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Anthropomorphism brings us closer: The mediating role of psychological distance in User–AI assistant interactions

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ABSTRACT

In the current era, interacting with Artificial Intelligence (AI) has become an everyday activity. Understanding the interaction between humans and AI is of potential value because, in future, such interactions are expected to become more pervasive. Two studies—one survey and one experiment—were conducted to demonstrate positive effects of anthropomorphism on interactions with smart-speaker-based AI assistants and to examine the mediating role of psychological distance in this relationship. The results of Study 1, an online survey, showed that participants with a higher tendency to anthropomorphize their AI assistant/s evaluated it/them more positively, and this effect was mediated by psychological distance. In Study 2, the hypotheses were tested in a more sophisticated experiment. Again, the results indicated that, in the high-anthropomorphism (vs. low-anthropomorphism) condition, participants had more positive attitudes toward the AI assistant, and the effect was mediated by psychological distance. Though several studies have demonstrated the effect of anthropomorphism, few have probed the underlying mechanism of anthropomorphism thoroughly. The current research not only contributes to the anthropomorphism literature, but also provides direction to research on facilitating human–AI interaction.

1. Introduction

Artificial Intelligence (AI) technology is burgeoning, and products and services adopting AI have permeated into our society. People have begun to read news articles written by AI, use self-driving automobiles, receive deliveries transported by drones, and arrange schedules with their AI assistants. The global AI industry market size was worth approximately 20.67 billion dollars in 2018 and it is expected to grow to 202.57 billion dollars by 2026 (Fortune Business Insights, 2019). With the continuing development of AI technology, the usage of AI will become more common in the near future. Thus, scrutinizing AI, especially the interaction between humans and AI, is necessary and of potential value in this era of the Fourth Industrial Revolution.

One of the most frequently-studied concepts in the field of human–AI interaction is anthropomorphism, which is defined as "the tendency to imbue real or imagined behavior of nonhuman agents with humanlike characteristics, motivations, intentions, or emotions" (Epley et al., 2007, p. 864). The importance of anthropomorphism in the context of human–AI interaction lies in the fact that it offers a theoretical basis for how people interact with a nonhuman entity like AI, as well as for illuminating the psychological mechanism of this relationship (Duffy, 2003). For example, Artificial Intelligence anthropomorphism is linked with attributing humanlike minds and provoking emotions (Shank et al., 2019), as well as privacy concerns (Ha et al., 2020). Prior research suggests that a chatbot's anthropomorphic visual features could act as a buffer for its low-level message interactivity (Go & Sundar, 2019). Kim and her colleagues also found that the type of relationship with an AI influences the degree of anthropomorphism of AI assistants, which in turn affects the perceived warmth of and pleasure derived from interactions with AI assistants (Kim et al., 2019).

In the domain of consumer studies, Aggarwal and McGill (2007) found that schema congruity was one of the mechanisms involved in anthropomorphism. They found that people liked the target product more when the activated human schema was congruent with product characteristics. Nevertheless, limited research has been conducted to reveal the underlying mechanism of effects of anthropomorphism on human–AI interaction. Thus, we aimed to explore a potential mechanism of this effect. Specifically, we suggest that psychological distance—the subjective experience of something or someone being close to or far from the self, here, and now (Trope & Liberman, 2010)—to be

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the basis of the underlying mechanism of anthropomorphism. Two studies were conducted to examine the role of psychological distance in evaluating smart-speaker-based AI assistants with different degrees of anthropomorphism. The current research would not only contribute to the literature on anthropomorphism, but it would also improve AI developers' understanding of how they can facilitate human–AI interaction.

2. Theoretical background

2.1. Artificial Intelligence and interactions with AI

Artificial Intelligence refers to "a branch of computer science dealing with the simulation of intelligent behavior of computers" or "the capability of a machine to imitate intelligent human behavior" (Artificial Intelligence, 2019). The potential value of AI technology is tremendous, as it can be implemented in a wide range of industries such as education, healthcare, home assistance, and commerce. In fact, people are already interacting with numerous AI products in their daily lives. For example, Netflix provides users with personalized movie recommendations using AI and Big Data; Facebook highlights faces (if there are any) and suggests tags for people's faces when a photo is uploaded. Among various products and services equipped with AI technology, people interact most frequently with AI assistants like Siri and Alexa. Amazon released Amazon Echo with its assistant Alexa in 2014, which quickly took the lead in the smart speaker market and it continues to maintain a 70% market share in the US (Sterling, 2019). Siri was released in 2011, and Apple claimed that it is now being used by a staggering 500 million users (Maggio, 2018).

As AI technology continues to develop, the emerging focal research question aims to explain is how humans generally or socially interact with robots and AI agents (for a comprehensive review, see Broadbent, 2017). Researchers have investigated issues such as whether people perceive robots with different functions (i.e., economic function or social function) differently (Wang & Krumhuber, 2018), whether consumers are reluctant to adopt healthcare provided by AI (Longoni et al., 2019), and how the behavior of robots toward other robots influences their interactions with humans (Fraune et al., 2020). Gratch et al. (2014) studied how people's resistance to self-disclosure varies as their perception of virtual human agents varies; Lee et al. (2019) examined user characteristics that influence satisfaction with AI assistants; and Chattaraman et al. (2019) investigated what type of interaction styles (i.e., social- or task-oriented) AI-based conversational digital assistants should employ.

Since robots and AI agents possess features that more or less resemble human features, a notable question is how the humanlike features of AI influence their interaction with users. Consequently, anthropomorphism has naturally become one of the most widely-studied concepts in the field of human–robot or human–AI interaction. In the next section, the definition and ubiquity of anthropomorphism will be presented and the effects of anthropomorphism on human–AI interaction will be discussed.

2.2. Anthropomorphism

Anthropomorphism, argued to be a prevalent way of thinking (Mithen & Boyer, 1996), refers to the tendency to attribute human characteristics, emotions, and intentions to nonhuman entities (Epley et al., 2007). As a universal phenomenon, anthropomorphism has existed throughout the history of mankind and has appeared in a variety of disciplines. For instance, anthropomorphism has been acknowledged as a key element in religion (Westh, 2009). Xenophanes (6th Century BC, as cited in Lesher, 1992) was the first philosopher to use the term "anthropomorphism" to depict the relationship between religious entities and their followers. People unintentionally anthropomorphize God in some situations (Barrett & Keil, 1996), since doing so could satisfy their effectance motivations, and help them understand and control the world (Waytz, Morewedge, et al., 2010). For example, during a drought, ancient and modern Greeks performed religious rituals and prayed to their gods for plentiful rain (Håland, 2005). Before the accumulation of medical knowledge, diseases and natural disasters were regarded as God's punishment for sin, and such a belief still prevails (Kopelman, 2002; Phillips III & Stein, 2007).

Further, other examples of anthropomorphism can be found in the field of literature, like in Aesop's fable *The North Wind and the Sun* or *The Hare and the Tortoise*. Markowsky (1975) pointed out several reasons behind adopting anthropomorphism in children's literature. One of these, perhaps the most important one, is to enable readers identify with the characters appearing in the work (Markowsky, 1975). Films too portray anthropomorphism. For instance, in the movie *Cast Away,* the character Chuck Noland anthropomorphized the famous volleyball "Wilson" to relieve his loneliness. In fact, along with effectance motivation, sociality motivation is another important antecedent of anthropomorphism because the desire to build and maintain social bonds with others is fundamental in humans (Baumeister & Leary, 1995; Epley et al., 2007). Research has shown that loneliness has a positive effect on anthropomorphism tendency (Epley et al., 2008), and anthropomorphized entities could in turn act as a buffer for social exclusion and loneliness (Mourey et al., 2017). In everyday life, it is common for people to anthropomorphize both living entities such as plants and animals as well as inanimate objects (Guthrie, 1993). Anthropomorphism literature has covered a variety of entities such as cars (Aggarwal & McGill, 2007), brands (MacInnis & Folkes, 2017), disease (Kim & McGill, 2011), time (May & Monga, 2013), money (Zhou et al., 2018), and, of course, AI agents.

In addition to creating social connections and meanings, anthropomorphism has other consequences. One is that sometimes people's behaviors toward anthropomorphized entities are similar to their behaviors toward humans. Abundant research has indicated that people treat anthropomorphic entities as social entities and they follow social norms in encounters with anthropomorphic entities (e.g., Aggarwal & McGill, 2007; Brown & McLean, 2015; Nass & Moon, 2000). In one study, after interacting with a computer tutor, participants completed a questionnaire about its performance, which was either administered on the same computer (the computer tutor), with paper and pencil, or on a different computer that appeared similar to the tutor computer but was placed in another room. Results showed that participants who rated the tutor computer on the same computer provided more positive evaluations than did those who rated it with paper and pencil or on another computer. More importantly, participants opposed the possibility that the questionnaire medium influenced their evaluations (Nass et al., 1999). In this study, though Nass et al. (1999) attempted to reduce social demand characteristics, it appeared that participants still unconsciously anthropomorphized the tutor computer and acted more politely when they had to evaluate it on the same computer.

Another consequence of anthropomorphism is the ascription of a humanlike mind to anthropomorphized entities. A mind has two dimensions—the ability to feel (experience) and that to act (agency) (Gray et al., 2007). If an entity is able to experience emotions, it merits moral concern (Gray & Wegner, 2009). If it has the ability to plan and act, it bears responsibility for its actions (Bigman et al., 2019; Waytz, Gray, et al., 2010). As robots are perceived to have less of a mind than humans (Gray et al., 2007), anthropomorphizing robots and AI would make them seem to have a more humanlike mind, as confirmed in previous research (Broadbent et al., 2013). In one study, participants were asked to watch different video clips and rate how sorry they felt for the protagonists in the clips. Actors in the clips treated the protagonists cruelly, and different clips featured different protagonists that varied in likeness to humans (including machine and human). The results indicated that participants felt sorrier for highly anthropomorphized protagonists and wished to help such protagonists more (Riek et al., 2009).

Although sometimes anthropomorphism backfires, such that people

feel more embarrassed when asked to undress and receive a medical check-up in front of an anthropomorphized robot than in front of a technical box (Bartneck et al., 2010), and they tend to have more privacy concerns when interacting with highly anthropomorphized virtual assistants (Ha et al., 2020; Xie et al., 2020), a more general consequence of anthropomorphism is a positive influence on interactions with anthropomorphized entities. Anthropomorphism was shown to increase trust in autonomous vehicles (Waytz et al., 2014), interaction pleasure with AI assistants (Kim et al., 2019), perceived amiability, sociability of robots, and preference for robots (Broadbent et al., 2013; Yam et al., 2020). Though robots, virtual assistants, and other types of AI agents have different levels of anthropomorphism, considering that it brings nonhuman entities into the realm of humanity, and that people generally have positive attitudes toward the human category and its members (Rauschnabel & Ahuvia, 2014), we hypothesized that anthropomorphism would have a positive effect on the evaluation of an AI assistant. Thus, we proposed the following hypothesis:

H_1: Anthropomorphism has a positive effect on the evaluation of the AI assistant.

2.3. Psychological distance

Psychological distance refers to the subjective experience of something or someone being close to or far from the self, here, and now (Trope & Liberman, 2010). Psychological distance comprises dimensions such as spatial, temporal, and social distance and hypotheticality (Liberman et al., 2007a,b; Liberman & Trope, 2014). As stated in the definition, psychological distance is subjective. Due to the influence of various psychological factors, people do not always perceive distances such as spatial distance or temporal distance objectively even if they can be measured precisely. For example, the valence (i.e., positive or negative value) of an event or object influences distance perception. Researchers have shown that more desired objects or locations seem spatially closer than less desired ones (Balcetis & Dunning, 2010). Others have found the opposite results, such that negative events, such as the day of a move to a worse place, feel temporally closer than do positive events (Bilgin & LeBoeuf, 2010). Han and Gershoff (2018) clarified this seeming discrepancy with the concept of perceived control. When perceived control is high, people perceive positive targets to be closer and negative targets to be further away. Contrariwise, when perceived control is low, people perceive positive targets to be further away and negative targets to be closer. The discrepancy occurs because the baseline level of perceived control is different for space and time—it is possible to go from one place to another, but one can never turn back time for even one second. Motivations such as the need to belong also influence distance perception. People perceive others to be closer after being socially rejected (Pitts et al., 2014), and they distance those who rejected them (Knowles et al., 2014). Factors such as perceived control (Wakslak & Kim, 2015), emotional intensity (Van Boven et al., 2010), power (Lammers et al., 2012), and different communication modalities also influence distance perception (Kaju & Maglio, 2018). Evidently, researchers have investigated numerous factors related to psychological distance, but they have neglected its relationship with anthropomorphism.

Since anthropomorphizing AI assistants has more to do with social distance than with other dimensions of psychological distance, the current research focused on this dimension though all psychological distance dimensions are correlated (Trope & Liberman, 2010). Anthropomorphism, by definition, pertains to ascribing humanlike features to nonhuman entities (Epley et al., 2007). Perhaps a fundamental feature ascribed to anthropomorphized entities is a sense of humanness. When a nonhuman entity is brought into the human realm, perceived similarity with that entity should increase. Because perceived similarity is regarded as one of the dimensions of social distance or psychological distance (Liviatan et al., 2008), the psychological distance between oneself and a nonhuman entity should decrease if the entity is anthropomorphized.

Previous research has indicated that people are more willing to help socially-close others (Rachlin & Jones, 2008), and they favor in-groups than out-groups (Brewer, 1979). Further, consumers have been found to form stronger self-brand connections with brands that seem to possess features of in-group members (Escalas & Bettman, 2005). Not limited to the social distance dimension, early research on other dimensions of psychological distance has also indicated that shorter distance could lead to more positive attitudes. Taking spatial distance as example, in the 1930s, Bossard discovered that, among five thousand couples, one-third lived within a range of five or less blocks of each other, and the percentage of marriages decreased as the distance between the parties increased (Bossard, 1932). Back et al. (2008) found that students who were randomly assigned to a seat closer to each other formed stronger friendships after a year. Nahemow and Lawton (1975) reported similar results: if people resided within a close distance to each other, friendships developed between people with different races and ages. If people generally have positive attitudes toward psychologically close others, then reduced psychological distance could be one potential mechanism underlying the positive effect of anthropomorphism on human–AI interaction. We hypothesized that people will generally have positive attitudes toward anthropomorphized AI assistants because of the reduced psychological distance between them. That is, psychological distance acts as a mediating variable in the relationship between anthropomorphism and people's evaluation of an AI assistant. Formally, the following hypothesis was proposed and the conceptual framework of the current research has been presented in Fig. 1:

H_2: Psychological distance mediates the relationship between anthropomorphism and evaluation of the AI assistant.

3. Study 1

3.1. Participants

An online survey was conducted to test the research hypotheses. Participants using smart speakers were recruited from a pool of panels maintained by Macromill Embrain, an online survey company in South Korea (http://embrain.com). The data of 206 participants who indicated in the screening question that they currently use smart speakers and who completed the survey were included in the analysis (57% females). The mean age of all participants was 34.43 years (SD = 8.64 years, 20–57 years). Most participants used one (82%) or two (16%) smart speakers. Regarding the period of use, 2.4% had used a smart speaker for less than 1 month, 10.2% for 1 to less than 3 months, 24.3% for 3 to less than 6 months, 45.6% for 6 to less than 12 months, and 17.5% for 12 months or more. Regarding the frequency of use, 32.5% of the participants used the smart speaker 1–2 times a week, 21.4% used it 3–4 times a week, 8.7% used it 5–6 times a week, and 37.4% used it every day. As for the duration of use each time, 40.8% of the participants indicated that they used it for less than 10 min, 28.2% for 10–30 min, 16.0% for 30–60 min, and 15.0% for more than 60 min.

3.2. Measures

Anthropomorphism was measured on a five-item seven-point self-report scale adapted from Waytz, Cacioppo, and Epley (2010) ("The AI assistant has intentions," "The AI assistant has free will," "The AI assistant can experience emotions," "The AI assistant has consciousness, " and "The AI assistant has a mind of its own"; 1 = *strongly disagree*, 7 =

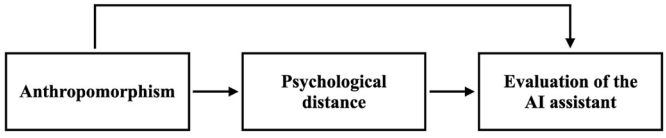

Fig. 1. Conceptual framework of the current research.

strongly agree; $\alpha = .95$). *Psychological distance* was measured on a three-item seven-point self-report scale ("I am familiar with my AI assistant," "The AI assistant is similar to me," and "The AI assistant is psychologically close to me"; 1 = *strongly disagree*, 7 = *strongly agree*; $\alpha = .86$). Evaluation of the AI assistant was characterized as *attitude toward the AI assistant* and *satisfaction with the AI assistant. Attitude toward the AI assistant* was measured on a three-item seven-point self-report scale adapted from Holbrook and Batra (1987) ("The AI assistant is good," "The AI assistant is likable," and "The AI assistant is favorable"; 1 = *strongly disagree*, 7 = *strongly agree*; $\alpha = .92$). Finally, *satisfaction with the AI assistant* was measured on a four-item seven-point self-report scale adapted from Lee et al. (2019) ("The AI assistant meets my expectations functionally," "The AI assistant satisfies me functionally," "The AI assistant meets my expectations emotionally," and "The AI assistant satisfies me emotionally"; 1 = *strongly disagree*, 7 = *strongly agree*; $\alpha = .92$).

3.3. Results

To test the mediating effect of psychological distance, bootstrapping analyses with 5000 samples were conducted using PROCESS macro (Hayes, 2013; Model 4). As for the attitude toward the AI assistant, the 95% confidence interval (*CI*) for the indirect effect through psychological distance did not include zero, $b = .36$, *BootSE* = .06, *BootCI* = [0.26 to 0.48]. Anthropomorphism had a positive effect on psychological distance, $B = .64$, $SE = .04$, $p < .001$. Moreover, psychological distance had a positive effect on attitude toward the AI assistant, $B = .57$, $SE = .07$, $p < .001$. The total effect of anthropomorphism on attitude toward the AI assistant was significant, $B = .16$, $SE = .04$, $p < .001$. When controlled for psychological distance, the direct effect of anthropomorphism on attitude toward the AI assistant remained significant but in a reversed direction, $B = -.21$, $SE = .06$, $p < .001$. Full model coefficients have been presented in Fig. 2. According to the classification of Zhao et al. (2010), the mediation type for psychological distance on attitude toward the AI assistant is competitive mediation.

As for satisfaction with the AI assistant, the 95% *CI* for the indirect effect through psychological distance did not include zero, $b = .40$, *BootSE* = .06, *BootCI* = [0.29 to 0.52]. Anthropomorphism had a positive effect on psychological distance, $B = .64$, $SE = .04$, $p < .001$. Further, psychological distance had a positive effect on satisfaction with the AI assistant, $B = .63$, $SE = .07$, $p < .001$. The total effect of anthropomorphism on satisfaction with the AI assistant was significant, $B = .45$, $SE = .05$, $p < .001$. When controlled for psychological distance, the direct effect of anthropomorphism on satisfaction with the AI assistant became nonsignificant, $B = .04$, $SE = .06$, $p > .05$. According to the classification of Zhao et al. (2010), the type of the mediation was indirect-only mediation. Based on these results, it can be concluded that anthropomorphism had a positive effect on the evaluation of the AI assistant, thus supporting H1. Moreover, psychological distance mediated the relationship between anthropomorphism and evaluation of the AI assistant. Additionally, controlling for gender, age, or other user-related characteristics did not affect the significance of the mediation analyses. Thus, H_2 was also supported.

3.4. Discussion-in-brief

Study 1 demonstrated the grounding effect of anthropomorphism on evaluation of the AI assistant, indicating that those who had a higher tendency to anthropomorphize their AI assistant/s evaluated it/them more positively, which is in line with the findings of previous research on the positive effects of anthropomorphism (Broadbent et al., 2013; Kim et al., 2019; Waytz et al., 2014). However, previous research did not answer why people have a more positive attitude toward anthropomorphized entities. The current study tried to address that question by revealing the underlying psychological mechanism of the effect of anthropomorphism. The present results showed that the relationship between anthropomorphism and evaluation of the AI assistant was mediated by psychological distance. In other words, because anthropomorphism reduced the psychological distance between the user and the AI, the latter was evaluated more positively.

Despite these contributions, the current study also had some limitations. It was conducted via an online survey, and the anthropomorphism tendency was measured but not manipulated. Thus, the internal validity of the study could be criticized. Indeed, the elimination of alternative explanations is crucial to establishing mediation or causality, but the current study did not control other variables that might influence the dependent variables, weakening the robustness of the results. Further, all participants had experience with interacting with AI assistants (as they owned one or more smart speakers), and most of them (87.4%) had interacted with their AI assistant/s for more than three months. Possibly, people with less experience with AI assistants could have different perceptions of an AI assistant's degree of anthropomorphism. To overcome the limitations of Study 1 and to test the hypotheses more rigorously, an experiment that directly manipulated anthropomorphism was designed and conducted in the next study.

Attributing human emotion to nonhuman entities is one feature of anthropomorphism (Epley et al., 2007). Since previous research indicates that people are averse to robots that seem to possess emotions (Waytz & Norton, 2014), it is reasonable to assume that anthropomorphizing AI could have both positive and negative outcomes. A feeling of uncanniness can be one of the detrimental effects of anthropomorphism (Gray & Wegner, 2012; Mori et al., 2012). According to the uncanny valley hypothesis proposed by Mori (1970), the relationship between human-likeness and affinity is not monotonic. At low levels of similarity, affinity increases as entities become more humanlike. However, when human-likeness reaches a certain level, affinity plummets suddenly because entities at these levels of human-likeness seem to be somewhat human but not fully so, evoking a sense of uncanniness. Beyond this "valley," as entities become fully humanlike, affinity increases again. As affinity and feelings of uncanniness are closely related to anthropomorphism, it would be beneficial to examine the relationship between anthropomorphism and this uncanny response. Hence, uncanny response was measured in the next study.

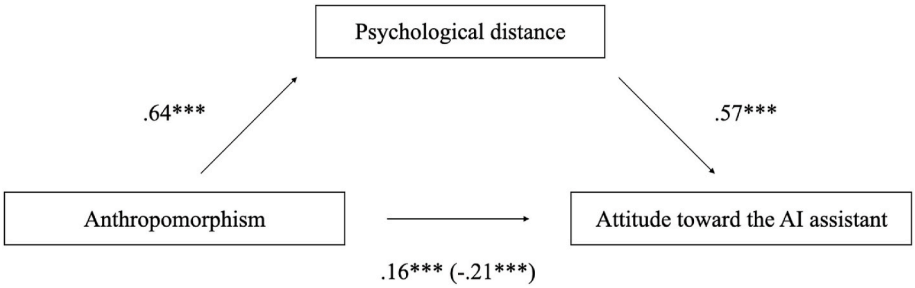

Fig. 2. Mediation model for the effect of anthropomorphism on attitude toward the AI assistant. Note. *$p < .05$, **$p < .01$, ***$p < .001$. Numerical values represent regression coefficients. The coefficients associated with the total and direct effects of anthropomorphism on attitude toward the AI assistant are not within parentheses and within parentheses, respectively.

4. Study 2

4.1. Experimental design

An experiment with a one-factor between-subject design was conducted. The degree of AI anthropomorphism was manipulated in four aspects: exterior, name, voice, and response contents. In the high-anthropomorphism condition, the speaker looked like a person with a headphone—two dots resembled eyes and a fractal line resembled a mouth. The AI assistant was named as "Guleum-i," meaning "cloud" in Korean. Guleum-i's voice was generated using Naver Papago (https://papago.naver.com), a language translation software that can pronounce words in a relatively fluent female voice. Its responses included features such as emotion expressions (e.g., "*It's really nice to see you*") and verbs typically used to describe animate entities (e.g., "*I was born on March 4th, 2019*"). In the low-anthropomorphism condition, the exterior of the speaker did not possess features that can be anthropomorphized easily. The AI was named "PBI-Bot" in order to emphasize its machinelike characteristics. The voice of PBI-Bot was drawn from iTextSpeaker, a mobile application that converts text into synthesized voice. The property of the voice was manipulated such that it still sounded like a female's voice, but it was more artificial and machinelike. The responses of PBI-Bot focused more on delivering objective information.

4.2. Participants and procedure

Participants were recruited over the course of one week. A total of 73 college students participated in the experiment (63% females). Their mean age was 22.89 years ($SD = 2.86$ years, 19–32 years). Participants were scheduled to participate in the experiment one at a time, and they were randomly assigned to one of the two conditions. Finally, 36 and 37 participants were ascribed to the high- and low-anthropomorphism conditions, respectively.

Following the "Wizard of Oz" paradigm, the experiment was conducted in a controlled laboratory room. When participants arrived at the laboratory, they were ushered into a separate room with a laptop and speaker placed on a table, where the experimenter informed them that their task was to evaluate an AI assistant embedded in the speaker on the table. Participants were first asked whether they had seen such a speaker elsewhere. They were then informed that the AI assistant was activated by voice, so that they would talk to the AI assistant during the experiment. They were also informed that the instructions they could give and questions they could answer were provided on the laptop. During the interaction, no other person was present in the experiment room. After completing all the tasks, participants were debriefed, thanked, and given a gift card worth $5. The length of the experiment was approximately 10 min.

4.3. Measures

Anthropomorphism, the independent variable, was measured using the same measurement scale as in Study 1, as a manipulation check ($\alpha = .91$) (Waytz, Cacioppo, & Epley, 2010). *Psychological distance*, the mediating variable, was measured on a three-item seven-point self-report scale adapted from Kim et al. (2008) ("Guleum-i/PBI-Bot is psychologically close to me," "Guleum-i/PBI-Bot is socially close to me," and "Guleum-i/PBI-Bot can be seen as a typical in-group member"; 1 = *strongly disagree*, 7 = *strongly agree*; $\alpha = .88$). *Attitude toward the AI assistant*, the dependent variable, was measured on the same scale as in Study 1 ($\alpha = .93$) (Holbrook & Batra, 1987). In addition, *uncanny response* was measured on a three-item seven-point self-report scale adapted from Gray and Wegner (2012) ("Sometimes Guleum-i/PBI-Bot makes me uneasy," "Sometimes Guleum-i/PBI-Bot is unnerving," and "Sometimes Guleum-i/PBI-Bot creeps me out"; 1 = *strongly disagree*, 7 = *strongly agree*; $\alpha = .93$). Finally, *attitude toward the exterior design of the speaker* was measured as covariate on a one-item seven-point self-report scale ("The exterior design of the speaker is good"; 1 = *strongly disagree*, 7 = *strongly agree*).

4.4. Manipulation check

An independent *t*-test showed that the degree of AI anthropomorphism was significantly higher in the high-anthropomorphism condition ($M = 3.38$, $SD = 1.38$) than that in the low-anthropomorphism condition ($M = 2.23$, $SD = 1.18$), $t = 3.82$, $p < .001$, Cohen's $d = .90$. An additional three-item self-report semantic differential scale adapted from Bartneck et al. (2009) was also applied as a manipulation check (1 = *machinelike/unconscious/artificial*, 7 = *humanlike/conscious/lifelike*; $\alpha = .90$). The participants in the high-anthropomorphism condition evaluated the AI as more humanlike ($M = 3.15$, $SD = 1.38$) than that in the low-anthropomorphism condition ($M = 2.28$, $SD = 1.23$), $t = 2.84$, $p < .01$, Cohen's $d = .67$. Thus, the anthropomorphism manipulation was successful.

4.5. Evaluation of the AI assistant

Participants in the high-anthropomorphism condition had more positive attitudes toward the AI assistant ($M = 5.19$, $SD = .89$) than did those in the low-anthropomorphism condition ($M = 4.43$, $SD = 1.35$), $t = 2.86$, $p < .01$, Cohen's $d = .67$. Participants also liked the exterior design of Guleum-i ($M = 5.75$, $SD = 1.03$) more than that of PBI-Bot ($M = 4.86$, $SD = 1.46$), $t = 3.01$, $p < .01$, Cohen's $d = .70$; however, this was not correlated with their attitude toward the AI assistant, $r = .11$, $p = .36$.

4.6. Mediating effect of psychological distance

Participants in the high-anthropomorphism condition reported higher psychological distance scores ($M = 3.15$, $SD = 1.27$) than did those in the low-anthropomorphism condition ($M = 2.45$, $SD = 1.36$), $t = 2.27$, $p < .05$, Cohen's $d = .53$. As a higher score represented shorter psychological distance, these results indicated that Guleum-i was perceived to be psychologically closer than was PBI-Bot.

A bootstrapping analysis with 5000 samples was conducted using PROCESS macro (Hayes, 2013; Model 4) to test the mediating effect of psychological distance. The mediating effect was significant, as the 95% *CI* for the indirect effect through psychological distance did not include zero, $b = .37$, *BootSE* = .18, *BootCI* = [0.05 to 0.75]. Specifically, anthropomorphism had a positive effect on psychological distance, $B = .70$, $SE = .31$, $p < .05$. Psychological distance had a positive effect on attitude toward the AI assistant, $B = .53$, $SE = .08$, $p < .001$. Moreover, the total effect of anthropomorphism on attitude toward the AI assistant was significant, $B = .76$, $SE = .27$, $p < .01$; however, when controlled for psychological distance, the direct effect of anthropomorphism on attitude toward the AI assistant became nonsignificant, $B = .39$, $SE = .22$, $p > .05$. The type of the mediation was indirect-only mediation (Zhao et al., 2010), and controlling for participants' gender and age did not affect the significance of the mediation. Full model coefficients have been presented in Fig. 3.

4.7. Uncanny response

Participants in the low-anthropomorphism condition tended to have stronger uncanny responses toward the AI ($M = 2.47$, $SD = 1.50$) than did those in the high-anthropomorphism condition ($M = 1.94$, $SD = 1.09$), but the difference between the two was not statistically significant, $t = -1.70$, $p = .09$. Additionally, anthropomorphism did not correlate with uncanny response, $r = -0.20$, $p = .09$.

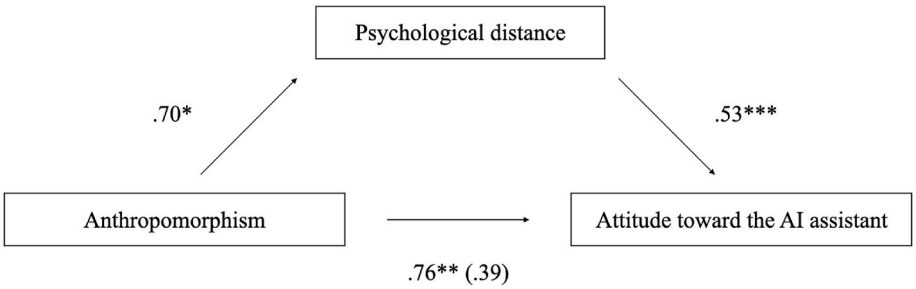

Fig. 3. Mediation model for the effect of anthropomorphism on attitude toward the AI assistant. Note. *$p < .05$, **$p < .01$, ***$p < .001$. Numerical values represent regression coefficients. The coefficients associated with the total and direct effects of anthropomorphism on attitude toward the AI assistant are not within parentheses and within parentheses, respectively.

5. General discussion

Generally, anthropomorphism has been found to have positive influences on human–AI interaction (Broadbent et al., 2013; Kim et al., 2019; Waytz et al., 2014); however, the mechanism of anthropomorphism itself is not yet clear (Duffy, 2003; Levillain & Zibetti, 2017), nor is the underlying psychological mechanism of the effect of anthropomorphism, which is the issue that the current research sought to address. The positive effect of anthropomorphism on evaluation of the AI assistant was robust across the two studies conducted in the current research. In a real-life setting, users who tended to anthropomorphize their AI assistant/s more had more positive attitudes toward and were more satisfied with their AI assistant/s. In an experimental setting, participants evaluated the highly anthropomorphized AI assistant more positively than the AI assistant with fewer anthropomorphic features. More importantly, the underlying psychological mechanism of anthropomorphism was revealed in the current research. Specifically, psychological distance was shown to mediate the relationship between anthropomorphism and evaluation of the AI assistant.

By demonstrating the mediating role of psychological distance, the current research contributes to the anthropomorphism literature. Furthermore, the current research also holds practical value. Researchers have delved into anthropomorphism due to its implications for promoting human–AI interaction (Duffy, 2003). Since the current research revealed that psychological distance is an important factor, developers could focus more on the aspects that render a sense of psychological closeness when designing the exterior and software of AI and robots. Moreover, the current research could also benefit parties in the marketplace. Chatbots and virtual assistants based on AI are being used to interact with consumers in a wide range of scenarios, and the effects of robot recommendation agents are also being tested in the field (Cervone et al., 2015). Because psychological distance influences attitudes, and both psychological distance and attitudes affect persuasion (Albert & Dabbs, 1970; Roskos-Ewoldsen & Fazio, 1992; Spassova & Lee, 2013), the current research suggests that anthropomorphism could act as an effective persuasion strategy in the costntext of human–AI interaction.

The results of our experiment indicated that anthropomorphism did not correlate with uncanny response. The degrees of uncanny response for both conditions were low and they did not significantly differ from each other, although the AI assistant in the low-anthropomorphism condition (PBI-Bot) was judged as somewhat uncannier than was that in the high-anthropomorphism condition (Guleum-i). In earlier studies, robots that seemed to elicit uncanny feelings were highly but ambiguously humanlike (e.g., Gray & Wegner, 2012; Ho & MacDorman, 2010). Most of them had body elements such as a head, eyes, a mouth, and arms. Speakers were used in the current study, and they did not possess features like arms or legs, or even the ability to perform simple movements (though Guleum-i had “eyes” and a “mouth,” they were more like two dots and a line rather than a biological mouth and eyes). Additionally, our experiment was conducted in South Korea, where people frequently interact with AI agents in their daily lives. As repeated interactions with robots could affect the perception of uncanniness (Zlotowski et al., 2015), the threshold of perceiving uncanniness may differ across countries. These might explain the null effect of anthropomorphism on uncanny response in our experiment.

Also, in our experiment, attitude toward the exterior design of the speaker was measured as a covariate to control its potential influence on the dependent variable, though the results showed that it did not correlate with attitude toward the AI assistant. However, other variables such as attitude toward the voice of the AI assistant or the response contents of the AI assistant were not examined. Measurement of these variables could have provided a more detailed examination of the effect of different anthropomorphic components on attitude toward the AI. Further, the duration of the experiment was about 10 min, which is a relatively short period of interaction. The effect of anthropomorphism on evaluation of the AI may differ as time goes by, because social distance is related to social familiarity (Linke, 2012), and familiarity with the AI would have increased as the frequency or duration of the interaction increased. A longitudinal study could be conducted to address this issue in the future.

Considering the close relationship between psychological distance and construal level (Trope & Liberman, 2010), future research could test whether users’ mindsets or construal levels change when encountering AI and robots with different degrees of anthropomorphism. Construal level influences a variety of human behaviors such as consumption and decision making (Dhar & Kim, 2007; Liberman et al., 2007a,b), use of languages (Snefjella & Kuperman, 2015), and time perception (Hansen & Trope, 2013). It is possible for users to perceive the interaction duration differently and to use sentences that vary in concreteness when interacting with robots or AI agents that have different degrees of anthropomorphism. Moreover, the current research showed that people evaluated the anthropomorphized AI assistant more positively because of the decreased psychological distance. Thus, the positive effect of anthropomorphism might suffer if an anthropomorphized entity is regarded as psychologically distant from the perceiver. Earlier research found that informed group membership of a robot influenced participants’ contact intention toward it, such that participants had higher contact intention for an in-group robot than an out-group robot (Eyssel & Kuchenbrandt, 2012). In a similar context, the evaluation of anthropomorphized AI with different levels of psychological closeness can be tested in future research.

Credit author statement

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Appendix

Speakers used in the experiment.
"Guleum-i" (in the high-anthropomorphism condition).

"PBI-Bot" (in the low-anthropomorphism condition).

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