Hey Siri… Are you human?

Assessing the roles of Anthropomorphism and Perceived Creepiness in the acceptance of Intelligent Personal Assistants

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ABSTRACT

Intelligent Personal Assistants (IPAs) like Siri and Alexa have experienced a fast growth in recent years, becoming almost ubiquitous in our daily lives. These applications are developed to resemble human beings and to be perceived as human-like assistants, a concept known as anthropomorphism. However, the effects of this anthropomorphism on IPAs' adoption intention has not been thoroughly investigated. In detail, the effects of IPAs' anthropomorphism on their perceived creepiness and perceived ease of use, and how these perceptions influence adoption intention, remain unexplored. This thesis investigates this matter by starting from the research question: What is the effect of anthropomorphism on perceived creepiness and perceived ease of use of IPAs, and how do these factors influence consumers' adoption intention towards IPAs?

To address this question, an experimental survey was conducted. Participants were randomly assigned to the description of one of three fictitious IPAs, each showcasing progressively higher levels of anthropomorphism. They were then asked questions about perceived creepiness, ease of use, usefulness, and privacy risks. Their responses were analyzed using Hayes' PROCESS macro (Model 4).

The results indicate that the level of anthropomorphism in IPAs does not significantly affect their perceived creepiness or perceived ease of use. Additionally, neither perceived creepiness nor perceived ease of use significantly impact people's adoption intention of IPAs. These findings reveal that perceived creepiness and perceived ease of use do not mediate the relationship between IPAs' anthropomorphism and adoption intention. However, perceived usefulness and perceived privacy risks were found to significantly affect adoption intention, with perceived usefulness having a positive effect and perceived privacy risks having a negative effect. These results reveal that factors such as perceived usefulness and privacy risks play a more crucial role in influencing adoption intention than perceived creepiness and ease of use.

The thesis ends with theoretical reflections and implications for practitioners. Additionally, it proposes an overview of the main limitations of the study.

KEYWORDS: *Anthropomorphism, perceived creepiness, perceived ease of use, adoption intention, IPAs*.

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Chapter 1: Introduction

Smart technologies are defined as electronic devices or systems capable of internet connectivity and interactive use (Foroudi et al. 2017, p. 271). Such technologies are nowadays ubiquitous: they have gained broad acceptance across all segments of society, and they are applied in a growing number of fields such as healthcare, transportation, industrial manufacturing, logistics, education, governance, retail, agriculture and many more (Li et al., 2014, p. 243; Silverio-Fernández et al., 2018, p. 1). It is no surprise, then, that different estimates agree on the fact that smart 'things', i.e., objects with the capability of communicating and computing like simple sensors or smartphones, will soon be in vastly bigger number than the humans in the world (Silverio-Fernández et al., 2018, p. 1).

The notion of smart 'things' is central in the world of the Internet of Things (IoT), i.e., everyday objects equipped with smart technologies, both hardware and software, that can be connected in a network and can be used for a broad range of everyday purposes (Xia et al., 2012, p. 1101). As mentioned, smart technologies and devices that belong to the Internet of Things are growing fast, not only because they are capable of gathering and analysing data, but also due to their ability to be self-learning and self-aware, which are all crucial features in today's industry (Silverio-Fernández et al., 2018, p. 1).

In the context of the Internet of Things, one specific case is that of Intelligent Personal Assistants (IPAs), which will be the interest of this study. These are software or applications such as Amazon Alexa, Microsoft Cortana, Apple Siri and others, with which users can interact by vocal control in a human-to-machine dialogue, to perform various tasks (Silva et al., 2020, p. 1). These technologies are able to understand and produce human speech, by displaying a humanized voice and natural language, through the use of artificial intelligence (Rajaobelina et al., 2012, p. 2339). They can autonomously perform various complex tasks, capture their users' preferences and needs, and tailor themselves to meet their user's necessities in everyday life (Hu et al., 2020, p. 1; Moussawi et al., 2020, p. 345). Furthermore, they have a human-like voice, a gender, and their own conversational skills (Chen & Park, 2021, p. 2724). In one word, IPAs can display *anthropomorphism* (Chen & Park, 2021, p. 2722): they can 'behave' like actual humans, and they can be perceived as such by the users. Moussawi et al. (2020, p. 343) suggest that anthropomorphism is the very distinctive trait of IPAs: although they do not possess a human-like body (unlike robots), they are explicitly designed "to behave as much as possible like a human actor", showcasing sociality and self-awareness.

Thanks to the recent world-wide breakthrough of artificial intelligence, IPAs and other smart technologies continue to spread and to become more popular among consumers (Cao et al., 2022, p. 1; Han & Yang, 2017, p. 618; Handrich, 2021, p. 1; Hu et al., 2021, p. 1). However, despite this large-scale expansion, the adoption of these technologies is still problematic: a large number of users remain sceptical

towards smart technologies and IPAs, and some of them ultimately refuse to adopt them in their life (Handrich, 2021, p. 1; Moussawi et al., 2020, p. 343; Raff & Wentzel, 2023, p. 2; Wright & Shank, 2022, p. 352). More specifically, users of IPAs were found to display some degree of resistance to the devices, to the point that "only half of the population used IPAs in recent years" (Handrich, 2021, p. 1). This elicits question as to why such resistance takes place.

Among the factors that are known to foster innovation resistance, one concept that has recently gained attention in a growing number of studies is devices' perceived creepiness (PC) (Handrich, 2021, p. 1; Phinnemore et al., 2023, p. 1; Wozniak et al., 2023, p. 2). Recent studies agree on the fact that smart technologies such as voice assistants and home assistants can be perceived as creepy by a large number of users (Phinnemore et al., 2023, p. 1; Raff et al., 2023, p. 1). This creepiness is a reaction to non-human entities showcasing anthropomorphism, i.e., displaying advanced human skills and a realistic human-like physical appearance (Shank et al., 2019, p. 261). This is perfectly in line with what Mori (2012) called the "uncanny valley" (p. 98), i.e., an effect by which humans perceive eeriness when exposed to highly realistic displays of anthropomorphism by non-human entities. In Mori's work, the eeriness takes place when such human replicas reach extremely high levels of human-likeness, appearing as almost human but missing key human features, thus eliciting a sense of disgust in users (Männistö-Funk & Sihvonen, 2018, p. 47). For AI applications, creepiness was found to play a central role in fostering adoption resistance (Handrich, 2021, p. 11).

Furthermore, a second factor well-known to influence the resistance against new technologies is the difficulty involved in using them. Rogers (2003, p. 15) named such concept perceived complexity, considering it central in fostering innovation resistance. However, an opposite concept that is much more widely used is that of perceived ease of use (PEOU), which consists of the level of simplicity that the user expects to encounter when adopting a new technology (Davis, 1989, p. 320). Together with perceived usefulness (PU), PEOU is a key concept in the Technology Acceptance Model (TAM), which proposes that these two factors positively influence people' intention to adopt technologies (Davis, 1989, p. 320). The model has been effectively employed to investigate the adoption of various smart technologies (de Boer et al., 2018, p. 148; Dong et al., 2016, p. 131), and it suggests that low levels of PEOU (which is the same as high levels of perceived complexity) can be antecedents of innovation resistance (Davis, 1989, p. 320).

The relationship between IPAs' anthropomorphism and their adoption intention has been investigated through the mediation of self-efficacy, social connection and perceived enjoyment (Cao et al., 2022, p. 5; Moussawi et al., 2020, p. 349). However, to the best of our knowledge, the influence of IPAs' anthropomorphism on perceived creepiness and perceived ease of use is still to be seen, as well as the impact of these perceptions on users' adoption intention towards such technologies. Considering IPAs' highly anthropomorphic nature (Chen & Park, 2021, p. 2722; Moussawi et al., 2020, p. 343), such investigation appears necessary. In light of the previous paragraphs, it is legit to suppose that perceived

creepiness and perceived ease of use of IPAs could foster the resistance towards the adoption of such technologies. Both factors were found to affect the adoption intention towards AI applications (de Boer et al., 2018, p. 152; Handrich, 2021, p. 11): thus, we have reasons to suppose that they could play the role of mediators in the relationship between anthropomorphism and adoption intention of IPAs.

The parallel between IPAs' adoption resistance among users (Handrich, 2021, p. 1) and their huge spread in the last decade (Han & Yang, 2017, p. 618) suggests that an analysis of how anthropomorphism influences people's perceptions and thereby adoption of such technologies is needed. This is because studies on perceived creepiness and perceived ease of use usually investigate relatively new and uncommon technologies (Dong et al., 2016, p. 117; Rajaobelina et al., 2021, p. 2340). To the best of our knowledge, no such studies were conducted on devices as common and familiar for consumers as IPAs. This means that it remains to be seen whether perceived creepiness and perceived ease of use impact adoption intention towards IPAs as they do for other products and technologies.

This thesis aims to explore this topic, shedding light on the impact of anthropomorphism on adoption intention of IPAs through the mediating role of perceived creepiness and perceived ease of use. In detail, we aim to understand whether highly anthropomorphic IPAs can transmit to users the sense of creepiness that Mori (2012, p. 98) noted in the uncanny valley effect, ultimately leading to higher resistance to the usage of these technologies. Furthermore, through the lens of the TAM, we intend to grasp whether anthropomorphic IPAs can be perceived as more user-friendly and easier to use, and if this can lead users to higher adoption intention of such technologies.

We believe that this study can be of great academical significance. The findings in regard to the impact of perceived ease of use and perceived creepiness on adoption intention could challenge our current knowledge on technology acceptance, such as posited in the Technology Acceptance Model. This is particularly true if we consider that this thesis will assess the impact of creepiness and ease of use on devices that are already commonplace in society, thus familiar for users: in our opinion, this can lead to findings that challenge those of previous investigations. Furthermore, this thesis' findings about the impact of anthropomorphism on adoption intention will inform us about the potential benefits and drawbacks of anthropomorphizing technology. This can provide us more information about Mori's uncanny valley theory.

Along with the academical relevance, this study can have significant societal implications. In our view, the societal relevance is in providing insights that can increase marketers' awareness of how their devices are perceived, and how these perceptions can influence adoption intention towards their products. This can lead to more effective marketing campaigns, to increase customer purchase behavior. Therefore, the following is the research question of this thesis:

What is the effect of anthropomorphism on perceived creepiness and perceived ease of use of IPAs, and how do these factors influence consumers' adoption intention towards IPAs?

Chapter 2: Theoretical framework

2.1 Intelligent personal assistants (IPAs)

The paradigm of Internet of Things refers to a network of everyday objects equipped with sensors and technologies that can interact with each other and with their surroundings (Silverio-Fernández et al., 2018, p. 1; Xia et al., 2012, p. 1101). These objects are interconnected through ubiquitous computing technologies, which employ sensors to spread and receive data and information to and from the entire network system they are part of (Choi et al., 2021, p. 1). In this context, the devices can interact both with the users and the other devices in the network, sometimes even without human supervision (Silverio-Fernández et al., 2018, p. 1). One example is that of smart homes (Choi et al., 2021, p. 1), where residents can use IPAs like Alexa to manage the home automation system by controlling schedules, lights, or even sensitive features such as alarms (Han & Yang, 2017, p. 620).

In the realm of the Internet of Things are IPAs, defined by Hu et al. (2021, p. 2) "a class of autonomous agents designed as human-assistance aids to perform daily tasks according to their users' needs or preferences". Such software agents are often referred to under a plethora of different names, including Virtual Personal Assistants, Personal Digital Assistants, Personal Intelligent Assistants, Voice-Enabled Assistants and others (Cowan et a., 2020, p. 1). In the last decade, major tech companies such as Apple, Google and Amazon have developed such agents and implemented them in their devices (Han & Yang, 2017, p. 618; Hu et al., 2021, p. 1; Saad et al., 2016, p. 12518). Subsequently, IPAs have developed greatly: nowadays, some of them constitute specific hardware devices, with which users can perform a much vaster range of tasks than they could before (Han & Yang, 2017, p. 620). In particular, as mentioned above, the development of Internet of Things technologies and applications led to the proliferation of IPAs in the context of smart homes, called Smart Home Assistants. These IPAs, among which the most famous are certainly Amazon Alexa and Google Home, allow users to centrally control the home systems, to ease their daily life (Han & Yang, 2017, p. 620).

Thanks to technological developments, especially in the field of artificial intelligence, a proficient IPA can now autonomously analyze its user's actions and recommend tasks or choices to simplify the interaction of its user with their surroundings (Ponciano et al., 2015, p. 310). As better explained in the following paragraphs, this autonomy is crucial in simplifying users' operations. Examples of this are verbally asking the IPA to turn on the light, to play a song, or to do a google research. This is possible because IPAs now provide a speech interface, which allows users to control them by simply speaking, and to receive vocal responses from the agents as in a human conversation (Saad et al., 2016, p. 12518).

As understandable, this ability to both understand and replicate human language is key in technological assistants' humanlikeness (Rajaobelina et al., 2012, p. 2339). However, speech recognition is

only one of the many humanlike characteristics that IPAs display. They now have high levels of autonomy (Hu et al., 2021, p. 2), their own voice and communication style, a human-like intonation, a gender, and their own conversational skills (Chen & Park, 2021, p. 2724). As better explained in the next paragraphs, these features could be related to perceived creepiness and perceived ease of use of IPAs.

2.2 Anthropomorphism

First used in ancient Greece, the term 'anthropomorphism' refers to the attribution of a human shape or a human mind to non-human entities (Waytz et al., 2010a, p. 220). This obviously entails an initial consideration of what is exclusively human and what is not, followed by the attribution of a human feature to a non-human being. According to Waitz et al. (2010b, p. 411), if this feature is considered as exclusively human, people will perceive the non-human agent as anthropomorphic. This happens frequently, as people anthropomorphize Gods, animals and, most importantly in the context of this study, technological products (Salles et al., 2020, p. 89).

In studying technological advancements, the concept of anthropomorphism was first employed in Mori's work on the uncanny valley effect, to be then translated to English by MacDorman (2006, p. 297). In this context, the term initially referred to the display of humanlike features in androids and robots (Mori, 2012, p. 98), focusing on the physical features of such agents. However, throughout the decades, the concept has been applied to the investigation of various technologies and products, focusing on humanlike features that go beyond physical attributes (Hu et al., 2021, p. 2).

To understand this, it is important to highlight the distinction of anthropomorphism in embodied and disembodied agents. According to Moussawi et al. (2020, p. 346), anthropomorphism in embodied agents like robots emerge mainly from visual cues that make the agent physically similar to humans. Such cues are physical characteristics like facial expressions or the fluidity of body movements. As mentioned, Mori's work on the uncanny valley (2012, p. 98) was centred on humanoid robots, thus focusing on this conception of anthropomorphism. On the other hand, disembodied agents such as chatbots can display anthropomorphism in humanlike characteristics such as their name, communication style, voice, and personality (Moussawi et al., 2020, p. 346; Hu et al., 2021, p. 2). This is the case for IPAs: while many of them are software agents integrated in hardware devices like smartphones and laptops, some IPAs constitute specific hardware devices (Han & Yang, 2017, p. 618), but they do not possess a human-like body (Moussawi et al., 2020, p. 343). Thus, anthropomorphism in IPAs does not lie in their physical appearance: it lies in their various human-like features mentioned multiple times above, in their employment of a humanized and natural language through the use of AI (Rajaobelina et al., 2012, 2339), and in their humanlike intelligence, which allows them to perform various tasks autonomously and brings the public to see them as similar to humans (Gursoy et al., 2019, p. 164). This conception of anthropomorphism can be

sometimes referred to as perceived anthropomorphism (Cao et al., 2022, p. 3; Moussawi et al., 2020, p. 346).

A further important distinction is that between cognitive and affective anthropomorphism. The former consists of the ability of technological devices to rationally understand and organize their tasks, while the latter is the ability to have feelings, express them, and relate them to their users (Cao et al., 2022, p. 3). To elaborate, cognitive anthropomorphism is how devices deal with their tasks, while affective anthropomorphism is how devices deal with people. In their study on IPAs, Cao et al. (2022, p. 3) identified cognitive anthropomorphism with the devices' interactivity and autonomy, and affective anthropomorphism with their sociability. However, as noted by the authors, this distinction belongs to a conception of anthropomorphism that focuses on devices' mental and intellectual skills (Waytz et al., 2010a, p. 220). As this study will focus on all the human-like characteristics that make IPAs anthropomorphic, not limited to their mental capacities, this distinction will not be considered.

2.3 Theoretical lens: The Technology Acceptance Model

Developed by Davis (1989, p. 319), the Technology Acceptance Model is one of the most used models in technology acceptance literature (Reynolds & de Maya, 2012, p. 627; Teo, 2010, p. 66). It proposes that potential users of a technology develop a positive mindset towards it when they perceive it as useful and easy to use (Davis, 1989, p. 320). In detail, perceived usefulness and perceived ease of use are the two main factors that influence people's attitude towards a technology. In turn, attitude determines people's intention to use the technology, which obviously leads to the actual usage (Davis, 1989, p. 320; Yousafzai et al., 2010, p. 1177).

The model originates from the Theory of Reasoned Action, developed by Fishbein and Ajzen in 1975 (de Boer et al., 2018, p. 148). Such theory posits that people's behavioural intention, which leads to the actual adoption of a behaviour, is influenced by their personal attitude towards the behaviour and the perceived social pressure on the performance of it (Fishbein and Ajzen, 1975, as cited in Yousafzai et al., 2010, p. 1174). From this theory the TAM derives its structure, based on the relationship between beliefs, attitude, and intentions, and their effects on actual behaviour. In detail, the TAM considers attitude (towards the technology) at the centre of the process that ultimately leads to adoption (Yousafzai et al., 2010, p. 1177). In this context, attitude is influenced by the beliefs that people have towards the technology, i.e., perceived usefulness and perceived ease of use (Yousafzai et al., 2010, p. 1177).

As mentioned, the TAM is highly appreciated and used in a lot of different fields (Lee et al., 2003, p. 753). According to Yousafzai et al. (2010, p. 1178), this success is due to the model's versatility in investigating both a wide range of different IT technologies and different populations. For this reason, it has been employed throughout the decades to analyse the adoption of several different technologies, including those belonging to the Internet of Things (de Boer et al., 2018, p. 148; Dong et al., 2016, p. 131). However,

the model received criticism throughout the years, mainly due to the oversimplification of the antecedents of perceived ease of use and perceived usefulness (Yousafzai et al., 2007, p. 268). This led to the development of TAM2 and TAM3, which included social norms and enjoyment as variables influencing adoption intention (McLean & Osei-Frimpong, 2019, p. 29).

In the context of this study, the TAM will be applied to investigate the process by which anthropomorphism impacts adoption intention. While perceived ease of use, together with creepiness, will be investigated as a mediator in this process, the impact of anthropomorphism on perceived usefulness will not be investigated. This is because, in our view, the primary influencers of usefulness are likely to be IPAs' functionality and efficiency, whereas anthropomorphism also extends to technological devices' appearance. Thus, we see no apparent reason to suppose that anthropomorphism has an influence on it. However, perceived usefulness will be included as control variable.

2.4 Perceived creepiness

Creepiness is a feeling that most people experience frequently throughout their life, yet is not easy to define rationally. Olivera-La Rosa et al. (2019, p. 4) define it as "an unpleasant emotional response that arises from some ambiguity in a potential threat". It is important to highlight that the concept of ambiguity is central. McAndrew and Koehnke (2016, p. 10) note that a situation of clearly defined danger and threat can certainly instill a sense of terror in people, yet it could not be considered a creepy situation. The authors argue that it is from the ambiguity of the potential threat that people derive a sense of creepiness, not being able to define the potential danger and its nature. Accordingly, Doyle et al. (2021, p. 179) propose that humans engage in a constant risk analysis of ambiguous situations, as these elicit a sense of discomfort, which can evolve into perceived creepiness. In turn, this creepiness can lead people to prepare for a potential danger, whether this is real or not (p. 177).

The association of innovative technologies with creepiness goes back a long way, originating in Mori's work on humanoids that led to the conceptualization of the uncanny valley effect (2012, p. 98). The literature regarding robots and humanoids mainly links creepiness to the sensation of uncanniness that human feel when in contact with objects that physically resemble a human (Wozniak et al., 2023, p. 2). However, several other factors were found to influence technological devices' perceived creepiness. According to Tene & Polonetsky (2014, p. 4), a technology can elicit a sense of creepiness when it is always listening, and when it makes an unclear display of personal data. Additionally, and in accordance with what discussed above about creepiness, Wozniak et al. (2023, p. 3) conducted a literature review on creepy technological devices and found that a recurrent feature of such devices was their ambiguity, both in their nature and goal. Finally, Rajaobelina et al. (2021, p. 2350) found privacy concerns, technological anxiety and need for human interaction to be all antecedents of perceived creepiness in chatbots.

In the context of this study, we propose that anthropomorphism of IPAs can be positively linked with their perceived creepiness. This is partially a reworking of Mori's uncanny valley, focusing on the already mentioned human-like features of IPAs that make them highly anthropomorphic (Chen & Park, 2021, p. 2722; Moussawi et al., 2020, p. 343). Elaborating from the notion that humans perceive uneasiness when they see non-human agents display realistic human features (Mori et al., 2012, p. 98) and intelligence (Shank et al., 2019, p. 261), we hypothesize that the more an IPA is similar to a human, operating human tasks with human skills, the creepier it will result to consumers. Thus, the following is the first hypothesis:

H_1 *Anthropomorphism has a positive effect on perceived creepiness.*

Furthermore, we hypothesize that perceived creepiness of IPAs will lead to lower levels of adoption intention towards them. As mentioned, Handrich (2021, p. 11) found that creepiness plays a central role in the adoption of AI applications, discouraging consumers to use AI. McAndrew and Koehnke (2016, p. 1) suggest that humans possess 'creepiness detectors', which enable them to stay away from unsettling situations: in the context of technology adoption, humans avoid devices perceived as creepy (Raff et al., 2024, p. 10). This is because creepiness elicits negative feelings in consumers, such as fear, uncertainty and stress, that foster innovation resistance toward the technology (Fuglseth & Sørebø, 2014, p. 162; Sohn & Kwon, 2020, p. 12). Thus, this is the second hypothesis:

H_2 *Perceived creepiness has a negative effect on adoption intention of IPAs.*

2.5 Perceived ease of use

Davis (1989, p. 320) define perceived ease of use as "the degree to which the prospective user expects the target system to be free of effort". As mentioned above, PEOU is proposed in the TAM as a crucial predictor of technology adoption: the more a product is easy for users, the less resistance it will encounter in the market. This obviously leads practitioners to develop products that will be perceived as easy to use, but finding a balance is key: designing a product to be as simple as possible might mean excluding key features and functionalities (Burke, 2013, p. 1227).

The same concept of perceived ease of use can be found in Rogers' work on the diffusion of innovation theory (2003, p. 15), though presented under the name of perceived complexity. Of course, the concept is exactly the opposite of perceived ease of use (Naicker & Van Der Merwe, 2018, p. 509). Rogers (2003, p. 15) define it as "the degree to which an innovation is perceived as difficult to understand and use". In the author's view, innovations that are seen by people as more difficult to understand and use will be adopted more slowly than those that do not require users to learn any new skills. Although the concept has been employed in the literature on innovation adoption (Al-Jabri & Sohail, 2012, p. 381; Naicker & Van Der

Merwe, 2018, p. 509), research that employed the name of perceived ease of use (in the framework of the TAM) is much more extensive. For this reason, the present study will only refer to it as perceived ease of use.

Hu et al. (2021, p. 2) propose that one element that leads consumers to perceive an AI device as humanlike is its autonomy, i.e., the ability of a technological object to operate without receiving guidance and supervision from humans (Hoffman & Novak, 2018, p. 1187). Accordingly, Gursoy et al. (2019, p. 158) state that autonomy enables AI devices to operate without requiring users to undergo a learning process, making them significantly more user-friendly for the public. Song and Shin (2022, p. 1) argue that "more human-like interfaces are preferable since they demand less adjustment for users to initiate social interactions with the interface". For these reasons, it is legitimate to suppose that there is positive a relation between IPAs' anthropomorphism and their perceived ease of use. In detail, we have reasons to hypothesize that when people approach a more human-like IPA, they perceive less complexity in learning how to use it, as they can interact with it in a similar way that they interact with other humans. This leads to the third hypothesis:

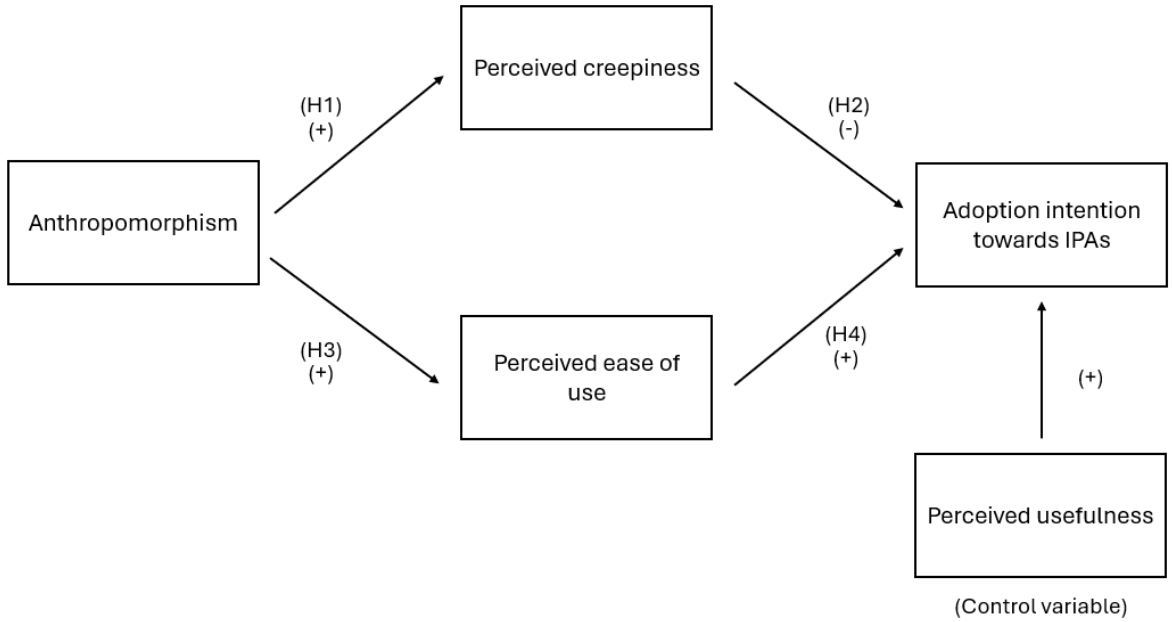
H_3 *Anthropomorphism has a positive effect on perceived ease of use.*

In their investigation on Internet of Things technologies, Dong et al. (2016, p. 130) found that perceived ease of use positively influences consumers' adoption intention. This is because when individuals perceive that the advantages of utilizing a technology surpass the effort required to use it, they view it as convenient, they develop confidence in using it, and they ultimately adopt it (Davis, 1989, p. 322). Thus, it is legit to suppose that the same happens for IPAs, i.e., that people who perceive an IPA as easy to use will consider it convenient, feeling that they will not need to struggle to learn how to control it, thus reporting higher intentions to use it. For these reasons, this is the fourth hypothesis:

H_4 *Perceived ease of use has a positive effect on adoption intention of IPAs.*

Figure 1

Conceptual framework of the study



Chapter 3: Method

3.1 Procedure

To address the research question, a between-subjects experimental survey was developed through the software Qualtrics and distributed to participants online. The survey was distributed to participants through the most common social media, mainly WhatsApp, Instagram and LinkedIn.

Before starting the survey, participants read an informed consent and learned about the purpose of the study, the voluntary nature of their participation, their possibility to withdraw from the study at any moment and the use that would be made of their data, with specific attention on the confidentiality measures that would be adopted to guarantee the correct display of their personal data. They were also informed that the survey was estimated to take 8 minutes to complete. By going forward with the survey, they accepted the conditions of the study and declared to be at least 18 years old.

Participants began by reading a concise description of IPAs, focusing solely on such devices' features and providing real-life examples like Apple Siri and Microsoft Alexa, to allow an easier understanding of the type of device the survey was about. This description maintained as much as possible a neutral tone, to ensure an unbiased representation of IPAs to participants who were unfamiliar with them.

Next, participants were randomly assigned to the stimulus material, i.e., a description of a fictitious IPA, including a picture and a name. Three descriptions of fictitious IPAs were developed in total, each very similar to the others and differentiated only by its level of anthropomorphism. For this purpose, the description of the tasks that the IPAs can perform was exactly the same across the three: the differences were in the IPAs names, pictures, pronouns, and references to their intelligence, personality and sensitivity. All the materials can be found in the appendix A.

Moving forward, participants replied to questions about their perceived ease of use and perceived creepiness of the IPA they had been proposed. Subsequently, they were asked about their perceived usefulness and privacy concerns towards the IPA. Then, participants answered questions regarding adoption intention of the specific IPA they encountered, as explained above. Finally, they were asked to report their demographics, i.e., year of birth, gender, level of education and familiarity with technology.

After concluding the survey, participants were directed to a “thank you” page, informing them that their answers had been recorded successfully.

3.2 Sample

The study used a convenience sampling technique. This allowed a straightforward recruitment, ensuring an easy and efficient data collection. The participants were mainly recruited on social media platforms like WhatsApp and Instagram, through personal connections and groups. Particular importance

was given to collecting a diverse demographic sample, paying attention to including variations in age and education level. For this reason, snowball sampling was also employed, starting snowballs among different populations. In detail, two snowballs were started to reach participants of 50 years of age or above, as the sample was initially unbalanced in that sense. Furthermore, since the first participants were all holders of bachelor's degrees, a snowball was started to reach participants that had high school diploma as their highest level of education. This allowed to recruit participants with different backgrounds. Due to the layout of the last page, 17 participants did not see the question regarding their age, thus leaving it empty. However, being they among our personal connections, we managed to track them and manually enter their year of birth after they had completed the survey.

For legal reasons, the study only included participants over 18 years of age. Among the 187 respondents, 8 had at least one missing value, thus they were excluded from the dataset. After data cleaning, total of 179 participants were included in the sample. Participants were initially asked their year of birth: consequently, to calculate the descriptives statistics for the age, all the replies were recoded from the participants' year birth into their actual age, e.g., "1999" was recoded as "25".

3.3 Design

In answering to the RQ, this research examined the three different levels of anthropomorphism as independent variables, whereas perceived creepiness and perceived ease of use of IPAs were analysed as mediators. Adoption intention of the IPA was the dependent variable of the study.

As previous research found that perceived usefulness and perceived privacy risks can affect consumers' behavioural intention towards technological innovations, Internet of Things technologies, and IPAs in particular (Davis, 1989, p. 320; Hsu and Yeh, 2016, p. 1091; Manikonda et al., 2017, p. 1; McLean & Osei-Frimpong, 2019, p. 33), the study included them as control variables. Furthermore, sociodemographic variables such as age and technological familiarity were also be treated as control variables, to isolate the specific effects of the independent variables on adoption intention.

3.4 Materials

As already explained, anthropomorphism was manipulated by developing the three fictitious IPAs and providing a brief description, a name and a picture for each of them. These IPAs differed from each other only in their level of anthropomorphism. Each participant only read the description of one IPA, thus being randomly exposed to a specific level of anthropomorphism.

The first IPA was *CortexBot3409*. It did not have a gender or a defined shape, as the picture consisted of strings of code on a black background. No references were made to its intelligence or autonomy, but it was outlined that it can perform its activities according to the algorithms developed by its creators. For these reasons, we proposed it as the least anthropomorphic IPA of the three (low A.). The

second IPA was *Syntharus*. Both the picture and the name suggested a human-like entity, as the picture was that of a humanoid robot. References were made to the IPA's own intelligence and personality. The last sentence suggested that it can become a friend of the user, getting to know their habits and preferences. We proposed it as medium level in terms of anthropomorphism (medium A.). Finally, the third IPA was *Alicia*. In line with the name, the picture used was that of a real woman in front of a display with several lines of code. This IPA was referred to it as a "she", thus having pronouns that revealed its gender. Alicia was described as capable of performing the tasks according to its sensitivity and depending on its mood. It was stated that it bases its operations on its experience, which allows it to understand the user and become a "close friend". For these reasons, we proposed it as the most anthropomorphic IPA of the three (high A.). All the three descriptions can be found in the appendix.

To measure the validity of these stimuli, two pretests were conducted. First, the three descriptions of the fictitious IPAs were proposed to six people among our personal connections, who were asked to rank the fictitious IPAs based on their anthropomorphism. For this purpose, the following definition of anthropomorphism was provided to the respondents before the ranking: "Anthropomorphism is the attribution of human characteristics and qualities to non-human beings, objects, natural, or supernatural phenomena" (New World Encyclopedia, 2023). All the rankings matched with the levels of anthropomorphism we had developed, i.e., all the respondents ranked CortexBot3409 (low A.) as the least anthropomorphic, Alicia (high A.) as the most anthropomorphic, and Syntharus (medium A.) in between the two. Thus, the first pretest validated the materials.

For the second pretest, 16 other people among personal connections were proposed a Qualtrics questionnaire, asking questions regarding their perceived anthropomorphism of the three fictitious IPAs. Participants were not informed about the definition of anthropomorphism, and they read the three descriptions of IPAs, answering questions about anthropomorphism for each description. For this purpose, the six-item Likert scale developed by Waytz et al. (2010b, p. 420) and adapted by Ruijten et al. (2019, p. 493) was used. The scale has questions like "To what extent does this IPA have thoughts of its own?" or "To what extent does this IPA have intentions?". Values varied between a minimum of 1 (indicating low anthropomorphism) and 7 (indicating high anthropomorphism). The results validated the stimulus materials: CortexBot3409 (low A.) scored on the scale an average of 2.35 (SD = 1.38), Syntharus (medium A.) scored 3.43 (SD = 1.16), while Alicia (high A.) scored 5.29 (SD = 1.49). Furthermore, we conducted a paired samples t-test to compare the perceived anthropomorphism levels of the three different IPAs. The perceived anthropomorphism of CortexBot3409 (M = 2.35, SD = 1.38) was significantly lower than that of Syntharus (M = 3.43, SD = 1.16), $t(15) = -3.14$, $p = .007$. The same is true for the anthropomorphism of Syntharus, which was significantly lower than that of Alicia (M = 5.29, SD = 1.49), $t(15) = -6.00$, $p < .001$. This validated the materials, confirming progressively higher levels of anthropomorphism from CortexBot3409 to Alicia.

Moving to the other main constructs of the study, perceived usefulness was measured using a four-item scale developed by Shin (2007, p. 482). The scale consists of Likert scale-based items, in which participants are asked about the extent to which they agree or disagree with sentences regarding how useful and convenient it seems to them to use the fictitious IPA. E.g.: “This IPA would be very useful to my life in general”.

To measure perceived privacy risks, the study used a four-item scale developed by Al-Debei et al. (2014), as adapted by McLean & Osei-Frimpong (2019, p. 32). The scale consists of Likert scale-based items, in which participants are asked about the extent to which they agree or disagree with sentences regarding how their privacy and personal information are at risk when using the fictitious IPA. E.g.: “I have my doubts over the confidentiality of my interactions with this IPA”.

To measure perceived creepiness, the study employed an eight-item scale developed by Woźniak et al. (2023, p. 8), with sub-measures for Implied Malice, Undesirability and Unpredictability. The scale consists of Likert scale-based items, in which participants are asked about the extent to which they agree or disagree with sentences regarding how the fictitious IPA is maliciously designed, socially undesirable and unpredictable. E.g.: “I think that the designer of this IPA had immoral intentions”.

To measure adoption intention, the study used a three-item scale developed Kulviwat et al. (2007, p. 1084). The scale consists of Likert scale-based items, in which participants are asked “How likely is it that you would use and IPA?”, and answers are anchored by unlikely/likely, improbable/probable and impossible/possible.

To measure perceived ease of use, the study employed a three-item scale developed by Dong et al. (2016, p. 137). The scale consists of Likert scale-based items, in which participants are asked about their agreement with sentences regarding the ease of use of the IPA. E.g.: “I believe that it is easy to get this IPA to do what I want it to do”.

Chapter 4: Results

4.1 Sample characteristics

Table 1 shows that the percentage of females among the participants was 53.6% (n = 96), while that of males was 44.1% (n = 79). The remaining 2.2% of the sample (n = 4) indicated their gender as 'other' or preferred not to specify it. Participants' age was on average 30.39 (SD = 13.39), varying from a minimum of 19 to a maximum of 72 years old. The most frequent highest education level was bachelor's degree, with 40.8% of the respondents (n = 73), whereas 36.9% reported having achieved a high school diploma (n = 66), and 18.2% of the cases were holders of at least one master's degree (n = 31). Only 5.0% of the sample (n = 9) declared to have obtained an elementary/middle school diploma as their highest level of education. No participants reported having a PhD or similar. The participants were divided across to the three experimental conditions as follows: a total of 65 participants were assigned to CortexBot3409 (low A.), 59 participants to Syntharus (medium A.), and 55 to Alicia (high A.).

Table 1

Characteristics of the sample

Characteristic	Frequency in sample	Percentage of sample
Age		
18-30	137	76.5
31-40	15	8.4
41-50	3	1.7
51-60	10	5.6
61-70	13	7.3
71-80	1	.6
Gender		
Male	79	44.1
Female	96	52.3
Other	2	1.1
Prefer not to say	2	1.1
Level of education		
Elementary/middle school	9	5.0
High school	66	36.9
Bachelor's degree	73	40.8
Master's degree	31	18.2
PhD	0	0
Assignment to IPA		
CortexBot3409 (low A.)	65	36.3
Syntharus (medium A.)	59	33.0
Alicia (high A.)	55	30.7

4.2 Psychometric properties of the measurement scales and correlations

An exploratory factor analysis (principal component extraction) was conducted to assess the dimensionality and underlying structure of the items. The components were extracted based on eigenvalue of 1.0, and factor loadings of 0.40 were employed as cut-off points. The Cronbach's alpha values for all the scales met or exceeded the threshold of 0.70, thus indicating good or high levels of reliability. For this reason, and considering that dropping items would have not led to any improvement in the alphas, no items were dropped from any scale.

In the factor analysis for the multi-item scale for perceived creepiness, it was possible to determine two components, which we called Malice and Undesirability, according to the original names employed by

the researchers in the development of the scale (Woźniak et al., 2023). The subdimension *malice* contained three items that referred to the purpose of the IPA, its design, and the intentions of the people who developed it; on the other hand, the subdimension *undesirability* was made of four items that referred to the IPA's appearance and the way it would be perceived by other people when used in public. The resultant model explains 64.4% of the variance in perceived creepiness. The scale has high reliability, given the Cronbach's alpha of .82. The two components had alphas of .72 (Malice) and .79 (Undesirability). They were coded as two different variables and included in correlation and regressions analyses. They were also grouped to compute a "creepiness" variable, which was also included in the analyses for correlation and regression.

The factor analysis for perceived ease of use resulted in a single component. The model explained 64.9% of the variance. The scale had a Cronbach's alpha value of .73, just above the acceptability threshold.

The factor analysis for perceived usefulness resulted in a single component. The model explained 75.5% of the variance. The reliability analysis revealed high levels of reliability for the scale, given the Cronbach's alpha value of .89.

The factor analysis for perceived privacy risk resulted in a single component. The model explained 64.7% of the variance. The scale had a Cronbach's alpha value of .81, thus indicating good reliability for the scale.

Finally, the factor analysis for adoption intention resulted in a single component. The model explained 89.4% of the variance. The scale had a Cronbach's alpha value of .94, well above the acceptability threshold. Appendix B presents all the measurements used, the factor loadings of the items, and the Cronbach's alpha for all the scales.

Table 2 showcases the descriptive statistics for the main variables in the study, together with the correlations among them.

Table 2
Descriptive statistics and correlations (*n* = 179)

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*Mean*	*SD*
1. Perceived ease of use	-												5.08	0.87
2. Perceived creepiness	-.37*	-											3.12	0.96
3. Perceived usefulness	.42*	-.53*	-										4.51	1.10
4. Perceived privacy risks	-.19*	.44*	-.27*	-									5.16	1.09
5. Adoption intention	.21*	-.38*	.46*	-.30*	-								3.72	1.50
6. Familiarity with technology	.02	-.05	-.01	-.15**	-.01	-							5.68	1.25
7. CortexBot3409 (low A.)	.08	-.04	.08	.01	.07	-.04	-						0.36	0.48
8. Syntharus (medium A.)	-.09	-.08	-.01	-.07	.05	.08	-.53*	-					0.33	0.47
9. Alicia (high A.)	.01	.12	-.07	.06	-.13	-.04	-.50*	-.47*	-				0.31	0.46
10. Age	-.21*	.22*	-.24*	.13	-.15	-.07	.00	.04	-.04	-			30.4	13.39
11. Malice (Creepiness)	-.37*	.87*	-.52*	.41*	-.41*	-.02	-.05	-.11	.16**	.24*	-		3.05	1.10
12. Undesirability (Creepiness)	-.28*	.87*	-.40*	.35*	-.26*	0.7	-.02	-.03	.05	.14	.51*	-	3.20	1.12

**$p \leq .05$, (2-tailed). *$p \leq .01$, (2-tailed).

4.3 Hypotheses testing

To test all the hypotheses, the Hayes module PROCESS was used on SPSS. We employed the mediation model 4 to test the effect of anthropomorphism on adoption intention through the mediation of perceived creepiness and perceived ease of use. As the PROCESS can report the indirect effect of only one independent variable at a time, we ran the analysis twice: first, the dummy variable Alicia (high A.) was the predictor and Syntharus (medium A.) was a control variable; next, the two variables were swapped, thus Syntharus (medium A.) was the predictor and Alicia (high A.) was a control variable. This allowed us to observe the indirect effect of both the dummy variables (i.e., two different levels of anthropomorphism) on adoption intention. In both analyses, the other control variables were perceived usefulness, perceived privacy risks, age, and familiarity with technology. Perceived creepiness and perceived ease of use were the two mediators, while adoption intention was the dependent variable. Finally, we ran two additional analyses with the PROCESS, with the same structure of the previous two, but employing as mediators the two subdimensions found for creepiness in the factor analysis (malice and undesirability). A summary of all the results can be found Table 3.

Hypothesis 1 stated that *anthropomorphism has a positive effect on perceived creepiness*. To test this hypothesis, we examined the direct effect of the dummy variables Alicia (high A.) and Syntharus (medium A.) on perceived creepiness. In both these examinations we found no significant effect of anthropomorphism on perceived creepiness (Alicia: b = -.10, t = .70, p = .49; Syntharus: b = -.08, t = -.56, p = .58). For Alicia, the 95% confidence interval ranged between -.18 and .39. For Syntharus, the 95% confidence interval ranged between -.36 and .20. Therefore, the data does not support H1, and we can reject it.

Furthermore, we ran the analysis with the two subdimensions of creepiness found in the factor analysis: malice and undesirability. No significant effect of anthropomorphism was found on any of the two subdimensions (Alicia on malice: b = .21, t = 1.31, p = .19; Syntharus on malice: b = -.13, t = -.83, p = .41; Alicia on undesirability: b = .02, t = .09, p = .93; Syntharus on undesirability: b = -.04, t = -.22, p = .83).

Looking at the control variables, perceived usefulness was found to have a significant negative effect on perceived creepiness (b = -.37, p = .00). This is also the case for perceived privacy risks, which had a significant positive effect on perceived creepiness (b = .27, p = .00). As of age and familiarity with technology (the other control variables), no significant effects were found on perceived creepiness.

Hypothesis 2 stated that *perceived creepiness has a negative effect on adoption intention*. No significant effect of perceived creepiness on adoption intention was found (b = -.17, t = -1.32, p = .19); the 95% confidence interval ranged between -.43 and .08. As mentioned for the first hypothesis, the data does not support H2, and we can reject it.

However, the results showed a significant, negative effect of the subdimension malice on adoption intention (b = -.24, t = -1.98, p = .05), with the 95% confidence interval ranging between -.47 and -.00. As of undesirability (the other subdimension), no significant effect was found (b = .02, t = .20, p = .84), with the 95% confidence interval ranging between -.19 and -.23.

Hypothesis 3 stated that *anthropomorphism has a positive effect on perceived ease of use*. For both Alicia (high A.) and Syntharus (medium A.), we found no significant relationship between anthropomorphism and perceived ease of use (Alicia: b = -.008, t = -.05, p = .96; Syntharus: b = -.17, t = -1.17, p = .24). For Alicia, the 95% confidence interval ranged between -.29 and .28. For Syntharus, the confidence interval ranged between -.45 and .11. Again, we can reject H3 as it is not supported by the data.

Similarly to what observed for creepiness, perceived usefulness was found to have a significant positive effect on perceived ease of use (b = .29, p = .00); however, no significant effects were found for age, perceived privacy risks and familiarity with technology.

Finally, hypothesis 4 stated that *perceived ease of use has a positive effect on adoption intention*. No significant effect of perceived ease of use on adoption intention was found (b = -.03, t = -.20, p = .84); the 95% confidence interval ranged between -.28 and .23. This means that H4 can also be rejected.

The control variables perceived usefulness (b = .48, p = .00) and perceived privacy risks (b = -.22, p = .03) were found to have significant influence on adoption intention of the IPA. No significant effects were found for age and familiarity with technology.

The indirect effects of anthropomorphism on adoption intention through the mediation of perceived creepiness and perceived ease of use were also found to be not significant. This was true in both the analyses we ran with PROCESS, i.e., both with Alicia (high A.) or Syntharus (medium A.) as predictor. In the first case (Alicia), the path through creepiness showed an effect of b = -.02 with 95% confidence interval ranging between -.12 and .04, thus resulting as not significant, as it contained 0. Similarly, in the path through ease of use, the effect was b = .00, and the 95% confidence interval ranged between -.05 and .04, thus resulting as not significant. In the second analysis (Syntharus), the same results were observed: the path through creepiness showed an effect of b = .01 with 95% confidence interval between -.05 and .08, thus it was not significant. The path through ease of use showed an effect of b = .00, and the 95% confidence interval was between -.06 and .06, thus resulting as not significant. Therefore, we can conclude that neither perceived creepiness nor perceived ease of use are mediators in the relationship between anthropomorphism and adoption intention.

Table 3

Results of the Hayes PROCESS analyses (Model 4)

Independent variables	*Dependent variables*		
First analysis (main constructs)	Perceived creepiness	Perceived ease of use	Adoption intention
Control variables			
Perceived Usefulness	-.37***	.29***	.48***
Perceived Privacy Risks	.27***	-.22	-.22**
Familiarity with technology	-.001	.01	.02
Age	.01	-.01	-.003
Main effects			
Syntharus (medium A.)	-.08	-.17	.00
Alicia (high A.)	.10	-.01	-.28
Perceived creepiness			-.17
Perceived ease of use			-.03
R^2	.37***	.20***	.26***
F-statistic	16.8***	7.21***	7.59***
Second analysis (creepiness' subdimensions)	Malice (creepiness)	Undesirability (creepiness)	Adoption intention
Malice (Creepiness)			-.24**
Undesirability (Creepiness)			.02
Syntharus (medium A.)	-.13	-.04	-.01
Alicia (high A.)	.21	.02	-.25
R^2			.27***
F-statistic			8.0***

n=179. *** $p \leq .01$, ** $p \leq .05$. * $p \leq .10$. Note: One-tailed tests were conducted for all the effects.

Chapter 5: Discussion

The aim of this study was to understand the impact of anthropomorphism on adoption intention of Intelligent Personal Assistants. In detail, the goal of the thesis was to shed light on whether creepiness and perceived ease of use can be mediators in this process, i.e., whether more anthropomorphic IPAs can be perceived as more creepy and easier to use, and if this can reduce (in the case of creepiness) or foster (in the case of perceived ease of use) people's intention to use IPAs in their life. The results of the experimental survey indicated that no significant relationships were found between the main variables of the study. This means that, based on the results of this investigation, more anthropomorphic IPAs are not perceived as creepier by the users. Likewise, a more anthropomorphic IPA is not perceived as easier to understand and use than a less anthropomorphic one. Furthermore, the level of perceived creepiness was not related to participants' intention to use the IPA they were proposed: however, one of the two subdimensions of creepiness (malice) was found to significantly reduce people's intention to use IPAs. As for creepiness, the extent to which participants perceived the IPA to be easy to use was not related to their intentions to ultimately use it. We can therefore conclude that neither perceived creepiness nor perceived ease of use mediate the impact of anthropomorphism on adoption intention towards IPAs.

The analyses conducted revealed significant effects for two other variables: perceived usefulness and perceived privacy risks. Perceived usefulness was found to affect both perceived creepiness (negatively) and perceived ease of use (positively): this means that the more the IPA was perceived by participants as useful for their life, the more it was seen as simple to use and the less it was perceived as creepy. Unsurprisingly, usefulness was also found to positively affect the participants' intention to adopt the IPA they were exposed to. As of perceived privacy risks, the results showed that they do not have an effect on participants' perceived ease of use, but they positively impact perceived creepiness: the more participants perceived their IPA as potentially risky for their privacy, the more they perceived it as creepy. Overall, perceived privacy risks negatively affect people's intention to use the IPA they were exposed to. However, anthropomorphism was not found to affect either perceived usefulness or perceived privacy risks: for this reason, it cannot be said that such perceptions play the role of mediators in the relationship between anthropomorphism and adoption intention of IPAs.

5.1 Theoretical implications

The notion that anthropomorphism does not increase creepiness, as we found in our analyses, is partially in contradiction with Mori's uncanny valley effect, which posits that higher levels of anthropomorphism can lead technological artefacts to be perceived as creepier by the public (Mori et al., 2012, p. 98). Our findings do not support this idea, neither for the creepiness construct, nor for its two

subdimensions malice and undesirability. However, it must be noted that Mori's work was centred on humanoid robots, and his conception of anthropomorphism focused on physical attributes that gave such robots a human-like appearance. As already explained in chapter 2, we adopted in this study a different notion of anthropomorphism, focused also on human-like attributes that go beyond physical resemblance to humans and that pertains to other human-like features, such as autonomy, humor, the display of a personality, and many more. Given that we found no effect of anthropomorphism on perceived creepiness in IPAs, we have reasons to suppose that Mori's uncanny valley theory might be only limited to physical attributes, i.e., the human-like features that lead people to perceive a sense of eeriness are only those that make the technological artifact physically similar to a human. In this view, anthropomorphic cues such as voice, gender and personality lead people to perceive a technological artifact as human-like (see results of the pretests), but they do not elicit a sense of creepiness in the public.

Creepiness was also not found to negatively influence adoption intention towards IPAs. This is not in line with previous research on the concept of creepiness in technology adoption, like Handrich (2021, p. 11), who found creepiness to negatively impact adoption intention towards AI application, or Raff et al. (2024, p. 10), who posited that humans tend to avoid the technological artifacts they perceive as creepy. Our results also suggest a negative correlation between creepiness and adoption intention, but such relationship is not significant in the regression analysis. As better explained below, such results might be due to the large-scale expansion and adoption of IPAs, and thus the familiarity many people have with such applications (Han & Yang, 2017, p. 618). Further investigations should focus on the effect of creepiness on adoption intention towards other technologies that are already commonplace in society, to assess whether the results we found are limited to IPAs, or they extend to different technologies. In any case, it must be noted that one of the two dimensions of creepiness (malice) was found to significantly, negatively impact adoption intention. This component's items referred to the extent to which the IPA had an unclear purpose and its designers had immoral intentions: based on our findings, this subdimension of creepiness does indeed reduce people's intention to use IPAs. However, when combined with the other subdimension (undesirability) into the overall perceived creepiness construct, this construct does not significantly affect adoption intention. We believe that future studies should explore this matter, to understand whether a relationship between creepiness (as a whole) and adoption intention exists, or it is only significant in one dimension of creepiness.

As of perceived ease of use, we found it to not be influenced by anthropomorphism. Again, this contradicts previous findings: Song and Shin (2022, p. 1) stated that human-like interfaces make it easier for people to start social interactions with technological applications, but we found no confirmation in this study. Similarly, Gursoy et al. (2019, p. 158) stated that AI devices' autonomy (key element in anthropomorphism) makes them user-friendly for users, but our results do not support this statement. The effect of anthropomorphism on perceived ease of use might be mediated by other factors.

Furthermore, perceived ease of use does not impact adoption intention of IPAs. Similarly to what found for creepiness, the results indicated a (positive) correlation between perceived ease of use and adoption intention, but this correlation is not significant in the regression analysis. This is partially not in line with one of the main notions of Davis's Technology Acceptance Model (1989, p. 319). Once again, we believe that the reason behind this finding could be that the investigation was on applications that are commonplace and familiar for many people in society. For example, Dong et al. (2016, p. 130) found perceived ease of use to positively influence adoption intention of Internet of Things technologies, but it must be noted that the study was conducted in 2016, when IoT was far from commonplace and still resulted as new to large parts of the population. This might mean that people's familiarity with the technology of interest in the study alters effects found in previous research. In any case, it is important to notice that the other variable of the TAM, perceived usefulness, was instead found to influence both perceived creepiness (negatively) and perceived ease of use (positively), as well as adoption intention (positively). This perfectly aligns with the TAM. Furthermore, it reveals that the more an IPA is perceived as useful, the less it is perceived as creepy. To the best of our knowledge, this effect has not been observed yet in literature, and it can be object of future investigations.

Finally, the role of perceived privacy risks on perceived creepiness was found to be significant. This is not surprising, given that Tene and Polonetsky (2014, p. 4) already found that technologies are perceived as creepy when they are always listening and when they make an unclear display of personal data. Our result also confirms what found by Rajaobelina et al. (2021, p. 2350), i.e., that privacy concerns is an antecedent of perceived creepiness in chatbots. When it comes to adoption intention, perceived privacy risks negatively affect people's intention to use IPAs. This is in line with a rich amount of previous research on technological innovations, Internet of Things technologies, and IPAs in particular (Davis, 1989, p. 320; Hsu and Yeh, 2016, p. 1091; Manikonda et al., 2017, p. 1; McLean & Osei-Frimpong, 2019, p. 33).

In light of our findings, i.e., that anthropomorphism does not affect perceived creepiness, perceived ease of use and adoption intention, we believe it is important to discuss a possible explanation of why the effects we hypothesized were not significant in our study. As explained in the introduction, IPAs are commonplace in society, to the point that they result somewhat familiar to part of the public (Han & Yang, 2017, p. 618). This might explain why IPAs' level of perceived anthropomorphism does not affect their perceived creepiness and ease of use, as well as the latter do not influence adoption intentions towards such applications. The reason is that people who already know (and possibly use) IPAs in their life might be *used* to their high levels of anthropomorphism, which means that they might not be creeped out (anymore) by IPAs' humanlike features, as well as they might not perceive IPAs to be particularly easy to use. Given IPAs' great diffusion, their anthropomorphism might be 'taken for granted' by people, regardless of whether they use IPAs in their life or not. For the same reason, perceived creepiness and ease of use might not affect adoption intention of IPAs. This leads us to suppose that previous exposition to IPAs might strongly reduce

the impact that anthropomorphism plays on the perceptions, and that perceptions play on adoption intention. In general, we suppose that the previous exposition to the technology of interest might significantly alter the relationships found to be true for new and unfamiliar technologies. For this reason, we believe that further research is needed on the impact of anthropomorphism on adoption intention through the mediation of creepiness and ease of use, to understand whether familiarity with the specific technology of interest reduces the effect of people's perceptions on their adoption intention.

5.2 Practical implications

A first implication for IPAs practitioners (developers, marketers) that can be derived from this study is that we do not know whether trying to make IPAs as anthropomorphic as possible (Moussawi et al., 2020, p. 343) will make them appear easier to use. We can assume that this is not the case, as found in this study, because users of IPAs now 'take for granted' the anthropomorphism of the applications; in any case, the effort spent until now in fostering IPAs' anthropomorphism might be reconsidered and directed elsewhere. Similarly, given that we found no evidence that more anthropomorphic IPAs are perceived as more useful, practitioners might want to invest their resources on other features of IPAs, rather than enhancing their anthropomorphism.

As of perceived creepiness and perceived ease of use, our results indicated no effects on adoption intention of IPAs. This means that practitioners might want to focus on other factors that could potentially affect the diffusion of their applications. However, since malice (subdimension of creepiness) was found to significantly reduce people's intention to use IPAs, we can conclude that practitioners should focus their efforts on ensuring that their IPAs clearly declare their purpose and are not perceived as developed with immoral intentions. This might be done by displaying clear disclaimers and explanations, declaring that the IPA is only intended to assist and facilitate people's life, and it has no other purpose, nor is it programmed to perform immoral activities.

The results of the analyses suggest that IPAs practitioners should definitely consider the importance of perceived usefulness and perceived privacy risks. Based on our results, developers and marketers should focus on making IPAs perceived as useful as possible, in order to enhance the adoption of their applications. Users must feel that the IPA can significantly ease their life, saving them time and/or effort in daily tasks: this will improve the IPAs adoption. Similarly, practitioners should concentrate on reducing IPAs' perceived privacy risks, as we found them to reduce people's intention to use IPAs. Users must perceive that when using the IPA, their privacy is not in danger: their data will not be stolen, as the IPA only has the purpose of assisting its users. Once again, this could be achieved with clear explanations and disclaimers, showcasing the 'real' purpose of the product and guaranteeing that users' data are safe.

For the practical implications of this thesis, it is crucial to consider what already explained above: the fact that no relationships were found between anthropomorphism, creepiness, ease of use and

adoption intention might be due to great diffusion of IPAs in today's society. This means that one must be cautious in deriving from this study practical implications; we consider the implications we presented to be significant only for IPAs practitioners. We hypothesize that such implications might be significant also for other technologies already adopted and considered familiar by large numbers of users, but further research is certainly needed on this topic.

5.3 Limitations and future research

We believe that this study has several limitations that need to be acknowledged, despite our effort to ensure a meticulous methodology. These limitations concern both the representativity of the sample and the validity of the methodology we adopted.

First, the recruitment of participants mainly occurred on social media platforms like WhatsApp, LinkedIn and Instagram, spreading the questionnaire among our personal and professional networks. This use of a convenience sampling technique might have generated a selection bias in the study. Thus, the generalizability of the results might be limited, as the sample might not be representative of the population. In this regard, it is evident that the average age of the participants was heavily unbalanced towards young adults, as more than 3 participants out of 4 were between 18 and 30 years old. Furthermore, the vast majority of the participants had either a high school diploma or a bachelor's degree, which is significantly higher that the OECD average of 40.7% for tertiary education (OECD, 2023). If we consider that young adults and more cultivated people tend to use internet and technology more (Pew Research Centre, 2021), and that the survey was almost exclusively distributed through online channels, it is easy to understand that the sample was unbalanced in terms of technological familiarity: in fact, 73.2% of participants declared to be moderately or extremely familiar with technology. In turn, this high familiarity might have led participants not to perceive higher creepiness or ease of use when presented with more anthropomorphic IPAs, or not to base their adoption intention on such perceptions. People who are less familiar with technology might have perceived higher creepiness in relation to the anthropomorphism of the IPAs, thus reporting lower adoption intention. In a future investigation about the perceptions of Intelligent Personal Assistants, including more participants with scarce familiarity with technology could improve the representativity and thus the generalizability of the results.

It is also important to notice that the cultural context in which the study was conducted may be another factor that limits the generalizability of the findings. As mentioned, the sample was almost exclusively made of Italians, or internationals living in the Netherlands, France or Belgium. Given that the notions of anthropomorphism, creepiness and usefulness can vary significantly across different cultures and nations, replicating the study in different cultural settings would be useful to evaluate the consistency of the findings. What is not perceived as creepy in Western Europe might well be perceived as creepy in other regions: the same stands for what is anthropomorphic, what is useful, what is potentially harmful for

people's privacy, etc. This means that it might be possible that the more anthropomorphic IPAs we developed (Syntharus and Alicia) could have been perceived as more creepy or easier to use by a sample including people from totally different areas of the world. This of course limits the generalizability of our results, and it shows the necessity of replicating similar investigations in different geographic and cultural contexts.

Moving forward, one major limitation of our study is that participants did not *interact* with the fictitious IPA they were assigned to. Considering that IPAs are products with which people interact multiple times every day, to the point that such technologies almost become part of their users' life, only reading a short description might not be enough for users to develop detailed perceptions and intentions towards such technologies. Real-world IPAs showcase interactive functionalities that can impact their users' perceptions much more intensely than simple descriptions and pictures. Future studies should maybe implement experimental designs, in which users have the possibility to actually interact with the IPA, before being asked about their perceptions of them. It must also be noted that only three fictitious IPAs were developed, to present three different levels of anthropomorphism. Although the results of the pretest validated the materials, we believe that developing more IPAs would have allowed us to represent the different nuances of anthropomorphism, capturing the whole spectrum of human-likeness that IPAs showcase. For example, some IPAs could have showcased progressively higher levels of human-likeness only in terms of their physical appearance; other IPAs could have displayed a human-like personality and sensibility, but without a human-like body; others could have completed complex human tasks autonomously, but showing no signs of personality and/or human feelings, etc.

To sum up, this study has limitations both in the representativity of the sample and in the design of the experimental survey. We acknowledge that further research is needed on the topic, with a broader sample made of participants from different cultural backgrounds and with different levels of education, age, and familiarity with technology. Furthermore, additional studies with experimental designs would better assess the impact of anthropomorphism on adoption intention through the mediation of perceived creepiness and perceived ease of use, shedding light on the topic and generating important implications.

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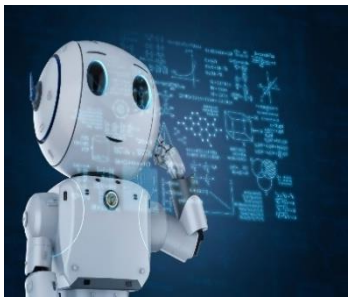
Appendix A - Stimulus material: three descriptions of IPAs

Low anthropomorphism	Medium anthropomorphism	High anthropomorphism
		
This is CortexBot3409. It is an Intelligent Personal Assistant that makes use of AI to understand your requests and help you in your daily tasks. Since it understands your language, you can talk to it, and it can reply vocally to your words. It can give you suggestions, based on the algorithms developed by its creators. You can use it to play a song, control the heating, store your passwords, write emails for you, and much more. It can memorize your choices and your activities, in order to better profile you and to assist you in your daily life.	This is Syntharus. It is an Intelligent Personal Assistant that makes use of AI to understand your requests and help you in your daily tasks. Since it understands your language, you can talk to it, and it can reply vocally to your words, according to its intelligence. It can give you suggestions, based on its personality. You can ask it to play a song, control the heating, store your passwords, write emails for you, and much more. It will remember your choices and your habits, in order to know you, and to assist you in your daily life like a friend.	This is Alicia. She is an Intelligent Personal Assistant that makes use of AI to understand your requests and help you in your daily tasks. Since she understands your language, you can talk to her and have with her a conversation, according to her mood and her sensitivity. You can ask her to play a song, control the heating, store your passwords, write emails for you, and much more. She can give you suggestions, based on her experience. She will remember your choices and your habits, in order to know you better and to assist you in your daily life, like a close friend.

Appendix B – Multi-item measurements

Construct	Items	Factor Loadings
Perceived ease of use (α =.73)	(1=strongly disagree, 7= strongly agree)	
	1. I believe that it is easy to get this IPA to do what I want it to do.	0.78
	2. It is easy for me to remember how to perform tasks using this IPA.	0.81
	3. Overall, I believe that this IPA would be easy to use.	0.83
Perceived creepiness (α =.82)	(1=strongly disagree, 7= strongly agree)	
Malice (α =.72)	1. I think that the designers of this IPA have immoral intentions.	0.87
	2. The design of this IPA is unethical.	0.83
	3. I don't know what the purpose of this IPA is.	0.60
Undesirability (α =.79)	4. I would feel uneasy using this IPA in public.	0.80
	5. Using this IPA in public areas will make other people laugh at me.	0.83
	6. This IPA looks bizarre to me.	0.74
	7. This IPA does not look as expected.	0.62
Perceived usefulness (α =.89)	(1=strongly disagree, 7= strongly agree)	
	1. This IPA would be very useful to my life in general.	0.87
	2. This IPA would provide very useful services and information to me.	0.86
	3. Using this IPA would be helpful to improve my performances in general.	0.89
	4. Using this IPA would be helpful to enhance the effectiveness in my life in general.	0.86
Perceived privacy risks (α =.81)	(1=strongly disagree, 7= strongly agree)	
	1. I have my doubts over the confidentiality of my interactions with this IPA.	0.72
	2. I am concerned to perform a financial transaction via this IPA.	0.84
	3. I am concerned that my personal details stored with this IPA could be stolen.	0.85
	4. I am concerned that this IPA collects too much information about me.	0.84
Adoption intention (α =.94)		
	1. Assuming you have access to this IPA in the future, what is the probability that you would buy it? (1= extremely unlikely, 7= extremely likely)	0.96
	2. Assuming you have access to this IPA in the future, what is the probability that you would buy it? (1= extremely improbable, 7= extremely probable)	0.94

	3. Assuming you have access to this IPA in the future, what is the probability that you would buy it? (1= extremely impossible, 7= extremely possible)	0.93

Appendix C – Survey

Introduction

Welcome to my survey on Intelligent Personal Assistants (IPAs)!

Before you begin, I would like to provide you with some important information about the study and your participation.

The purpose of this survey is to investigate your perceptions of Intelligent Personal Assistants (IPAs). I aim to gain insights that can inform the development of better IPAs, regarding user experiences and functionalities.

Your participation in this survey is entirely voluntary. You are under no obligation to participate, and if you decide to do so, you may withdraw from the study at any time without providing a reason. In this case, you answers would not be collected.

Any data collected during this survey will be used for research purposes only. Your responses will be kept anonymous and confidential, and they will only be analysed in aggregate form. All the information will be totally erased within 6 months after your completion of the survey.

This survey is estimated to take approximately 8 minutes to complete. Your time and input are greatly appreciated, and I thank you in advance for your valuable contribution to this study. By continuing with this survey, you acknowledge that you have read and understood the information provided above, and you are older than 18. Thank you for your participation!

Description of IPAs

Intelligent Personal Assistants are software agents that use artificial intelligence and speech recognition to operate various tasks. The most famous IPAs are Siri, Alexa, Cortana, and Google Assistant. They can be controlled by users primarily through voice commands or text input, and they can perform a vast range of tasks, like making phone calls, playing a song or a movie, sending messages and emails, controlling your house's lights, and much more.

Questions about perceived ease of use (7 points Likert scale)

I believe that it is easy to get this IPA to do what I want it to do.

It is easy for me to remember how to perform tasks using this IPA.

Overall, I believe that this IPA would be easy to use.

Questions about perceived creepiness (7 points Likert scale)

I think that the designers of this IPA have immoral intentions.

The design of this IPA is unethical.

Appendix C – Survey (continued)

Using this IPA in public areas will make other people laugh at me.

I would feel uneasy using this IPA in public.

This IPA looks bizarre to me.

This IPA does not look as expected.

I don't know what the purpose of this IPA is.

Questions about perceived usefulness (7 points Likert scale)

This IPA would be very useful to my life in general.

This IPA would provide very useful services and information to me.

Using this IPA would be helpful to improve my performances in general.

Using this IPA would be helpful to enhance the effectiveness in my life in general.

Questions about privacy risks (7 points Likert scale)

I have my doubts over the confidentiality of my interactions with this IPA.

I am concerned to perform a financial transaction via this IPA.

I am concerned that my personal details stored with this IPA could be stolen.

I am concerned that this IPA collects too much information about me.

Questions about adoption intention (7 points Likert scale)

Assuming you have access to this IPA in the future, what is the

probability that you would buy it?

Unlikely/likely

Improbable/probable

Impossible/possible

Questions about demographics

In what year were you born?

Appendix C – Survey (continued)

What is your gender identity? (male/female/other/prefer not to say)

What is the highest level of education you have completed? (Elementary/middle school, High School, Bachelor's, Master's, PhD).

How would you rate your familiarity with technology? (extremely unfamiliar - extremely familiar).

Debriefing

We thank you for your time spent taking this survey. Your response has been recorded.