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TECHNOLOGY ACCEPTANCE OF VOICE ASSISTANTS: ANTHROPOMORPHISM AS A FACTOR

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ABSTRACT

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Technology acceptance has been studied for years in information systems, to explain what factors influence technology adoption. These studies have resulted in different models, that explain the process from technical, and motivational point of view. This study attempts to build a model that explains technology acceptance, with the addition of anthropomorphism as a measured factor. This model is studied in the context of voice assistants.

This master's thesis consists of a literature review, and an empirical study. The literature review establishes the potential of anthropomorphism on user behavior. The review further identifies suitable measurements for anthropomorphism, and reviews existing technology acceptance models, to identify factors to be included in the research framework. The resulting framework combines system quality, perceived usefulness, perceived ease of use, social influence, and popularity with anthropomorphism, to see how these factors affect intention to use and user satisfaction. The framework also measures the features of the voice assistant, that cause anthropomorphism to occur, as well as user's dispositional factors. This framework is tested as a quantitative research.

Based on the results of the study, anthropomorphism did not have the expected influence on intention to use, or user satisfaction. Instead, the significant effects came from perceived usefulness, perceived ease of use and system quality. At the end of the thesis, the results are discussed and potential explanations to these results are considered. Topics for future research are also suggested.

Keywords: technology acceptance, anthropomorphism, intention to use, user satisfaction

TIIVISTELMÄ

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Teknologian omaksumista on tutkittu tietojärjestelmätieteissä vuosia, tarkoituksena selvittää mitkä tekijät vaikuttavat teknologian omaksumiseen. Nämä tutkimukset ovat tuottaneet erilaisia malleja, jotka selittävät tämän prosessin niin teknisestä, kuin motivaation näkökulmasta. Tämä tutkimus yrittää luoda mallin joka selittää teknologian omaksumisen, kun antropomorfismi on lisätty tekijäksi. Tätä mallia tutkitaan ääniavustajien kontekstissa.

Tämä pro-gradu tutkielma koostuu kirjallisuuskatsauksesta, sekä empiirisestä tutkimuksesta. Kirjallisuuskatsaus osoittaa antropomorfismin voivan vaikuttaa käyttäjän käyttäytymiseen. Lisäksi katsaus tunnistaa sopivia tekijöitä, joilla mitata antropomorfismia, sekä tarkastelee tekijöitä nykyisissä teknologian omaksumismalleissa uutta teoreettista viitekehystä varten. Tämän tuloksena syntyvä viitekehys yhdistää järjestelmän laadun, koetun hyödyllisyyden, koetun helppokäyttöisyyden, sosiaalisen vaikutuksen sekä suosittuuden antropomorfismin kanssa, jonka avulla voidaan nähdä miten nämä tekijät vaikuttavat käyttöaikomukseen ja käyttäjätyytyväisyyteen. Lisäksi tämä viitekehys mittaa antropomorfismia aiheuttavia ääniavustajan ominaisuuksia, sekä käyttäjän taipumuksellisia tekijöitä. Tätä viitekehystä tutkitaan kvantitatiivisena tutkimuksena.

Tutkimuksen tulosten perusteella, antropomorfismilla ei ollut odotettuja vaikutuksia käyttöaikomukseen tai käyttäjätyytyväisyyteen. Sen sijaan vaikuttavimmat tekijät olivat koettu hyödyllisyys, koettu helppokäyttöisyys sekä järjestelmän laatu. Tutkielman lopuksi näistä tuloksista keskustellaan, sekä mahdollisia selitysmalleja harkitaan. Tutkielma tarjoaa myös mahdollisia aiheita jatkotutkimukseen.

Asiasanat: teknologian omaksuminen, antropomorfismi, käyttöaikomus, käyttäjätyytyväisyys

PREFACE

The writing process of this thesis began in February 2015, from the initial idea of studying the adoption of voice assistants in popular smartphones. My interest in pursuing this topic stemmed from my fascination with virtual and artificial intelligence, as well as the recent technological developments in mobile devices. After conducting preliminary literature review and discussing the subject with my supervisor, Dr. Yixin Zhang, the topic evolved steadily to studying anthropomorphism in voice assistants, and how to include this aspect to technology acceptance models.

Conducting a quantitative research was a completely new experience to me, and I faced many challenges along the way. During the writing of this thesis, I learned much about hypothesis development process, creating questionnaires, collecting, analyzing, and assessing data, and using tools and applications, such as SmartPLS and Mendeley. The writing of this thesis was a great learning process that left me more knowledgeable and experienced.

I want to thank my supervisor, Dr. Yixin Zhang, for her enormous support and guidance during the writing of this thesis. Her help was invaluable, when the task felt insurmountable to me. She supported me through the challenges of this thesis, all the way from developing the topic, to the end. She tutored me how to approach the challenges, and taught me how to organize, schedule, plan, and carry out all the phases of the thesis writing process. She familiarized me with tools, such as SmartPLS and Mendeley, and showed me how to use these tools effectively. I could not have finished this thesis without her help.

I also want to thank Ryan Gilbert Garcia for his aid and support with Amazon Mechanical Turk and LimeSurvey platforms, which were used in conducting this research. His knowledge and experience with these sites made the data collection process reliable, timely, as well as a personally informative experience. With his aid, the data sample used in this study became reliably sizeable, and the demographics diverse.

Finally, I want to thank my friends for lending me their time and support, when I asked for feedback on my questionnaire. I also want to thank my family for encouraging me, and supporting me along the way.

FIGURES

TABLES

TABLE OF CONTENTS

1 INTRODUCTION

Speech has been argued to be the most natural and comfortable way to communicate (Tadeusiewicz, 2010). Potential benefits of using natural language to control technology can be seen in day to day use, for example while driving a car, when both hands are required to drive, or aiding users with disabilities or injuries, that prevent the use of traditional, touch-based interface. In 2016, estimated 1,5 billion smartphones have been sold to end users worldwide (Statista, 2017). Three of the largest smartphone operating systems, Android, iOS and Windows (Gartner, 2017) have integrated voice assistants as their features. A notable feature of voice assistants is their voice user interface, which allows the user to operate the mobile device without physical contact, to a certain extent. These features have also become more common in home appliances through devices like smart speakers (Amazon, 2017) (Harman Kardon, 2017), and desktops, in operating systems such as Windows 10 (Microsoft, 2017b).

There are several trends that support the inclusion of natural language in information systems. These trends include statistical language models, speaker verification technologies, multilingual applications, and personalization, which affect the flexibility of the communication, security through biometrics, and preferences through user's language and interests (Larson, 2011).

Other considerable research branch that studies natural language in information systems is in human-robot interaction, where robots are designed to be perceived humanlike in their behavior, both visually and aurally (Holzapfel, Mikut, & Burghart, 2008). Anthropomorphic perception of robots has been studied to affect the way humans react and behave, when they assign human characteristics to robots. Aspects such as trust (Waytz, Heafner, & Epley, 2014), likeability, and a feeling of comfort around a robot (Bartneck, Kulić, Croft, & Zoghbi, 2009) have been studied to be affected by how humanlike we perceive robots to be.

The purpose of this thesis is to study how anthropomorphism, the misattribution of human traits in non-human agents, influences user's behavior in technology acceptance. This study limits the examination of this phenomena to voice assistants. The technologies behind the voice assistants, speech recogni-

tion and text-to-speech, are also present in other voice based devices, but due to the possible differences in these applications, as well as the large group of potential users in smartphones owners, this study focuses on the popular voice assistants available in mobile devices.

1.1 Literature review

The first part of the thesis identifies relevant concepts and theories, with a literature review. The literature review was conducted by searching databases and portals such as IEEE Xplore, Google Scholar, SpringerLink, ProQuest and Finna-portal. The search itself focused on keywords and terms such as “technology acceptance”, "anthropomorphism" “brand”, “brand personality”, “perceived personality”, and “human-robot –interaction”. The search results were limited to the most relevant sources, which provide ample theoretical background for this research. For the purposes of defining voice assistants in this research, their respective company websites, as well as sites describing their features, are referenced. The literature review was conducted with the intention to answer these three research questions, that would aid the formation of the hypotheses:

- Does anthropomorphism in information systems influence user behavior?
- How can anthropomorphism be measured in voice assistants?
- What existing theories or models can be used to explain the technology acceptance of voice assistants?

1.2 Empirical research

Second part of the thesis contains the hypothesis development and the empirical study. After the literature review, a research framework was created to include anthropomorphism as a factor into a new model, that explains technology acceptance. Hypotheses were formed with the intention of testing the framework, by investigating the effect of anthropomorphism on user intention and satisfaction, in parallel with identified significant factors of prior technology acceptance models, called perceived usefulness, perceived ease of use and social influence. Other hypothesis tests included assessing the identified factors that cause anthropomorphism, in form of cues that activate anthropomorphism, as well as user's dispositional factors. Significance of system quality is also tested. The main research questions behind these hypotheses are:

- How does anthropomorphism contribute to user's behavioral intention to use a voice assistant?

- How does anthropomorphism contribute to user satisfaction, when using a voice assistant?

The empirical study was conducted as a quantitative research. A survey of 138 questions was created to measure the formed hypotheses, based on survey items found in literature, as well as some self-developed measurement items. The survey was created with LimeSurvey, and distributed through Amazon Mechanical Turk. A data sample of 183 participants was gathered with the survey. The data was analyzed with the aid of three software: Excel, SmartPLS and Stata.

The results of the empirical study are analyzed and the results of the hypothesis tests discussed. In the final chapter, the results are further reflected upon, and topics for future research are suggested.

2 CONCEPTS

In this chapter, key concepts are identified and defined from literature. The concepts that are defined for this research are voice assistant, anthropomorphism, brand personality, social presence, system quality and technology acceptance. Essential aspects are reviewed in these concepts, with the intention to uncover their relevance to this study. Theories related to these concepts; brand personality, anthropomorphism and technology acceptance will be further examined in the next chapter.

2.1 Voice assistant

Voice assistant is defined for this study as an intelligent software, which can perform tasks for the user through interaction with natural language, or a combination of natural language and touch-based interface. It can also respond to the user with natural language, that can be formed with a combination of text-to-speech and recorded lines. Depending on the device capabilities and user's settings, voice assistants can also be activated with voice from a locked state. The tasks they are capable of, include internet searches, controlling apps, such as messaging, weather, calendars, and photos (Apple, 2017). Some of the current voice assistants in the markets are also referred to as intelligent, personal, and virtual assistants (Apple, 2017) (Google, 2017) (Microsoft, 2017a). To use a uniform term in this research, they're only referred to as voice assistants from now on.

In the last years, voice assistants have become a common feature of mobile devices, such as smartphones and tablets, as well as desktops, with Windows 10 (Microsoft, 2017b). Voice assistants have also become a part of home appliances in smart speakers, such as Amazon Echo (Amazon, 2017) and Harman Kardon Invoke (Harman Kardon, 2017).

Through integration to the three of the most common smartphone operating systems (Gartner, 2017), they have become available to many new users, in

the last few years. However, the tasks assistants can perform, can most of the time be done alone with touch-based interface, which makes the use of voice assistants an optional choice for most people.

2.2 Anthropomorphism

Anthropomorphism can be defined as the tendency of people to imbue real or imagined behavior of nonhuman agents with human characteristics, motivations, intentions, or emotions (Epley, Waytz, & Cacioppo, 2007). In human-robot interaction, anthropomorphism has been defined as misattributing human traits, that the robot does not have, by attributing characteristics that are unproven and unlikely (Zawieska, Duffy, & Sprońska, 2012). Guthrie (1995) lists three types of anthropomorphism. Partial anthropomorphism refers to a situation when some human characteristics are recognized in an object, without thinking about the object as a real person. When a person considers the target of anthropomorphism to be an actual person, the term "literal anthropomorphism" is used. Accidental anthropomorphism can happen when a non-human object causes people to recognize human-like patterns, for example, a face in a cloud.

A research on humanlike robots by Złotowski, Strasser, and Bartneck (2014) suggested two dimensions of anthropomorphism; uniquely human, and human nature. The first dimension included traits that implied high cognition, and were listed as broadminded, humble, organized, polite, thorough, cold, conservative, hard-hearted, rude, and shallow. Removing the traits from this dimension was considered to lead to an animal-like perception of humans. The traits included in the second dimension, implied emotionality, and were listed as curious, friendly, fun-loving, sociable, trusting, aggressive, distractible, impatient, jealous, and nervous. Removing the traits from this dimension lead to a perception, that the agent lacks empathy. The research found that feedback, that was perceived as emotional, made the robot appear more humanlike, unlike the perception of intelligence. Intelligence, in the context of robotics, was noted to make a robot appear lifelike, but not necessarily humanlike. The research considered, that intelligence might be a characteristic that people already expect from robots, and does not necessarily contribute to anthropomorphism in their context.

Audio cues that activate anthropomorphism have also been examined in research on robotics. In a study by Eyssel, Kuchenbrandt, Hegel, and De Ruiter (2012), the effect of vocal cues provided by a robot was studied with synthetic and human-like voice, as well as giving the robot a voice that reflected gender. One of the notions of the study was that hearing familiar features in a robot's voice would activate observer's elicited agent knowledge, leading to anthropomorphism. The study found that when a robot was given a human-like voice, it received higher ratings on likeability. Another effect was also identified, in which the participants experienced more psychological closeness to a same-sex robot than towards a robot representing opposite sex.

Chandler and Schwarz (2010) studied how anthropomorphism affected consumers' intentions when it came to replacing a product. In the research, owners of cars were primed by having one group rate their cars with personality traits, such as enthusiastic, sympathetic, dependable, open to new experiences and calm. Another group was asked to rate their cars with non-anthropomorphic attributes, such as loud, responsive, reliable, versatile, and smooth. The control group did not rate their cars at all. Anthropomorphism was found to have an effect on the participants' replacement intentions. The research suggested a lower intention to replace a car, when the owner had considered their car with anthropomorphic traits. The quality of the car also had less weight on replacement decision, after the priming. However, Chandler and Schwarz (2010) note that in their experiment, anthropomorphic priming could have accidentally primed other positive characteristics in the cars, making the effect of anthropomorphizing more indirect, rather than direct.

Waytz, Heafner, and Epley (2014) studied how anthropomorphism influenced people's attitudes in the context of autonomous vehicles in simulator conditions. In their experiment, they assigned the participants to normal condition, agentic condition, and anthropomorphic condition. Members of the normal group drove a vehicle themselves, agentic group with a vehicle controlling the steering and speed, while in the anthropomorphic group the vehicle was named, gendered, and voiced, in addition to the autonomous qualities. The test involved driving a course, which included one unavoidable accident, caused by another vehicle. The results of this test showed that the participants liked, trusted the anthropomorphic vehicle more, but also blamed the autonomous vehicle for the accident.

Bartneck et al., (2009) studied measurements of key concepts in human-robot interaction by reviewing anthropomorphism, as well as animacy, likeability, perceived intelligence, and perceived safety. Idea behind this study was to build standardized measurement scales, with which to measure perceived human-likeness in robots. This research suggests that anthropomorphism in robotics could be further studied by measuring observer's impressions on the animacy of the robot, impressions on the likeability of the robot, and perceived intelligence and perceived safety of the robot. From developers' point of view, a robot with high anthropomorphism on all scales, would calm and relax the observer, while appearing intelligent, likeable, and have lifelike movement.

In this study, anthropomorphism is studied in how voice assistants can cause a user to perceive humanlike attributes. Literature suggests there exists effects on user and consumer behavior, based on how well the non-human agent triggers a misattribution of humanlike traits to the user. Literature numbers different visual and audio cues that influence anthropomorphism when people interact with robots. Voice assistants lack similar visual cues, but they provide audio cues in the same way as robots. Audio cues in a voice assistant could cause an anthropomorphic priming in a user, by providing cues from recorded audio or convincing text-to-speech.

2.3 Brand personality

A brand is defined as a way for a company to differentiate themselves, their products, or services. Brand personality is defined as a set of human characteristics associated with a brand (Aaker, 1997). Brands can be described with adjectives, often used to describe human personality traits, such as daring and intelligent.

Wee (2004) described ways to manipulate this perception through attributes such as the name, symbols, signs, logos, music, type of endorsers, imagery, layout, use of provocation and humor. Considerable impact on consumer perception has been found typically in product design and colors (Seimiene & Kamarauskaite, 2014). Seimiene and Kamarauskaite (2014) researched how the brand personality was influenced based on bottle designs of several brands of beer, by interviewing 15 people on their perceptions. They made findings, such as that the design could make the brand appear refined, or having a high social status. Labels with dark and dirty red colors were assigned with an aggressive personality. Designs that had remained the same for a long period of time were perceived to be stubborn and closed to the world.

A brand can also be extended from a parent brand, by moving existing brand beliefs and attitudes to closely related brands (Aaker & Keller, 1990). A brand extension means the use of brand associations which are transferred to new brands. Parent brand could be one associated with a certain category of products, while an extension is a new product. Brand extension strategies can be applied for example by direct or indirect naming strategies (Nhat Hanh Le, Ming Sung Cheng, Hua Lee, & Jain, 2012). For instance, following this line of thought, Apple iPhone could be considered a direct extension, which transfers associations from Apple's parent brand to iPhone's specific brand.

The effect of brand personality on consumer behavior has been studied by Aaker, Fournier, and Brasel (2004) through consumer-brand relationships. The results of the study suggested that in the absence of a transgression, brands perceived as sincere developed stronger relationships with the customers, like a close friendship. However, when a transgression occurred in the relationship, sincere brands recovered much more slowly than brands that were considered exciting.

Alike to anthropomorphism, the concept of brand personality revolves around the idea of misattributing human traits to brands, which the brands do not have.

2.4 Social Presence

Social presence has been defined as the feeling of warmth and sociability, conveyed through a medium (Hess, Fuller, & Campbell, 2009). According to Lombard and Ditton (2006), social presence explains how people perceive a

medium as sociable, warm, sensitive, personal or intimate. Biocca, Harms, and Burgoon (2003) defined social presence as a sense of being with another.

When social presence is studied in computer-human interaction, the sense of being with another can be conveyed through an interface, by artificially representing another human or intelligence (Biocca et al., 2003). Social presence in information systems has been studied in product recommendation agents in online shopping, in which the website's design and characteristics would make the shopper perceive a social presence, for example through live chat and online reviews (Cyr, Hassanein, Head, & Ivanov, 2006), but also by humanoid embodiment and voice output (Qiu & Benbasat, 2009). According to Biocca et al. (2003), as social beings, humans want to increase the sense of social presence, by seeking sociality. This would make a website with a strong social presence become more appealing to a user, who is seeking sociality.

2.5 System quality

System quality has been identified to be a category of information system success (Delone & Mclean, 1992). Other categories of information system success included information quality, use, user satisfaction, individual impact, and organizational impact. System quality is a technical dimension that denotes the characteristics of the information system, that produces the information.

System quality has been measured by assessing its characteristics, such as efficiency, accuracy, access, usefulness, flexibility, reliability, and response times (Delone & Mclean, 1992). Along with information quality, these categories affect the use of the information system, as well as user satisfaction.

2.6 Technology acceptance

Technology acceptance refers to the process of user's adoption of new technologies. Theories behind the psychology of this behavior include the theory of reasoned action (Fishbein & Ajzen, 1980) and the theory of planned behavior (Ajzen, 1985). Theoretical models that explain human behavior have been applied to different contexts. The theories that explain this behavior include antecedents and moderating factors that contribute to people's behavior.

Regarding the behavior that leads a person to use information system technologies, several theories have been made. A famous such model is the technology acceptance model, created by Davis (1985), which uses perceived usefulness and perceived ease of use as measurements to determine user's behavioral intention to use a technology. This theory has been further developed for different contexts by adding other measurements, such as hedonic motivation, social influence, as well as variables such as age and gender (Venkatesh, Thong, & Xu, 2012). Technology acceptance can also be measured with the

technical dimension of an information system, as part of information system success. A model was created by Delone and Mclean (1992), called I/S success model, that focused on aspects of system quality and information quality. This model has been later revised, with the inclusion of service quality as a factor (Delone & Mclean, 2003). These theories will be further examined in the next chapter.

3 THEORIES

Following the review on the concepts, several theories and models were examined from existing literature. The first theory to be reviewed is the dimensions of brand personality (Aaker, 1997), which divides perceived personality traits in brands into categories, based on human personality dimensions. The second theory, three-factor theory of anthropomorphism (Epley et al., 2007), can be used to explain the likeliness of anthropomorphism to occur, based on three psychological determinants. Finally, theories on information system success and technology acceptance are studied, to review how technology acceptance has been measured from different aspects.

3.1 Dimensions of brand personality

The model for dimensions of brand personality (figure 1) was created by Aaker (1997) as a framework for brand personality traits. The intention was to create a framework for brand personality based on the existing frameworks discussed in psychology on human personality. The resulting model was based on the "Big Five" personality dimensions, which is commonly used in personality psychology. The personality dimensions in the "Big Five" have been listed as extraversion, emotional stability, agreeableness, conscientiousness, and openness to experience (Barrick & Mount, 1991).

The dimensions described in the "Big Five" cannot be used to describe brand personalities directly, as its dimensions describe actual human psychology, and because brands are designed, non-human agents. Aaker (1997) identified five dimensions of brand personality as sincerity, excitement, competence, sophistication, and ruggedness, that can be used in design of brands to create an illusion of personality. These dimensions are divided into multiple facets, that describe their dimensions as characteristic personality traits. Sincerity-dimension contained traits, listed as down-to-earth, honest, wholesome, and cheerful. Excitement-dimension covered daring, spirited, imaginative and up-

to-date. Competence-dimension comprised of reliable, intelligent, and successful. Sophistication-dimension had traits upper class and charming. Finally, ruggedness-dimension held the traits outdoorsy and tough.

As mentioned earlier in the literature review, when brand personality was defined, some of these dimensions have been studied to affect customer-brand relationships in different ways, depending on which dimension was perceived the strongest. Identifying the dimensions, and the effects of these dimensions can be used, when designing brands. An anthropomorphic perception of personality in the brand can also cause emotional attachment in the consumer, and move their attention away from more typical, non-anthropomorphized concerns, such as object quality (Chandler, 2010).

FIGURE 1 Dimensions of brand personality (Aaker, 1997)

3.2 Three-factor theory of anthropomorphism

According to (Epley et al., 2007), the extent of anthropomorphism can be predicted by studying a three part process. First part is the likelihood of knowledge activation about humans, when examining non-human objects. The second part is the likelihood of correcting and adjusting anthropomorphic representations, to accommodate nonanthropomorphic knowledge about nonhuman agents. Third part is the likelihood of applying activated and corrected anthropomorphic representations to non-human agents.

Epley et al. (2007) created a psychological three-factor theory of anthropomorphism, which can be used to predict the likeliness of people to anthropomorphize nonhuman agents. According to the theory, there are three key psychological determinants affecting anthropomorphism. These factors are elicited agent knowledge, effectance motivation and sociality motivation. These factors have been further divided into dispositional, situational, developmental, and cultural categories.

According to the theory, elicited agent knowledge is the primary factor of the three. It refers to a person's knowledge about human characteristics and traits, in themselves, or in humans in general (Epley et al., 2007). This knowledge can be activated by cues, which would prompt anthropomorphism to occur, for example by distinguishing human features in a non-human agent (Eyssel et al., 2012).

Elicited agent knowledge works together with two motivational mechanisms. In the context of anthropomorphism, effectance motivation is considered to indicate the motivation to interact effectively with the perceived, nonhuman agent. People have a psychological tendency to give human traits to nonhuman agents to help understand their actions and motivations. When this motivation is high, so is the likeliness to anthropomorphize. (Epley et al., 2007)

The third factor, sociality motivation, refers to the human need to create social connections. The motivation to form these connections exists, even if the target of social connection was nonhuman. According to Gardner, Pickett, Jefferis, and Knowles (2005), sociality motivation increases the accessibility of social cues, such as humanlike traits and characteristics. Sociality motivation also increases the likeliness of anthropomorphizing nonhuman agents, when a person is feeling socially isolated or lonely (Epley et al., 2007).

The theory also suggested dispositional, situational, developmental, and cultural aspects to these factors. These facets create depth to the three dimensions by considering how disposition of the person, their situation during the examined anthropomorphic experience, their psychological development, and culture, can affect the level of anthropomorphism. For example, dispositional factors affecting anthropomorphism, suggested by the theory, included aspects such as need for cognition and chronic loneliness. According to the research, people who have a high need for cognition tend to enjoy effortful thinking, and are more likely to consider alternative nonanthropomorphic representations when faced with elicited agent knowledge. This means people with high need for cognition would be less likely to anthropomorphize a non-human agent. Dispositional, chronic loneliness, is also predicted to influence anthropomorphism, when a person is motivated to create a social connection (Epley et al., 2007).

3.3 Theories regarding technology acceptance and use

Theories and models pertaining technology acceptance and use exist to predict and explain why people adopt technologies. Technology acceptance has been widely researched, and has accumulated several models to explain the phenomenon. These models explain how the effects of external variables, as well as user's perceptions and beliefs, have on their attitudes to use a technology or information system. Variations of the models exist to account the difference of context, by adding, replacing, or removing explaining constructs. The first model to be reviewed is the updated information success model (Delone &

Mclean, 2003), which among other aspects, examines variables from technical dimension. Second model to be reviewed is the technology acceptance model (Davis, 1985), which instead of technical dimensions, focuses on psychological motivational processes. Third model is the unified theory of acceptance and use of technology, UTAUT (Venkatesh, Morris, Davis, & Davis, 2003), and its more recent modification, UTAUT2 (Venkatesh, Thong, & Xu, 2012).

3.3.1 Information system success

Delone and Mclean (2003) proposed metrics for assessing the success of an information system, by defining metrics under six different categories. In their study, they applied these measurements to evaluate the success of an e-commerce system. System quality was measured with technical properties, identified in this context as usability, availability, reliability, adaptability, and response time. Second category is called information quality, which includes completeness, ease of understanding, personalization, relevance, and security. Third category is mentioned as service quality, which contains assurance, empathy, and responsiveness. Fourth category, use, involves nature of use, navigation patterns, number of site visits and number of transactions executed. Fifth category, user satisfaction, was measured with repeat purchases, repeat visits, and user surveys. Finally, sixth category called net benefits, was measured with cost savings, expanded markets, incremental additional sales, reduced search costs and time savings.

In their model, shown in figure 2, Delone and Mclean (2003) proposed a relationship, in which information quality, system quality and service quality are related to intention to use, as well as user satisfaction. The attitude, intention to use, causes actual use behavior, which also has an influence on user satisfaction. User satisfaction further influences intention to use. Use, along with user satisfaction, is related to net benefits, which have a returning effect on intention to use, as well as user satisfaction. The relationship of these constructs was explained to be causal, in which high quality of an information system would be related to positive use, user satisfaction and net benefits, while low quality of the information system would lead to negative results.

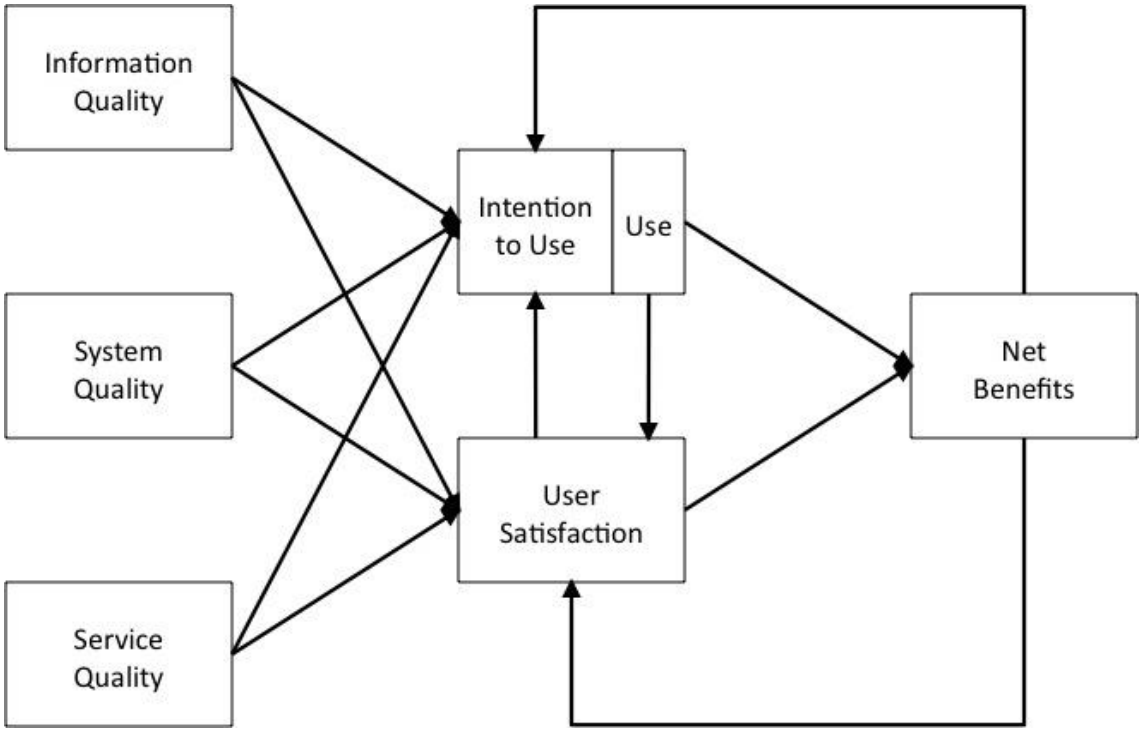

FIGURE 2 Updated D&M IS Success Model (Delone & Mclean, 2003)

3.3.2 Technology acceptance model

Technology acceptance model was created by Davis (1985), to explain user acceptance of information systems, based on the perceptions caused by system's characteristics. The incentive of the theory was to support the design of information systems by making it possible to evaluate them before actual implementation.

The conceptual framework behind the technology acceptance model was designed to explain the motivational processes between an information system's features and capabilities, and the resulting information system use. The design features of a system would result in a cognitive response from the user. This cognitive response is divided into two personal beliefs: perceived usefulness, and perceived ease of use. Perceived usefulness has been defined to mean the belief of a user, that the system would enhance their job performance. Perceived ease of use has been defined to explain the belief of a user, that the system they are using is free of physical and mental effort, to some degree. Perceived ease of use also influences the perceived usefulness of the system, as the user beliefs an easy-to-use system to increase their productivity. These two cognitive responses result in affective response, which in this framework was named attitude toward using. Ultimately this attitude would reflect in actual system use. As the theory focuses on the motivational process itself, it does not focus on measuring the system qualities, as much as user's own perceptions and

beliefs, influenced by those qualities. The model of this theory is presented in figure 3.

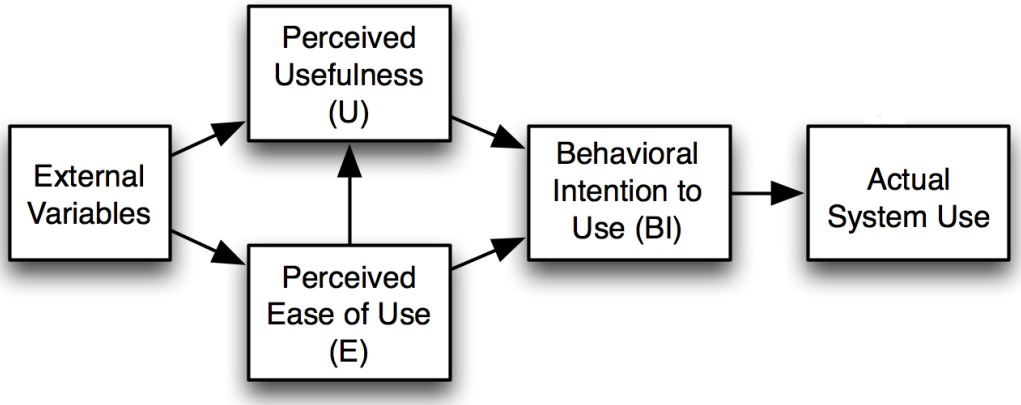

FIGURE 3 Technology Acceptance Model (Davis, 1985)

3.3.3 Unified theory of acceptance and use of technology

Unified theory of acceptance and use of technology by Venkatesh, Morris, Davis, and Davis (2003) was created by integrating eight models: theory of reasoned action, the technology acceptance model, the motivational model, the theory of planned behavior, the model of PC utilization, the innovation diffusion theory, and social cognitive theory. UTAUT consists of performance expectancy, effort expectancy, social influence and facilitating conditions, which lead to behavioral intention, and use behavior. Gender, age, experience, and voluntariness of use moderate these relationships.

UTAUT was created to understand technology acceptance and use in managerial context, when a new technology was introduced in an organization. A similar model was created to explain technology acceptance with same depth, but outside of managerial context, called UTAUT2 by Venkatesh, Thong, and Xu (2012). This model was created to explain technology acceptance in consumer context, which required alterations to the original UTAUT model. UTAUT2, as presented in figure 4, adds constructs such as hedonic motivation, price value and habit as constructs, while voluntariness of use is removed from moderating variables. This removal is due to the assumed voluntary acceptance and use behavior by consumers, as opposed to an organization, where an information system or technology could be a required aspect of a job.

Like in the technology acceptance model, performance expectancy and effort expectancy measure the same aspects as perceived usefulness and perceived ease of use. Social influence is defined to measure the extent of how much the user perceives that important others think they should use the technology (Venkatesh et al., 2003). Social influence, noted in the study by Venkatesh et al. (2003) to be referred to as subjective norm or social norm in

related theories, can also be construed to mean how user's belief of how they will be viewed for using a technology, affects their behavioral intention. Another aspect to social influence is how the use of technology affects the user's public image or status (Moore & Benbasat, 1991). If the technology is expected to enhance user's public image, it is assumed to increase their behavioral intention.

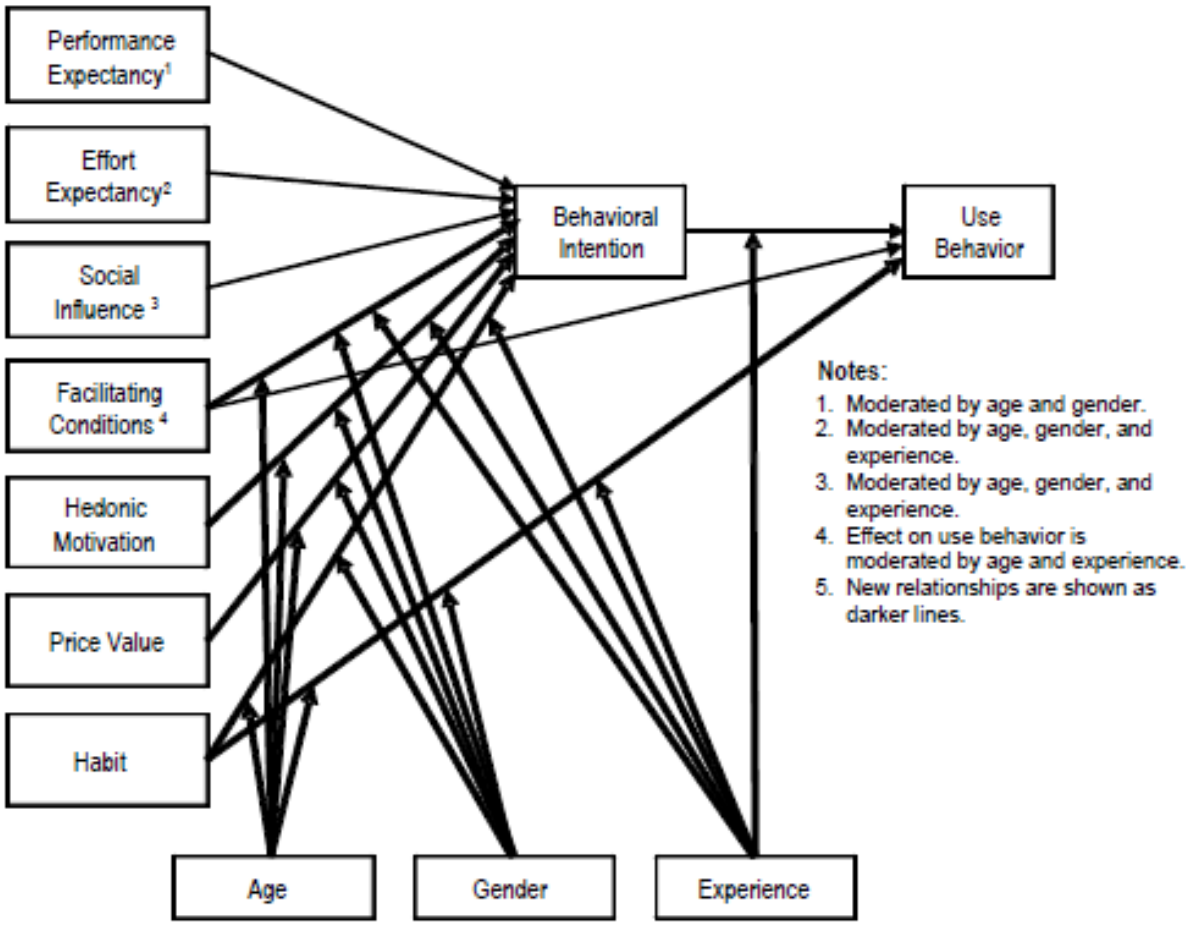

FIGURE 4 UTAUT2 (Venkatesh et al., 2012)

4 HYPOTHESIS DEVELOPMENT

Prior research states that anthropomorphism can have an impact on consumer's or user's behavior, when it's triggered successfully by cues. Typically, technology acceptance has been measured with models, such as the technology acceptance model and the unified theory of acceptance and use of technology, which do not directly consider the influence, that perceived anthropomorphism in a non-human agent could have on user's behavioral intention. Based on the literature review, a framework was created to combine aspects of technology acceptance models with anthropomorphism, while also measuring factors that can activate anthropomorphism in a user, through perceived anthropomorphic features, and user's dispositional factors. This framework is displayed in figure 5.

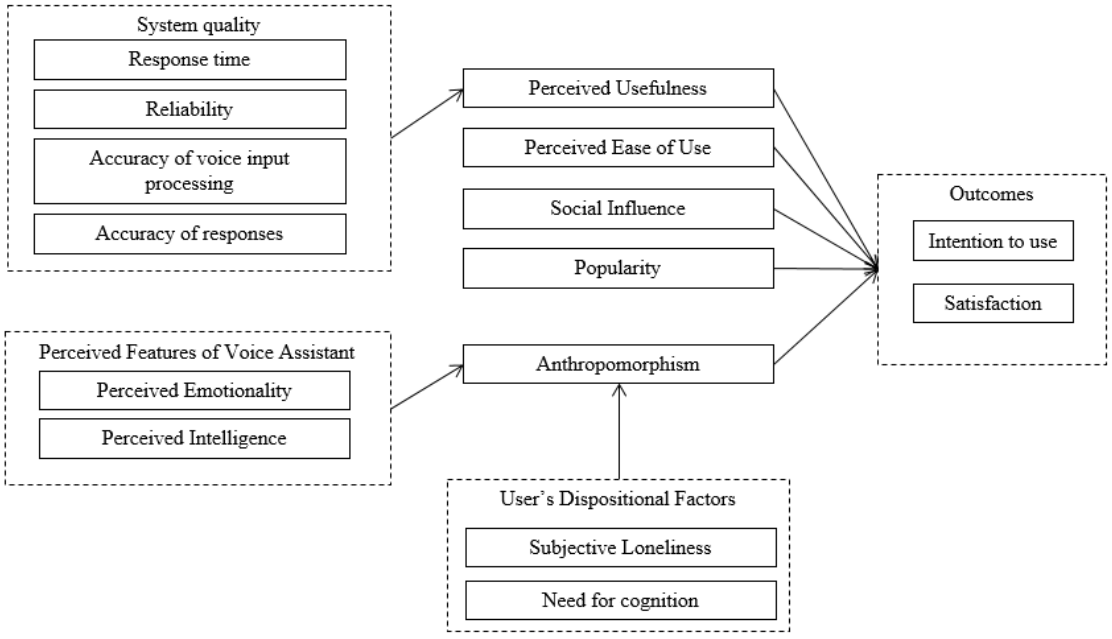

FIGURE 5 Research framework

4.1 Hypotheses on anthropomorphism

Anthropomorphism could have an impact on user's intention to use a voice assistant, as well as their user satisfaction. There are many different factors that can affect the likeliness of anthropomorphizing of voice assistants. In the literature, different possible measurements were reviewed with the intention to determine the level of anthropomorphism. For this research, concepts such as anthropomorphism in robotics, social presence, and brand personality, were assessed. To avoid multicollinearity, social presence and brand personality were dropped from the framework. Ultimately, two concepts from literature were chosen into the research model to measure perceived features of the voice assistant. These were the two dimension of anthropomorphism, human nature, and uniquely human, as mentioned by Złotowski et al. (2014), to represent perceived personality traits. These two dimensions form a large collection of personality traits together, which to some extent are also present in the other measuring concepts, such as the trait "sociable" in social presence, and "intelligent" in brand personality. Prior research in literature had established the anthropomorphizing effects of perceived emotion in robotics, caused by human nature traits. Perceived intelligence did not have a similar effect, but due to differences in context, this dimension is also studied. Two concepts were chosen for user's dispositional factors, based on the three-factor theory on anthropomorphism (Epley et al., 2007). These two concepts, need for cognition, as well as subjective loneliness, have been theorized to predict the likeliness of anthropomorphism to occur. These are expected to work as measurements to determine how well a voice assistant has been anthropomorphized.

4.1.1 Anthropomorphism as part of technology acceptance

The literature review established that anthropomorphism can have an effect on user- and consumer behavior. Literature identified anthropomorphism to have an influence on different aspects, such as lowering the intention to replace a product, or overall benefiting consumer-brand relationships and trust. The main hypothesis of this research is that anthropomorphism can take a place as a major factor in technology acceptance models. It is hypothesized, that anthropomorphism increases a user's intention to use voice assistants. We also hypothesize anthropomorphism to have a positive effect on user satisfaction.

H1a. Anthropomorphizing the voice assistant has a positive effect on user's intention to use a voice assistant.

H1b. Anthropomorphizing the voice assistant has a positive effect on user's satisfaction with a voice assistant.

4.1.2 Perceived Emotionality

The literature review established two dimensions of anthropomorphism, first one being human nature. Perceived personality traits belonging to this dimension imply emotionality, which according to Złotowski et al. (2014) can produce a sense of empathy and anthropomorphism in a non-human agent. This was also suggested to be the most affecting dimension to prompt anthropomorphism to occur, in the context of robotics. Similar effect is expected to occur in the context of voice assistants. Emotionality traits under the human nature -dimension are expected to cue anthropomorphism in a user. A following hypothesis is made:

H2. Emotional personality traits in the assistant, as perceived by the user, positively affect anthropomorphizing of the voice assistant.

4.1.3 Perceived Intelligence

The other dimension mentioned by Złotowski et al. (2014), called uniquely human, consists of personality traits that imply intelligence. In the context of robotics, this dimension did not increase anthropomorphism. However, voice assistant can be considered a different type of context. In robotics, it was speculated that users might expect intelligence from a robot, and thus not anthropomorphize when meeting these cues. Robots are also more complicated in the sense, that they provide both visual and aural cues, that can either cause or hinder anthropomorphism. Advancements in technology can make a voice assistant's text-to-speech appear natural. In addition, voice assistant lacks any visual cues that could cause a user to not anthropomorphize, for example an uncanny face or animacy. Instead, a user could sense a voice assistant to be just a voice in the phone. Based on the differences in context from robotics, we hypothesize perceived intelligence to also affect anthropomorphism. Following the same structure as with perceived emotionality, a hypothesis is formed:

H3. Intelligent personality traits in the assistant, as perceived by the user, positively affect anthropomorphizing of the voice assistant.

4.1.4 Subjective Loneliness

Epley et al. (2007) suggested psychological factors outside of anthropomorphized agent's own characteristics, that would affect the likeliness of people to anthropomorphize. One of these factors is chronic loneliness, which suggests that people who feel socially isolated, would be more likely to seek anthropomorphic qualities in nonhuman agents, motivated by their need for social connections. Based on this implication, we can assume that chronic loneliness would influence anthropomorphizing a voice assistant.

H4. User's subjective feeling of loneliness and social isolation positively affects anthropomorphizing of the voice assistant.

4.1.5 Need for cognition

Another psychological factor mentioned by Epley et al. (2007) is a person's need for cognition. According to Cacioppo, Petty, and Kao (1984), need for cognition refers to tendency to engage in and enjoy effortful cognitive endeavors. As a psychological factor in anthropomorphism, Epley et al. (2007) suggest a person with high need for cognition tends to rely less on available anthropomorphic information and is more likely to consider alternative representations. This means those in high need for cognition would be less likely to anthropomorphize, than those with low need for cognition.

H5. Users with high need for cognition are less likely to anthropomorphize a voice assistant.

4.2 Hypotheses on Technology Acceptance and Use

To measure the scale of possible influence of anthropomorphism on technology acceptance, it should be measured in parallel with more traditional models. Aspects like perceived usefulness, perceived ease of use and perceived social influence are used from both technology acceptance model and the unified theory of acceptance and use of technology. With social influence, we will also consider the effect of perceived popularity of the assistant, on the use intention and user satisfaction. These factors are expected to create a sufficient framework in which the effect of anthropomorphism can be evaluated in parallel with technology acceptance models. Perceived usefulness is further examined by measuring the design features through perceived quality of the system, with the assumption that different platforms for voice assistants can lead to differences in their performance.

4.2.1 System quality

User of an information system has expectations concerning its performance. One way to assess the performance quality of an information system, is to examine its performance metrics, usability, and design. A link between system quality and perceived usefulness of the system has been noted by Wixom and Todd (2005). In the context of a voice assistant, usefulness can be assessed by examining the quality of the system through based on interaction with it. This can be done by evaluating how well the voice assistant reacts to voice input, and how timely and relevant the output is for the user. If the voice assistant fails to perform according to user's expectations, they could return to using

regular manual input instead. As such, the quality of the voice assistant's system is expected to be crucial to its perceived usefulness.

H6. Voice assistant's system quality influences perceived usefulness of the voice assistant. Low quality of the interaction makes the assistant appear less useful to the user. Meanwhile, high quality of the voice assistant makes the voice assistant appear more useful.

4.2.2 Perceived usefulness

Perceived usefulness was mentioned in the literature review to be used as a measurement in technology acceptance model (Davis, 1985), as well as UTAUT (Venkatesh et al., 2003) and UTAUT2 (Venkatesh et al., 2012) models, where it was named performance expectancy. This difference was reviewed to only be in name, as they measure the same aspect. This facet comprises of usefulness beyond system quality, for example how well the user finds the voice assistant to increase their productivity. Based on the literature review, we make the following hypotheses:

H7a. Perceived usefulness of the voice assistant has a positive effect on user's intention to use a voice assistant.

H7b. Perceived usefulness of the voice assistant has a positive effect on user satisfaction.

4.2.3 Perceived ease of use

Perceived ease of use was defined as a measurement, on how much effort and how easy to use a technology was perceived to be (Davis, 1985). Also called effort expectancy in UTAUT and UTAUT2 models (Venkatesh et al., 2003) (Venkatesh et al., 2012), perceived ease of use describes how easy it is to use, or learn to use a technology, as well as how much mental or physical effort it is expected to cause. Based on the existing models this aspect is also hypothesized to influence the outcomes.

H8. Ease of use has a positive effect on user's intention to use a voice assistant.

H8b. Ease of use has a positive effect on user satisfaction.

4.2.4 Social influence

Social influence describes the influence, that people close to the user have regarding their technology use. If a user's entire family or a group of friends are perceived to encourage a user to use voice assistants, the pressure from the social norm can affect their behavioral intention. In addition to social influence affecting their intention to use, we hypothesize it to affect their user satisfaction. When there exists a perceived social influence to use a voice assistant, the user is more satisfied to have used the voice assistant.

H9a: Social influence has a positive effect on user's intention to use a voice assistant.

H9b. Social influence has a positive effect on user satisfaction.

Social influence could also be caused by perceived popularity of the voice assistant. In this case, a person would believe that using a voice assistant is common and widespread, without perceiving to be directly influenced by people important to them, making it socially and publicly normal and acceptable. Popularity could also affect their behavioral intention through perceived social status, when a person feels the adoption of a technology to enhance their status. This type of perceived popularity differs enough from close social influence, that we form a separate pair of hypotheses.

H9c. Perceived popularity has a positive effect on user's intention to use a voice assistant.

H9d. Perceived popularity has a positive effect on user satisfaction.

5 RESEARCH METHODOLOGY

Based on the literature and the formed research model, a survey was created to evaluate how anthropomorphism influences user's intention to use and user satisfaction on using voice assistants. The survey was designed to measure the respondent's technology acceptance, the level of anthropomorphism they feel toward the voice assistant as well as their psychological feelings on social isolation and need for cognition. Since most survey items concerned the user's own perception of the voice assistant, without the use of accurate metrics, seven-point Likert scales were used heavily. Some of the survey items were not used in the final research framework model, as during the data collection, the final included constructs were not yet identified.

5.1 Survey

Anthropomorphic perceptions were measured by surveying the way user perceive seemingly human features of the voice assistant. This requires separating the qualities the voice assistant has, from the ones that it only seems to have. This included aspects such as brand personality traits (Aaker, 1997), sense of social presence (Qiu & Benbasat, 2009), trust (Venkatesh, Thong, & Chan, 2016), likeability, intelligence and safety (Bartneck, Kulic & Croft, 2008), and dimensions implying emotion and intelligence (Złotowski et al., 2014). The survey used survey items from prior research in the field of robotics to measure users' impressions between the artificial and humanlike appearance of the assistant (Bartneck, Kulic & Croft, 2008). These sets of items were modified to measure a voice assistant, rather than a visual, moving robot, by not including items that measured animacy.

The survey consisted of 138 questions based on the research model, divided into nine groups. First group was demographics, which contained questions to determine the structure of the sample to be used as control variables. These questions determined respondents' age, gender, nationality, education, profes-

sion or occupation, device preferences, tenure, operating systems, perceived frequency of use, language, and voice-type preferences.

Second group focused on users' experiences on system quality, based on survey items by Palmer (2002), using seven-point Likert scale. Design, response times, and reliability are assumed to crucially influence the perceived usefulness of voice assistants. The original survey items were modified to represent the use of voice assistant.

Third group included survey items asking the respondents for their impressions related to perceived usefulness and perceived ease of use, hedonic motivation, and social influence, based on survey items found in literature on technology acceptance (Davis, 1989), (Venkatesh, Thong, & Xu, 2012), as well as self-developed measurement items on perceived popularity and user satisfaction, on a seven-point Likert scale. Also at the end of the third group, self-developed survey items were included for measuring users' impressions on the human-likeness of the voice, and their emotional attachment towards the assistant, on a seven-point Likert scale. This group of questions generates a basic idea on the traditional aspects of technology acceptance, making it easier to see if anthropomorphism has had any further effect on the usage of voice assistants.

Fourth group of questions focused on users' impressions on the social presence of the voice assistant (Qiu & Benbasat, 2009), and users' trust towards the assistant (Venkatesh et al., 2016), on a seven-point Likert scale. Based on the literature, it was assumed that perception of human warmth and sociability, as well as trust, could to some extent be used in measuring anthropomorphism.

Fifth and sixth group surveyed users' perceptions on the personality traits of the assistant. Based on the literature, both personality traits based on brand personality dimensions (Aaker, 1997) and perceived emotionality and intelligence traits, based on uniquely human and human nature (Złotowski et al., 2014) were used. These were all measured using a seven-point Likert scale.

Seventh group consisted of survey items on users' perceptions of how life-like or artificial the voice assistant seems to them, based on the Godspeed questionnaire of anthropomorphism in robotics (Bartneck, Kulic & Croft, 2008). These survey items used a five-point Likert scale.

Eighth group included survey items from the need for cognition -scale (Cacioppo et al., 1984), by selecting items that provide a relevant control variable, based on existing literature (Ho & Bodoff, 2014) Three of the selected items in need for cognition -scale were reversed score items.

The final group consisted of survey items from the UCLA Loneliness Scale (Russell, 1996) for measuring respondents subjective loneliness, as well as assessing how users' subjective loneliness affects the use of voice assistants. This scale was included with all its 20 items.

5.2 Sample

The survey was created on LimeSurvey, and distributed online on Amazon Mechanical Turk. Responses were asked from people who have had experiences with voice assistant -capable smart devices. The Mechanical Turk's settings were used to receive a total of 200 responses, by offering the respondents a reward between $0.20 and $0.30 based on region, while preventing same users from responding more than once. To create some diversity to the demographics, half of the responses were limited geographically to the United States, while the other half was open globally. Globally received responses were largely received from Indian respondents. 200 responses were received and 187 responses were chosen as the final sample, after removing responses that took less than half of the expected time to finish the survey. 51.37% of the remaining respondents were female and 48.63% male. Largest group of respondents by age, was ages 25-34 by 53.55%, followed by ages 35-44 by 21.86%. Largest group by education, based on respondent's highest degree, was bachelor's degree, by 46.99%, followed by master's degree, 24.59%. Most respondents used voice assistants on a smartphone, by 48.43%, while most common operating system was Google Android, by 44.69%. Duration of ownership of voice assistant capable devices was also surveyed. 28.96% of respondents had owned such a device for 1-2 years, followed by 21.31% for 3-4 years, and 20.22% for 2-3 years. An overview of the sample demographics is displayed in table 1.

TABLE 1 Sample Demographics

Variables	Options	Frequency	Percent
Gender	Male	89	48.63
	Female	94	51.37
Age	24 or less	14	7.65
	25-34	98	53.55
	35-44	40	21.86
	45-54	17	9.29
	55-64	12	6.56
	over 65	2	1.1
Nationality	US	68	37.16
	India	67	36.61
	Other	48	26.23
Education	Some school, no degree	1	0.55
	High school graduate	12	6.56
	Some college, no degree	31	16.94
	Bachelor's degree	86	46.99
	Master's degree	45	24.59
	Professional degree	6	3.28
	Doctorate degree	2	1.09

Device	Smartphone	123	48.43
	Tablet	39	15.35
	Desktop or laptop	85	33.46
	Other	7	2.76
Operating system	Apple iOS	69	30.53
	Google Android	101	44.69
	Microsoft Windows	50	22.12
	Other	6	2.65
Tenure	less than a year	28	15.30
	1-2 years	53	28.96
	2-3 years	37	20.22
	3-4 years	39	21.31
	4-5 years	12	6.56
	5-6 years	6	3.28
	6-7 years	2	1.09
	more than 7 years	6	3.28

5.3 The measurement model

The descriptive statistics of the analyzed constructs are presented in table 2. When assessing the results of the analysis, item loadings and internal consistencies should be greater than 0.70 (Fornell & Larcker, 1981).

As seen from confirmatory factor analysis, none of the items under the construct need for cognition (CG) reached high loadings. Under human nature (HN), items HN1, HN3, HN4, HN6, HN7 and HN8 did not show high loadings. Under subjective loneliness (LON), items LON1, LON3, LON6, LON11, LON13 and LON14 did not show high loadings. Under uniquely human (UH), items UH2, UH7 and UH8 did not show high loadings. Rest of the items under all constructs had values over 0.70. As seen from table 5, Composite reliability remained over 0.70 in all constructs. During the analysis, due to the high amount of low scoring item loadings, different approaches were attempted and the most problematic items removed to see if the loadings would cause considerably changes in the results. The results, however, did not change considerably, and the analyzed model was returned to its current state.

To assess discriminant validity, there are two steps that are followed. (Chin, 1998). First, indicators should have higher loadings in their corresponding constructs, than what their cross-loadings are. Secondly, the square root of the average variance extracted (AVE) should be higher than the inter-construct correlations.

As shown by the confirmatory factor analysis in table 3, there are some items that resulted in higher loadings outside their construct. Items HN4, UH7 and UH8 exhibited high loadings. Indicator HN4 had its highest loading under the construct UH, while indicators UH7 and UH8 had their highest loading un-

der the construct HN. All of these indicators had their second highest loadings in their corresponding constructs. These loadings could be explained by the perceived similarity of some of the personality traits in the anthropomorphic dimensions. Some traits that imply intelligence, could be perceived to also imply emotionality, to some extent. For the rest of the items, loadings were highest within their corresponding constructs, and did not create higher cross-loadings.

The inter-construct correlations are displayed in table 4. These values were created with SmartPLS by retrieving a table from latent variable correlations, and by adding the square root of AVE to compare with the other correlations. Similar to the first step, there is a deviation between the two anthropomorphic dimensions. The square roots of AVE for human nature and uniquely human did not generate largest values. Instead, the inter-construct correlations between uniquely human and human nature had the largest values, followed by their square root of AVE. Again, this could be explained by the similarity of the two groups. For every other construct, the square root of AVE was higher than inter-construct correlations.

TABLE 2 Descriptive Statistics

Variable	**Obs**	**Mean**	**Std. Dev.**
Intention to Use (INT)	183	5.57	1.18
Perceived Usefulness (USE)	183	4.88	1.35
Ease of Use (EASE)	183	5.44	1.21
Social Influence (SOC)	183	4.46	1.62
Popularity (POP)	183	4.96	1.25
Satisfaction (SAT)	183	5.02	1.31
System Quality (SYS)	183	5.31	1.03
Human Nature (HN)	183	3.49	1.32
Uniquely Human (UH)	183	4.13	1.15
Anthropomorphism (ANT)	183	4.65	1.56
Need for Cognition (CG)	183	3.13	0.64
Subjective Loneliness (LON)	183	3.04	0.71
Notes: All constructs are seven-point scales, apart from Need for Cognition and Subjective Loneliness, where 1 = Strongly disagree, 4 = Neutral, 7 = Strongly Agree. Need for Cognition is a five-point scale with 1 = Extremely uncharacteristic of me, 3 = Neutral, 5 = Extremely characteristic of me. Subjective Loneliness is a four-point scale, where 1 = I often feel this way, 4 = I never feel this way.			

TABLE 3 Results of Factor Analysis

	ANT	CG	EASE	HN	INT	LON	POP	SAT	SOC	SYS	UH	USE
ANT1	0,9065	0,5208	0,3663	0,7089	0,3058	0,1586	0,5093	0,5538	0,6167	0,3741	0,6525	0,5567
ANT2	0,9189	0,5163	0,606	0,6225	0,5338	0,1254	0,5481	0,687	0,57	0,5809	0,6557	0,6693
CG1	0,3301	0,6868	0,2688	0,3264	0,2264	0,1949	0,3147	0,3098	0,3234	0,2913	0,3722	0,3333
CG2	0,3512	0,6995	0,3876	0,2824	0,3114	0,1741	0,3967	0,4389	0,3684	0,329	0,2877	0,4118
CG3	0,2339	0,4277	0,096	0,3009	0,0725	0,0056	0,1949	0,1329	0,2534	0,1106	0,2657	0,1891
CG4	0,1649	0,3135	0,0603	0,2472	0,0796	-0,0529	0,211	0,1701	0,1845	0,1006	0,2973	0,1188
CG5	0,375	0,572	0,153	0,4318	0,1145	-0,0454	0,2905	0,3026	0,4609	0,1763	0,3973	0,2776
CG6	0,477	0,7607	0,3521	0,4054	0,4068	0,2433	0,3829	0,4369	0,3657	0,3419	0,4432	0,4172
EASE1	0,3786	0,3198	0,8832	0,2042	0,6148	0,2228	0,5126	0,5837	0,2967	0,6049	0,3087	0,5474
EASE2	0,5067	0,3844	0,8657	0,3043	0,6912	0,1361	0,6468	0,7317	0,3733	0,7044	0,3946	0,6495
EASE3	0,5331	0,3786	0,9214	0,3253	0,6449	0,2126	0,5614	0,7141	0,3924	0,7061	0,4218	0,6514
EASE4	0,4706	0,3314	0,8721	0,2772	0,5365	0,24	0,4886	0,6249	0,3992	0,6296	0,358	0,575
HN1	0,3931	0,3767	-0,0194	0,677	-0,0135	-0,0534	0,1885	0,2078	0,3762	0,0312	0,4628	0,2075
HN2	0,5399	0,443	0,2213	0,792	0,1798	-0,0341	0,45	0,3958	0,4728	0,2257	0,6819	0,4024
HN3	0,336	0,2566	-0,024	0,6128	0,0092	0,0755	0,1435	0,163	0,2742	-0,0025	0,4154	0,2141
HN4	0,5874	0,447	0,4413	0,6691	0,448	0,0961	0,492	0,5339	0,4233	0,4458	0,7202	0,5702
HN5	0,732	0,528	0,4566	0,8645	0,3987	0,0603	0,5566	0,5807	0,6176	0,3973	0,785	0,6064
HN6	0,3188	0,3186	-0,0166	0,6144	-0,0197	0,0194	0,1665	0,1893	0,3162	0,0249	0,4435	0,1937
HN7	0,3177	0,2905	-0,0969	0,5917	-0,1304	-0,0813	0,1093	0,126	0,2733	-0,0868	0,4088	0,1192
HN8	0,2845	0,1883	-0,1222	0,5292	-0,1523	-0,1081	0,0613	0,0798	0,2266	-0,0745	0,3329	0,0803
HN9	0,6718	0,4607	0,3968	0,8399	0,3624	0,0507	0,5276	0,5182	0,5178	0,3577	0,7706	0,5534
HN10	0,5942	0,4504	0,3476	0,7571	0,3298	0,0216	0,4577	0,5087	0,4306	0,3666	0,7144	0,5095
INT1	0,3773	0,3215	0,6253	0,2138	0,9109	0,0985	0,5356	0,5611	0,3129	0,6869	0,2884	0,6567
INT2	0,47	0,3648	0,6675	0,3099	0,9194	0,0956	0,5364	0,5926	0,3324	0,6106	0,364	0,6476
LON1	0,0452	0,0632	0,251	-0,0194	0,1728	0,3612	0,046	0,0875	-0,0049	0,2183	0,0328	0,0953
LON2	0,0339	0,0114	0,1642	-0,1069	0,0827	0,7345	0,0284	0,0925	0,0291	0,1313	-0,0395	0,1074
LON3	-0,0067	0,0648	0,249	-0,1078	0,1492	0,455	0,0435	0,1007	-0,0369	0,196	0,0116	0,0953

LON4	0,0838	0,1786	0,2611	-0,067	0,1646	0,7425	0,1329	0,2022	0,0823	0,1954	-0,0221	0,1632
LON5	0,114	0,1339	0,1616	0,0071	0,0015	0,7918	0,0636	0,1009	0,0926	0,1895	0,0997	0,0901
LON6	-0,0141	0,0738	0,0881	-0,063	0,0727	0,534	-0,033	0,0524	-0,0066	0,1837	-0,0161	0,0718
LON7	0,0408	0,0117	0,1977	-0,0887	0,1222	0,7619	0,0621	0,0915	0,0376	0,2104	-0,0186	0,0677
LON8	0,008	0,0271	0,1632	-0,1323	0,0675	0,7338	0,0292	0,0717	0,0442	0,2015	-0,0305	0,0684
LON9	0,1308	0,1574	0,1695	0,0769	0,0437	0,7756	0,1653	0,1563	0,1092	0,1402	0,0592	0,1414
LON10	0,0584	0,0929	0,1844	-0,0945	0,1064	0,7731	0,0214	0,1173	0,0187	0,222	-0,0321	0,0991
LON11	-0,082	0,0328	0,168	-0,2086	0,1011	0,6663	0,0399	0,0612	0,0163	0,1883	-0,125	0,0253
LON12	0,0634	0,0388	0,2073	-0,0987	0,1644	0,7457	0,0999	0,0929	0,0097	0,2191	-0,0488	0,0659
LON13	-0,0299	-0,0447	0,0641	-0,0737	-0,0141	0,6035	0,0201	0,0479	0,0139	0,1109	-0,0455	0,0356
LON14	-0,0638	0,0424	0,1923	-0,1717	0,098	0,5567	-0,002	0,0898	-0,0031	0,1855	-0,1189	0,0456
LON15	0,0686	0,156	0,0636	0,0314	-0,0148	0,7607	0,0628	0,0634	0,1	0,1033	0,0366	0,0759
LON16	0,0601	0,1202	0,1741	-0,0011	0,0503	0,7881	0,028	0,1441	0,1124	0,156	0,0032	0,1421
LON17	0,0255	0,0966	0,2478	-0,0601	0,1838	0,7121	0,0847	0,149	0,0591	0,2432	-0,0375	0,1668
LON18	0,114	0,1578	0,1355	0,0016	0,0951	0,8035	0,0737	0,0841	0,0719	0,0835	0,0024	0,094
LON19	0,0066	0,0343	0,1645	-0,0888	0,13	0,739	-0,0297	0,0676	-0,02	0,1917	-0,0512	0,0809
LON20	0,1044	0,1366	0,1718	-0,0174	0,094	0,8505	0,0722	0,1114	0,1251	0,2048	0,0224	0,1731
POP1	0,551	0,4812	0,6673	0,4794	0,6151	0,0775	0,8744	0,7509	0,623	0,6196	0,5084	0,6915
POP2	0,5365	0,4617	0,4442	0,5139	0,4074	0,1484	0,8567	0,6532	0,6955	0,3379	0,4813	0,6088
POP4	0,4037	0,3756	0,4878	0,3372	0,4684	0,0957	0,8618	0,6022	0,5496	0,3974	0,4038	0,5476
SAT1	0,5436	0,4571	0,6566	0,4171	0,5446	0,1747	0,6801	0,8991	0,5842	0,5886	0,5229	0,7367
SAT2	0,6221	0,4929	0,7176	0,4806	0,5919	0,1646	0,7233	0,9384	0,6391	0,6542	0,5334	0,7656
SAT3	0,6907	0,5332	0,6596	0,5813	0,5576	0,1116	0,7398	0,9246	0,7114	0,6155	0,6199	0,7796
SAT4	0,6592	0,4776	0,755	0,4972	0,6366	0,1477	0,7433	0,9377	0,6558	0,6701	0,5533	0,7996
SOC1	0,5988	0,5587	0,3986	0,5528	0,3382	0,1458	0,6836	0,6689	0,9299	0,426	0,5342	0,6283
SOC2	0,622	0,5182	0,3702	0,5698	0,3069	0,0858	0,6779	0,6347	0,9471	0,329	0,5234	0,6268
SOC3	0,6169	0,5086	0,4004	0,5501	0,3514	0,098	0,6762	0,6802	0,9535	0,3776	0,532	0,6547
SYS1	0,4962	0,4061	0,6074	0,3645	0,6123	0,1652	0,4888	0,625	0,414	0,8742	0,4322	0,6357
SYS2	0,4651	0,3242	0,584	0,3011	0,5837	0,1981	0,4485	0,5939	0,3446	0,8771	0,3645	0,5789
SYS3	0,4123	0,3129	0,6912	0,1762	0,5759	0,1721	0,4376	0,5645	0,3262	0,8085	0,3252	0,5277
SYS4	0,4015	0,3098	0,6785	0,2112	0,6321	0,1795	0,445	0,5265	0,258	0,8268	0,3849	0,5027

UH1	0,6239	0,3747	0,3072	0,7237	0,3016	0,049	0,4879	0,5027	0,4711	0,3222	0,7867	0,5219
UH2	0,2771	0,417	-0,0113	0,4519	-0,0023	0,1231	0,1626	0,1385	0,2629	0,0488	0,4853	0,1272
UH3	0,4807	0,4818	0,1957	0,6717	0,1335	-0,0042	0,3303	0,3365	0,3979	0,1982	0,7684	0,3036
UH4	0,6303	0,4759	0,2849	0,7427	0,2556	0,0524	0,4335	0,476	0,5119	0,3149	0,7842	0,4919
UH5	0,531	0,3666	0,544	0,4834	0,4559	0,0614	0,4691	0,5669	0,3855	0,5556	0,7241	0,5196
UH6	0,4508	0,381	0,4657	0,5002	0,4217	0,0717	0,4587	0,452	0,3373	0,4587	0,7158	0,4817
UH7	0,2482	0,2313	-0,1254	0,5403	-0,1526	-0,0556	0,0387	0,1036	0,2198	-0,1079	0,3774	0,1055
UH8	0,3277	0,3778	-0,0021	0,6017	-0,0773	-0,0089	0,1377	0,1663	0,276	-0,0116	0,5114	0,1973
UH9	0,5647	0,4279	0,5088	0,5433	0,4417	0,0377	0,4771	0,6058	0,4222	0,5469	0,7581	0,5581
USE1	0,576	0,4461	0,6638	0,4822	0,7089	0,1618	0,6339	0,768	0,5435	0,64	0,5121	0,9138
USE2	0,6302	0,5514	0,5601	0,5305	0,5918	0,15	0,6857	0,7524	0,707	0,5749	0,5818	0,884
USE3	0,6232	0,4378	0,6628	0,4965	0,678	0,1499	0,6105	0,7574	0,5635	0,6318	0,5372	0,9265
USE4	0,6284	0,4555	0,6141	0,5364	0,6105	0,1563	0,6961	0,759	0,6566	0,5785	0,5395	0,919

ANT = Anthropomorphism; CG = Need for Cognition; EASE = Ease of Use; HN = Human Nature; INT = Intention to Use; LON = Loneliness; POP = Popularity; SAT = Satisfaction; SOC = Social Influence; SYS = System Quality; UH = Uniquely Human; USE = Usefulness

TABLE 4 Inter-Construct Correlations

	ANT	CG	EASE	HN	INT	LON	POP	SAT	SOC	SYS	UH	USE
ANT	0,9127											
CG	0,5258	0,5983										
EASE	0,3663	0,3976	0,8859									
HN	0,7043	0,5621	0,3031	0,7030								
INT	0,3056	0,3694	0,7067	0,2741	0,9152							
LON	0,1946	0,1724	0,1717	0,0472	0,0686	0,7055						
POP	0,5093	0,5098	0,6289	0,5069	0,5856	0,1148	0,8643					
SAT	0,554	0,5287	0,7544	0,5268	0,6306	0,1437	0,7809	0,9251				
SOC	0,6167	0,5668	0,4135	0,5874	0,3527	0,1311	0,72	0,7018	0,9436			
SYS	0,3741	0,3992	0,7504	0,3058	0,708	0,169	0,5379	0,6841	0,4012	0,8472		
UH	0,6581	0,585	0,3937	0,8723	0,3315	0,0648	0,5285	0,5878	0,5635	0,4193	0,6729	
USE	0,5567	0,5162	0,6878	0,5503	0,7125	0,1563	0,7192	0,8335	0,6751	0,6666	0,5816	0,9109

TABLE 5 Quality Criteria

	AVE	Composite Reliability	Cronbachs Alpha
Anthropomorphism	0,8331	0,9089	0,7999
Need for Cognition	0,358	0,7566	0,6299
Ease of Use	0,7848	0,9358	0,9086
Human Nature	0,4942	0,9052	0,891
Intention to use	0,8376	0,9116	0,8062
Loneliness	0,4977	0,9505	0,9569
Popularity	0,747	0,8986	0,8323
Satisfaction	0,8558	0,9596	0,9438
Social Influence	0,8903	0,9605	0,9383
System Quality	0,7177	0,9104	0,8689
Uniquely Human	0,4528	0,8765	0,8437
Usefulness	0,8298	0,9512	0,9316

5.4 The structural model

In a PLS structural model, loadings of measures can be interpreted as loadings in principal components factor analysis (Agarwal & Karahanna, 2000). The paths can be interpreted as standardized beta weights in a regression analysis (Agarwal & Karahanna, 2000).

Demographic controls gathered during the survey, age, gender, nationality, education, device, operating system, and tenure, were examined during the data analysis. These were studied one by one, by measuring for any possible explanatory effects, when applied to intention to use, satisfaction, and anthropomorphism. This was done to find possible unexpected variables, that were not considered for the research framework or in the hypotheses. None of the demographics were found to have any significant explanatory value on any of the main constructs, and were not required for further analysis.

The constructs comprised of multiple measuring indicators, that were chosen from the data sample. These indicators were moved in SmartPLS under their respective constructs, based on the factors they measured, while making sure no additional measures from similar factors were included by mistake. No summated scales were used as indicators.

The results on total effects seen in table 6 were created with a bootstrapping algorithm provided by SmartPLS. Constructs with T-statistics above 1.96 are considered significant, and their path coefficients were studied to explain causal links between constructs.

The results of the analysis show that anthropomorphism, perceived usefulness, perceived ease of use, social influence and popularity explained 63.2% of the variance in intention to use, while together they explained 81.8% of the variance in user satisfaction. Uniquely human, human nature, need for cogni-

tion and subjective loneliness explained 59.5% of the variance in anthropomorphism. System quality explained 44.4% of the variance in usefulness.

TABLE 6 Total Effects

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	Standard Error (STERR)	T Statistics (|O/STERR|)
Anthropomorphism -> Intention to Use	-0,0062	-0,0161	0,0779	0,0779	0,0796
Anthropomorphism -> Satisfaction	0,0867	0,0905	0,0543	0,0543	1,5966
Need for Cognition -> Anthropomorphism	0,1718	0,1841	0,0632	0,0632	2,7178
Need for Cognition -> Intention to Use	-0,0011	-0,0036	0,0159	0,0159	0,0671
Need for Cognition -> Satisfaction	0,0149	0,0172	0,0131	0,0131	1,1389
Ease of Use -> Intention to Use	0,3334	0,3385	0,0949	0,0949	3,5137
Ease of Use -> Satisfaction	0,2988	0,2946	0,0585	0,0585	5,105
Human Nature -> Anthropomorphism	0,3967	0,3748	0,0954	0,0954	4,1572
Human Nature -> Intention to Use	-0,0025	-0,0058	0,0294	0,0294	0,0837
Human Nature -> Satisfaction	0,0344	0,0335	0,0216	0,0216	1,5891
Loneliness -> Anthropomorphism	0,099	0,0724	0,0985	0,0985	1,0055
Loneliness -> Intention to Use	-0,0006	-0,0019	0,0098	0,0098	0,0625
Loneliness -> Satisfaction	0,0086	0,0063	0,0107	0,0107	0,8023
Popularity -> Inten-	0,2002	0,2159	0,0977	0,0977	2,0484

tion to Use					
Popularity -> Satisfaction	0,1937	0,1962	0,0711	0,0711	2,7229
Social Influence -> Intention to Use	-0,2884	-0,2899	0,0848	0,0848	3,4027
Social Influence -> Satisfaction	0,1689	0,1652	0,0597	0,0597	2,8295
System Quality -> Intention to Use	0,3587	0,3548	0,0852	0,0852	4,2109
System Quality -> Satisfaction	0,2108	0,2123	0,0548	0,0548	3,8484
System Quality -> Usefulness	0,6667	0,6698	0,0391	0,0391	17,0659
Uniquely Human -> Anthropomorphism	0,2694	0,2793	0,1004	0,1004	2,6825
Uniquely Human -> Intention to Use	-0,0017	-0,0044	0,0241	0,0241	0,0694
Uniquely Human -> Satisfaction	0,0233	0,0257	0,0191	0,0191	1,2229
Usefulness -> Intention to Use	0,538	0,5285	0,1181	0,1181	4,557
Usefulness -> Satisfaction	0,3162	0,3162	0,0772	0,0772	4,0954

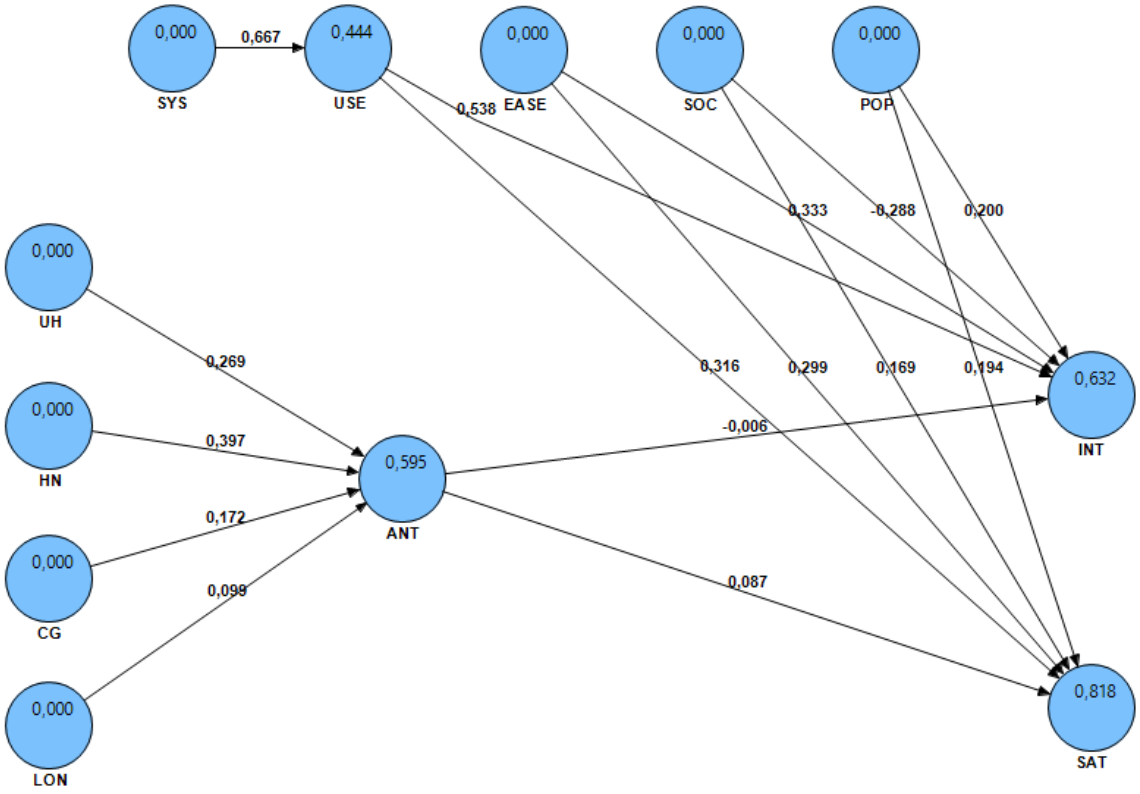

FIGURE 6 PLS model

6 RESULTS

As seen in table 6 for total results, intention to use was affected positively, in order from highest weight to lowest, by perceived usefulness (0.538), system quality (0.3587), perceived ease of use (0.3334), perceived popularity (0.2002) and negatively affected by social influence (-0.2884). User satisfaction was affected positively by perceived usefulness (0.3162), followed by ease of use (0.2988), system quality (0.2108), popularity (0.1937) and least by social influence (0.1689). Anthropomorphism is most affected positively by human nature (0.3967), followed by uniquely human (0,2694) and finally by user's need for cognition (0.1718). Perceived usefulness was positively influenced by system quality (0.6667). Summary of the hypotheses can be seen in table 7.

The main hypotheses stated that there is a positive effect from anthropomorphism towards intention to use and satisfaction. On both accounts, these hypotheses were not supported. The results show no significant effect from anthropomorphism towards intention to use or satisfaction. This could be explained by the overwhelming effect from other factors. For instance, perceived usefulness, which had the highest effect on intention to use and user satisfaction, appears to be much more important to a user than anthropomorphism in voice assistants. Technology is still developing and users might not find voice input to be necessarily a better option than manual input. It is possible, if technology develops to a point where usefulness and ease of use become obvious, anthropomorphism might become a more considerable factor.

Second hypothesis stated that perceived emotional personality traits in the assistant would positively affect anthropomorphizing of the voice assistant. This hypothesis was strongly supported. This confirms that the user anthropomorphized the voice assistant to some extent.

Third hypothesis stated that perceived intelligent personality traits would have a positive effect on anthropomorphism. This is also supported, but with lesser effect than what perceived emotional personality traits had on anthropomorphism. This appears to be consistent with the assumptions made in the

literature, that implied anthropomorphism to be more affected by implied emotionality than implied intelligence (Złotowski et al., 2014).

Fourth hypothesis stated that subjective loneliness and social isolation has positive effect on anthropomorphizing of the voice assistant. This hypothesis was not supported, as the effect was not significant. One possible explanation to this result could be in the low item loadings in many of the items under the construct. This would mean that this hypothesis was not conclusive, as the reliability of the results is in question.

Need for cognition was problematic, as its item loadings never reached above 0.70 on any of the items. However, it did have composite reliability score above 0.70, and its discriminant validity was positively assessed. The fifth hypothesis stated there would be a negative effect from high need for cognition. Instead, the results suggested a positive effect on anthropomorphism. This can't be considered a certain result, due to its low item loadings, and is deemed inconclusive.

System quality was hypothesized to have a positive effect on perceived usefulness. This hypothesis was very strongly supported by the results. In detail, people found a voice assistant more useful when the quality of the interaction it provided in form of answers, was accurate, relevant, understandable, and timely.

Perceived usefulness was hypothesized to have a positive effect on both intention to use and user satisfaction. The results support its influence on intention to use very strongly, as well as on user satisfaction.

Perceived ease of use was hypothesized to have a positive effect on both intention to use and user satisfaction. The results support both hypotheses strongly. This seems to imply that when the amount of effort to use the voice assistant is low, it increases intention to use it, as well as makes the user more satisfied.

First half of the final hypotheses stated that social influence has a positive effect on intention to use and user satisfaction. The results on intention to use do not support the first hypothesis, while its effect on user satisfaction is supported. The negative effect of social influence on intention to use is interesting, as it would indicate that people influencing or perceived to be influencing the user to use a voice assistant, would actually have a negative effect on use intention. Meanwhile social influence also has a positive effect on user satisfaction. One explanation for this discrepancy could be that people who haven't adapted a voice assistant for frequent use, have had satisfying experiences with the voice assistant after being influenced to try it, but because of the influence from other factors, it has not become a habit. In fact, the encouragement to use a voice assistant reduces their intention to use it. One way to interpret this could be that users who feel encouraged to use a voice assistant, find this encouragement to be displeasing and lose their use intention out of social annoyance.

Second half of the final hypotheses addressed social influence in the form of perceived popularity, which predicted a positive effect on intention to use and user satisfaction. Both of these hypotheses were supported by the results.

Considering the differing results from social influence directed from close and important people, this suggests a different dimension to social influence. The perception that a voice assistant is popular among public and friends, and has been reviewed positively by other users, increased user's intention to use and user satisfaction. One way to interpret this difference is that people care more about how socially normal the use of voice assistants is in public, than how its use is viewed among people important to them. This type of social norm could be more meaningful when a voice assistant is used in public, and how the user perceives strangers around them to deliberate this type of interaction.

TABLE 7 Summary of Hypothesis Tests

Hypothesis		**Support**
H1a	ANT -> INT	NO
H1b	ANT -> SAT	NO
H2	HN -> ANT	YES
H3	UH -> ANT	YES
H4	LON -> ANT	NOT CONCLUSIVE
H5	CG -> ANT	NOT CONCLUSIVE
H6	SYS -> USE	YES
H7a	USE -> INT	YES
H7b	USE -> SAT	YES
H8a	EASE -> INT	YES
H8b	EASE -> SAT	YES
H9a	SOC -> INT	NO
H9b	SOC -> SAT	YES
H9c	POP -> INT	YES
H9d	POP -> SAT	YES

7 CONCLUSION

In literature review, relevant key concepts were examined on voice assistants, anthropomorphism, and technology acceptance, as well as their related concepts like human-robot interaction, brand personality and social presence. Additionally, five theories or models related to the concepts were reviewed: the dimensions of brand personality, three-factor theory of anthropomorphism, IS success model, technology acceptance model and unified theory of acceptance and use of technology. The reason for this review was to form a picture of what type of research has been done in the fields of anthropomorphism and technology acceptance, as well as how anthropomorphism has been seen affecting user behavior.

In the literature, anthropomorphism was found out to have an effect on user- and consumer behavior. When a person was making a product replacement decision, after the product had been primed with anthropomorphic personality traits, the person was less willing to replace the product (Chandler & Schwarz, 2010). Another research discovered how a user was more willing to trust an autonomous vehicle, when it was given a name, gender and voice (Waytz et al., 2014). Brand personality was also found to affect consumer behavior through the anthropomorphic traits associated with brand characteristics.

The three-factor theory of anthropomorphism proposed a way to predict the likeliness of people to anthropomorphize an object or agent. The factors influencing anthropomorphism included dispositional factors such as user's need for cognition, and subjective loneliness. These two factors were included in this study to measure the extent of anthropomorphizing of voice assistants, in parallel with voice assistant's own anthropomorphic cues.

The literature review went through theories on information system success and technology acceptance, such as the IS success model, technology acceptance model, unified theory of acceptance and use of technology, as well as its variant for consumer context. The review studied the different aspects of technology acceptance, to find how perceptions, behavior, and system quality lead to use intention, and use. The goal of reviewing these theories was to iden-

tify important factors to use for measurement in usage of voice assistants, in parallel with the anthropomorphic factor.

Based on the review, a framework for hypotheses was created to combine the effect of anthropomorphism with factors of traditional technology acceptance models. In this framework, anthropomorphism was decided to be measured with the reviewed personality traits from the two dimensions of anthropomorphism (Złotowski et al., 2014), as well as two dispositional factors based on the three-factor theory of anthropomorphism (Epley et al., 2007). To measure how the effect of anthropomorphism compares with traditional takes on technology acceptance, the framework included factors that were recognized to be relevant. The chosen factors were perceived usefulness, perceived ease of use, social influence, and perceived popularity of the assistant. Perceived usefulness was further measured with system quality, to understand how important factor this technical dimension is. Outcomes of the hypotheses were measured with user's intention to use a voice assistant, as well as user satisfaction.

In conclusion, this thesis aimed to answer four research questions, which were addressed with a literature review, and a quantitative research. The first question was:

- Does anthropomorphism in information systems influence user behavior?

In the literature review, several studies were found, in which the perception of human characteristics in non-human objects were found or implied to increase likeability, psychological closeness, trust, and relaxedness as well as influence replacement decisions. Anthropomorphism through brand personality was also found to influence relationships between a customer and a brand, and affect the recovery of these relationships, in case of a transgression. Social presence was also found to have an effect, by appealing to human need for sociality. This establishes that anthropomorphism can influence behavior.

The second question was:

- How can anthropomorphism be measured in voice assistants?

The literature review identified several possible ways to measure anthropomorphism. These included perceived emotionality and perceived intelligence, through two groups of personality traits, called human nature and uniquely human. Other possible measurements were found in dimensions of brand personality, and partially in the five measurement scales in robotics, presented by Bartneck et al. (2009). These other measurements were not used in the final framework due to overlapping traits, and the assumed extensiveness of the two used personality dimensions.

Third research question stated:

- What existing theories or models can be used to explain the technology acceptance of voice assistants?

Two dimensions were reviewed, that could be used to explain technology acceptance. These were the technical dimension, where intention to use and user satisfaction were affected by the quality of the system, information, and service. This dimension was reviewed with information system success model. The second dimension for technology acceptance explains the motivational processes between the information system, and actual system use. This dimension was examined with technology acceptance model, and unified theory of acceptance and use of technology, with its updated model for consumer context.

Fourth research question was:

- How does anthropomorphism contribute to user's behavioral intention to use a voice assistant?

This question was answered with an empirical study. No significant influence was found from anthropomorphizing a voice assistant, towards the use intention of a voice assistant.

Fifth, and the final research question was:

- How does anthropomorphism contribute to user satisfaction, when using a voice assistant?

This was the second question answered with the empirical study. No significant influence was found between anthropomorphism towards user satisfaction.

It is evident that measuring anthropomorphism by dividing the personality traits into the two chosen personality dimensions, did not provide the most accurate results with this survey method. This problem in measurement was caused by the deviations in the validity check between these two groups. More similar setbacks in validity of the items happened with need for cognition, and subjective loneliness.

For this research, the two dimensions were expected to form a clear division of personality traits between perceived emotion and intelligence, which was not successful. Due to challenges brought by the validity of some of the items, it raises a question on how conclusive this research can be considered. A different factor for measuring cues that activate anthropomorphism could be a sounder choice for future research. This could be done by re-evaluating the chosen method of estimating anthropomorphism, by other means than surveying user's impressions. One possibility is to use a more controlled research environment, with both controlled anthropomorphized object, and control groups for different approaches. A popular method in reviewed literature was to prime the studied groups with different levels of anthropomorphic cues, and comparing the results by surveying them, to see if the priming had resulted in different attitudes. A similar method could also be used to study how anthropomor-

phism affects use intention, by creating voice assistant variants with different levels of cues for anthropomorphic priming, while providing the same level of functionality, to reduce the influence from other variables.

One explanation as to why the main hypotheses failed, could be that the users view the most significant effects; perceived usefulness, system quality and perceived ease of use, to be so important, that anthropomorphism never becomes a conscious or subconscious priority to them. It is possible, if given time for voice assistant -systems, their platform devices and internet speeds to improve, that these significant factors become self-evident, and allow other factors to emerge as significant. If the conditions were such that technology was advanced enough to make performing tasks with voice assistant practically effortless to use, accurate to recognize and understand the speaker, even in challenging conditions, and interact with a speed that represents natural human interaction, it could make anthropomorphism a significant factor.

In future research, anthropomorphism as part of technology acceptance, could be studied in other contexts than voice assistants, to see how it influences use intention, if the system quality, usefulness, and ease of use are not a priority to a user. Other methods of research should be attempted, to avoid the problems this research faced with validity. New methods, such as using other variables than uniquely human and human nature, could be considered to better measure anthropomorphism. More reliable results could also be obtained by using a controlled environment, with multiple groups of participants cued with different levels of anthropomorphism. Anthropomorphism in voice assistants could also be researched again, after the technology has advanced further enough to make the effects of studied system quality, perceived usefulness, and perceived ease of use, more self-evident to a user.

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APPENDIX 1

TABLE 8 Survey items

Question	**Options**
Gender	Female Male
Age	24 or less 25-34 35-44 45-54 55-64 over 65
Nationality	
Education	Some school, no degree High school graduate Some college, no degree Bachelor's degree Master's degree Professional degree Doctorate degree
Profession / Occupation	
On what device do you use a voice assistant? Check any that apply	Smartphone Tablet Desktop or laptop Other:
How long have you owned a voice assistant -capable device?	Less than a year 1-2 years 2-3 years 3-4 years 4-5 years 5-6 years 6-7 years More than 7 years
What operating system(s) are you using on your device(s)? Check any that apply	Apple iOS Google Android Microsoft Windows Other:
How would you rate your usage of voice assistants?	I never use them – I use them all the time 1 2 3 4 5 6 7

Which type of voice do you prefer for the voice assistant?	Male Female No preference
What language do you use with the voice assistant?	
System quality: (1) I find it easy to get the voice assistant to do what I want it to do. (2) The answers the voice assistant provides are accurate. (3) The answers the voice assistant provides are relevant to my questions. (4) The answers the voice assistant provides are understandable. (5) The answers the voice assistant provides are timely. (6) I intend to use the voice assistant again in near future. (7) The sequence of interacting with the voice assistant is: (8) The feedback given by the voice assistant is: (9) The voice assistant is: (10) The voice assistant made tasks easier: (11) If you had a future need for information/service provided by the voice assistant, how likely is it that you would consider using the assistant?	Strongly disagree - Strongly agree 1 2 3 4 5 6 7 Confusing – Clear 1 2 3 4 5 6 7 Predictable - Unpredictable 1 2 3 4 5 6 7 Frustrating - Satisfying 1 2 3 4 5 6 7 Never – Always 1 2 3 4 5 6 7 Very unlikely - Very likely 1 2 3 4 5 6 7
Perceived usefulness: (1) I find the voice assistant useful in my daily life. (2) Using the voice assistant increases my chances of achieving things that are important to me. (3) Using the voice assistant helps me accomplish things more quickly. (4) Using the voice assistant increases my productivity.	Strongly disagree - Strongly agree 1 2 3 4 5 6 7
Perceived ease of use: (1) Learning how to use the voice assistant is easy for me. (2) My interaction with the voice assistant is clear and understandable. (3) I find the voice assistant easy to use. (4) It is easy for me to become skillful at using the	Strongly disagree - Strongly agree 1 2 3 4 5 6 7

voice assistant.	
Hedonic motivation: (1) Using the voice assistant is fun. (2) Using the voice assistant is enjoyable. (3) Using the voice assistant is very entertaining.	Strongly disagree - Strongly agree 1 2 3 4 5 6 7
Social influence: (1) People who are important to me think that I should use the voice assistant. (2) People who influence my behavior think that I should use the voice assistant. (3) People whose opinions I value prefer that I use the voice assistant.	Strongly disagree - Strongly agree 1 2 3 4 5 6 7
Perceived popularity: (1) Voice assistants have received positive user reviews. (2) The voice assistant is popular among my friends. (3) The voice assistant is popular among the public.	Strongly disagree - Strongly agree 1 2 3 4 5 6 7
User satisfaction: (1) I am very contented with the voice assistant. (2) I am very pleased with the voice assistant. (3) I feel delighted with the voice assistant. (4) Overall, I am very satisfied with the voice assistant.	Strongly disagree - Strongly agree 1 2 3 4 5 6 7
Human-likeness and emotional attachment: (1) The voice assistant sounds lifelike. (2) I feel the voice assistant is like a human being. (3) How close do you feel to the voice assistant? (4) I am emotionally attached to the voice assistant.	Not at all - Always 1 2 3 4 5 6 7 Not at all – Very close 1 2 3 4 5 6 7 Strongly disagree - Strongly agree 1 2 3 4 5 6 7
Social presence: (1) I felt a sense of human contact in the voice assistant. (2) I felt a sense of personalness in the voice assistant. (3) I felt a sense of human warmth in the voice assistant. (4) I felt a sense of sociability in the voice assistant. (5) I felt a sense of human sensitivity in the voice assistant.	Strongly disagree - Strongly agree 1 2 3 4 5 6 7

Trust: (1) I believe the voice assistant acts in my best interest. (2) I expect the voice assistant to be sincere and genuine. (3) I believe the voice assistant performs its roles very well.	Strongly disagree - Strongly agree 1 2 3 4 5 6 7
Brand personality: To what extent do you feel the voice assistant is: (1) Down-to-earth (2) Honest (3) Wholesome (4) Cheerful (5) Daring (6) Spirited (7) Imaginative (8) Up-to-date (9) Reliable (10) Intelligent (11) Successful (12) Upper class (13) Charming (14) Tough	I never feel the voice assistant this way - I often feel the voice assistant this way 1 2 3 4 5 6 7
Perceived intelligence: To what extent do you feel the voice assistant is: (1) Broadminded (2) Humble (3) Organized (4) Polite (5) Thorough (6) Cold (7) Conservative (8) Indifferent (9) Rude (10) Shallow	Not at all - Very much 1 2 3 4 5 6 7
Perceived emotionality: To what extent do you feel the voice assistant is: (1) Curious (2) Friendly (3) Fun-loving (4) Sociable (5) Trusting (6) Aggressive (7) Distractible (8) Impatient	Not at all - Very much 1 2 3 4 5 6 7

(9) Jealous (10) Nervous	
The Godspeed questionnaire on anthropomorphism: Please rate your impressions of the voice assistant on these scales: (1) Fake - Natural (2) Machinelike – Humanlike (3) Unconscious - Conscious (4) Artificial - Lifelike (5) Dead - Alive (6) Stagnant - Lively (7) Mechanical - Organic (8) Inert - Interactive (9) Apathetic - Responsive (10) Dislike - Like (11) Unfriendly - Friendly (12) Unkind - Kind (13) Unpleasant - Pleasant (14) Awful - Nice (15) Incompetent - Competent (16) Ignorant - Knowledgeable (17) Irresponsible - Responsible (18) Unintelligent - Intelligent (19) Foolish – Sensible Please rate your emotional state during interaction with a voice assistant on these scales: (1) Anxious – Relaxed (2) Agitated - Calm (3) Quiescent - Surprised	1 2 3 4 5 1 2 3 4 5
Need for cognition: (1) I prefer complex to simple problems. (2) I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought. (3) I find little satisfaction in deliberating hard and for long hours. (4) I prefer to think about small, daily projects to long-term ones. (5) I think primarily because I have to. (6) I tend to set goals that can be accomplished only by expending considerable mental effort.	Extremely uncharacteristic of me - Extremely characteristic of me 1 2 3 4 5
Subjective Loneliness: (1) I am unhappy doing so many things alone.	I often feel this way -

(2) I have nobody to talk to. (3) I cannot tolerate being so alone. (4) I lack companionship. (5) I feel as if nobody really understands me. (6) I find myself waiting for people to call or write. (7) There is no one I can turn to. (8) I am no longer close to anyone. (9) My interests and ideas are not shared by those around me. (10) I feel left out. (11) I feel completely alone. (12) I am unable to reach out and communicate with those around me. (13) My social relationships are superficial. (14) I feel starved for company. (15) No one really knows me well. (16) I feel isolated from others. (17) I am unhappy being so withdrawn. (18) It is difficult for me to make friends. (19) I feel shut out and excluded by others. (20) People are around me but not with me.	I never feel this way 1 2 3 4