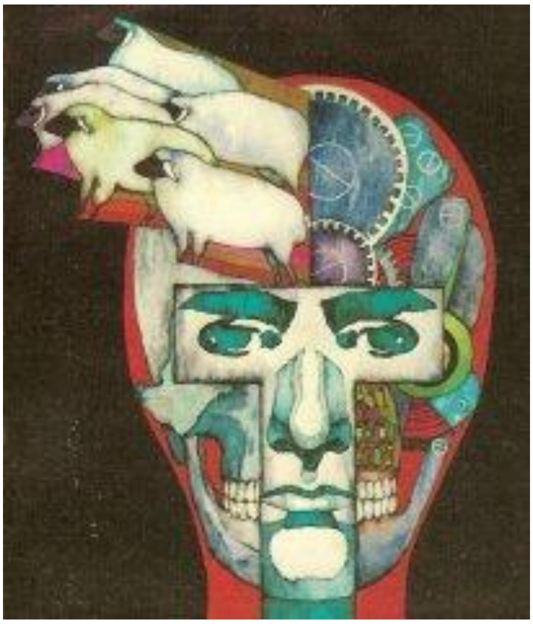
Do Geeks Dream of Electric Sheep?

An investigation of ‘Geeks’ and their Tendency to Anthropomorphism



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Contents

Abstract

The aim of this study was to fill the knowledge gap which was found concerning the individual differences between people in their tendency to anthropomorphize, with information about individuals tending to 'geekism'. Based on the literature about 'geekism' and anthropomorphism the main-hypothesis stated that individuals, who tend to 'geekism' would tend to anthropomorphize robots less. In order to test the main-hypothesis, two explanatory paths were selected with one focusing on the 'geeks' and characteristics that were found or assumed to be descriptive of these individuals and the other focusing on reasons why these individuals should anthropomorphize less, based on the theory of Epley et al. (2007). Through gathering the scores of 60 participants on different questionnaires, the 'Humanness index' of the 'Perceived Humanness Scale' and analyzing the scores by means of linear mixed effects model analyses and correlational analyses, the hypotheses were tested. Based on the results we are not able to conclude that 'geeks' do tend to anthropomorphize robots less. With regard to the literature and the theories about anthropomorphism, only tentative conclusions can be made about the trueness based on the results of this study and future research is needed firstly to eliminate the limitations and secondly to draw conclusions about the literature with certainty and thirdly to be able to fill the knowledge gap concerning individual differences with information about the so-called 'geeks'.

Samenvatting

Het doel van dit onderzoek was het verklaren van de verschillen tussen mensen in hun neiging niet-menselijke entiteiten te antropomorfiseren aan de hand van informatie over een persoonsgebonden neiging naar ‘geekism’, om een kenniskloof over deze individuele verschillen te overbruggen. Gebaseerd op de literatuur over ‘geekism’ en antropomorfisme werd de hoofdhypothese opgesteld dat individuen die een neiging hebben naar ‘geekism’ een lagere neiging hebben om robots te antropomorfiseren. Om de hoofdhypothese te testen zijn twee verklarende paden gekozen, waarbij de ene focust op de ‘geeks’ en eigenschappen die gevonden zijn of worden gezien als beschrijvend als het om deze individuen gaat en de andere focust op redens waarom deze individuen minder zouden moeten antropomorfiseren, gebaseerd op de theorie van Epley et al. (2007). Door het verzamelen van de scores van 60 deelnemers van verschillende enquêtes, de ‘Humanness index’ van de ‘Perceived Humanness Scale’, en het analyseren van deze scores door middel van linear mixed effects model analyses en correlational analyses, werden de hypothesen getest. Gebaseerd op de resultaten zijn we niet in staat te concluderen dat ‘geeks’ inderdaad ertoe neigen om robots minder te antropomorfiseren. Gebaseerd op de resultaten van dit onderzoek, kunnen met betrekking tot de literatuur en de theorieën over antropomorfisme slechts voorzichtige conclusies worden getrokken wat de juistheid van deze theorieën betreft. Vervolgonderzoek is vereist; ten eerste om de beperkingen van dit onderzoek te elimineren, ten tweede om met zekerheid conclusies te kunnen trekken over de literatuur en ten derde om in staat te zijn de kenniskloof te overbruggen betreffende individuele verschillen met informatie over de zogenoemde ‘geeks’.

1. Introduction

In the course of the last decades "robots have become an important part of human life by performing hazardous or mundane tasks previously done by humans, enhancing efficiency and accuracy in industry, and exploring terrestrial and extraterrestrial environments" (Lee, Kaloutsakis & Couch, 2009, p.60). More recently, robots are increasingly becoming a part of the everyday life of the general public, for example in the form of robot vacuum cleaners (Young, Hawkins, Sharlin, & Igarashi, 2008). Another form of robots which is expected to become increasingly present, are social robots (de Graaf & Ben Allouch, 2013). According to Breazeal (2003) these social robots are designed to facilitate the communication with humans and consequently increase the acceptance of the robots by the users. Robots diverge from simpler as well as from more complex machines, as e.g. computers, in the way that robots are frequently designed to be more autonomous and more mobile while at the same time they force a form of social interaction which is not compatible to or does not happen in other relationships between humans and machines (Rogers, 2004). In general, because of the distinctive physical appearance of robots and due to the fact that the interaction with robots has more resemblance to the interaction with living creatures, people are expected to react differently to robots than to other advanced technologies, as for example personal computers (Young et al., 2008). According to de Graaf and Ben Allouch (2013) it is necessary to understand the reasons potential users consider to decide about accepting the robots, in order to introduce robots successfully.

According to Fink (2012), one possibility to increase people's acceptance of robots is to try to enhance the familiarity of a robot through usage of humanlike, anthropomorphic design and manlike social characteristics. This approach implies that for example facial expressions, humanlike communication and interaction are employed (Fink, 2012). However, Duffy (2002) argues that the task of anthropomorphism in designing robots is not to build a robot that is highly humanlike or even an artificial human, but to use the advantageous mechanism of anthropomorphism in order to facilitate social interaction. According to Caporael (1986) anthropomorphism is a widespread phenomenon in the modern life and even though we are rationally aware that for example cars, ships, or in this case computers or robots do not have human attributes, anthropomorphism still occurs despite this objective knowledge. The essence of this anthropomorphic mechanism is explained by Epley, Waytz and Cacioppo (2007) as the attribution of "humanlike properties, characteristics, or mental states to real or imagined nonhuman agents and objects" (p.865). Epley et al. (2007) note that "treating agents as human versus nonhuman has a powerful impact on whether those agents are treated as moral agents worthy of respect and concern or treated merely as objects, on how people expect those agents to behave in the future, and on people's interpretations of these agents' behavior in the present" (p.864). Epley et al. (2007) also note that the facilitation of anthropomorphism can present a method which is effective in the improvement of the usefulness of technological agents the creation of a social bond that can enhance a feeling of social connection.

One group that is of special interest with regard to their reaction and interaction with robots, are people tending to 'geekism' or having the 'geek predisposition'. According to Schmettow and Passlick (2013) the word 'geek' is also used as synonym for 'nerd' and "(…) is meant to characterize a person with intellectual expertise that excels in the use of and interaction with technology" (p.5). O'Brien (2007) found that these 'geekish' individuals, who are often in technical careers, are more than anything motivated through an internal desire to examine computers and technology, to learn as much as possible about it and to create new ideas that go beyond the scope of an average person. Further, Schmettow and Passlick (2013) mention, that the development and improvement of technology is very important for (self-proclaimed) geeks. Put together these individuals are probably the most in contact with technology due to their high interest in technology and their career choices and therefore have a higher chance to come into contact with robots than other people. In conjunction with their curiosity and their wish to understand and especially to improve technology, these individuals could be of great interest and importance in order to understand Human-Robot Interaction.

Within their theory of anthropomorphism, Epley et al. (2007) assumed that people differ in their tendencies to anthropomorphize non-human agents. These individual differences include, for example, that children have a greater tendency to anthropomorphism than adults and that people from various cultures differ in their tendencies to anthropomorphize, too (Epley et al., (2007). However, up to this point in time there is no research examining whether individuals, who tend to 'geekism', do also have a tendency to anthropomorphize non-human agents, such as robots. Therefore, the aim of this study is to try and fill this knowledge. To provide the basis for achieving this goal, it will be first described what the term 'geek' or having the 'geek predisposition' involves in the following section. This will be followed by a definition of 'anthropomorphism' and factors influencing a person's tendency to anthropomorphize. Subsequently, it will be discussed how these two aspects can be combined.

1.1 Geekism

Originally, the term ‘geek’, like the term ‘nerd’, was used as an insult to “degrade and belittle intelligent outcasts” (McArthur, 2008, p.61) because of their expertise and missing social skills. However, according to McArthur (2008) the meaning of the term geek has changed into one that expresses affection and these days a geek is “one who becomes an expert on a topic by will and determination” (p.62). ‘Geeks’ can be found in specific groups and places which can be classified as typically ‘geekish’ such as e.g. a comic convention or chat rooms about computer topics and the like, but they can also be found where expertise is required (McArthur, 2008). Different types of ‘geeks’ be found and the question is, by which aspects all of these ‘geeks’ can be characterized or to what kind of behavior these individuals tend.

In the interview study of Schmettow and Passlick (2013) ‘self-proclaimed geeks’ were interviewed in order to identify factors influencing the interaction between geeks and technology. It was found that nearly all of the self-proclaimed geeks stated that one of the key aspects of being a geek was “being an expert in [a] subject area” (p.14), which is in line with the newer meaning of the term ‘geek’ of McArthur (2008). In the interview study of O’Brien (2007) the term ‘Computer Technology Talent’ was used, referring to “high knowledge of and ability with computer technology, above and beyond same age peer groups.” (p.16). According to O’Brien (2007), who had a quite selective sample of participants, these ‘computer technology talented’ individuals build on positive feelings with regard to technology, they pursue to explore computer systems and create new ideas that often go beyond the scope of average people. According to Schmettow and Passlick (2013) many of their interviewees reported that they had at least familiarity with or even knowledge about software programming, that they enjoyed gaining new knowledge and felt pleasure through obtaining a deeper understanding of processes. Correspondingly, one aspect that could be descriptive of these individuals is their tendency to have expert knowledge in their subject areas.

It is further assumed, based on the questionnaire-study of Schmettow and Drees (2014) that ‘geekism’ or the ‘geek predisposition’ is composed of two components. Based on their results, Schmettow and Drees (2014) take the stock that ‘geekism’ is reflected and should be assessed through two aspects: the so-called ‘computer enthusiasm’ and the ‘need for cognition’. With regard to the former, Schmettow and Drees (2014) “take the perspective that computer enthusiasm is a continuous trait (i.e. everybody has it to some extent)” (p.1). According to Schmettow, Noordzij and Mundt (2013) this component entails that computer-enthusiastic individuals tend to see a computer itself as an interesting object. In accordance with this, Schmettow and Passlick (2013) found that their interviewees had a strong technology-enthusiasm, which entailed that these individuals were intensely enthusiastic about the progress in technology, the optimization and automatization of processes and about the development that could occur in the future.

With regard to the second component, the 'need for cognition', Schmettow et al. (2013) assumed in their study, that individuals, who could be characterized as 'geeks', would have a strong wish to understand a system and its inner workings and would customize technological devices more often than using them. Thus, according to Schmettow et al. (2013) "the degree to which an individual enjoys intellectually demanding tasks, may be a good predictor" (p. 2043) for the geek predisposition. Therefore the 'need for cognition' construct, which is defined as the "tendency to engage in and enjoy thinking" (Cacioppo & Petty, 1982, p.116), was used by Schmettow et al. (2013) in order to approach differences between individuals which are related to the concept of 'geekism'. 'Need for cognition' is a motivational construct, reflecting differences of individuals in their "intrinsic motivation to engage in effortful cognitive processes" (Cacioppo, Petty, Feinstein, & Jarvis, 1996, p.215). According to Cacioppo et al. (1996), those individuals high in 'need for cognition' tend to be less stressed and less anxious through cognitive challenges and effortful thinking than others. In agreement with this, Schmettow et al. (2013) assumed that 'geeks' would appreciate the intellectual effort that is involved in the mastering of a technical system. The results of the study of Schmettow et al. (2013) suggested that those individuals "with a geek predisposition tend to think of computers as objects of intellectual challenge and play" (p. 2039). In addition, Schmettow and Passlick (2013) learned from their participants that many of them enjoy engaging themselves in challenging work and to be challenged. Moreover, O'Brien (2007) found that 'geekish' were "fearless with computers" (p.189) and were capable of working through mistakes and problems without giving up.

Furthermore, hints pointing to another aspect that could be descriptive of these 'geeks' were found: Schmettow and Passlick (2013) report that many of the self-proclaimed geeks in their interview-study "referred to feelings of a need for control in given situations (…) [and] a feeling of being in control while dealing with games, devices, applications or other software programs." (p.20). In addition, the experiences of being in control of products and situations and the experience of being skilled led some of their interviewees to engage themselves in challenging tasks or behavior, which would eventually lead to successful behavior (Schmettow & Passlick, 2013). However, it is important to mention that Schmettow and Passlick (2013) did not have clear evidence for the 'need for control' construct, as it is for example described by Epley et al. (2007) in their theory about anthropomorphism. Hence, Schmettow and Passlick (2013) deemed it necessary for future research to examine whether individuals with the geek predisposition do indeed have a ‘need for control’.

Furthermore, in the study of O’Brien (2007) it was found that many of the interviewees appreciated the clarity with regard to programming and the interaction with other people. According to some participants it was important to get a good understanding of what they were doing, in order to try to figure something out (O’Brien, 2007). Also, it was important for them to understand the rules first, before playing with them and thereby possibly breaking them. Further, the participants appreciated that the computer behaved in the way they expected it to do (O’Brien, 2007). In the study of Schmettow and Passlick (2013) some interviewees said that it is important to understand a computer in order to be able to use it efficiently. Furthermore, O’Brien (2007) found that her respondents did persevere and did not give up easily when they were facing problems. All of these findings could be hints in the direction of the ‘need for closure’ construct, which is defined as a desire “for *an* answer on a given topic, *any* answer, … compared to confusion and ambiguity” (Kruglanski, 1990b, p.337, quoted in Webster & Kruglanski, 1994, p. 1049 and as also quoted in Roets & Hiel, 2010, p.90).). It is possible that those individuals, who are associated with geekism, can be described as having a low ‘need for closure’.

1.2 Anthropomorphism

According to Epley, Waytz, Akalis, & Cacioppo (2008) “(…) anthropomorphic representations are important determinants of how a person behaves towards these [nonhuman] agents[…], or how a person may behave in light of these agents (…)” (p.144). As mentioned earlier, the essence of anthropomorphism is that people attribute various aspects of humans, such as properties, characteristics or even mental states, to a real or only imagined nonhuman agent or object (Epley et al., 2007). The word ‘anthropomorphism’ is “derived from the Greek words anthrōpos (meaning “human”) and morphē (meaning “shape” or “form”)” (Epley et al.,2007, p.865). According to Epley et al., (2007) it “involves going beyond behavioral descriptions of imagined or observable actions (e.g., the dog is affectionate) to represent an agent’s mental or physical characteristics using humanlike descriptors (e.g., the dog loves me)” (p.865). According to de Graaf and Ben Allouch (2013), anthropomorphism is a variable specifically influencing the experiences users have with social robots. However, Young et al. (2009) state that various kinds of robots are anthropomorphized, even those kinds of robots like robot vacuum cleaners, which have more mechanical appearances and are less social than for example social robots.

Epley et al. (2007) state that anthropomorphism is determined through multiple psychological determinants, with one of them being the cognitive determinant ‘elicited agent knowledge’ and the other two being motivational determinants, namely ‘effectance motivation’ and ‘sociality motivation’. The cognitive key determinant of anthropomorphism, the ‘elicited agent knowledge’, entails the knowledge one has about humans in general, or more specifically, the knowledge about the self, which is likely to be the basis for inductive processes (Epley et al., 2007). In comparison to knowledge about non-human agents, the knowledge about humans and the self is more detailed, earlier acquired and directly experienced and therefore more easily accessible (Epley et al., 2007). However, when knowledge about non-human agents is available, the likeliness of using the knowledge about humans and the self as the basis for inductive processes should be reduced, because this non-anthropomorphic knowledge can be used instead (Epley et al., 2007).

The ‘elicited agent knowledge’-determinant is composed of one dispositional aspect, the ‘need for cognition’ mentioned earlier. According to Cacioppo et al. (1996) this construct is a motivational one, reflecting the differences in the intrinsic motivation of individuals to involve themselves in demanding cognitive processes. In addition, it causes individuals with a high need for cognition to be less anxious and stressed by demanding thinking and cognitive challenges in comparison to those low in ‘need for cognition’ (Cacioppo et al., 1996). Epley et al. (2007) suggest that the need for cognition, leads people to rely less on information that is more easily accessible like anthropomorphic knowledge, and instead leads to an increased usage of alternative knowledge that may be better suited for reasoning about a given non-human agent. Therefore, those individuals who have a high need for cognition should be less tempted to anthropomorphize non-human agents, especially when they do have access to and can use alternative knowledge (Epley et al., 2007).

The second key determinant of anthropomorphism is the ‘effectance motivation’, which “entails the desire to reduce uncertainty and ambiguity, at least in part with the goal of attaining a sense of predictability and control in one’s environment” (Epley et al., 2007, p. 872). This key determinant is composed of two dispositional aspects, which are the ‘need for closure’ and the ‘desire for control’ (Epley et al., 2007). The ‘desire for control’ is defined as the “extent to which people generally are motivated to see themselves in control of the events in their lives” (Burger, 1992, p.6, quoted in Epley et al., 2007, p.873). According to Epley et al. (2007) there are individual differences in the ‘desire for control’ and this desire inspires to anthropomorphize in order to establish an organized present and in order to build predictability for future interactions with nonhuman agents. “Those with a strong desire for control exhibit more vigorous attributional activities to explain others’ behavior, usually focusing on typically anthropomorphic concepts such as intentions and desires” (Burger & Hermans, 1988; Liu & Steele, 1986; Pittman & Pittman, 1980, as mentioned in Epley et al., 2007, p.873). Epley et al. (2007) assume that the desire for control should lead to a facilitation of the activation and application of anthropomorphic representations in order to obtain an explanation for the behavior of an agent and it should lead to an increased feeling of being able to predict the future behavior of that agent.

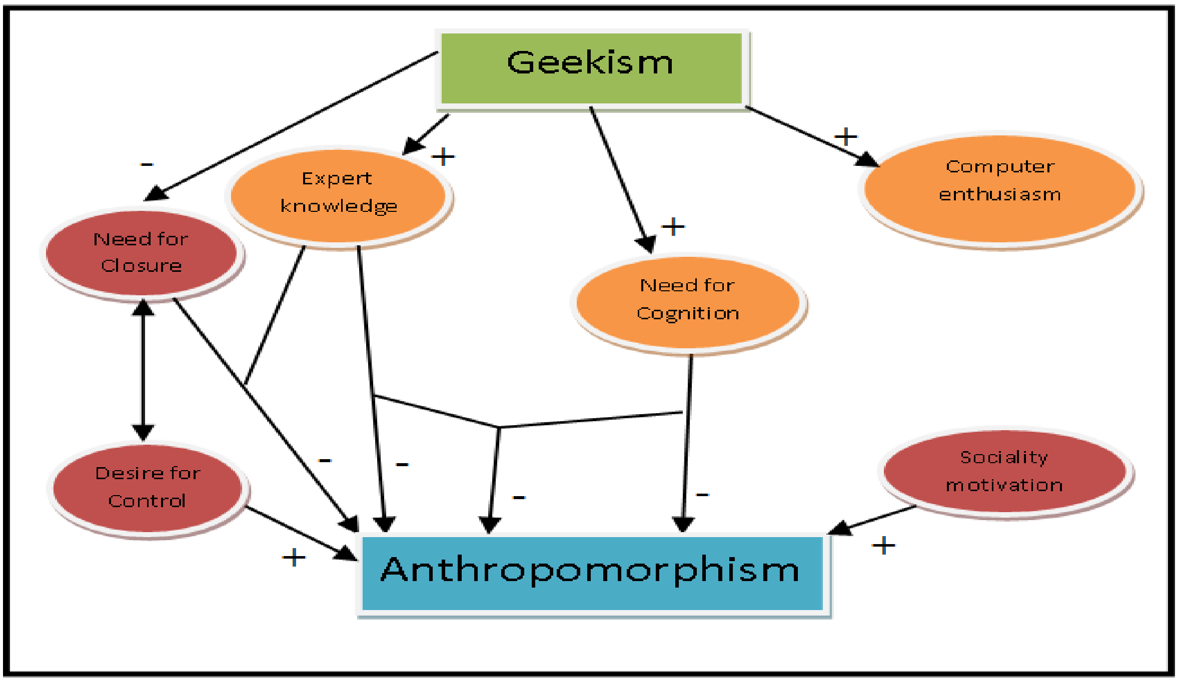
The second dispositional aspect of effectance motivation, the ‘need for closure’ is, as mentioned earlier, defined as the desire “for *an* answer on a given topic, *any* answer, … compared to confusion and ambiguity” (Kruglanski, 1990b, p.337, quoted in Webster & Kruglanski, 1994, p. 1049 and as also quoted in Roets & Hiel, 2010, p.90). According to Webster and Kruglanski (1994) “persons with a high need for closure should desire definite order and structure in their lives and abhor unconstrained chaos and disorder.” (p.1050). In addition, Webster and Kruglanski (1994) assume that the desire for knowledge to be stable and secure, increases as a result of a high need for closure. Epley et al. (2007) suggest that individuals, who have a high need for closure, should activate their anthropomorphic knowledge more likely, when they have to make inferences about non-human agents and should be less likely to correct it afterwards. Therefore, those individuals who have a high need for closure probably tend to anthropomorphize more than those low in need for closure (Epley et al., 2007). However, Epley et al. (2007) state that the ‘effectance motivation’-determinant of anthropomorphism increases anthropomorphism when there is no other non-anthropomorphic knowledge accessible. Therefore, it could be hypothesized that even individuals high in ‘need for closure’ would not anthropomorphize non-human agents more than individuals low in ‘need for closure’, in case they do have alternative, non-anthropomorphic knowledge accessible.

The third key determinant of anthropomorphism is the ‘sociality motivation’, which is described as “the need and desire to establish social connections with other humans.” (Epley et al., 2007, p.866). Through facilitating the perception of a humanlike relation with a nonhuman agent, anthropomorphism satisfies this need (Epley et al., 2007). Those individuals, who lack social connections to other humans, use anthropomorphism in order to create a humanlike agent out of a nonhuman agent in order to satisfy their ‘sociality motivation’ (Epley et al., 2007).

Table 1. *Key Psychological Determinants of Anthropomorphism based on Epley et al. (2007)*

	Key psychological determinants		
	Elicited agent knowledge	Effectance motivation	Sociality motivation
Dispositional influences	Need for cognition	Need for closure, desire for control	

Figure 1. Research Model: Linking 'Geekism' to the Theory of Anthropomorphism of Epley et al. (2007).*



* The '+' indicates that both aspects are high or low, the '-' indicates that one of the aspects is high and the other is low.

1.3 Connecting Anthropomorphism to Geekism

In the sections above it was first described what it means to have the 'geek predisposition', followed by the description what the term 'anthropomorphism' entails and which determinants are important, in order to predict why people do or do not anthropomorphize non-human agents. In the following section it will be discussed how these two aspects could be connected and hypothesis will be established with regard to the possible connections.

Following Epley et al. (2007) with regard to their theory about the 'elicited agent knowledge'-determinant of anthropomorphism and following the different findings of Schmettow and Passlick (2013) or O'Brien (2007) which revealed that 'expert knowledge' or being an expert in a given subject-area seems to be descriptive for 'geekism', it could be hypothesized that individuals, who tend to 'geekism', do have 'expert-knowledge' about technology and that they could use this technological knowledge instead of using anthropomorphic knowledge, resulting in less anthropomorphism. In addition, on the basis of Schmettow and Drees (2014) and Schmettow et al. (2013) it was assumed that a high need for cognition is one part of the 'geek predisposition'. Based on the theory of Epley et al. (2007) with regard to the influences that the need for cognition is assumed to have on the tendency to anthropomorphism and the usage of non-anthropomorphic knowledge, it could be hypothesized that individuals, who tend to 'geekism', do anthropomorphize robots less, because their high need for cognition leads them to rely more on and to increasingly use non-anthropomorphic knowledge, if it is available.

With regard to the other two key determinants of anthropomorphism, 'effectance motivation' and 'sociality motivation', the focus was placed on the 'effectance motivation'. Regarding the two dispositional influences of this determinant, the focus of this study was placed on the 'need for closure'. Epley et al. (2007) suggest that, in comparison to individuals with a low need for closure, those with a high need for closure would tend to anthropomorphize more and would not change those anthropomorphic representations when they are presented with a non-human agent. Following the findings of O'Brien (2007) that 'geeks' seem to work through problems and do not give up when they are faced with a problem, it could be hypothesized that individuals, who tend to 'geekism', tend to have a low need for closure, leading them to anthropomorphize less. In addition, Epley et al. (2007) assume that non-anthropomorphic knowledge influences the relation between anthropomorphism and the 'effectance motivation' determinant, which is composed among others of the need for closure. Even individuals with a high 'effectance motivation' are assumed to anthropomorphize non-human agents less when they have alternative, non-anthropomorphic knowledge (Epley et al., 2007). With regard to individuals, who tend to 'geekism', it could be hypothesized that they anthropomorphize robots less, because they are assumed to have a low need for closure that interacts with their expert knowledge. However, based on the theory of Epley et al. (2007), we could hypothesize that 'geeks' anthropomorphize less even when they have a high need for closure, because they are assumed to have expert knowledge that they could use instead.

1.4 Hypotheses

Based on the discussed literature about anthropomorphism and 'geekism' and the discussed assumptions about possible links between these two aspects, the main-hypothesis of this study states, that individuals, who tend to 'geekism', thus those individuals who are assumed to have a high need for cognition and a strong computer enthusiasm, do anthropomorphize robots less.

Main-hypothesis: *Individuals high in need for cognition and high in computer enthusiasm, tend to anthropomorphize robots less.*

In order to test the main-hypothesis two explanatory paths are followed. The first explanatory path and the corresponding hypotheses are focused on the 'geeks', examining whether and how the need for cognition, the computer enthusiasm and the expert knowledge that were found or assumed to be descriptive of these individuals are related to each other. Based on the assumptions of Schmettow et al. (2013) and Schmettow and Drees (2014) that 'geekism' is composed of or should be assessed by means of the need for cognition and the computer enthusiasm, the first sub-hypothesis examines whether there is a relation between these two aspects and tries to replicate the findings of Schmettow and Drees (2014) that this relation is of a positive nature.

Sub-hypothesis 1.1: *The need for cognition correlates positively with the computer enthusiasm*.

In addition, it was assumed that individuals, who tend to 'geekism', would also have expert knowledge about technology. The following sub-hypotheses try to link the expert knowledge with the two aspects that are assumed to be composing 'geekism'. Therefore, the second sub-hypothesis examines whether the need for cognition has a positive relation with the expert knowledge and the third sub-hypothesis examines whether the computer enthusiasm has a positive relation with the expert knowledge, as well. In this study, the expert knowledge will be approximated through the knowledge that students have, who are following technical studies. We assume that the knowledge that they gain through their technical studies could be used as an approximation of the expert knowledge that individuals, who tend to 'geekism', are assumed to have. Hence, technical students represent the expert knowledge of 'geeks' and non-technical students represent the knowledge of 'non-geeks', respectively non-experts.

Sub-hypothesis 1.2: *Technical students have a high need for cognition.*

Sub-hypothesis 1.3: *Technical students have a high computer enthusiasm.*

Based on the theory of Epley et al. (2007), the second explanatory path and the corresponding hypotheses, try to examine for what reasons individuals, who tend to 'geekism', tend to anthropomorphize robots less, as we have assumed in our main-hypothesis. Following the stock that was taken in the previous section with regard to the 'elicited agent knowledge' and the link between the need for cognition and anthropomorphic and non-anthropomorphic knowledge, the first sub-hypothesis of the second path states that 'geeks' do anthropomorphize less, because of the interaction between their high need for cognition and their expert knowledge.

Sub-hypothesis 2.1: *Technical students with a high need for cognition tend to anthropomorphize robots less.*

Moreover, with regard to the interaction between non-anthropomorphic knowledge and the need for closure, Epley et al. (2007) assumed that individuals, who have a high need for closure, tend to anthropomorphize non-human agents less, when they do have non-anthropomorphic knowledge that they could use instead. Hints were found leading to the assumption that 'geeks' would have a lower need for closure. However, this is only an assumption and it is possible that these individuals can have a higher need for closure than assumed. Therefore, based on the theory of Epley et al. (2007) we hypothesize that even when these 'geeks' have a high need for closure, they would tend to anthropomorphize less, because they could use their expert knowledge instead.

Sub-hypothesis 2.2: *Technical-students with a high need for closure tend to anthropomorphize robots less.*

2. Method

In order to test the hypotheses, different kinds of measuring tools were chosen, such as an implicit and an explicit measurement. In addition, four self-report instruments were applied to assess among other things the degree to which the participants tend to 'geekism'. The measurement instruments, as well as the measuring procedure and the analysis will be explained in detail in the following section.

2.1 Participants

In order to have a sample that would allow for generalization to the population, n = 60 participants were asked to participate. In this study a convenience sample was used, because only students from the University of Twente were invited to contribute. In recruiting the participants, the emphasis was placed on achieving as much variance among the participants as possible. In order to achieve this, students of different kinds of studies were invited. Schmettow et al. (2013) assumed that students of computer sciences, would have "a stronger predisposition for geekism, as compared to psychology students" (p.2043) and in line with this assumption they found that the students studying computer sciences showed associations with geekism words that were stronger than the associations with hedonic words. Therefore, students who were studying technological studies, such as for example technical informatics or creative technology, were chosen to represent a high tendency to geekism. In order to have students who represent a low tendency to geekism, psychology students were asked to participate, because they were assumed to have a weaker tendency for geekism than computer science students (Schmettow et al., (2007). The non-psychology students were offered 12.50 Euros for their participation and in addition had the chance of winning 25 Euros. However, many of the psychology students enrolled themselves for the study through the online system of the University of Twente in order to accomplish their course fulfillments. The courses of study pursued by the participants eventually ranged from technical studies, such as technical informatics and creative technology, to behavioral studies like psychology or communicational science.

Eventually, the sample (Table 2) was composed of n_m = 26 male participants and $n_{f\,=}$ 34 female participants while their age ranged from 19 to 29 with a mean of M = 22.23 (*SD* = 1.962) and the nationalities were Dutch and German. The participants were split up in two sub-samples: the participants in sub-sample A (about n = 38 (almost two-thirds) of the participants with n_m = 14 male participants and $n_{f\,=}$ 24 female participants), did not participate in the whole experiment, but only took part in the explicit measurement and filled out the different questionnaires. The others, a little over one third (n = 22) of all participants, were assigned to sub-sample B and passed through the whole experiment. In subsample B, n_m = 13 male and $n_{f\,=}$ 9 female persons participated. These participants did thus the same as the participants in subsample A, except that they participated in the implicit measurement prior to the explicit one. As mentioned earlier, the participants were also split up in two groups, with one involving all technical students (n_t = 14) and one involving all non-technical students (n_{nt} = 4). The technical students and their knowledge were assumed to be able to approximate the expert knowledge of individuals, who tend to ‘geekism’.

Table 2. *Demographics and group/sample-allocation*

		Gender		Mean (Standard Deviation)
		Male (Percent)	Female (Percent)	
		26 (43.3)	34 (56.7)	
Knowledge				
Technical studies	21	17 (80.95)	4 (19.05)	
Non-technical studies	39	9 (23.08)	30 (76.92)	
Subsample				
Subsample A	38	14 (36.84)	24 (63.16)	
Subsample B	22	13 (59.09)	9 (40.90)	
Age				22.25 (1.962)
Minimum				19
Maximum				29

2.2 Materials

2.2.1 Video clips

In order to determine how the participants react to robots and to have the possibility to assess whether the 'geekish' participants also tend to anthropomorphize robots, twenty short videos with different kinds of robots were chosen. These videos were used for both the implicit and the explicit measure. All of the video clips had a resolution of 1920*1080 pixels and a length of 5 seconds and showed one robot per video, engaging in one kind of movement. The robots can be in turn classified into two groups on the basis of their movements: One group consists of primitive, locomotive movements (9 videos) like rolling or running, whereas the other group (11 videos) consists of complex movements, such as washing a window. In addition, the robots can be distinguished on the basis of their appearance: while some of the robots have a more mechanical appearance, as for example a ball moving in circles, others had a more animal-like appearance, as for example an ape or a spider, and yet others appeared rather humanlike, with a corps, limbs, a head, hair and facial features.

2.3 Measures

2.3.1 Questionnaires to assess geekism and other concepts

As mentioned earlier, four self-report instruments were used in order to test among other things to what degree the participants tend to 'geekism'. Additionally, some of the questionnaires were used to assess concepts that could be related to 'geekism'. The answer options of the questionnaires were adjusted so that they were structured in the form of a 7-point Likert scale, ranging from "strongly disagree" (1) to "strongly agree" (7). However, one of the questionnaires, the "Exposure to Technology" questionnaire, did not make use of the 7-

point Likert scale structure, but instead, the participants were asked to answer with “yes” or “no” or had to fill in their age.

GEX Scale. According to Schmettow and Sander (2013) the aim of the GEX scale is to measure “[…] the degree to which one has got *geekism* […]” (p.10). In this study the scale was used to measure the extent to which the participants tend to have computer enthusiasm, which is one of the two components that is assumed to compose ‘geekism’. Originally, the scale had 34 items and according to Schmettow and Sander (2013) the items of the scale were constructed based on the interview study of Schmettow and Passlick (2013). In this study the 15-item version used by Schmettow and Drees (2014) was used. This version entails items like “I want to understand how computer parts and software work.” and “Sometimes I use technical devices different to what their were intended for.”. According to Schmettow and Drees (2014) this 15 items-version yielded a very good constancy, as expressed by means of a Cronbach’s alpha of 96% and a very good test-retest stability of r = 96%. In addition, the 15 items-version yielded a good discriminant validity towards the ‘Need for Closure Scale’, with a fairly low correlation of r = .36.

Need for Cognition Scale. The Need for Cognition Scale (NCS) was used in the study of Schmettow et al. (2013) in order to “approximate the differences related to geekism” (p.2043). In this study, the NCS was also used as a predictor for the geek predisposition but also to examine to what extent the participants have a need for cognition. The original version had 34 items, but Cacioppo, Petty and Kao (1984) constructed a short form of 18 items, which was applied in this study. The factor analysis showed that one factor was dominant (Cacioppo et al., 1984), therefore it can be said that the NCS is unidimensional. The reliability of the NCS was not sacrificed through the construction of a short version, as it still has a theta coefficient of +.90. A total score of the 18 items was calculated, in order to determine the respective participant’s need for cognition. In case a participant had a high need for cognition, this would be reflected by a higher total score on the NCS.

Need for Closure Revised. Webster and Kruglanski (1994) originally constructed the Need for Closure Scale as an unidimensional scale to “tap stable individual differences in the motivation for cognitive closure” (p.1061). According to Webster and Kruglanski (1994) five aspects are assumed to represent the ‘Need for Closure’ construct, which are ‘Preference for Order’, ‘Preference for Predictability’, ‘Closed-mindedness’, ‘Discomfort with Ambiguity’ and ‘Decisiveness’. However, Neuberg, Judice and West (1997) analyzed the Need for Closure Scale thoroughly and found that it is not an unidimensional instrument as Webster and Kruglanski (1994) have intend it to be. Instead, Neuberg et al. (1997) argued that it is a multidimensional instrument that consists of two factors: the nonspecific closure and specific closure. Van Hiel and Roets (2007) have yet another conclusion with regard to the 'Need for Closure Scale': according to them, the psychometric problems of the Need for Closure Scale stem from the fact that the original 'Decisiveness facet scale' "is contaminated by ability-related content, whereas the NFCS intended to solely measure the need component of closure" (p. 276). Additionally, they further argue that the findings of Neuberg and his colleagues are derived from an operationalization of the Decisiveness facet, which is less than optimal. Therefore, Van Hiel and Roets (2007) replaced the old 'Decisiveness facet scale' with a new one correlating highly and positively with the other facets of the Need for Closure Scale and thereby created the 'Need for Closure Scale – Revised', consisting of 41 items. In order to determine the psychometric qualities, Van Hiel and Roets (2007) used two samples. The new items raised the Cronbach's alpha of the total 'Need for Closure Scale' from .85 to .87 in Sample 1 and in Sample 2 from .82 to .86 (Van Hiel and Roets, 2007). In addition, the replacement of the items of the Decisiveness scale lead to a rise of the median interitem correlation in Sample 1 from .14 to .16 and in Sample 2 from .12 to .16 (Van Hiel and Roets, 2007). Based on these findings the 'Need for Closure Scale – Revised' (NCCR) was used in this study in order to examine whether the participants with a geek predisposition do tend to a low 'need for closure' as hypothesized.

Exposure to Technology Questionnaire. In order to test the degree to which the participants were exposed to technology from their early childhood until the age of 12, an objective questionnaire was developed. It consisted of 8 questions like "At what age did you first get access to a television?" or "Would you state that you have experience with technology?" and as explained above the participants had to answer with 'yes' or 'no' or to state their age. To this point, there are no psychometric qualities determined.

2.3.2 Explicit measurement - Perceived Humanness Scale

Ho and MacDorman (2010) evaluated the Godspeed indices (Bartneck, Kulić, Croft, & Zoghbi, 2008) which eventually lead to the development of the 'Perceived Humanness Scale' as "a new measure for human perceptions of anthropomorphic characters that reliably assess four relatively independent individual attitudes" (p.1517). The Perceived Humanness Scale entails four indices 'humanness', 'eeriness', 'attractiveness' and 'warmth', which further consists of a number of semantic differential items (in total 19 items) to assess the human perceptions of anthropomorphic characters (Ho & MacDorman, 2010). The 'warmth' index is not included as an own index in the final version of the scale, because it is only designed in order to assess the correlation between the other indices and itself (Ho & MacDorman, 2010).

In this study only the 'humanness' index was used, which, according to Ho and MacDorman (2010), can be applied to measure how people subjectively perceive the humanness of a non-human agent. In the current study this subjective measurement is necessary to determine whether the participants tend to perceive the different robots as having humanlike characteristics and thereby indicating a tendency to anthropomorphism. The 'humanness' index consists of six semantic differential items such as "Artificial - Natural" or "Without Definite Lifespan - Mortal". The internal reliability of this index was high (Cronbach's α = .92) and explained 68.96% of the variance (Ho & MacDorman, 2010). According to Ho and MacDorman (2010) one advantage of the Perceived Humanness Scale is that the presented stimuli need not to be limited to humanlike robots, but can include also computer-generated agents. This is advantageous for the current study, as the Humanness index is used to examine how the participants perceive the different kinds of robots that in the abovementioned videos.

2.3.3 Stroop Task

In this study different self-report measurements were used to test the different hypotheses. According to Schmettow et al., (2013), these different kinds of self-report measurements, as e.g. semantic differentials or Likert scales, do have their advantages, but they have limitations and can lead to possible biases. Therefore, Schmettow et al. (2013) tried to expand the present, explicit methodologies with the Stroop priming task, which is an implicit experimental method that assesses the spontaneous association a person has with a particular product. The version of the Stroop priming task used in this study, relies heavily on the research of Schmettow et al. (2013) and their version of the Stroop Task.

In the study of Schmettow et al. (2013) they made use of *priming* in order to examine which unconscious association their respondents had regarding technical products. According to Tulving and Schacter (1990) priming is a type of memory that is implicit and does not entail the conscious or explicit recollection of earlier experiences. Priming itself can be best understood through the spreading activation theory of Balota and Lorch (1986). According to Balota and Lorch (1986) different concepts in memory are represented as nodes and the relationships between these concepts are represented in the form of associative pathways between those nodes. When some parts of the memory network are activated, this activation spreads to other related areas through using the associative pathways and therefore these related areas are more accessible for additional cognitive processing through the spreading of activation (Balota and Lorch, 1986). According to Tulving and Schacter (1990) the mechanism of relating the current stimulus (in this case the robot videos) to information that is stored in the memory network is indicated as priming.

However, in the present study a different variant of the Stroop priming task of Schmettow et al. (2013) was used. In this case the earlier described video clips about robots were used as the primes, in order to examine which unconscious associations the respondents had with those robots. After each video clip one target word was shown in one of the three colors red, green or blue and the participants had to press the arrow-key corresponding to the respective color. The 40 target words belonged to three categories, which were ‘human’, ‘system’ and ‘neutral’. The categories ‘human’ and ‘system’ had the themes ‘mobility’, ‘energy’ and ‘cognition’. The category ‘neutral’ had only the theme ‘weather’ with words like ‘darken’ or ‘thundering’. An example for the category ‘human’ with the ‘mobility’-theme, as shown in Table 3, is the word ‘walking’ and an example for the ‘system’-category with the ‘cognition’-theme is ‘computing’. All of the target words were available in the languages English, German and Dutch and were written in the infinitive form with regard to German and Dutch or the present progressive with regard to English so that they could not be confused with the corresponding nouns.

According to Schmettow et al. (2013) “longer response times in the subsequent color-naming task indicate strong associations between prime and target“(p.2041). Thus, presumably ‘geeks’ should show a longer response time, and thus a stronger association with words from the category ‘system’ (like ‘computing’ or ‘reloading’) after seeing the robots, because if they, as hypothesized, anthropomorphize robots less and have more knowledge about technology which could be activated through the priming and the corresponding spreading of activation.

Table 3. *Word Category, Themes and Examples of the Target Words used in the Stroop priming task.*

	Word category		
	Human	System	Neutral
Themes			
Mobility	‘walking’	‘rolling’	
Energy	‘waking up’	‘recharging’	
Cognition	‘forgetting’	‘computing’	
Weather			‘darken’, ‘thundering’

2.4 Procedure

In order to keep the chance of disturbance or interruption of the experiment at a minimum and to standardize the procedure, the first measurement moment of the study took place at the special research chambers of the University of Twente. The participants were alone in the room and had to complete an informed consent form before they started, explaining that all data would be rendered anonymous and that they could leave whenever they wanted. Subsequently they received the respective instructions, depending on which subsample they were in. The participants, who took part in the implicit measurement (n= 22, subsample B), started with the implicit measurement and after completing it, they received further instructions for the second, explicit part of the measurements. After completion of both parts, the participants received the questionnaires they were to complete at home. In subsample B, the participants were only instructed for the explicit measure and after completing it received the questionnaires, too. Both groups were advised to take a pause of approximately two hours before filling out the questionnaires, in order to be less influenced and less cognitively tired through the previous tasks. The described chronology of the various parts of the experiments was chosen in order to ensure that the participants were influenced as little as possible before taking part in the very sensitive implicit measurement as well as before taking part in the explicit measurement.

The procedure of the implicit measurement, the Stroop priming task, proceeded as follows: At first, the participants had to select their native language as the participants needed to be able to understand the words correctly, so that it was possible to examine which unconscious association the participants had with the words and the robots. Then, during the course of the experiment they were instructed which keys they had to press. In this case they had to press the arrow-keys that represented the colors red, green and blue (left = red; down = green; right = blue). Before the actual experiment started, the participants had to accomplish the practice trial in order to gain a certain familiarity with the keys and their corresponding colors. In this practice trial, monochrome pictures of fruits were shown, followed by words in the three mentioned colors, and the participants had to press the button that corresponded to the respective color of the shown word. After each picture-word-sequence they received feedback about the accuracy of the key they pressed and the time they needed to press it. Following, the practice trial, the participants had to conduct 8 blocks of the actual experiment. They saw the 20 videos of the robots (Figure 2) per block, one after another. After each video one of the 40 described target words (Figure 4) in one of the three colors was shown and they had to press the corresponding arrow-key, without feedback after each sequence. Between the videos and the words, the X (Figure 3) was shown so that the participants focused on the place, where the words appeared some seconds later. After each block they had an obligatory pause. When they had accomplished the experiment, the explicit measurement was conducted after a short pause and instruction.

Before starting the explicit measurement, the participants were instructed that they would see short videos and would have to fill out the six items of the Humanness Index of the Perceived Humanness Scale after each video. They were not allowed to watch the video more than once, because it was important that they expressed their first impression without thinking too much about it.

After completion of the first measurement moment, which was divided into the two subsamples A or B, all participants received the questionnaires and went home. Filling out the questionnaire can be considered as second measurement moment. In order to complete the study, the participants had to bring back the questionnaires 1 to 3 days later after the first measurement moment. When they brought back the questionnaires, they were debriefed about the purpose of this study.

Figure 2

Figure 3

Figure 4

2.5 Analysis

In order to be able to test the hypotheses, the data-files were examined with the assistance of the statistics program ‘SPSS’. The ‘GEX’ scale was used as the measurement for the computer enthusiasm and the NCS was used in order to measure the participants’ need for cognition. Moreover, anthropomorphism was operationalized by means of the six-items of the ‘Humanness Index’ of the ‘Perceived Humanness Scale’ and in addition through the responses times on the Stroop priming task. The need for closure was operationalized by means of the NCCR. The expert knowledge of those individuals, who tend to ‘geekism’, was approximated through the technical studies, respectively through the knowledge of the technical students.

First of all, the means and standard deviations were computer for the various questionnaires and computations were made with regard to the demographics of the participants. In order to test the hypotheses of the first explanatory path, correlations were computed for the diverse questionnaires.

The hypotheses of the second explanatory path were tested by means of a linear mixed effects (LME) model. The decision to choose this model was based on the fact that repeated measurements were made per item, per subject and per prime. Through the repeated measures these three variables were not ‘independent and identically distributed’ as necessary for other statistical procedures such as e.g. an ANOVA, so that the LME model had to be chosen instead. The LME model includes two kinds of effects, which are the ‘fixed effects’ and the ‘random effects’. The item-, subject- and prime-variables were included in the LME model as ‘random effects’. The scores of the ‘Need for Cognition Scale’, the scores of the ‘GEX’ scale and the scores of the ‘Need for Closure Revised’ were included as ‘fixed effects’. The expert knowledge and the gender were included in the LME model as factors. The dependent variable in this model was the response on the ‘Humanness index’ of the ‘Perceived Humanness Scale’. Subsequently, main-effects and interaction-effects of all ‘fixed effects’ and factors were computed.

In addition, the same main- and interaction-effects were computed through another LME model that made use of the reaction time on the Stroop Priming task as measure for anthropomorphic responses. In this LME model the participants, the primes and the target words were included as the ‘random effects’. The response time on the Stroop Priming task was the dependent variable, the word category-, the gender- and the expert knowledge-variables were included as factors and the scores on the NCS, NCCR and the GEX-scale were included as the fixed effects.

3. Results

In this section the results of the various analyses will be described. First of all, the descriptive statistics, thus the means and standard deviations per questionnaire, will be described. Subsequently, the results of the correlational analyses will be described, followed by the results of the linear mixed model analyses. For all analyses an alpha of 0.05 was used to determine the statistical significance of the results. The descriptions of the demographics of the participants can be found in section 2.1.

3.1 Descriptive Statistics

Table 4 shows that the average score of the participants on the GEX-scale was M = -.08 (SD = .49). The mean of the scores on the NCS was M = .22 (SD = .27) and the average score on the NCCR was M = .09 (SD = .19). With regard to the subscales of the NCCR the means differed noticeably from each other, as shown in Table 4. The 'Closed Mindedness' subscale for example was the only subscale with a negative average score (*M* = -.19, *SD* = .22). In comparison to the average scores on the other three subscales, the mean of the scores on the 'Discomfort with Ambiguity' subscale (*M* = .27, *SD* = .25) and the 'Preference for Order' subscale (*M* = .22, *SD* = .33) were noticeably higher.

Table 4. *Descriptive Statistics (Means and Standard Deviations) per Questionnaire*

	M	SD	N
Gex	-.08	.49	60
NCS	.22	.27	60
NCCR	.09	.19	57
Closed Mindedness	-.19	.22	60
Decisiveness	.07	.31	60
Discomfort with Ambiguty	.27	.25	60
Preference for Order	.22	.33	58
Preference for Predictability	.08	.32	59

3.2 Correlational analyses

The hypotheses of the first explanatory path were all tested by means of correlational analyses. The results are shown in Table 5. With regard to the first sub-hypothesis 1.1: "*The need for cognition correlates positively with the computer enthusiasm*" the correlational analyses revealed a significant and positive correlation (r (58) = .456, p < .001), between the scores on the GEX-scale and the NCS 5.

The correlation analysis with regard to sub-hypothesis 1.2: "*Technical students have a high need for cognition.*" revealed a positive, but not significant correlation (r *(58)* = .208, p = .111) between the scores on the NCS and the expert knowledge as shown in Table 5 and through Figure 6.

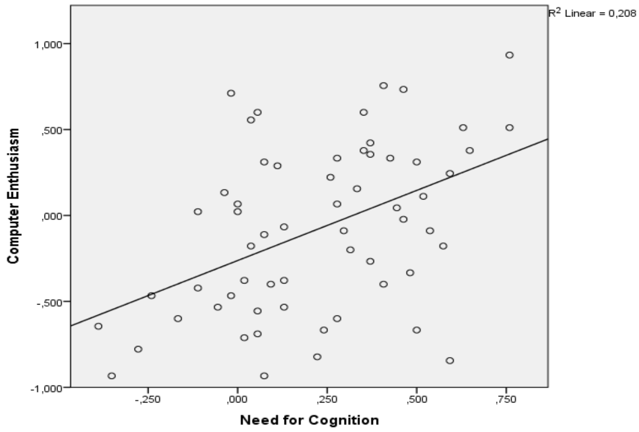


Figure 5. Correlation between the scores on the NCS (Need for Cognition) and the GEX-scale (Computer enthusiasm). Pearson's r = .456.

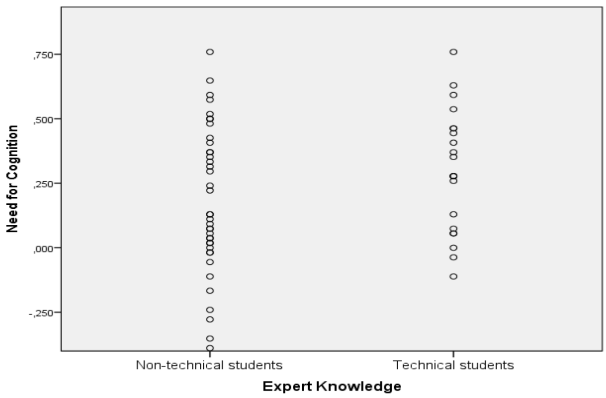


Figure 6. Correlation between the scores on the NSC and expert knowledge, represented through technical and non-technical students. Pearson's r = .208.

The results with regard to sub-hypothesis 1.3: "*Technical students have a high computer enthusiasm.*" as shown in Table 5 and Figure 7, revealed that there is a significant and positive correlation (*r (58)* = .417, *p* = .001) between the scores on the GEX-scale and the expert knowledge.

In addition, a significant and negative correlation (*r (55)* = -.273, *p* = .040) was found between the scores on the NCS and the NCCR (Table 5 and Figure 8) and a significant and negative correlation (*r (55)* = -.317, *p* = .016) was found between the expert knowledge and the scores on the NCCR as shown in Table 5 and Figure 9.

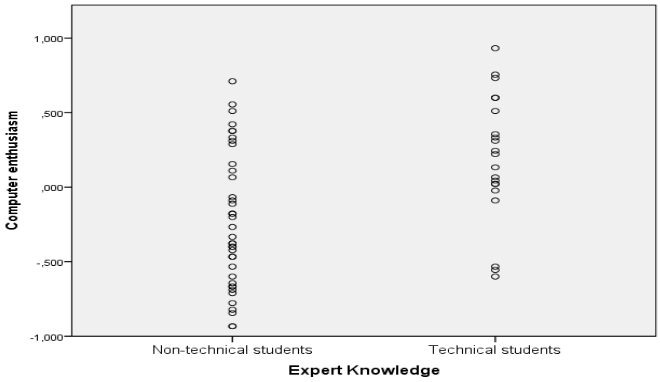


Figure 7. Correlation between the scores on the GEX-scale and expert knowledge, represented through technical and non-technical students. Pearson's r = .417.

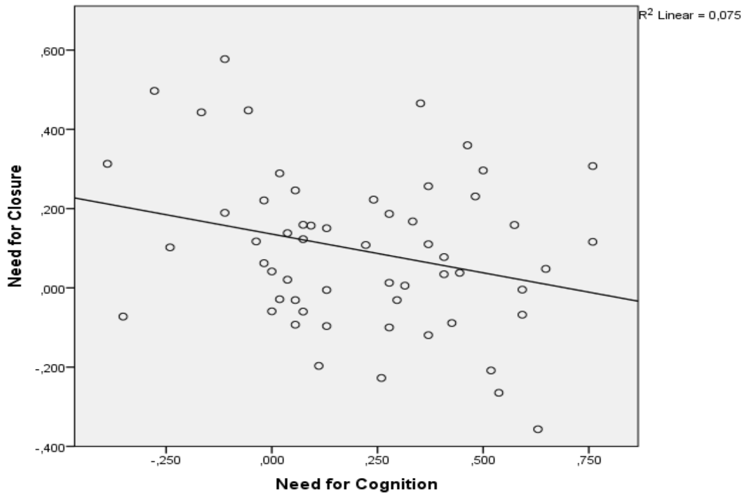


Figure 8. Correlation between the scores on the NCS and the NCCR (Need for Closure). Pearson's r = -.273.

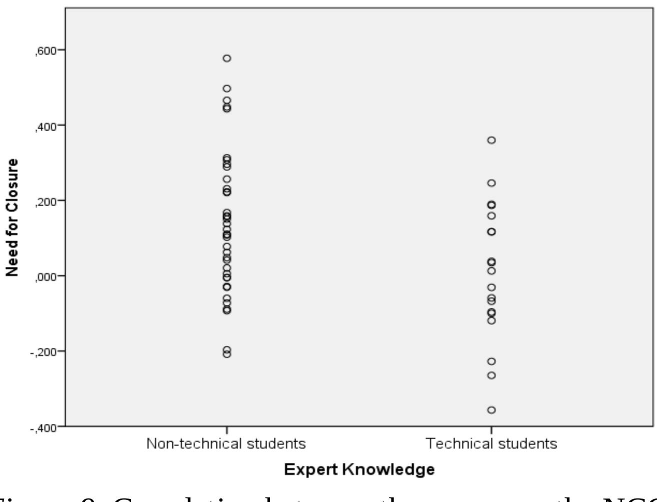


Figure 9. Correlation between the scores on the NCCR and the expert knowledge-variable.

Pearson's r = -.317.

Furthermore, the gender and also the five subscales of the NCCR were correlated with each other and the other measurement questionnaires. The gender correlated significantly and negatively with the scores on the GEX-scale (*r (58)* = -.414, *p* = .001) and the expert knowledge (*r (58)* = -.557, *p* < .001). In addition, the gender correlated significantly and positively with the scores on the NCCR (*r (55)* = .400, *p* = .002), and all of the subscales of the NCCR as shown in Table 5 except of the 'Closed Mindedness'-subscale (*r (58)* = .032, *p* = .810). The correlation between the gender and the scores on the NSC was negative, but not significant (*r (58)* = -.085, *p* = .518)

Moreover, Table 5 reveals that not all subscales of the NCCR correlate significantly with each other. The 'Closed Mindedness' subscale for example does only correlate significantly and positively with one other subscale: the 'Preference for Order'-subscale (*r (56)* = .286, *p* = .030). With regard to for example the GEX-scale, only the scores on the 'Preference for Order'-subscale correlated significantly and negatively with the scores on the GEX-scale (*r (56)* = -.259, *p* = .049).

Table 5. *Correlational analysis*

		Gex	NCS	Know-ledge	NCCR	Close-Mind	Deci-sive	Discom-Amb	Pref-Order	Pref-Predict	Gender
Gex	r										
	p	---									
	N										
	r	.456									
NCS	p	.000	---								
	N	60									
	r	.417	.208								
Knowledge	p	.001	.111	---							
	N	60	60								
NCCR	r	-.208	-.273	-.317							
	p	.120	.040	.016	---						
	N	57	57	57							
	r	-.213	-.442	.059	.442						
Closed	p	.102	.000	.652	.001	---					
Mindedness	N	60	60	60	57						
	r	-.108	.021	-.380	.672	.207					
Decisiveness	p	.411	.876	.003	.000	.113	---				
	N	60	60	60	57	60					
Discomfort	r	.024	-.003	-.222	.688	.116	.361				
with	p	.855	.983	.088	.000	.379	.005	---			
Ambiguity	N	60	60	60	57	60	60				

Preference for	r	-.259	-.162	-.237	.848	.286	.497	.548			
Order	p	.049	.225	.073	.000	.030	.000	.000	---		
	N	58	58	58	57	58	58	58			
Preference for	r	-.163	-.348	-.245	.710	.154	.232	.397	.519		
Predict-ability	p	.218	.007	.061	.000	.246	.077	.002	.000	---	
	N	59	59	59	57	59	59	59	57		
Gender	r	-.414	-.085	-.557	.400	.032	.298	.334	.356	.292	
	p	.001	.518	.000	.002	.810	.021	.009	.006	.025	---
	N	60	60	60	57	60	60	60	58	59	

3.2 Hypothesis testing

The hypotheses of the second explanatory path were tested by means of the two earlier described linear mixed effect (LME) models. Neither the LME model (1) using the score on the ‘Humanness index’ of the ‘Perceived Humanness Scale’ as measure for the anthropomorphic responses, nor the LME model (2) using the response time on the Stroop priming task as measure for anthropomorphic responses, yielded significant main- or interaction-effects as shown in Table 6 and 7. The results with regard to the two sub-hypotheses and the main-hypothesis will be described shortly. The other main and interaction-effects that were computed and can be found in Table 6 and Table 7 will not be described further, because of the non-significant results.

With regard to the sub-hypothesis 2.1: “*Technical students with a high need for cognition tend to anthropomorphize less.”* no significant interaction-effect was found between the expert knowledge and the need for cognition, F (1,40) = .556, p = .460 (Model 1, Table 6), F (1,3) = .006, p = .945 (Model 2, Table 7). Table 6 shows that the regression coefficient (-.276) has no significant strength, because the confidence interval [-1.023; .472] includes zero and the regression coefficient itself is close to zero. Table 7 indicates as well that the regression coefficient (.047) is of no practical relevance through being very close to zero and the interval [-1.951; 2.046] enclosing zero almost symmetrically. The corresponding main-effects of the expert knowledge and the need for cognition were also not significant, as can be seen in Table 6 of Model 1 and Table 7 of Model 2.

With regard to the sub-hypotheses 2.2: “*Technical students with a high need for closure tend to anthropomorphize robots less.*” also no significant interaction-effect was found between the need for closure and the expert knowledge, F *(1,40)* = .189, p = .666 (Model 1, Table 6) and F *(1,3)* = .210, p = .678 (Model 2, Table 7). For the same reasons that were mentioned with regard to sub-hypothesis 1.2, the regression coefficients regarding sub-hypotheses 2.2 are of no relevant strength in both models (.214; Model 1, Table 6), (.236; Model 2, Table 7). The corresponding main-effect of need for closure was also not significant (Table 6; Table 7).

Regarding the main-hypothesis of this study: "*Individuals high in need for cognition and high in computer enthusiasm, tend to anthropomorphize robots less.*" no significant interaction-effect was found between the need for cognition and the expert knowledge, $F_{(1,40)} = .894$, $p = .350$ (Model 1, Table 6) and $F_{(1,3)} = .076$, $p = .800$ (Model 2, Table 7). The regression coefficients of both models (-.082; Model 1, Table 6), (.098; Model 1, Table 7) were of no relevant strength. The main-effect of the computer enthusiasm was also not significant as can be seen in Table 6 and Table 7.

Table 6. *Linear Mixed Effects Model (1) (Scores on the 'Humanness Index' as Dependent Variable).*

Covariate/Factor	F	P	β	Confidence interval (95%)	
				Lower Bound	Upper Bound
Intercept	128.303	.000	3.638	2.544	4.732
Main effects					
Knowledge	2.421	.128			
Non-tech. students 1			-.780	-1.847	.287
Tech. students 2			0*		
GEX	.002	.965	.020	-.433	.474
NCS	.000	.997	.228	-.556	1.012
NCCR	.286	.596	-.358	-1.663	.945
Gender	.320	.574			
Male			-.422	-1.490	.646
female			0*		
Interaction effects					
GEX * NCS	.894	.350	-.082	-.257	.093
GEX * NCCR	1.065	.308	.207	-.198	.612
NCS * NCCR	.031	.862	.050	-.528	.628
Knowledge * NCS	.556	.460			
Non-tech. students *NCS			-.276	-1.023	.472
Tech. students *NCS			0*		
Knowledge * GEX	.076	.784			
Non-tech. Students * GEX			.056	-.354	.465
Tech. Students * GEX			0*		
Knowledge * NCCR	.189	.666			
Non-tech. Students*NCCR			.214	-.782	1.209
Tech. Students*NCCR			0*		
Knowledge * Gender	.678	.415			
Non-tech. Students * male			.447	-.651	1.545

Tech. Students * male			0*		
Non-tech. Students * female			0*		
Tech. Students * female			0*		
Gender * NCS	.232	.633			
male * NCS			-.182	-.944	.581
female * NCS			0*		
Gender * NCCR	.092	.763			
male * NCCR			.151	-.851	1.153
female * NCCR			0*		
Gender * GEX	.315	.578			
Male * GEX			-.106	-.486	.275
Female * GEX			0*		

* The parameter was set to zero through SPSS, because it was redundant.

Table 7. *Linear Mixed Effects Model (2) (Response Time on the Stroop Priming Task as Dependent Variable)*

	F	P.	β	Confidence interval (95%)	
Parameter				Lower Bound	Upper Bound
Intercept	48.380	.006	.428	-.030	.886
Main effects					
Gender	4.922	.113			
Male			.199	-.287	.687
Female			0*		
Knowledge	.978	.396			
Non-tech. Students			.084	-.560	.727
Tech. Students			0*		
Word Category	.601	.549			
Human			-.015	-.067	.038
Neutral			-.003	-.066	.059
System			0*		
GEX	.134	.738	.083	-.413	.5797
NCS	.273	.637	-.121	-1.8297	1.587
NCCR	.381	.581	-.180	-1.416	1.055
Interaction effects					
Gender * Knowledge	.258	.646			
Male * Non-tech. Students			.145	-.7596	1.049
Male* Tech. Students			0**		
Gender * Word Category	.480	.619			
Male * Human			-.003	-.051	.045
Male * Neutral			-.028	-.086	.030
Male * System			0**		
Gender * GEX	.044	.848			
Male * GEX			-.029	-.475	.416
Female * GEX			0*		
Gender * NCS	.065	.815			
Male * NCS			.1196	-1.375	1.614

Female * NCS			0*		
Gender * NCCR	.355	.593			
Male * NCCR			-.212	-1.341	.918
Female * NCCR			0*		
Knowledge * Word Category	.238	.788			
Non-tech. Students * Human			-.001	-.042	.0396
Non-tech. Students* Neutral			.015	-.034	.064
Non-tech. Students * System			0**		
Knowledge * GEX	.025	.883			
Non-tech. Students * GEX			.060	-1.146	1.268
Tech. Students *GEX			0*		
Knowledge * NCS	.006	.945			
Non-tech. Students * NCS			.047	-1.951	2.046
Tech. Students * NCS			0*		
Knowledge * NCCR	.210	.678			
Non-tech. Students * NCCR			.236	-1.406	1.879
Tech. Students * NCCR			0*		
Word Category * GEX	.660	.517			
Human * GEX			.003	-.018	.023
Neutral * GEX			-.011	-.036	.013
System *GEX			0*		
Word Category* NCS	.950	.387			
Human * NCS			-.021	-.050	.008
Neutral * NCS			-.009	-.046	.026
System *NCS			0*		
Word Category * NCCR	.149	.862			
Human * NCCR			-.013	-.063	.036
Neutral * NCCR			-.011	-.071	.049
System *NCCR			0*		
GEX * NCS	.076	.800	.098	-1.036	1.233
GEX * NCCR	.249	.652	.115	-.621	.852
NCS * NCCR	.031	.872	-.082	-1.574	1.411

* The parameter was set to zero through SPSS, because it was redundant.
** The estimates of the interactions between the other categories (female * knowledge; female * word category; technical students * word category) are set to zero through SPSS, because they were redundant.

4. Discussion and Conclusion

The aim of this study was to fill the gap with regard to the interindividual differences in the tendency to anthropomorphize with information about individuals, who tend to 'geekism'. On the basis of the literature about 'geekism' we assumed that the so-called 'geeks' could be described as having a high need for cognition, a high computer enthusiasm and expert knowledge about technology and the literature pointed also in the direction of a low need for closure. On the basis of the literature it was assumed that 'geeks' would anthropomorphize less. In order to examine the reasons why these individuals would tend to anthropomorphize robots less, two explanatory paths were followed, one focusing on individuals, who tend to ‘geekism’, and the other trying to link ‘geekism’ with the theory about anthropomorphism of Epley et al. (2007). In the following section, we will summarize what we did or did not find in this study. Subsequently, we will discuss possible reasons for the fact that we did not find significant results with regard to some of our hypotheses, followed by the discussion of the limitations of our study, possible future research and a completing conclusion.

4.1 Conclusion

With regard to the first explanatory path and the corresponding hypotheses, the analyses yielded some confirming results. First of all, we found a significant and positive correlation (r = .456) between the scores on the NCS and the GEX-scale, what is in accordance with sub-hypothesis 1.1. According to Zou, Tuncali and Silverman (2003) this correlation is of a weak, but almost moderate nature. These findings are in accordance with the findings of Schmettow and Drees (2014), who found a moderate positive correlation which was however not significant. Based on our results, it seems thus that there is a significant relation between the two aspects, and individuals who have a high need for cognition seem to have some computer enthusiasm, as well and vice versa. Moreover, the findings of the weak, almost moderate positive correlation seems to be in accordance with the assumption that ‘geekism’ is composed of the need for cognition and computer enthusiasm, but the correlation is not too strong, indicating that these aspects do reflect two different aspects of ‘geekism’ as Schmettow and Drees (2014) concluded.

With regard to sub-hypothesis 1.2 we did not find significant results. The positive correlation between the expert knowledge and the scores on the NCS of r = .208, which denotes a weak correlation (Zou et al., 2003), was not significant. Based on the results of our study, we are not able to conclude that individuals with a higher need for cognition would also have more expert knowledge and vice versa. Furthermore, we found a significant and positive correlation between the scores on the GEX-scale and the expert knowledge of r = .417, which is in accordance with sub-hypothesis 1.3. According to Zou et al. (2003), this denotes also a weak but almost moderate correlation. Hence, individuals who have expert knowledge, thus ‘geeks’ or the technical students, seem to be enthusiastic about computers and technology to some extent, as well.

In addition, we also found that the need for cognition correlates significantly with the need for closure (r = -.273), which denotes a weak positive correlation (Zou et al., 2003).

These findings are highly in accordance with and confirm the findings of Webster and Kruglanski (1994) who also found a low and negative correlation of r = -.283. This indicates that individuals, who have a high need for cognition, seem to have a lower need for closure and vice versa. In addition to the hints that were found in the literature, this could be a further reason to assume that ‘geeks’ have a lower need for closure. Moreover, we found that not all of the subscales of the NCCR correlated significantly with each other, indicating that the NCCR is not as unidimensional as Van Hiel and Roets (2007) have argued. This is also supported through the missing homogeneity of the average scores per subscales.

Furthermore, we found significant differences in the relations between the gender and the computer enthusiasm, expert knowledge and the need for closure. A significant and, according to Zou et al. (2003) weak almost moderate, negative correlation of r = -.414 was found between the gender and the GEX-scale and a significant and moderate negative correlation (Zou et al., 2003) was found between the gender and the expert knowledge (r = -.557). This seems to indicate that female participants seem to have a lower score on the GEX-scale or tend to be less enthusiastic about computers and have less expert knowledge than male participants. Moreover, a significant positive correlation of r = .400 was found between the gender and the scores on the NCCR, which denotes a weak almost moderate correlation (Zou et al., 2003). Female participants seem to have higher scores on the NCCR. Hence, they seem to have a higher need for closure than male participants. The negative correlation that was found between gender and need for cognition of r = -.085, which denotes a weak correlation (Zou et al., 2003), was not significant. Nevertheless, we did not find any significant main- and interaction-effects between the gender and the other variables, indicating that the gender does not predict any significant differences with regard to anthropomorphic responses.

With regard to the second explanatory path no significant results were found. On the basis of the results of our study we cannot conclude that individuals, who have a high need for cognition, tend to anthropomorphize less, because their need for cognition would cause them to use more of their expert knowledge, instead of using anthropomorphic knowledge (sub-hypothesis 2.1). We are also not able to conclude that individuals, who have a high need for closure, tend to anthropomorphize less, because they could use their expert knowledge instead (sub-hypothesis 2.2). The non-significant findings with regard to the individual sub-hypotheses of the second explanatory path, but also the findings of the analysis with regard to the main-hypothesis itself, did not yield significant results.

4.2 Discussion

In the previous section we summarized the significant and non-significant results that were found in this study. In this section we will discuss possible reasons for the fact that some of our findings were not significant.

With regard to the first explanatory path only sub-hypothesis 1.2 was not supported through the results. Therefore, we are not able to conclude that individuals, who tend to have a higher need for cognition would also have expert knowledge, as it was assumed with regard to ‘geeks’ and the technical students. It could be argued that the participants did not have sufficient expert knowledge about technology or in this case about robots. However, according to Cacioppo et al. (1996), different studies provided evidence that individuals high in need for cognition acquire more knowledge than individuals low in need for cognition, because of their tendency to engage in more effortful thinking and problem solving. Together with the assumption that ‘geeks’ do have a high need for cognition and that the ‘geeks’ we approached were following studies that are technology related, is seems less reasonable to assume that they would not have enough knowledge. As will be discussed in detail later, it is possible that the approximation of the expert knowledge was not a suitable measure for the expert knowledge.

4.2.1 The interaction between the need for cognition and the expert knowledge

With regard to the second explanatory path, both hypotheses were not supported through the results of our study. In this subsection, we will discuss the possible reasons for the fact that sub-hypothesis 2.1: “*Technical students with a high need for cognition tend to anthropomorphize robots less.*” was not supported. Based on our study, we are not able to conclude that the need for cognition in interaction with the expert knowledge would lead to less anthropomorphism. Nevertheless, on the basis of the assumption of Epley et al. (2007) individuals, as ‘geeks’ for example, should anthropomorphize non-human agents less, because their assumingly high need for cognition would lead to the activation of alternative, non-anthropomorphic knowledge insofar as it is available. The first instinct, with regard to the non-significant results of our study, would be to argue that these were not significant, because Epley et al. (2007) err in their assumptions about the interactive influences of the need for cognition and the non-anthropomorphic knowledge.

In addition, we did not find significant main-effects of the expert knowledge and the need for cognition, either. This seems to contradict the theory of Epley et al. (2007) even more. However, different authors argue that situational and other kinds of influences can change the motivation to engage in effortful thinking or can lead to more reliance on anthropomorphic knowledge, as will be discussed in the following paragraphs.

With regard to the non-anthropomorphic knowledge, Epley et al. (2007) stated that the knowledge about humans is directly experienced, more easily acquired and easier to access, than non-anthropomorphic knowledge. This anthropomorphic knowledge is often used as an "anchor or starting point when reasoning about nonhuman agents, and correction of this anchor is possible to the extent that people are motivated and able to do so" (Epley et al., 2007, p. 869). According to Epley, Keysar, Van Boven and Gilovich (2004) different factors influence the effortful process of adjusting from such an anchor. Epley et al. (2004) state that, for instance, the time someone has to make a judgment or the cognitive load while making a judgment could lead to an increasing egocentric bias. When having less time and more cognitive load, the egocentric bias would increase and with more time and less cognitive load, the egocentric bias would be reduced (Epley et al., 2004). It is possible that the participants of this study and especially the participants, who tend to 'geekism', were not sufficiently motivated in order to adjust from the anthropomorphic anchor. Also, it might be that the participants were not able to adjust from the egocentric, anthropomorphic anchor, due to the fact that the videos of the robots were only 5 seconds long. This shortness of the videos did not leave the participants much time to make a judgment, and according to Epley et al. (2004) having less time to make a judgment leads to an increased egocentric bias and less adjustment from the egocentric anchor. This might be a reason why we did not find significantly reduced anthropomorphic responses.

In addition, Epley et al. (2007) state that situational influences can lead to more reliance on anthropomorphic knowledge, when reasoning about or judging a non-human agent. Non-human agents who are more similar to humans in their morphology and their motion, for instance, cause humans to rely more on their anthropomorphic knowledge instead of using non-anthropomorphic knowledge (Epley et al., 2007). However, in our study we tried to include robots that differ from each other in their appearance. Therefore, robots that were more human-like and also robots that were rather animal-like were included. This would indicate that the argument of Epley et al. (2007) that the similarity in appearance between robots and the person who sees the robot, causes this person to anthropomorphize human-like robots more, is not true for each of the robots that were included in this study. It could only be true for the more human-like robots, but not for the more animal-like robots.

With regard to the need for cognition, Epley et al. (2007) mentioned that a high need for cognition should cause individuals to adjust from the anthropomorphic starting point that was mentioned earlier. According to Cacioppo et al. (1996) a high need for cognition leads to more recalling and processing of information, and to less reliance on cues that are simpler and possibly unreliable. However, Cacioppo et al. (1996) state that "situational factors can moderate cognitive motivation such that the motivation to think is so low that neither individuals low nor individuals high in need for cognition think about the material or is so high that both individuals low and high in need for cognition think extensively about the material" (p.229). With regard to the situational influences, Cacioppo et al. (1996) mentioned that influences like external circumstances, which are surrounding the task or the extent to which an event is relevant for someone, need to be considered. Hence, through the circumstances surrounding the experiment of our study or through the extent to which the participants perceived the task as relevant, they could have been so strongly motivated that there are no differences to detect between those participants who would be characterized as 'geeks' and those who would be characterized as 'non-geeks', or their motivation was so undermined that even those high in 'need for cognition' did not think about the robots any further.

In addition, Thompson, Chaiken and Hazlewood (1993) found that the need for cognition is related to the intrinsic motivation and suggested that extrinsic rewards can undermine the intrinsic motivation of the need for cognition. Many of the students who participated in this study gained a monetary reward or participated for gaining points that are necessary to fulfill their study requirements. It is possible that these rewards undermined the intrinsic motivation of these students to think further about the robots and therefore they did not adjust from their anthropomorphic anchor. This seems to be in accordance with the theory of Festinger (1957) about cognitive dissonance. Festinger (1957) assumed that an extrinsic reward could lead to some extent of cognitive dissonance, which is a feeling of stress or discomfort caused through a conflict between opposing beliefs, behaviors, attitudes etc. The person who experiences the dissonance, wants to and attempts to reduce it through changing his or her beliefs, behavior etc. (Festinger, 1957). In the case of our study, we could argue that the monetary rewards lead to a state of cognitive dissonance, between being intrinsic motivated to think effortful and being rewarded with money. This could have lead the participants to try to reduce the dissonance, resulting possibly in less intrinsic motivation and therefore causing them not to adjust from the anchor. Hence, through situational influences or through extrinsic rewards and possibly emerging cognitive dissonance, it is possible that the participants were not motivated enough to really think about the robots.

It is thus possible that the various influences on the need for cognition and the anthropomorphic knowledge hindered these two aspects to significantly reduce anthropomorphic responses on their own. In addition, we possibly did not find a significant interaction-effect, due to the situational influences and extrinsic rewards that possibly resulted in the undermining of the need for cognition, wherefore the anthropomorphic starting point, mentioned earlier, was possibly not adjusted even though the participants had a high need for cognition and non-anthropomorphic knowledge.

Although these different situational influences could have influenced the participants and their results, our results seem to suggest that the theory of Epley et al. (2007) with regard to the 'elicited agent knowledge'-determinant, is not as generally applicable to every person as they claimed it to be. Epley et al. (2007) stated that they described "a theory to explain when people are likely to anthropomorphize and when they are not" (p.864). However, our insignificant results with regard to the hypotheses about individuals, who tend to 'geekism', which were based on the theory of Epley et al. (2007) suggest that their theory is not applicable to these individuals.

4.2.1 The interaction between the expert knowledge and the need for closure

Also sub-hypothesis 2.2 "*Technical-students with a high need for closure tend to anthropomorphize robots less*." of the second explanatory path was not supported through the results of our study. In addition, we also did not found a significant main-effect of the need for closure.

The results of our study seem to contradict the theory of Epley et al. (2007) that a high need for closure should lead to less anthropomorphism, when alternative non-anthropomorphic knowledge is available. Additionally, it seems to contradict the idea that 'geeks', who were assumed to have a low need for closure, would anthropomorphize less through the interaction with their expert knowledge. However, Epley et al. (2007) assumed that the 'effectance motivation' is composed of two dispositional influences, the need for closure and the desire for control, and even when the 'effectance motivation' is high, anthropomorphism should be reduced because of alternative non-anthropomorphic knowledge. Nevertheless, the desire for control aspect was not included in this study. It is possible that this variable could explain why we did not find a significant main-effect of the need for closure and no significant interaction-effects. According to Epley et al. (2007) those individuals high in the desire for control seem to anthropomorphize non-human agents in order to gain a sense of control. In the study of Schmettow and Passlick (2013) the interviewees talked about feelings of a need for control. It could be possible that 'geeks' have a high desire for control that could lead them to anthropomorphize more. However, Schmettow and Passlick (2013) had no clear evidence for the need for control aspect, so this assumption is highly hypothetical and further research would be necessary in order to examine whether 'geeks' do have a high desire for control, whether the desire for control leads to more or less anthropomorphism and whether and how the desire for control and the need for closure interactively affect the tendency to anthropomorphism. In addition, the desire for control would need to exert a great influence order to be able to yield significant results. It is questionable whether this is the case.

Moreover, Kruglanski and Webster (1996) stated that different factors or situations can exert influence on the need for closure and change it. When a person is fatigued, when there are noises or when the task he or she has to do is dull or unpleasant, the need for closure should be increased (Kruglanski & Webster, 1996). The need for closure should also be heightened when the person is required to give a judgment about a topic (Kruglanski & Webster, 1996). Thus even when we assume, based on the literature, that the need for closure was low, it is possible that we did not yield significant results, because of the influences on the need for closure that could have arisen through the experimental situation. One possibility in this regard is that the participants perceived the task as being dull or unpleasant or they felt that it is required to give a judgment about the robots on the 'Humanness index', what would lead to a higher need for closure in the experimental situation and more anthropomorphic responses. However, the participants were informed that they have the possibility to leave an item empty, thus their need for closure should not have been heightened through this. Nevertheless, Kruglanski and Webster (1996) stated that the need for closure should be increased through time pressure. The shortness of the robot-videos (5 seconds per video) could have worked similar to the time pressures mentioned by Kruglanski and Webster (1996), heightening the need for closure of the participants and causing them to accept any answer they could get or in this case any first idea how to judge the robots they see on the 'Humanness index', instead of thinking about the robot until they made another, probably less anthropomorphic judgment.

Furthermore, according to Webster and Kruglanski (1997) "individuals experiencing a need for closure may process less information and generate fewer competing hypotheses prior to reaching a judgment because of their propensity to 'seize' upon early information and quickly 'freeze' on judgments it implies, thus closing their minds to further relevant information" (p.139). Through the tendency of 'seizing', individuals use early cues more quickly in order to make a judgment and through the tendency of 'freezing' their judgments get fixated, wherefore the person is restricted in the search for information before making a judgment (Webster & Kruglanski, 1997). In addition with the theory over 'seizing' and 'freezing' of Webster and Kruglanski (1997) it is possible that the heightened or generally high need for closure caused the participants to 'seize' on early information about the robots and 'freeze' on the judgment about the robots which is implied in the information they seized on. It could be argued that through the 'seizing' and 'freezing' the non-anthropomorphic, expert knowledge would not have gotten the chance to be considered in the judgment and could not reduce the anthropomorphic responses. In addition, the considerations with regard to influences on the non-anthropomorphic knowledge of section 4.2.1 do apply here, too.

Even though we did not include the desire for control and although the situational influences etc. could have lead to a higher need for closure and other influences to less reliance on anthropomorphic knowledge, there is still a chance that Epley et al. (2007) err in their assumption that a low need for closure alone would lead to less anthropomorphism and that a high or low need for closure would lead to less anthropomorphism, when there is alternative non-anthropomorphic knowledge accessible.

4.3 Limitations

This study has several limitations or points of weaknesses and their implications for the results of the study and the validity will be discussed in the following.

One very important limitation which has to be mentioned is that we used the fields of studies that the participants were pursuing as approximation for the expert knowledge. Technological studies were assumed to be able to provide the technical students with knowledge that could approximate the knowledge that was found to be descriptive of 'geeks'. Nevertheless, the studies are probably not genuine indicators for the expert knowledge. Therefore, the conclusions with regard to the hypotheses including the expert knowledge have to be drawn with caution.

The second possible limitation is that the 'Humanness index' of the 'Perceived Humanness Scale' had to be translated into Dutch and German. Through the translation the meanings of the words could have changed and therefore, the validity of the translated versions could have been reduced. The translated versions were not checked for their psychometric qualities. This could be responsible for the insignificant results that were found. It is possible that another measurement for anthropomorphism would have yielded other and maybe significant results. However, we used the Stroop priming task as other measurement and still did not find any significant results. With regard to the Stroop priming task one limitation is that the sample-size (n = 22) was too small to yield useable results with this generally very sensitive measurement.

The fourth limitation is that not all aspects of the theory of Epley et al. (2007) were included in our study and the last limitation is that we did not include the situational and motivational influences. They were controlled through keeping them constant, but it seems necessary to include them as additional measurements.

4.2 Implications for future research

The implications for future research are highly based on the limitations of our study. Firstly the anthropomorphism measurements of this study must be improved. It could also be possible to use different anthropomorphic measurements. Also a higher sample-size should be reached with regard to the Stroop priming task. Regarding the theory of Epley et al. (2007) the same or similar measurements should be used in order to be able to falsify or confirm their theory and all of their determinants should be included. With regard to the 'sociality motivation' it could be useful to include two conditions in the experimental setup: with one of them triggering a feeling of loneliness in the participants and one being the control condition. The loneliness-condition could include a role playing game were a group of people is isolating another person, in order to evoke a feeling of loneliness and isolation or the loneliness-condition could include different pictures and films with topics showing loneliness-related situations. Another implication for future research is that the expert knowledge has to be measured and not only approximated in order to be able to draw conclusions with certainty. This could be done for example by means of tests that resemble exams about programming and other technology and robot related topics in order to measure, whether the participants do have expert knowledge. With regard to the situational und motivational influences, future research could manipulate the situational and motivational aspects in one group and not in a control-group and then compare the two groups in order to measure what influence these motivational and situational factors have.

4.3 Conclusion

Based on the results of our study we are not able to conclude that individuals, who tend to 'geekism', thus those individuals with a high computer enthusiasm and a high need for cognition would tend to anthropomorphize robots less. We were also not able to find significant results with regard to the hypotheses that were formulated on the basis of the theory of Epley et al. (2007), in order to examine the possible reason, why these 'geeks' should anthropomorphize less. The results of this study seem to contradict the theory of Epley et al. (2007). However, the conclusions with regard to the theory of Epley et al. (2007) have to be made with caution, due to the various possible influences that could have influenced the participants and due to the limitations of this study. In order to be able to conclude that Epley et al. (2007) err in their assumption or that their theory is not applicable to ‘geeks’, future research has to eliminate the limitations of this study and has to include all aspects of the theory of Epley et al. (2007). However, we were able to find a significant, weakly positive, but almost moderate, correlation between the computer enthusiasm and need for cognition, what seems to be in accordance with the assumption of Schmettow and Drees (2014) and should be kept in mind for future research.

5. References

Balota, D. a., & Lorch, R. F. (1986). Depth of automatic spreading activation: Mediated priming effects in pronunciation but not in lexical decision. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *12*(3), 336–345. doi:10.1037//0278-7393.12.3.336

Bartneck, C., Kulić, D., Croft, E., & Zoghbi, S. (2008). Measurement Instruments for the Anthropomorphism, Animacy, Likeability, Perceived Intelligence, and Perceived Safety of Robots. *International Journal of Social Robotics*, *1*(1), 71–81. doi:10.1007/s12369-008-0001-3

Breazeal, C. (2003). Emotion and sociable humanoid robots. *International Journal of Human-Computer Studies*, *59*(1-2), 119–155. Doi:10.1016/S1071-5819(03)00018-1

Cacioppo, J. T., & Petty, R. E. (1982). The need for cognition. *Journal of Personality and Social Psychology*, *42*(1), 116–131. doi:10.1037/0022-3514.42.1.116

Cacioppo, J. T., Petty, R. E., Feinstein, J. a., & Jarvis, W. B. G. (1996). Dispositional differences in cognitive motivation: The life and times of individuals varying in need for cognition. *Psychological Bulletin*, *119*(2), 197–253. doi:10.1037//0033-2909.119.2.197

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

Caporael, L. (1986). Anthropomorphism and mechanomorphism: Two faces of the human machine. *Computers in Human Behavior*, *2*, 215–234. Retrieved from http://www.sciencedirect.com/science/article/pii/074756328690004X

De Graaf, M. M. A., & Ben Allouch, S. (2013). Exploring influencing variables for the acceptance of social robots. *Robotics and Autonomous Systems*, *61*(12), 1476–1486. doi:10.1016/j.robot.2013.07.007

Duffy, B. R. (2002). Anthropomorphism and Robotics. *The Society for the Study of Artificial Intelligence and …*, 3–5. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.60.297&rep=rep1&type=pdf

Epley, N., Keysar, B., Van Boven, L., & Gilovich, T. (2004). Perspective taking as egocentric anchoring and adjustment. *Journal of Personality and Social Psychology*, *87*(3), 327–39. doi:10.1037/0022-3514.87.3.327

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

Festinger, L. (1957). *A Theory of Cognitive Dissonance*. Stanford, California: Stanford University Press.

Fink, J. (2012). Anthropomorphism and human likeness in the design of robots and human-robot interaction. *Social Robotics*, 199–208. Retrieved from http://link.springer.com/chapter/10.1007/978-3-642-34103-8_20

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

Lee, K., Kaloutsakis, G., & Couch, J. (2009). Towards social-therapeutic robots: How to strategically implement a robot for social group therapy? *2009 IEEE International Symposium on Computational Intelligence in Robotics and Automation - (CIRA)*, 60–65. doi:10.1109/CIRA.2009.5423241

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. (2011). Item selection and validation of a brief, 15-item version of the Need for Closure Scale. *Personality and Individual Differences*, *50*(1), 90–94. doi:10.1016/j.paid.2010.09.004

Rogers, E. (2004). HUMAN FACTORS HUMAN-ROBOT. *Berkshire Encyclopedia of Human-Computer Interaction*, 328–332.

Schmettow, M., & Drees, M. (2014). What drives the geeks ? Linking computer enthusiasm to achievement goals. *BCS Learning and Development Ltd.*

Schmettow, M., Noordzij, M., & Mundt, M. (2013). An implicit test of UX: individuals differ in what they associate with computers. *CHI '13 Extended Abstracts on Human Factors in Computing Systems on - CHI EA '13, ACM Press*, 2039–2048. Retrieved from http://dl.acm.org/citation.cfm?id=2468722

Schmettow, M., & Passlick, F. (2013). *Being Geek - An attempt at building a theory of geekism*. University of Twente.

Schmettow, M., & Sander, N. (2013). *The Construction and Evaluation of a Questionnaire Measuring Geekism*. University of Twente.

Stroop, J. R. (1992). Studies of Interference in Serial Verbal Reactions (Reprint). *Journal of Experimental Psychology*, *121*(1), 15–23.
(Original version printed in 1935)

Thompson, E. P., Chaiken, S., & Hazlewood, J. D. (1993). Need for cognition and desire for control as moderators of extrinsic reward effects: A person× situation approach to the study of intrinsic motivation. *Journal of Personality and …*, *64*(6), 987–999. Retrieved from http://psycnet.apa.org/journals/psp/64/6/987/

Tulving, E., & Schacter, D. (1990). Priming and human memory systems. *Science*, *247*(4940), 301–306. Retrieved from http://www.sciencemag.org/content/247/4940/301.short

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

Webster, D. M., & Kruglanski, A. W. (1997). Cognitive and Social Consequences of the Need for Cognitive Closure. *European Review of Social Psychology*, *8*(1), 133–173. doi:10.1080/14792779643000100

Young, J. E., Hawkins, R., Sharlin, E., & Igarashi, T. (2008). Toward Acceptable Domestic Robots: Applying Insights from Social Psychology. *International Journal of Social Robotics*, *1*(1), 95–108. doi:10.1007/s12369-008-0006-y

Zou, K., Tuncali, K., & Silverman, S. (2003). Correlation and Simple Linear Regression 1. *Radiology*, 617–622. Retrieved from http://pubs.rsna.org/doi/abs/10.1148/radiol.2273011499

6. Appendix

6.1 Syntax

Syntax – Descriptives/Demographics

```
GET
  STATA FILE='W:\Groups\BA Electric sheep\Data\D4.dta'.
DATASET NAME DataSet1 WINDOW=FRONT.

RECODE Study ('1'=2) ('2'=2) ('3'=2) ('4'=2) ('5'=2) ('6'=1) ('7'=2)
('8'=1) ('9'=2) ('10'=1) ('11'=2) ('12'=1) ('13'=2) ('14'=2) ('15'=2)
('16'=2) ('17'=2) ('18'=2) INTO Knowledge.
VARIABLE LABELS  Knowledge 'Knowledge'.
EXECUTE.
RECODE TypeOfStudy ('Tech'=2) ('Social'=1) INTO Knowledge.
VARIABLE LABELS  Knowledge 'Knowledge'.
EXECUTE.
FREQUENCIES VARIABLES=Nationality Gender Age
  /STATISTICS=STDDEV MINIMUM MAXIMUM MEAN MEDIAN
  /ORDER=ANALYSIS.

DESCRIPTIVES VARIABLES=Gex NCS NCCR CloseMind Decisive DiscomAmb PrefOrder
PrefPredict
  /STATISTICS=MEAN STDDEV MIN MAX.

CROSSTABS
  /TABLES=Gender BY Knowledge
  /FORMAT=AVALUE TABLES
  /CELLS=COUNT
  /COUNT ROUND CELL.
```

Syntax – Correlational Analyses

```
CORRELATIONS
  /VARIABLES=Gex NCS NCCR Knowledge CloseMind Decisive DiscomAmb PrefOrder
PrefPredict Gender
  /PRINT=TWOTAIL NOSIG
  /STATISTICS DESCRIPTIVES
  /MISSING=PAIRWISE.


* Chart Builder.
GGRAPH
  /GRAPHDATASET NAME="graphdataset" VARIABLES=NCS NCCR MISSING=LISTWISE
REPORTMISSING=NO
  /GRAPHSPEC SOURCE=INLINE.
BEGIN GPL
  SOURCE: s=userSource(id("graphdataset"))
  DATA: NCS=col(source(s), name("NCS"))
  DATA: NCCR=col(source(s), name("NCCR"))
  GUIDE: axis(dim(1), label("NCS"))
  GUIDE: axis(dim(2), label("NCCR"))
  ELEMENT: point(position(NCS*NCCR))
END GPL.

* Chart Builder.
GGRAPH
  /GRAPHDATASET NAME="graphdataset" VARIABLES=Knowledge NCS
MISSING=LISTWISE REPORTMISSING=NO
  /GRAPHSPEC SOURCE=INLINE.
```

```
BEGIN GPL
  SOURCE: s=userSource(id("graphdataset"))
  DATA: Knowledge=col(source(s), name("Knowledge"), unit.category())
  DATA: NCS=col(source(s), name("NCS"))
  GUIDE: axis(dim(1), label("Knowledge"))
  GUIDE: axis(dim(2), label("NCS"))
  SCALE: cat(dim(1), include("1", "2"))
  SCALE: linear(dim(2), include(0))
  ELEMENT: point(position(Knowledge*NCS))
END GPL.


* Chart Builder.
GGRAPH
  /GRAPHDATASET NAME="graphdataset" VARIABLES=NCS Gex MISSING=LISTWISE
REPORTMISSING=NO
  /GRAPHSPEC SOURCE=INLINE.
BEGIN GPL
  SOURCE: s=userSource(id("graphdataset"))
  DATA: NCS=col(source(s), name("NCS"))
  DATA: Gex=col(source(s), name("Gex"))
  GUIDE: axis(dim(1), label("NCS"))
  GUIDE: axis(dim(2), label("Gex"))
  ELEMENT: point(position(NCS*Gex))
END GPL.

* Chart Builder.
GGRAPH
  /GRAPHDATASET NAME="graphdataset" VARIABLES=Knowledge Gex
MISSING=LISTWISE REPORTMISSING=NO
  /GRAPHSPEC SOURCE=INLINE.
BEGIN GPL
  SOURCE: s=userSource(id("graphdataset"))
  DATA: Knowledge=col(source(s), name("Knowledge"), unit.category())
  DATA: Gex=col(source(s), name("Gex"))
  GUIDE: axis(dim(1), label("Knowledge"))
  GUIDE: axis(dim(2), label("Gex"))
  SCALE: cat(dim(1), include("1", "2"))
  SCALE: linear(dim(2), include(0))
  ELEMENT: point(position(Knowledge*Gex))
END GPL.

* Chart Builder.
GGRAPH
  /GRAPHDATASET NAME="graphdataset" VARIABLES=Knowledge NCCR
MISSING=LISTWISE REPORTMISSING=NO
  /GRAPHSPEC SOURCE=INLINE.
BEGIN GPL
  SOURCE: s=userSource(id("graphdataset"))
  DATA: Knowledge=col(source(s), name("Knowledge"), unit.category())
  DATA: NCCR=col(source(s), name("NCCR"))
  GUIDE: axis(dim(1), label("Knowledge"))
  GUIDE: axis(dim(2), label("NCCR"))
  SCALE: cat(dim(1), include("1", "2"))
  SCALE: linear(dim(2), include(0))
  ELEMENT: point(position(Knowledge*NCCR))
END GPL.
```

Syntax – Linear Mixed Effects Models (Humanness Index)

```
GET
```

```
  STATA FILE='W:\Groups\BA Electric sheep\Data\D3.dta'.
DATASET NAME DataSet2 WINDOW=FRONT.
RECODE Study (1=2) (2=2) (3=2) (4=2) (5=2) (6=1) (7=2) (8=1) (9=2) (10=1)
(11=2) (12=1) (13=2) (14=2) (15=2) (16=2) (17=2) (18=2) INTO Knowledge.
VARIABLE LABELS  Knowledge 'Knowledge'.
EXECUTE.

MIXED response BY Knowledge Gender 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=Knowledge Gender Gex NCS NCCR Knowledge*Gender Knowledge*Gex
Knowledge*NCS Knowledge*NCCR Gender*Gex Gender*NCS Gender*NCCR Gex*NCS
Gex*NCCR NCS*NCCR | SSTYPE(3)
  /METHOD=REML
  /PRINT=SOLUTION
  /RANDOM=INTERCEPT | SUBJECT(participant) COVTYPE(VC)
  /RANDOM=INTERCEPT | SUBJECT(prime) COVTYPE(VC).
```

Syntax – Linear Mixed Effects Model (Stroop)

```
GET
  STATA FILE='W:\Groups\BA Electric sheep\Data\D2.dta'.
DATASET NAME DataSet3 WINDOW=FRONT.
RECODE Study (1=2) (2=2) (3=2) (4=2) (5=2) (6=1) (7=2) (8=1) (9=2) (10=1)
(11=2) (12=1) (13=2) (14=2) (15=2) (16=2) (17=2) (18=2) INTO Knowledge.
VARIABLE LABELS  Knowledge 'Knowledge'.
EXECUTE.

MIXED RT BY Gender Knowledge wordCat 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=Gender Knowledge wordCat Gex NCS NCCR Gender*Knowledge
Gender*wordCat Gender*Gex Gender*NCS Gender*NCCR Knowledge*wordCat
Knowledge*Gex Knowledge*NCS Knowledge*NCCR wordCat*Gex wordCat*NCS
wordCat*NCCR Gex*NCS Gex*NCCR NCS*NCCR | SSTYPE(3)
  /METHOD=REML
  /PRINT=SOLUTION
  /RANDOM=INTERCEPT | SUBJECT(participant) COVTYPE(VC)
  /RANDOM=INTERCEPT | SUBJECT(targetWord) COVTYPE(VC)
  /RANDOM=INTERCEPT | SUBJECT(prime) COVTYPE(VC).
```

6.2 Questionnaires

The different questionnaires (NCS, NCCR etc.) merged into one.

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 disagree	O---O---O---O---O---O---O	completely 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 <u>don't</u> 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 <u>dis</u>like 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 <u>don't</u> 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 <u>dis</u>like questions which could be answered in many different ways.	completely disagree	O---O---O---O---O---O---O	completely agree
I <u>don't</u> 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 <u>not</u> 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		

‘Humanness Index’ – 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

[…]