Can you repeat that again? Investigating the mediating effects of perceived accommodation appropriateness for accommodative voice-based assistants

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ABSTRACT

The widespread use of Voice-Based Assistants (VBAs) in various applications has introduced a new dimension to human-machine communication. This study explores how users assess VBAs exhibiting either excessive or insufficient communication accommodation in imagined initial interactions. Drawing on Communication Accommodation Theory (CAT) and the Stereotype Content Model (SCM), the present research investigates the mediation effect of perceived accommodation on the relationship between warmth and competence of the SCM and evaluations of the VBA as a communicator and a speaker. Participants evaluated the underaccommodative VBA significantly lower with respect to its communication and evaluations of the VBA as a speaker, which were indirectly predicted by warmth and competence stereotype content models via the perceived appropriateness of the communication. The implications of our findings and future research are discussed.

1. Introduction

The proliferation of voice-based assistants (VBA) has aided in numerous user applications, such as finding information, language tutoring, and practicing social interactions. These AI-powered voice systems, or VBAs, act as human surrogates by emulating human communication processes and catering to users' competence and task-related requirements. For instance, imagine a VBA language tutor built with human know-how for developing students' foreign language skills via practice, such as dialogue experiences. The foreign language practice dialogue between the language tutor and its pupil requires accommodation in communication, in part by the VBA. However, it can be challenging to gauge the appropriateness of such accommodations, especially when we expect machines to be objective, accurate, and well-mannered (Molina & Sundar, 2022; Sundar, 2008, pp. 73–100).

The affordances of human-machine communication through voice-based agents may result in varying interpretations of accommodation appropriateness, ranging from excessive to insufficient. For instance, an overaccommodative VBA, such as speaking extremely slowly with simple vocabulary and translating it into English despite already understanding what was said, may hold a different level of perceived appropriateness than an underaccommodative VBA, which speaks *too*

fast, uses complex vocabulary, and does not translate what was said into English, making it difficult for the user to understand the VBA. Previous research on human communication indicates that individuals respond positively to appropriately accommodative conversation that facilitates comprehension (e.g., Frey & Lane, 2021; Pitts & Harwood, 2015; Soliz & Giles, 2014), but with a VBA, do people excuse a machine's over- and under-accommodative behavior similar to what is expected in human-to-human communication? When the machine attempts to accommodate its communication with human interlocutors, the evidence of how receiving such accommodation affects the interaction experience is limited.

This study extends the understanding of how people assess VBAs exhibiting excessive or insufficient accommodation in initial interactions. Prior human-machine communication research (HMC; Edwards et al., 2019; Edwards et al., 2024; Spence, 2019) illuminates users' likely process for considering VBAs accommodative communication when evaluating the machine agent. For instance, the Computers are Social Actors (CASA) paradigm (Reeves & Nass, 1996) argues people apply cognitions relevant to human-to-human communication (e.g., gender and social cues) to interact with machines. Also, a newer and more popular idea in HMC research says that when people interact with machines, they do so with expectations and by using appropriate

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human-media scripts to make the interactions more purposeful (for example, a social robot with a face lets people talk; Gambino et al., 2020). A recent study on visually impaired pupils suggests that the voice-based AI tutor embedded in an online learning platform enhances student learning efficacy, accessibility, and inclusion (Sathsarani et al., 2023). Because of these expectations and applications of scripts to human-machine interaction, users' first impressions and evaluations of machines are interconnected, as both lead to how well a task is completed.

In particular, we use communication accommodation theory (CAT; Giles & Smith, 1979) and then the stereotype content model (SCM; Fiske et al., 2002, 2007; Fiske, 2018) as a theoretical framework. These two perspectives offer rival explanations for intergroup and interpersonal communication, which also imply processes and outcomes in human-AI interaction contexts. In light of these theoretical perspectives, we tested a model of accommodation appropriateness mediating the relationships between stereotype content models of warmth and competence and assessments of the VBA's messages and its role *as* a communicator. We will outline the experimental design and results in the following sections. Theoretical reasons underpinning the experiment and implications for future non-accommodative communication between humans and AI are discussed.

1.1. Communication accommodation theory (CAT)

CAT is a hypo-deductive theory that explains the complexity of communication adjustments, or *accommodation,* in social interaction (Gallois & Giles, 1998; Giles & Smith, 1979). At its core, CAT considers accommodation ubiquitous and a fundamental contribution to interaction success. People exert diverse adjustment strategies to manage comprehension and social relationships through communication. Early CAT research suggests that people adapt approximation strategies (i.e., similarity and liking) to adjust their communication to be similar or different to others to garner approval or enhance connections in social relationships (see Dragojevic et al., 2016). More recent research on the theory considers more ways people can adapt, such as interpretability, interpersonal control, emotional expressions, and discourse management, all of which can happen simultaneously in interactions (Soliz et al., 2021). For example, people may simplify syntax, slow their speech rate, or focus on body language to enhance message clarity and comprehension when talking to non-native speakers. They may also enact more patient and culturally sensitive conversations by using common polite expressions and avoiding idioms that may not translate well. Due to this theory's impressive generalizability, a substantial body of CAT work has examined communication accommodation across diverse cultural, linguistic, and social groups in different applied settings (e.g., healthcare, education, business, etc.) and even interactions among non-human species (see Giles et al., 2023).

Some new CAT studies have started to look at how communication accommodation applies in different HMC settings, with particular interest in interactions with accommodative machine agents. Several studies highlight how people attune themselves when communicating with technological interlocutors. Von der Pütten et al. (2011, pp. 183–194) demonstrated reciprocal self-disclosure among participants when interacting with talkative virtual agents. Cohn, Keaton, Beskow, and Zellou (2023), Cirillo, Runnqvist, Strijkers, Nguyen, and Baus (2022), and Shen and Wang (2023) also indicated that people engage in conceptual alignment even when interacting with social robots, leading to communication style changes such as their lexical choices or speech rates. These studies examined how human and machine agents used accommodation behaviors to improve interaction understanding, satisfaction, and positive evaluations. However, few studies have explored how human and machine agents' interactions are perceived when no accommodation occurs. This perspective shifts the focus to how recipients interpret the appropriateness of the communication, providing a unique insight into non-accommodation in HMC settings.

1.2. Nonaccommodation: overaccommodation vs. underaccommodation

Gasiorek (2016) noted that nonaccommodation is not equivalent to a failure or absence of the speaker's adaptation but to the recipient's perceived divergence of the communication adjustments the speaker makes. Nonaccommodation is categorized as either *over-* or *under-accommodation* (Gasiorek, 2016). *Overaccommodation* occurs when communication behaviors exceed what the recipient perceives as necessary for successful interaction, potentially diminishing communication effectiveness. For example, patronizing speech in nursing homes (Ryan et al., 1995) or providing excessively detailed explanations for a simple question are examples of over-accommodation. On the other hand, under-accommodation refers to the perception that the speaker has not sufficiently adjusted their communication to meet the recipient's needs. For instance, a language learner might perceive under-accommodation if a native speaker talks too quickly or uses unfamiliar jargon.

Accommodation and nonaccommodation are perceived subjectively, depending on the listener's perspective, which can be shaped by linguistic features, individual perceptions, and the surrounding context (Gasiorek, 2016). Perceptions of nonaccommodation are significantly influenced by the motives attributed to the communication source. Favorable evaluations of overaccommodation are observed when people perceive the speakers with a positive intention rather than a negative one (e.g., Gasiorek & Giles, 2012, 2015). The perception of said source's motivations can be paramount to considering how nonaccommodation is perceived, especially when considering socio-cultural norms and expectations.

CAT posits that individuals adapt their communication based on perceived social and cultural norms, which are deeply influenced by sociohistorical contexts and interpersonal dynamics (Dragojevic et al., 2016). In intergroup communication, people often adjust their behavior not based on actual preferences but on their perceived expectations of the other party's communicative needs. This phenomenon can lead to non-accommodation when the speaker's adjustments do not align with the recipient's expectations (Dragojevic et al., 2016). Importantly, these expectations are often shaped by stereotypes—mental shortcuts people use to categorize social groups during interactions.

In the Human-Machine Communication (HMC) context, these stereotypes extend to AI agents like VBAs. Media portrayals and popular narratives about VBAs often cultivate stereotypical expectations about how these agents should communicate (Edwards et al., 2024). People may perceive VBAs as having distinct social identities, similar to human-to-human interactions. According to the SCM (Fiske et al., 2002), individuals assess others, including VBAs, based on two primary dimensions: warmth and competence. These stereotypes guide how people evaluate the appropriateness of a VBA's communication behavior.

In HMC settings, users' preconceived notions of warmth and competence serve as cognitive heuristics that shape their expectations of appropriate accommodation from AI agents. These expectations, derived from stereotypical perceptions, create a framework through which users evaluate the appropriateness and effectiveness of VBA communication. When a VBA's communication deviates from these expectations, whether through over-accommodation (perceived as too simplistic or patronizing) or under-accommodation (perceived as insufficient adjustment), users base their evaluations on these stereotypes rather than the actual performance of the VBA. While CAT provides a framework for understanding communication adjustments, SCM offers insight into the perceptual foundations that guide these adjustments, particularly in novel contexts such as HMC. Thus, this study employs the SCM to explore how stereotypes about warmth and competence influence perceptions of VBA communication, particularly in situations of perceived non-accommodation.

1.3. Stereotype content model (SCM)

The SCM identifies warmth and competence as the two primary dimensions through which individuals evaluate social groups, including artificial agents (Fiske, 2018; Fiske et al., 2002, 2007). *Warmth* includes qualities like kindness, morality, sincerity, trustworthiness, and friendliness, whereas *competence* refers to attributes such as confidence, skills, and intelligence (Cuddy et al., 2008). These dimensions have been widely used to explain how people form first impressions and make social judgments about others, including non-human entities like robots or VBAs.

In HMC, the perception of warmth and competence plays a crucial role in shaping users' evaluations of AI agents' communicative behaviors. Recent studies suggest that impressions of a machine's warmth and competence often precede and influence how users perceive the machine's accommodative (or nonaccommodative) communication (Gasiorek & Giles, 2015). In particular, people may apply the same social judgments they use in human interactions when interacting with machines, making these stereotype dimensions critical in determining whether a machine's communication is seen as appropriate or not. The application of SCM to VBA interactions is particularly relevant as it provides a theoretical framework for understanding how preconceived notions of warmth and competence may influence users' expectations and subsequent evaluations of VBA communication behavior.

1.4. Current study

Building on this framework, (Edwards, Edwards, & Rijhwani, 2023) proposed a mediation model where the perceived communication accommodation of social robots mediated the relationships between warmth and competence, and users' overall evaluations of the machine's communication. Their findings highlighted the significant role of warmth and competence in predicting how people respond to accommodative behaviors in HMC. This study extends previous research by examining how stereotype-driven expectations of warmth and competence shape user evaluations of nonaccommodative VBA communication, specifically investigating the influence of over-accommodation and under-accommodation communication in the VBA context (c.f. Context of social robots; Edwards, Edwards, & Rijhwani, 2023). By exploring how these dimensions affect user perceptions in HMC, we aim to fill the gap in understanding the impact of stereotypes on user experiences with VBAs, an area that remains underexplored in current literature.

As the nature of HMC contexts shapes the availability of information cues, which may imply new interactional processes and norms as "what constitutes appropriate and accommodative communication becomes increasingly mutable" (Gallois et al., 2016, p. 204), our current study builds on prior research, particularly that of Gasiorek and Giles (2015) and Edwards et al., 2023, and tested the perceived appropriateness of a VBA's accommodation as a mechanism for which stereotype content models of warmth and competence indirectly lead to evaluations of the

VBA's as a communicator and its communication (see Fig. 1). This work intends to enhance our understanding of how individuals assess VBAs exhibiting excessive or insufficient accommodation in initial interactions to broaden insights into how people evaluate VBAs in instances of over- and under-accommodation.

Prior research has established that communication accommodation can be perceived differently based on various factors, including the perceived intentions of the speaker (Gasiorek & Giles, 2015). In the context of VBA communication, these perceptions may be particularly influenced by users' stereotypical expectations of warmth and competence. For instance, overaccommodation might be interpreted as a sign of attentiveness and support (high warmth) or as an indication of incompetence and misunderstanding of user needs (low competence). Similarly, underaccommodation could be viewed as a lack of responsiveness (low warmth) or a sign of efficiency and capability (high competence).

Edwards et al. (2023) have demonstrated that perceived communication accommodation mediates the relationship between warmth and competence and users' evaluations in human-robot interaction. Extending this work to the context of VBAs and nonaccommodative behaviors, we propose that the perceived appropriateness of a VBA's communication accommodation serves as a crucial mediating mechanism. Specifically, we suggest that users' initial stereotypes about a VBA's warmth and competence shape their expectations for appropriate communication, and these expectations, in turn, influence how they evaluate the communication itself and the VBA as a communicator. Therefore, we propose the following hypotheses:

H1. Perceived appropriateness of communication accommodation will mediate the relationship between stereotype content dimensions (warmth and competence) and evaluation of VBA communication.

H2. Perceived appropriateness of communication accommodation will mediate the relationship between stereotype content dimensions (warmth and competence) and evaluation of the VBA as a speaker.

These hypotheses reflect our expectation that the impact of stereotype content dimensions on user evaluations is not direct but operates through users' perceptions of communication appropriateness. This mediation process suggests that the same level of accommodation may be evaluated differently depending on the initial stereotypes users hold about the VBA's warmth and competence.

2. Methods

2.1. Participants and procedures

Participants were recruited using Prolific.com in October 2023 and directed to complete an online Qualtrics.com survey ($Mdn_{completion\ time}$ = 8 min). There were a total of 193 U.S. Prolific survey workers who participated in the study and were paid $1.00 USD each for their time. A small majority of participants self-identified as male (52.8%, $n = 102$) and Caucasian/White (68.9%, $n = 133$). Participants' ages ranged from 18 to 72 years ($M = 35.82$, $SD = 11.87$). After obtaining approval from the research review board and securing participant consent, individuals completed an online experiment. During the experiment, participants were randomly divided into two treatment groups: one receiving over-accommodation messages and the other receiving underaccommodation messages from a VBA. Participants were instructed to read a small vignette that described the overaccommodation and under-accommodation messages before facing a manipulation check question and being asked to complete a series of measures designed to assess the perceived accommodation, SCM, and evaluation of the VBA as a speaker and its communication. After completing the series of measures, participants were debriefed, thanked, and then compensated.
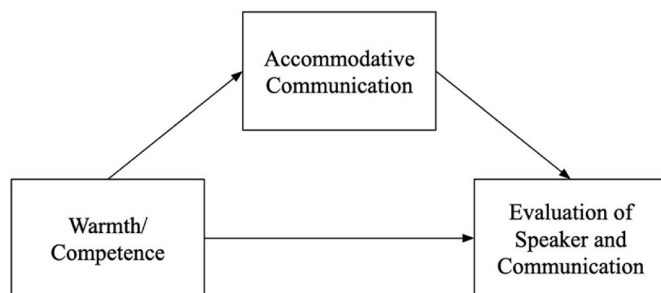

Fig. 1. Mediation model of warmth/competence predicting evaluation of speaker and communication indirectly through accommodative communication.

2.2. Materials

The vignette scenarios were modeled after Gasiorek and Giles' (2015) and the Edwards and colleagues' (2023) work, with adjustments made to reflect the capabilities and tasks of a VBA in a more realistic manner. Furthermore, the context of the scenarios mirrored those studies, with the reader engaging in learning a foreign language, albeit in this case, from a VBA. Each vignette began with a background description prior to the manipulation. Participants were told they were visiting relatives in a foreign country with a small amount of speaking and comprehension skills (though lacking fluency) in the local language. The background described to the participant, "You just started taking classes with a voice-based agent (similar to Amazon's Alexa or Apple's Siri) designed to teach you this foreign language," and asked them to imagine having a session with the VBA. As part of the study manipulation, vignettes were altered such that the overaccommodative condition described a VBA that speaks slowly, uses simple words, and translates into English. In contrast, the underaccommodative condition featured a vignette of a VBA that spoke quickly, used complex words, and did not stop to translate.

To maximize the salience of over/under accommodation for the participant, both vignettes indicated the robot's behavior persisted even if the participant already understood without issues (over-accommodative) or had difficulty following what the VBA was saying and had trouble understanding it (underaccommodative). The vignettes were also edited to maintain consistency across both conditions. See Appendix A for the exact vignettes used in the study (https://osf. io/zgqcd/?view_only=fbdb69e90c854d758e80cacaf38db8e0).

2.3. Dependent measures

Manipulation check. To assess the manipulation, participants were presented with two questions, asking whether the VBA had excessively compensated (or insufficiently compensated) in adapting its communication, as outlined in the works of Edwards and colleagues' (2023) and Gasiorek and Giles (2015). The two items were shown on a scale from 1 (not at all) to 7 (very much). A *t*-test for independent samples was performed to verify if the conditions evaluated were concurrent with the expected evaluations of the participants. Results indicated that the overaccommodative condition was seen as overcompensating ($M = 4.35$, $SD = 1.68$), significantly greater than the underaccommodative condition ($M = 3.17$, $SD = 1.93$), $t (191) = 4.51$, $p < .001$. The under-accommodative condition was seen as under compensating ($M = 4.52$, $SD = 2.08$) significantly greater than the overcompensating condition ($M = 2.31$, $SD = 1.48$), $t(191) = -8.51$, $p < .001$. Hence, these two manipulation checks proved effective for the present study.

Perceived accommodation. Modeling (Edwards et al. (2023) and Gasiorek and Giles (2015), participants were asked to assess the degree the VBA appropriately adapted its communication to suit the given scenario. This was assessed via the use of a single 7-point scale item asking participants to rate the extent the voice-based agent adjusted communication appropriately for the imagined you in the story, ranging from 1, not at all, to 7, very much (*Item M* = 3.16, *SD* = 1.78).

Stereotype content model scale. Based on the work of Fiske et al. (1999), we adapted Mieczkowski et al. (2019) stereotype content model and bias map into the context of voice-based agents to examine the two main dimensions of the stereotype content scale: warmth and competence. This measure asks on a 7-point scale (not at all/very much), "How [warm, tolerant, good-natured, sincere] is this voice-based agent?" for the warmth dimension and "How [competent, confident, independent, competitive] is the voice-based agent?" for the competence dimension. Finding that both scales were sufficiently reliable for analysis, the scale items for each respective construct were collapsed to form mean composites representing warmth (*α* = .95; *Item M* = 3.75 *Item SD* = 1.65) and competence (*α* = .93; *Item M* = 4.06; *Item SD* = 1.56).

Evaluation of the speaker. In order to assess perceptions of the

VBA, we employed a scale similar to that of Edwards et al. (2023) and Gasiorek and Giles (2015), modified for use with VBAs. Using a 7-point scale, participants were asked to indicate how good-natured, warm, sincere, friendly, and trustworthy they believed the VBA was (1 = not at all; 7 = very much). The items had adequate internal consistency and were collapsed to form a mean composite for analysis, representing the participant's evaluation of the VBA as a speaker (*α* = .95; *Item M* = 3.69, *Item SD* = 1.59).

Evaluation of communication. To assess the communication of the VBA, participants were asked to evaluate, using a 7-point scale, the degree to which they viewed the teaching interaction with the VBA to be satisfying, positive, and enjoyable (1 = not at all; 7 = very much; Edwards et al., 2023; Gasiorek & Giles, 2015). Achieving adequate reliability, the items were collapsed to form a mean composite score for analysis representing participant evaluations of the VBA's communication (*α* = .95; *Item M* = 3.22, *Item SD* = 1.61).

2.4. Analysis strategy

In order to examine our research questions regarding the associations between the SCM (warmth and competence) and (a) the appraisal of the speaker and (b) the assessment of its communication, we used Ordinary Least Squares (OLS) regression using PROCESS v4.0 macro (Hayes, 2022) in SPSS 28. Four mediation models were ultimately specified and estimated for each condition (e.g., estimating the four models using the overaccommodation participants, then again for the under-accommodation participants). The first two models (I & II) specified evaluation of the VBA's communication as the dependent variable (*Y*), which was predicted indirectly by the independent (*X*) variables of stereotype content models of warmth and competence, respectively, through the perceived appropriateness of the VBA's accommodation (*M*). The third and fourth models (III & IV) were virtually the same as the first two except for participants' evaluations of the VBA as a speaker being specified as the dependent variable (*Y*). 95% confidence intervals were constructed using 5,000 bootstrap resamples for inferences made regarding the effects). We report the unstandardized regression weights and their standard errors for each tested model. Table 1 contains the bivariate correlations among the continuous variables used in this study.

3. Results

Research question 1a to what extent does perceived appropriateness of communication accommodation mediate the relationship between stereotype content dimensions (warmth and competence) and communication evaluation. To answer this, we included warmth and competence as separate predictors in their respective models, with perceived appropriateness of the accommodation acting as the mediator and the evaluation of the VBA's communication designated as the outcome. In both the overaccommodative and underaccommodative conditions, the findings suggested a partial mediating effect for perceived accommodation, with warmth as the predictor and evaluation of the VBA's communication as the outcome. Furthermore, the results pointed to a partial mediating effect for perceived accommodation and competence as the predictor and evaluation of communication as the outcome for overaccommodation and underaccommodation.

Table 1
Bivariate correlations among study variables.

Variable	1	2	3	4	5
1. Evaluation of Communication	–				
2. Evaluation of Speaker	.679**	–			
3. Warmth	.726**	.659**	–		
4. Competence	.638**	.951**	.662**	–	
5. Perceived Accommodation	.769**	.558**	.558**	.515**	–

Note. **$p < .001$.

Research question 1b asked to what extent does perceived appropriateness of communication accommodation mediate the relationship between stereotype content dimensions and evaluations of the VBA as a speaker. To evaluate this, we included warmth and competence as separate predictors in their respective models, with perceived accommodation acting as the mediator and the evaluation of the speaker designated as the outcome. In the overaccommodation model, the findings revealed direct effects between the evaluation of the speaker and between competence and the evaluation of the speaker. This implies the absence of significant mediation. In the underaccommodation model, the findings demonstrate a partial mediation effects for perceived accommodation and the evaluation of the speaker for both warmth and competence. Table 2 provides the statistics of variables by condition; Table 3 provides an overview of the significant direct and indirect effects of warmth and competence for overaccommodation and underaccommodation, encompassing the dependent variables of both speaker assessment and communication evaluation.

In the overaccommodation model, the findings revealed direct effects between warmth and the evaluation of the speaker and between competence and the evaluation of the speaker. This implies the absence of significant mediation. In the underaccommodation model, the findings demonstrate a partial mediation effect for perceived accommodation and the evaluation of the speaker for both warmth and competence. Table 3 provides an overview of the significant direct and indirect effects of warmth and competence for overaccommodation and underaccommodation, encompassing the outcome variables of both speaker assessment and communication evaluation.

To further address the research question, we designated warmth and competence separately as the predictors in their respective models, with perceived accommodation serving as the mediator and the evaluation of communication as the outcome. In both the overaccommodation and underaccommodation scenarios, the findings suggested a partial mediation effect for perceived accommodation; warmth being the predictor and evaluation of communication as the outcome. Furthermore, for the overaccommodation and underaccommodation conditions, the results pointed to a partial mediation effect for perceived accommodation, with competence as the predictor and evaluation of communication as the outcome.

Hypothesis one proposed that in the overaccommodative communication condition, the VBA would be perceived as (a) warmer and more competent and (b) more accommodative than in the VBA in the underaccommodative communication condition. We conducted three independent samples t-tests to investigate this hypothesis, using warmth, competence, and perceived accommodation as the outcome variables. The results indicated that the VBA in the overaccommodative condition was perceived to be warmer, $t(191) = 6.76$, $p < .001$, perceived to be more competent, $t(191) = 6.55$, $p < .001$, and more

accommodative, $t(191) = 6.40$, $p < .001$, compared to the VBA in the underaccommodative condition.

The second hypothesis posited that the VBA in the overaccommodative communication condition would receive more positive evaluations (both for communication and the speaker) than the VBA in the underaccommodative communication condition. To test this hypothesis, we performed two independent samples t-tests using the evaluation of the speaker and the evaluation of communication as the outcome variables. The findings indicated that the VBA in the overaccommodative condition received higher ratings for both the evaluation of the speaker, $t(190) = 7.36$, $p < .001$, and the evaluation of communication, $t(191) = 9.11$, $p < .001$, compared to the VBA in the underaccommodative condition.

4. Discussion

The results of our study extend our insights of how people evaluate VBAs who exhibit over or underaccommodative communication in initial interactions, building upon the findings of previous work examining CAT and SCM in the human-machine context (c.f. Edwards, Edwards, Westerman, & Spence, 2019). Our study found that, like social robots, people judge a VBA's behavior according to the perceived warmth and competence of that VBA, depending on the perceived appropriateness of the VBA's accommodation.

Regarding evaluations of the VBA as a communicator, our process analysis suggests that warmth and competence for both over- and underaccommodative VBAs lead to positive evaluations of the agent as a communicator indirectly through its perceived accommodation. That is, greater use of the stereotype content models leads to, on average, greater perceived appropriateness of the accommodation, which brings about more positive evaluations of the VBA as a communicator. Considering evaluations of the VBA as a speaker, this partially mediated indirect effect was only present for the underaccommodative condition. Stereotype content models of warmth and competence lead to more positive evaluations of the underaccommodative VBA as a speaker indirectly through its perceived accommodation. Considering evaluations of the over accomodative VBA as a speaker, however, it is shown to be predicted directly by the stereotype content models of warmth and competence. Additionally, as we hypothesized, overaccommodative VBAs are warmer, more accommodating, and more competent than underaccommodative VBAs.

The findings from our study not only replicate those of Edwards et al. (2023) but also have important theoretical implications. The subjective experience of encountering an underaccommodative VBA shows that it poses a greater risk of not understanding what the machine says. Further, the context of VBAs as language tutors makes the importance of understanding the communication of the machine much more salient. For example, Gasiorek and Dragojevic (2018) argued that recent CAT research demonstrates the importance of the subjective experience leading to evaluations rather than objective parts of the interaction. Relatedly, when underaccommodation is inappropriate and can affect the individual, the underaccommodator is viewed as much less credible and less effective as a communicator (Frey & Lane, 2021). The results of our study show that an underaccommodative machine poses a significantly greater risk than an overaccommodative one in this context because both social robots and VBA vignettes place emphasis on the task posed to the participant and the expectation for machines to over rather than unaccommodated.

4.1. Limitations and future research

As with most research, there are limitations to our study. One major limitation is that we used a cross-sectional study design. While the results of our analysis suggest that the stereotype content models of warmth and competence predict evaluations of a VBA and its communication indirectly through how appropriate the VBA's communication

Table 2
Descriptive statistics of variables by condition.

Variable	M	SD
Overaccommodation		
Perceived Accommodation	3.88	1.68
Undercompensated	2.31	1.48
Overcompensated	4.35	1.68
Warmth	4.72	1.37
Competence	4.43	1.57
Evaluation of Speaker	4.40	1.48
Evaluation of Communication	4.08	1.48
Underaccommodation		
Perceived Accommodation	2.39	1.54
Undercompensated	4.52	2.09
Overcompensated	3.17	1.93
Warmth	3.35	1.44
Competence	3.02	1.40
Evaluation of Speaker	2.91	1.32
Evaluation of Communication	2.30	1.19

Table 3

Mediation analysis.

Relationship	Total Effect	Direct Effect	Indirect Effect	Confidence Interval		*t*-statistics	Conclusion
				LL	UL		
Overaccommodation							
Warmth → P.A. → Evaluation of Comm	.83 (.000)	.52 (.000)	.31	.184	.381	7.13	Partial
Competence → P.A. → Evaluation of Comm	.49 (.000)	.25 (.000)	.24	.128	.376	4.11	Partial
Warmth → P.A. → Evaluation of Speaker	.65 (.000)	.61 (.000)	.04	−.113	.189	5.48	Direct
Competence → P.A. → Eval of Speaker	.89 (.000)	.88 (.000)	.01	−.011	.045	27.69	Direct
Underaccommodation							
Warmth → P.A. → Evaluation of Comm	.42 (.000)	.29 (.000)	.15	.037	.299	4.65	Partial
Competence → P.A. → Evaluation of Comm	.47 (.000)	.29 (.000)	.18	.094	.361	4.05	Partial
Warmth → P.A. → Evaluation of Speaker	.50 (.000)	.39 (.000)	.1	.031	.210	5.16	Partial
Competence → P.A. → Evaluation of Speaker	.87 (.000)	.81 (.000)	.05	.015	.111	20.37	Partial

Note. *P.A. = perceived accommodation.

accommodation is perceived, all of these variables were measured post-experimental manipulation. Given they were measured at the same time, alternative nearly or plausibly equivalent models may exist. Additionally, with the use of self-reported data, participants' biases and inaccuracies (e.g., preferences for a slower VBA in the language contexts) may have influenced their responses. Future research should seek to capture the SCM dimensions of warmth and competence both pre and post experimental manipulation of communication accommodation in addition to capturing individuals' language ability and previous experience with technology in the language learning context. Relatedly, the term "warmth" appeared in two different sections of the surveys—both within the SCM scale and in the evaluations of the speaker. Therefore, any interpretation of the results should consider this overlap to ensure clarity and precision in understanding the findings. Another limitation of this study is the use of vignettes in the experimental manipulation. Our study only presented two vignettes with each their own specific differences. As there are many different types of encounters and interactions with a VBA (c.f. human communication; Jackson & Jacobs, 1983) it might be difficult with our study design to reject other possible explanations for the user's interpretation of the VBA's accommodation. Hence, the results of our analysis may be different than a study employing live interaction with VBAs given the additional variables that could be present but are not controlled (Gasiorek & Giles, 2015). Furthermore, the vignettes we used in the experimental manipulation mentioned the success of understanding the VBA. Specifically, it is possible that participants rated the underaccommodative VBA low on our pertinent DVs because the vignette mentioned that the user is having trouble understanding the VBA (e.g., see Appendix A for specific wording). Future research should also examine the task success as an additional experimental factor to parse out the confounding effects.

Future research can benefit from examining other accommodation strategies in the context of HMC interaction. Specifically, whereas previous research has sought to understand the differences in nonverbal communication from machines (e.g., Andrist et al., 2015; Cirillo et al., 2022; Shen & Wang, 2023), our study is the first (besides (Edwards et al., 2023) that we know of to fully apply CAT and SCM to interactions concerning verbal communication concerning the individual user (e.g., Von der Pütten et al., 2011, pp. 183–194). As an implication for future research surrounding machines that are designed to accommodate various users (e.g., algorithmically driven VBAs), future research would benefit from revisiting verbal and nonverbal communication accommodation strategies that may benefit the user in their interaction depending on that users perceptions of the machine's personalization algorithm designed for their own learning goals.

Our findings have important managerial implications when considering the interactions between people and machines for task-related endeavors. When communication is a salient aspect of interacting with a machine, incorporating accommodative strategies can aid in greater understanding and interpretation of what a user is supposed to do. As previous research has demonstrated the applications of human-to-human scripting in initial interactions (Edwards et al., 2023; Craig & Edwards, 2021) and that machines are expected to be objective, unbiased, and accurate (Craig & Choi, 2024), designers need to navigate the level of accommodation needed to benefit the user. If that machine has salient communication characteristics requiring human-machine communication, underaccommodative communication can bring about negative evaluations of that machine that could degrade the impression that tasks the user desires to accomplish are even accomplishable.

5. Conclusion

As the proliferation of VBAs has aided in creating a context for users to easily apply human-communication scripting for completing their goals via interaction, our study suggests that the accommodative behavior of such machines is critical to consider in their design. Specifically, judgments about VBAs in our research were brought about indirectly by the perceived appropriateness of the VBAs communication accommodations. These perceptions were motivated by the use of stereotype content models.

CRediT authorship contribution statement

Matthew J.A. Craig: Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Conceptualization. **Xialing Lin:** Writing – review & editing, Writing – original draft. **Chad Edwards:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Autumn Edwards:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Other Material

Overaccommodative VBA Vignette:

"You are visiting relatives in a foreign country, and although you are not fluent in the local language, you can speak and understand some of it. To improve your language skills, you have been trying to speak the language as much as you can. You just started taking classes with a voice-based agent (similar to Amazon's Alexa or Apple's Siri) designed to teach you this foreign language. Imagine having a session with this voice-based agent. The voice-based agent speaks **extremely slowly** and uses **only very simple and basic words with you**. At the end of each sentence, the agent **stops to translate what it just said into English, even though you have already understood what the agent said without any problems."**

Underaccommodative VBA Vignette:

"You are visiting relatives in a foreign country, and although you are not fluent in the local language, you can speak and understand some of it. To improve your language skills, you have been trying to speak the language as much as you can. You just started taking classes with a voice-based agent (similar to Amazon's Alexa or Apple's Siri) designed to teach you this foreign language. Imagine having a session with this voice-based agent. The voice-based agent speaks **very quickly** and uses **a number of words you don't know**. At the end of each sentence, the agent **continues to speak**. **Although you are trying hard to follow what the agent is saying, you are having a lot of trouble understanding it.**"

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