American Psychological Association

Technology, Mind & Society
2021 Conference Proceedings

© 2021 The Author(s)
ISBN:

http://dx.doi.org/10.1037/xxxxxxx

Being a Nice Partner: The Effects of Age and Interaction Types on the Perceived Social Abilities of Conversational Agents

Jessie Chin* and Smit Desai*
School of Information Sciences, University of Illinois at Urbana-Champaign

Conversational agents (CAs) are becoming increasingly prevalent and permeating into our daily lives. We conducted a between-subjects design experiment to examine the effects of age and interaction types on the perceptions about social abilities of CAs among 25 older (aged 60 or more) and 26 younger adults. Bridging the *Computers are Social Actors* paradigm and theories in socioemotional development and technology acceptance, CAs' perceived sociability (i.e., to what extent the CA was perceived as a pleasant conversational partner) and social presence (i.e., to what extent the CA was perceived as a living entity) were gauged by two types of interactions: human-human interaction (wherein the human experimenter interviewed participants) and human-agent interaction (wherein the CA itself interviewed participants). We found that older adults perceived CAs to be more pleasant to interact with when the CA gauged the perceptions than human experimenters. For younger adults, their perceived sociability of CAs did not differ across the types of interactions. Furthermore, the perceived pleasant social experience was associated with technology acceptance of CAs for both younger and older adults. However, social presence of CAs was only critical in the development of technology acceptance for older adults. The age differences in the associations between technology acceptance and perceived social abilities of CAs might be partly because of the tendency to favor positive social experience in our memories with age. Based on these findings, we discussed implications on designing social interactions with CAs, especially for older adults.

Keywords: Perceived Sociability, Social Presence, Conversational Agents, Aging, Technology Acceptance, Anthropomorphism, Computers are Social Actors

Conversational agents (CAs) include personal digital assistants like Google Assistant, Siri, or Amazon Alexa, embedded in commercially available smart speakers like Google Nest, Apple HomePod, or Amazon Echo. The present-day smart speakers leverage the Natural Language Processing (NLP) abilities of CAs to talk almost naturally. Although not fully conversational (Clark et al., 2019; Fischer et al., 2019; Porcheron et al., 2018), smart speakers implement a request-response mechanism to fulfill the users' commands. Users can perform various tasks using smart speakers, including setting alarms, checking the weather, performing a voice search, and listening to music. These products are marketed to make life easier by allowing users to perform activities of daily living using the simplistic power of voice-based interaction.

Aging, Technology Acceptance, and CAs

A demographic that could potentially gain the most benefit from the ubiquity of voice-enabled technologies are older adults. Traditional Graphics User Interfaces (GUI) like personal home computers (Czaja et al., 2006) and smartphones (Pew Research Center, 2021) are notoriously complicated to use and perceived to be complicated by older adults, resulting in low self-efficacy and anxiousness. Due to this, there is a common tendency to dismiss older adults and their use of technologies. However, there has been a marked change in older adults' attitudes toward technology. In 2000, 14% of adults above the age of 60 were internet users; in 2019, the number rose to 73%. Additionally, there is a significant increase in the number of older adults using smartphones (Wang et al., 2019), with 61% of older adults owning a smartphone in 2021 (Pew Research Center, 2021). There are some known barriers towards technology adoption in older adults, including the lack of self-efficacy, requirement of support to learn new technologies, lack of instructional guides, and age-related decline in motor and visual abilities (Vaportzis et al., 2017). Due to these factors, older adults are slow to adopt new technologies but will do so if they believe it will increase their quality of life (Heinz et al., 2013). CAs have been shown to increase the confidence of older adults to use

0000-0002-2878-8544; 0000-0001-6983-8838
The authors acknowledge the following people: Husna Hussaini, Alisha Mahkri, and Lauryn Praet, for their assistance in the study.
The authors have no conflict of interest to disclose.

Correspondence concerning this article should be addressed to Jessie Chin, School of Information Sciences, University of Illinois at Urbana-Champaign, Champaign, IL, 61820, USA. Email: chin5@illinois.edu

technology and provide easy access to digital technology for older adults (Pradhan et al., 2020). The popularity of smart speakers among older adults is highlighted by the adoption of smart speakers—22% of adults over the age of 55 own a voice-based device, with 33% being *first adopters* (Koon et al., 2020). Studies have also demonstrated the technology acceptance of CAs by older adults (Chin et al., 2020; Koon et al., 2020).

Technology Acceptance Model (TAM) provides several constructs to understand why users accept or reject information systems and how user acceptance is affected by system design features (Davis, 1989). The two main features impacting the adoption of new technology are: perceived usefulness, which is to what extent the technology affects user's performance; and perceived ease of use, which is to what extent the technology would be free from effort. TAM was mainly used to assess the adoption of information technology in business organizations (Marchewka & Kostiwa, 2007). Venkatesh et al. (2003) refined TAM and developed the Unified Theory of Acceptance and Use of Technology (UTAUT) to make technology acceptance models more general. UTAUT included constructs like performance expectancy (perceived usefulness), effort expectancy (perceived ease of use), social influence, and self-efficacy moderated by factors like gender, age, experience, and voluntariness of use to understand the adoption of new technology on an individual level. UTAUT has also been employed to study the acceptance of conversational robots (de Ruyter & Aarts, 2004) as well as CAs (Chin et al., 2020).

Social Interactions in CAs

Anthropomorphism is attributing human-like properties to real or imaginary objects and agents. These agents might include social agents that exhibit autonomy, including computers, robots, or conversational agents. Nass et al. (1994) proposed the concept of *Computers are Social Actors (CASA)* and explored the applications of anthropomorphism in user interface design by demonstrating that people adopt social rules during the interaction with technologies (e.g., computers) even though they might not perceive computers to be humans. For example, CASA suggested that people anthropomorphize technology by applying politeness and gender stereotypes to computers. According to Epley et al. (2007), three determinants affect people's likelihood to anthropomorphize agents: elicit agent knowledge, which is the applicability of applying anthropocentric knowledge to the agent; effectance motivation, which is the motivation to process the behavior of agents; and sociality motivation, which is the need for social connectedness. Nass and Moon (2000) argued that the anthropomorphism of social agents is inconsequential *overlearned social behavior* resulting from implicit social communication rules among humans. Fussel et al. (2008) suggested that as people interacted more with social agents, the more they anthropomorphized them. Anthropomorphic agents led to higher enjoyment and intention to use (Qiu & Benbasat, 2009; MacDorman, 2019).

The ability of conversational agents to interact with users using natural language encourages anthropomorphism (Eyssel et al., 2012). The anthropomorphism of CAs began with the earliest chatbots, "ELIZA" (Weizenbaum, 1976), in the 1960s and continues till today. People who interacted with "ELIZA" assumed it to be emotionally involved in their conversations. CAs embedded in voice-activated smart speakers have also been identified to elicit anthropomorphism. Lopatovska et al. (2018) found that users attributed gender and applied politeness to Amazon Alexa in the form of saying "*thank you*" and "*please*" to the device. Furthermore, Pradhan et al. (2019) found similar evidence of politeness and argued that participants fluidly move between thinking of Alexa as "object-like" and "human-like". Nass and Reeves (1996) encouraged researchers to design agents that could elicit the desired social response from humans. For example, the computer agent's voice could be used to impact users' perceived emotion of the convened content (Nass et al., 2001). Google's conversational design guidelines for CAs also suggest designing agents that evoke a distinct tone and personality (Conversation Design, 2021). These findings support the incorporation of anthropomorphism in the design of CAs.

Aging, Social Interactions, and CAs

There were different trajectories of cognitive development across the lifespan, while fluid ability (e.g., working memory) declines with age and crystallized ability (e.g., verbal ability) sustains with age (Baltes, 1997). From a socioemotional perspective, aging also tends to favor positive experiences in their memories (Charles & Carstensen, 2010). Hence, the social experience of technologies could be essential for older users. The social interactions between humans and computers have been examined in technology acceptance of CAs for older adults. Researchers proposed two constructs, perceived sociability, and social presence, to evaluate the perceived social abilities of CAs (Heerink et al., 2008; 2009; 2010). Perceived sociability refers to whether users are conscious of treating the technology (e.g., CAs) as a social entity with positive experience. For example, users will be gauged whether they consider CAs amiable conversational partners or nice to them. Social presence means to what extent users perceive the technology (e.g., CAs) as a real-life company. For example, users will be asked whether they found the interactions with CA similar to the interactions with a person and whether CAs seem to have real feelings. Studies showed that a socially intelligent robot would be more efficient in communication, making the interaction more pleasant and adoption easier for older adults (Heerink et al., 2008; 2009). To further advance our understandings of the perceptions of social abilities of CAs across the age groups, we modified the study paradigm in previous literature (Nass et al., 1994) to investigate how users across the two age groups anthropomorphized CAs when these perceptions were gauged by different types of interactions, a human experimenter or CAs themselves, and how these perceptions could affect the acceptance of CAs.

Method

To understand the age differences in the perceptions of social abilities towards CAs, we conducted a 90-minute online study with 51 participants (25 older and 26 young adults).

Participants. 51 participants were recruited from the university and community in a middle-sized city in the Midwest of the U.S. 25 older adults (17 females; >60 years old, mean age: 66.4 years old, SD=6.94), and 26 younger adults (21 females; mean age: 24.8 years old, SD=5.34) were invited in the study. The majorities of the participants were Caucasians. Out of the 25 older adults, there were 24 Caucasians and 1 Asian; out of the 26 younger adults, there were 13 Caucasians, 8 Asians, 3 Black or African Americans, and 2 multiple racial and ethnic categories (Asian and Caucasian). All participants either had a college degree or completed some years of education in a college.

Development of the CA. In this study, we developed two Google Actions in a Google Nest Mini device (Google Nest Mini Gen. 2) to support two types of CA activities. The first CA activity helped participants become familiar with the interaction with the CA by walking participants through the study instructions and then asked participants to learn the information from six health topics delivered through natural conversations with the CA. The learning task was developed based on a previous study (Desai & Chin, 2020). During the first CA activity, participants had the opportunity to listen and talk to the CA, answer questions, and receive feedback from the CA. The whole activity took about 30 to 40 minutes. The second CA activity supported the interview of questions about perceived sociability and social presence. The CA asked participants to give ratings on CA's perceived sociability and social presence based on their interaction that day. The CA would make no further comments or provide feedback on the ratings given by the participants.

Design. The study paradigm was modified from the previous research (Nass, 1994). We adopted a between-subjects design to assign participants into two groups, experimental and control, in a counterbalanced order. Participants answered questions with two types of interactions—in the experimental group, questions on social presence and perceived sociability were asked by the CA we developed, and in the control group, participants answered the same questions by the human experimenter.

Measures.

Perceived sociability, the degree to which users consider CAs can deliver preferred social interactions, is measured using four items on a 5-point Likert scale (Heerink et al., 2010). For example, "*I find CA is pleasant to interact with*," and "*I think CA is nice*."

Social presence, the degree to which users consider to be in the company of 'someone' when interacting with the CA, is measured using five items on a 5-point Likert scale (Heerink et al., 2010). For example, "*when interacting with CA, I felt like talking to a real person*" and "*I can imagine CA to be a living creature*."

Technology Acceptance, is measured by the UTAUT questionnaire, which covers 8 constructs, including performance expectancy (PE; perceived usefulness), effort expectancy (EE; perceived ease of use), attitudes toward technology (ATT), social influence (SI, to what extent their social networks encourage them to use CAs), facilitating conditions (FC, whether they have resources or knowledge to support their use of CAs), self-efficacy (SE; their perceived confidence to use CAs with minimum help), anxiety (ANX, anxiety to use CAs), and behavioral intention (BI, the intention to use CAs in the next three months) (Venkatesh, 2003). We adapted the UTAUT questionnaire to the context of CAs on a 5-point Likert scale.

Cognitive Measures. Working memory was measured using Letter Number Sequencing (Wechsler, 1997). Participants were needed to recall the letters and numbers in alphabetic and ascending order, respectively, from a list of letters and numbers they just heard. Verbal ability was measured using the advanced vocabulary task (Ekstrom et al., 1976), in which participants were required to recognize the meanings of 18 words.

Procedures.

Upon the beginning of the study, participants completed the informed consent in a teleconference study meeting. Participants were introduced to the study and the conversational agent (CA) we developed on the Google Nest Mini device. They were first asked to interact with the CA in a short practice session to go through the study instructions point-by-point. After participants became familiar with the CA, they performed a self-paced learning task, in which participants were asked to talk with the CA to learn six health-related topics. During the learning task, participants had the opportunity to talk with the CA and answer questions from the CA for about 30 to 40 minutes. After the learning task, participants performed two cognitive tasks. Then, participants evaluated their acceptance toward the CA using an online UTAUT survey. After that, half of the participants answered the questions about the CA's social presence and perceived sociability by the CA itself, and the other half answered the same questions (CA's social presence and perceived sociability) by the human experimenter. The study then ended with a debriefing session. Participants received an e-gift card to compensate for their participation.

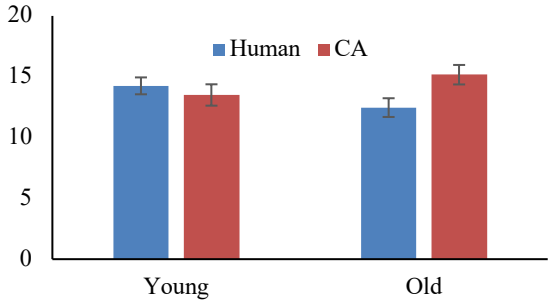
Results

We first analyzed the effects of age and experimenter (CA or human) on perceived sociability and social presence of CAs, explored the relationships among technology acceptance, perceived sociability, and social presence of CAs, and then examined the age differences in the associations between perceived sociability/social presence with technology acceptance.

The Effects of Experimenter and Age on Perceived Sociability and Social Presence

We conducted a 2 (Age: Younger vs. Older) x 2 (Experimenter: Human experimenters vs. Conversational agents) MANOVA on perceived sociability and social presence of CAs. There were no main effects of Age or Experimenter on perceived sociability ($F(1,47)=0.01$, $p=0.94$; $F(1,47)=1.54$. $p=0.22$, respectively). We found a significant interaction effect between Age and Experimenter on perceived sociability ($F(1,47)=4.80$, $p<.05$, $\eta^2 = 0.09$) (see Figure 1). Younger adults did not rate the perceived sociability of CAs differently across the human or CA experimenters ($t(24)=0.70$, $p=0.49$). Older adults perceived CAs with higher sociability if they were interviewed by CAs (M=15.17, SE=0.94) than by human experimenters (M=12.46, SE=0.69) ($t(23)=-2.35$, $p<.05$). After controlling the potential covariance of cognitive abilities, the interaction effect sustained ($F(1, 44)=6.39$, $p<.05$, $\eta^2 = 0.23$). Perceived sociability of CAs was varied across conditions for older adults and consistent for younger adults. Hence, older adults were likely to be affected by the existence of CAs when evaluating their social abilities.

Figure 1. The interaction effects of age and experimenter on perceived sociability of CAs



There were no main effects of Age or Experimenter on social presence ($F(1,47)=0.15$, $p=0.7$; $F(1,47)=0.58$, $p=0.45$, respectively), as well as no Age x Experimenter interaction effect on social presence ($F(1,47)=1.29$, $p= 0.26$). Regardless of the experimenter conditions, both younger and older adults perceived similar degrees of social presence of CAs.

The Relationships among Perceived Sociability, Social Presence, and Technology Acceptance

Pearson correlations were conducted among the 8 constructs in technology acceptance, social presence (SP), and perceived sociability (PS). We found that perceived sociability and social presence were associated with multiple constructs in technology acceptance (see Table 1).

Age Differences in the Relations Between Perceived Sociability, Social Presence, and Technology Acceptance

We summed up the Z-scores of 8 constructs in UTAUT to compute the composite score of technology acceptance. We then conducted regression analyses with technology acceptance as dependent variable and age (categorical variable; dummy coding), standardized scores of perceived sociability (PS)/social presence (SP), and the interaction terms of age and PS/SP as correlates, to examine age differences in the associations between PS/SP and technology acceptance.

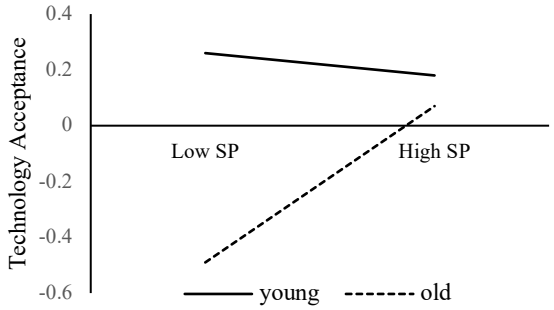
Table 1. Correlations among technology acceptance, social presence (SP) and perceived sociability (PS)

	PE	EE	ATT	SI	FC	SE	ANX	BI	SP
EE	0.33*								
ATT	0.68*	0.36*							
SI	0.55*	0.20	0.53*						
FC	0.11	0.18	0.22	0.17					
SE	0.27	0.43*	0.23	0.32*	0.26				
ANX	0.10	0.18	0.14	0.004	0.08	-0.16			
BI	0.42*	0.22	0.67*	0.45*	0.31*	0.22	0.11		
SP	0.47*	0.27	0.29*	0.47*	0.04	0.25	0.13	0.22	
PS	0.64*	0.35*	0.41*	0.42*	0.03	0.25	0.09	0.21	0.64*

Note. *$p<.05$

We first found that age, perceived sociability, and its interaction term could account for the variance in technology acceptance (Adjusted $R^2=0.32$, $F(3, 47)=8.79$, $p<.001$). Both age and perceived sociability of CAs were associated with technology acceptance (age: $B=-0.29$, $t=-2.45$, $p<.05$; PS: $B=0.47$, $t=3.96$, $p<.001$), suggesting that people with younger ages and higher perceived sociability of CAs showed higher technology acceptance. There were no age differences in the associations between PS and technology acceptance ($B=0.16$, $t=1.37$, $p=0.18$).

Figure 2. The interaction effect of age and social presence of CAs on the technology acceptance of CAs



We also found that age, social presence, and its interaction term could account for the variance in technology acceptance (Adjusted $R^2=0.29$, $F(3, 47)=7.84$, $p<.001$). Both age and social presence of CAs were associated with technology acceptance (age: $B=-0.26$, $t=-2.19$, $p<.05$; SP: $B=0.46$, $t=3.82$, $p<.001$). There was also an interaction effect of age and SP on technology acceptance ($B=0.26$, $t=2.19$, $p<0.05$). Slope analysis was further used to decompose the interaction of age and SP on technology acceptance (Preacher, Curran & Bauer, 2006) (see Figure 2). While younger adults generally showed higher technology acceptance of CAs than older adults, the effects of social presence on technology acceptance were different. For younger adults, the technology acceptance of CAs did not vary with their perceived social presence of CAs. Older adults

showed higher technology acceptance of CAs if they perceived a higher social presence of CAs.

Discussion

Our study followed a between-subjects design to examine the effects of age and experimenter on the perceived sociability and social presence of CAs. Our findings suggested that older adults perceived the CA as a more pleasant conversational partner or nicer to them (i.e., perceived sociability) if they were asked by CAs than the human experimenter. Younger adults did not differ in their perceptions of whether CAs were pleasant conversational partners or nice to them independent of who asked the questions. The findings suggested that older adults are likely to anthropomorphize CAs and provide a socially desirable response during the interaction with CAs by praising or giving positive evaluations on CAs' social ability. However, regardless of the types of interactions, younger and older adults did not differ in their response on whether the CA was like a real person/living creature, looking at them, or having real feelings (social presence). The lack of differences in social presence across the conditions of CA and human experimenters might be in part because of the limitations of the teleconference study settings. Given that participants did not interact with the *physical form* of the device, they were unlikely to provide a socially desirable response to recognizing the *presence* of CAs even when they answered the questions from the CA.

Findings further showed that perceived sociability of CAs was a determinant of technology acceptance for both younger and older adults. However, social presence of CAs was only critical in developing technology acceptance of older adults. For younger adults, to what extent they perceived the social presence of CAs did not influence their technology acceptance. Similar to previous findings in human-robot interaction research (Heerink et al., 2008), both perceived sociability and social presence of CAs were important for older adults to adopt these technologies. Again, the lesser importance of social presence in technology acceptance of CAs for younger adults might be partly because the interaction was solely speech-based without seeing/interacting with a physical entity. The age differences in the associations between perceived social abilities of CAs and technology acceptance could be explained by the increasing focus on the positive socioemotional experience in our perceptions and memories as we age (e.g., Charles & Carstensen, 2010). Hence, social interaction design in CAs for older adults should support the lifespan trajectories in socioemotional development.

These research findings have several implications for conversational interface design. First, both younger and older adults indicated acceptance of smart speakers in their daily lives. This finding not only suggests the potential impact of CAs on older users but also highlights the urgent need to improve its accessibility for older users. In the U.S., 27% of older adults live alone and are considered an *at-risk* group, reporting worse memory, lower physical activity, improper diet, social isolation, higher fall risk, and other health hazards (Kharicha et al., 2007). Resultantly, having CAs at home could open a multitude of opportunities to support isolated older adults to stay connected and independent. Second, following recent guidelines, Amazon expects developers to design conversational agents that are personal, relatable, available, and adaptable (Alexa Design Guide, n.d.). Concurrently, Google recommends creating "system personas" by designing personalities in CAs to make users feel more *familiar* with CAs (Conversation Design, 2021). Our study showed that perceived sociability is associated with technology acceptance regardless of age, supporting designing a pleasant social interaction experience between CAs and users would be critical for continuous adoption of CAs. Finally, designing social presence in CAs would still be important for older users (which may not be true for younger users). When designing CAs for older adults, generating the perceptions of social presence of CAs could increase its acceptance. For example, one recent study suggested that older adults had more positive feedback toward Amazon Echo Show (with a display) than Amazon Echo smart speakers (Blocker et al., 2020). For older adults, receiving visual feedback from CAs could increase social presence and result in positive attitudes. In the future, we aim to expand these findings further by conducting a mixed-method study on a larger group of adults with more diverse characteristics (e.g., more diverse educational backgrounds, including older old adults) to assess the efficacy of the design considerations discussed in this paper to improve perceived sociability and understand the effects of social presence more broadly for technology acceptance and user experience. Overall, CAs have the potential to ameliorate people's lives, and it is of increasing importance for researchers to make the experience more accessible and positive for people of all ages.

References

Alexa Design Guide. (n.d.). Amazon (Alexa). Retrieved May 19, 2021, from https://developer.amazon.com/en-US/alexa/techdoc-template.html

Baltes, P. B. (1997). On the incomplete architecture of human ontogeny: Selection, optimization, and compensation as foundation of developmental theory. *American psychologist*, *52*(4), 366.

Blocker, K. A., Kadylak, T., Koon, L. M., Kovac, C. E., & Rogers, W. A. (2020). Digital Home Assistants and Aging: Initial Perspectives from Novice Older Adult Users. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 64, No. 1, pp. 1367-1371). Sage CA: Los Angeles, CA: SAGE Publications.

Charles, S., & Carstensen, L. L. (2010). Social and emotional aging. *Annual Review of Psychology*, *61*, 383–409. https://doi.org/10.1146/annurev.psych.093008.100448

Chin, J., Quinn, K., Muramatsu, N., & Marquez, D. (2020). A User Study on the Feasibility and Acceptance of Delivering Physical Activity Programs to Older Adults through Conversational Agents. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *64*(1), 33–37. https://doi.org/10.1177/1071181320641010

Clark, L., Pantidi, N., Cooney, O., Doyle, P., Garaialde, D., Edwards, J., Spillane, B., Murad, C., Munteanu, C., Wade, V., & Cowan, B. R. (2019). What Makes a Good Conversation? Challenges in Designing Truly Conversational Agents. *Proceedings of the*

2019 CHI Conference on Human Factors in Computing Systems - CHI '19, 1–12. https://doi.org/10.1145/3290605.3300705

Conversation Design. (2021). Google Developers. https://developers.google.com/assistant/conversation-design/welcome

Czaja, S. J., Charness, N., Fisk, A. D., Hertzog, C., Nair, S. N., Rogers, W. A., & Sharit, J. (2006). Factors predicting the use of technology: Findings from the center for research and education on aging and technology enhancement (create). *Psychology and Aging*, *21*(2), 333–352. https://doi.org/10.1037/0882-7974.21.2.333

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, *13*(3), 319–340. https://doi.org/10.2307/249008

de Ruyter, B., & Aarts, E. (2004). Ambient intelligence: Visualizing the future. *Proceedings of the Working Conference on Advanced Visual Interfaces*, 203–208. https://doi.org/10.1145/989863.989897

Desai, S., & Chin, J. (2020). An Explorative Analysis of the Feasibility of Implementing Metacognitive Strategies in Self-Regulated Learning with the Conversational Agents. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *64*(1), 495–499. https://doi.org/10.1177/1071181320641112

Ekstrom, R. B., French, J. W., Harman, H. H., & Dermen, D. (1976). *Manual for kit of factor-referenced cognitive tests: 1976*. Education Testing Service.

Epley, N., Waytz, A., & Cacioppo, J. T. (2007). On seeing human: A three-factor theory of anthropomorphism. *Psychological Review*, *114*(4), 864–886. https://doi.org/10.1037/0033-295X.114.4.864

Eyssel, F., Kuchenbrandt, D., Bobinger, S., de Ruiter, L., & Hegel, F. (2012). "If you sound like me, you must be more human": On the interplay of robot and user features on human-robot acceptance and anthropomorphism. *Proceedings of the Seventh Annual ACM/IEEE International Conference on Human-Robot Interaction*, 125–126. https://doi.org/10.1145/2157689.2157717

Fischer, J. E., Reeves, S., Porcheron, M., & Sikveland, R. O. (2019). Progressivity for voice interface design. *Proceedings of the 1st International Conference on Conversational User Interfaces*, 1–8. https://doi.org/10.1145/3342775.3342788

Fussell, S. R., Kiesler, S., Setlock, L. D., & Yew, V. (2008). How people anthropomorphize robots. *2008 3rd ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, 145–152. https://doi.org/10.1145/1349822.1349842

Heerink, M., Kröse, B., Evers, V., & Wielinga, B. J. (2008). The influence of social presence on acceptance of a companion robot by older people. *Journal of Physical Agents*, *2*. https://dare.uva.nl/search?identifier=9b3aac4a-6eef-408a-97c6-e67e68dc390c

Heerink, Marcel, Kröse, B., Evers, V., & Wielinga, B. (2010). Assessing Acceptance of Assistive Social Agent Technology by Older Adults: The Almere Model. *International Journal of Social Robotics*, *2*(4), 361–375. https://doi.org/10.1007/s12369-010-0068-5

Heerink, Marcel, Krose, B., Evers, V., & Wielinga, B. (2009). Measuring acceptance of an assistive social robot: A suggested toolkit. *RO-MAN 2009 - The 18th IEEE International Symposium on Robot and Human Interactive Communication*, 528–533. https://doi.org/10.1109/ROMAN.2009.5326320

Heinz, M., Martin, P., Margrett, J. A., Yearns, M., Franke, W., Yang, H.-I., Wong, J., & Chang, C. K. (2013). Perceptions of technology among older adults. *Journal of Gerontological Nursing*, *39*(1), 42–51. https://doi.org/10.3928/00989134-20121204-04

Kharicha, K., Iliffe, S., Harari, D., Swift, C., Gillmann, G., & Stuck, A. E. (2007). Health risk appraisal in older people 1: Are older people living alone an 'at-risk' group? *The British Journal of General Practice*, *57*(537), 271–276.

Koon, L. M., McGlynn, S. A., Blocker, K. A., & Rogers, W. A. (2020). Perceptions of Digital Assistants From Early Adopters Aged 55+. *Ergonomics in Design*, *28*(1), 16–23. https://doi.org/10.1177/1064804619842501

MacDorman, K. F. (2019). In the uncanny valley, transportation predicts narrative enjoyment more than empathy, but only for the tragic hero. *Computers in Human Behavior*, *94*, 140–153. https://doi.org/10.1016/j.chb.2019.01.011

Marchewka, J. T., & Kostiwa, K. (2007). *An Application of the UTAUT Model for Understanding Student Perceptions Using Course Management Software*. *7*(2), 13.

Nass, C., Foehr, U., Brave, S., & Somoza, M. (2001). The effects of emotion of voice in synthesized and recorded speech. *Proceedings of the AAAI Symposium Emotional and Intelligent II: The Tangled Knot of Social Cognition*.

Nass, C., & Moon, Y. (2000). Machines and Mindlessness: Social Responses to Computers. *Journal of Social Issues*, *56*, 81–103. https://doi.org/10.1111/0022-4537.00153

Nass, C., Steuer, J., & Tauber, E. R. (1994). Computers are social actors. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 72–78. https://doi.org/10.1145/191666.191703

Pew Research Center. (2021). Demographics of Mobile Device Ownership and Adoption in the United States. *Pew Research Center: Internet, Science & Tech*. https://www.pewresearch.org/internet/fact-sheet/mobile/

Porcheron, M., Fischer, J. E., Reeves, S., & Sharples, S. (2018). Voice Interfaces in Everyday Life. *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, 640:1-640:12. https://doi.org/10.1145/3173574.3174214

Pradhan, A., Findlater, L., & Lazar, A. (2019). "Phantom Friend" or "Just a Box with Information": Personification and Ontological Categorization of Smart Speaker-based Voice Assistants by Older Adults. *Proceedings of the ACM on Human-Computer Interaction*, *3*(CSCW), 214:1-214:21. https://doi.org/10.1145/3359316

Pradhan, A., Lazar, A., & Findlater, L. (2020). Use of Intelligent Voice Assistants by Older Adults with Low Technology Use. *ACM Transactions on Computer-Human Interaction*, *27*(4), 31:1-31:27. https://doi.org/10.1145/3373759

Preacher, K. J., Curran, P. J., & Bauer, D. J. (2006). Computational Tools for Probing Interactions in Multiple Linear Regression, Multilevel Modeling, and Latent Curve Analysis. *Journal of Educational and Behavioral Statistics*, *31*(4), 437–448. https://doi.org/10.3102/10769986031004437

Qiu, L., & Benbasat, I. (2009). Evaluating Anthropomorphic Product Recommendation Agents: A Social Relationship Perspective to Designing Information Systems. *Journal of Management Information Systems*, *25*(4), 145–182. https://doi.org/10.2753/MIS0742-1222250405

Reeves, B., & Nass, C. (1996). *The media equation: How people treat computers, television, and new media like real people and places*. Cambridge University Press.

Vaportzis, E., Giatsi Clausen, M., & Gow, A. J. (2017). Older Adults Perceptions of Technology and Barriers to Interacting with Tablet Computers: A Focus Group Study. *Frontiers in Psychology*, *8*. https://doi.org/10.3389/fpsyg.2017.01687

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly*, *27*(3), 425–478. https://doi.org/10.2307/30036540

Wang, S., Bolling, K., Mao, W., Reichstadt, J., Jeste, D., Kim, H.-C., & Nebeker, C. (2019). Technology to Support Aging in Place: Older Adults' Perspectives. *Healthcare*, *7*(2), 60. https://doi.org/10.3390/healthcare7020060

Wechsler, D. & Psychological Corporation. (1997). *WAIS-III: Administration and scoring manual: Wechsler Adult Intelligence Scale*. Psychological Corporation.

Weizenbaum, J. (1976). *Computer power and human reason: From judgment to calculation* (pp. xii, 300). W. H. Freeman & Co.