

Should Machines Express Sympathy and Empathy? Experiments with a Health Advice Chatbot

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Abstract

When we ask a chatbot for advice about a personal problem, should it simply provide informational support and refrain from offering emotional support? Or, should it show sympathy and empathize with our situation? Although expression of caring and understanding is valued in supportive human communications, do we want the same from a chatbot, or do we simply reject it due to its artificiality and uncanniness? To answer this question, we conducted two experiments with a chatbot providing online medical information advice about a sensitive personal issue. In Study 1, participants ($N=158$) simply read a dialogue between a chatbot and a human user. In Study 2, participants ($N=88$) interacted with a real chatbot. We tested the effect of three types of empathic expression—sympathy, cognitive empathy, and affective empathy—on individuals' perceptions of the service and the chatbot. Data reveal that expression of sympathy and empathy is favored over unemotional provision of advice, in support of the Computers are Social Actors (CASA) paradigm. This is particularly true for users who are initially skeptical about machines possessing social cognitive capabilities. Theoretical, methodological, and practical implications are discussed.

Keywords: human-robot interaction, empathy, sympathy, uncanny valley, CASA

Introduction

I AM SORRY TO HEAR THAT. I totally understand how you feel." Coming from an intelligent agent, this kind of utterance, expressing humanlike sympathy and empathy, might seem uncanny, if not downright disingenuous.

As research across fields such as supportive communication, psychotherapy, nursing, and education has found the benefits of compassion and understanding from support providers,^{1–6} designers have been trying to build robotic agents with these elements. Examples of bots providing emotional support can be traced as far back as 1966 to ELIZA, a chatbot that simulated a Rogerian therapist.⁷ With the advancement in natural language processing and machine learning, designers now can create sophisticated chatbots that are able to recognize users' emotions and respond accordingly.^{8,9}

However, it is unclear how people respond to caring and understanding from such bots. Important as they are in human supportive communication, do we want the same from a robotic agent, which inherently is an inanimate entity? Existing research has not yet fully addressed this question. Nor has it considered the underlying psychological processes. We attempt to do both in this study, which aims at answering this question with two experiments involving interactions with a healthcare chatbot. Two theoretical perspectives—Computers are Social Actors

(CASA) and Uncanny Valley of Mind (UVM)—provide contradictory predictions, as described later.

Computers are social actors

The CASA paradigm suggests that users treat robotic agents socially, despite knowing that they are inanimate.^{10–12} Cues representing human characteristics, such as visual anthropomorphic features, voice, and language, could trigger social presence, that is, the feeling that the interactant is a social entity, and lead individuals to apply social rules derived from human-human interaction (HHI) to their interaction with inanimate agents.^{10,13,14}

As research has shown, computer-based supportive agents have been received positively in general.^{15–20} For example, an anthropomorphic online chatbot Ramona has successfully solicited trust and self-disclosure from its users.^{21,22} Robin,²⁰ a chatbot designed to comfort victims of cyberbullying with strategies such as expressing sympathy and compliments was evaluated as supportive by both anti-bullying experts and children. Individuals interacting with a caring computer for 4 weeks reported higher perception of caring and higher willingness to continue working with it than those unexposed to simulated caring.¹⁵

Laboratory experiments have also found that a computer's compliments,²³ emotions embodied in its voice,^{24,25} and a virtual agent's empathy toward human players in games¹⁶

influence individuals' perceptions as if they were coming from real humans. According to CASA, expression of empathy and sympathy from social robots should be as welcomed as they are in HHI.

Uncanny valley of mind

However, research on UVM suggests that a machine with a mind of its own can be disturbing to users.²⁶ Specifically, UVM suggests that cues in non-human agents that foster attribution of certain mental capabilities that are typically deemed to be distinctively possessed by human beings trigger an eerie sensation among individuals as a result of mental categorization conflicts and threats to human distinctiveness.²⁶ Research has demonstrated that people perceive others' minds along two dimensions: experience and agency.²⁷ Typically, people see the experience dimension as unique to human beings and attribute little feeling/experience to non-human entities.²⁷ Violation of this norm, such as machines showing the ability to feel/experience, is particularly disturbing compared with those with ability to think and act.²⁸ For example, a supercomputer described as being able to feel some form of hunger, fear, and other emotions (with experience) was perceived as more uncanny than a control supercomputer and even one that can "independently execute actions" with "self-control and the capacity to plan ahead."²⁸ Individuals are also less comfortable to have computers taking over roles that involve more experience, such as judges and psychiatrists.²⁹ Research has also found that an avatar ostensibly controlled by a computer expressing empathy (e.g., "That must be annoying for you") elicited strong uncanny perceptions because empathy is believed to be unique to humans.²⁶ Following the prediction of UVM, a non-human agent, when providing responses indicating psychological processes on the affective dimension, might elicit perceptions of "uncanniness" as a result of confusing nonhumans with humans, thereby posing a threat to human distinctiveness.

Effects of empathy and sympathy

Given the conflicting predictions of CASA and UVM, should a chatbot provide expressions of empathy, sympathy, or merely provide information in healthcare and other situations? Empathy and sympathy, together with compassion, and empathic concerns are often mistakenly conflated and used interchangeably.³⁰ However, the processes underlying each might or might not be compatible with our common ontological assumptions about machines.

Psychological studies reveal that empathy is a two-dimensional construct—cognitive empathy and affective empathy,^{31–33} involving cognitive and emotional processes.^{34,35} Cognitive empathy is defined as "comprehension of another person's emotions,"³³ which is often operationalized as "predictive accuracy" and "recognition accuracy."^{36,37} To have cognitive empathy, one need not experience any affective change as a result of seeing others' suffering. To be affectively empathic, one not only needs to be aware of others' feelings (emotion recognition),⁴ but also feels what others feel. Affective empathy is often defined as a "vicarious emotional response to the perceived emotion of others,"^{38,39} and operationalized as the degree of sharing and experiencing another's feelings.^{33,38}

Sympathy is also an affective process but it is other-oriented and is limited to feelings of sorrow, concerns, and sadness for

other's distressful events.^{4,40,41} Although sympathy can be an outcome of affective empathy,^{31,42} it need not involve a sharing of experience or a deeper knowledge of others,^{40,41} but may simply be a reaction to others' emotional needs.⁴

While seeking medical information about their symptoms, users are often under emotional distress associated with symptoms and uncertainty.^{43–45} As suggested by the Integrated Model of Advice Giving,^{46,47} advice preceded by emotional support is most effective in terms of recipients' evaluation of the advice and the likelihood of following the advice. Messages with expression of sympathy, cognitive empathy, and affective empathy signify a higher level of person-centered emotional support as they serve to legitimize the feelings of the distressed others, and encourage reappraisal of their situation, and are more positively evaluated.⁴⁸

According to CASA, the same should apply to messages from chatbots—users would prefer chatbots expressing sympathy, cognitive empathy, and affective empathy than one that provides only advice. However, UVM suggests that a chatbot's sympathy and affective empathy might be perceived as uncanny and, therefore, negatively evaluated because both involve affective processes that are believed to be uniquely human. Since UVM does not suggest that machines with cognitive capacity are disturbing, we only proposed competing hypotheses on the effects of affective empathy and sympathy expressed by a chatbot, and we hypothesized that "artificial feelings" give rise to the perception of "uncanniness."

Past research only tested UVM with virtual agent expressing empathy, as an operationalization for affective processes, without examining whether it was the affective or the cognitive component of empathy that results in the eerie sensation.²⁶ According to UVM, it is the affective capacity in machines that is disturbing, and the uncanny effect should be mediated by the perceived affective component—perception of a chatbot having feelings. However, since the cognitive processes underlying empathy, namely recognition of others' emotions and understanding how and why others feel in certain ways, are closely related to emotions, we proposed research questions regarding whether these cognitive components of empathy mediate the UVM phenomenon observed with empathic machines.

Although CASA suggests that individuals' beliefs in a machine's nature and capabilities do not matter,¹² prior beliefs in robotic capabilities might influence how they interpret a chatbot's socioemotional expression.⁴⁹ Believers in artificial emotion might see an expression of empathy or sympathy as a true manifestation of machine emotion, which could be disturbing, as suggested by UVM²⁶; disbelievers might treat the very same expression as nothing more than a trick rather than an indicator of machine emotion. All the hypotheses and research questions are presented in Table 1. We conducted two experiments, one with a scenario and the other with a real chatbot.

Study 1

Methods

We conducted a between-subjects online experiment. One hundred and fifty-eight participants (66.20 percent females; age: 19–71, $M_{\text{age}} = 34.76$, $SD_{\text{age}} = 12.34$) located in the United States were recruited from Amazon Mechanical Turk (MTurk).

Participants read a text-based hypothetical conversation script between an information seeker with concerns about sexually

TABLE 1. HYPOTHESES AND RESEARCH QUESTIONS

CASA	<p>H1a: Support with sympathy expressed by a chatbot will be more positively evaluated than advice-only support.</p> <p>H2a: Support with affective empathy expressed by a chatbot will be more positively evaluated than advice-only support.</p> <p>H3: Support with cognitive empathy expressed by a chatbot will be more positively evaluated than advice-only support.</p>
UVM	<p>H1b: Support with sympathy expressed by a chatbot will be less positively evaluated than advice-only support.</p> <p>H2b: Support with affective empathy expressed by a chatbot will be less positively evaluated than advice-only support.</p> <p>H4: Expression of sympathy will increase eeriness compared with advice-only support.</p> <p>H5: Expression of affective empathy will increase eeriness compared with advice-only support.</p> <p>H6: Perception of feelings possessed by the chatbot will mediate the relationship between expression of sympathy and eeriness.</p> <p>H7: Perception of feelings possessed by the chatbot will mediate the relationship between expression of affective empathy and eeriness.</p> <p><i>RQ1: Will perceived recognition of feelings by the chatbot mediate the relationship between expression of sympathy and eeriness?</i></p> <p><i>RQ2: Will perceived recognition of feelings by the chatbot mediate the relationship between expression of affective empathy and eeriness?</i></p> <p><i>RQ3: Will perception of chatbot's understanding mediate the relationship between expression of sympathy and eeriness?</i></p> <p><i>RQ4: Will perception of the chatbot's understanding mediate the relationship between expression of affective empathy and eeriness?</i></p> <p>H8: Belief in robotic feelings will moderate the effect of expression of sympathy such that support with sympathy from the chatbot would lead to (a) more eeriness perception, and (b) more negative evaluation than advice-only support for believers, but not for disbelievers.</p> <p>H9: Belief in robotic feelings will moderate the effect of expression of affective empathy such that support with affective empathy from the chatbot would lead to (a) more eeriness perception, and (b) more negative evaluation than advice-only support for believers, but not for disbelievers.</p>
Study 2	<p><i>RQ5: How does belief in robotic intelligence moderate the effect of expression of sympathy?</i></p> <p><i>RQ6: How does belief in robotic intelligence moderate the effect of expression of affective empathy?</i></p>

CASA, computers are social actors; UVM, uncanny valley of mind.

transmitted diseases (STD) and an online chatbot (referred to as "robot" in the text) answering health-related questions designed by the research team. We chose STD as the topic for two reasons—it is common for users with STD concerns to first turn to the Internet, which provides the anonymity for dealing with such a sensitive personal issue.^{50,51} Second, a biomedical context represents a typical scenario for social support studies.⁵

Participants were asked to imagine themselves as the support seeker bothered by STD concerns and randomly assigned to read one of four conversation scripts in which the chatbot gave either instrumental advice only, advice with sympathy, advice with cognitive empathy, or advice with affective empathy. The conversation script of the "advice-only" condition (control condition) can be found in Appendix 1, and variations to this script in the other three conditions are shown in Table 2.

After reading, participants filled out a questionnaire regarding their perceptions of the chatbot's performance. All perceptual variables, including message supportiveness,⁵² effectiveness,⁵² eeriness,⁵³ spine-tingling perception,⁵³ etc., were measured on seven-point scales (Table 3).

Results

Planned comparisons were conducted between each of the three treatment conditions (sympathy, affective empathy, and cognitive empathy) and the control condition. As presented in Table 4, H1a, H2a, H3a were supported and H4 and H5 were not supported.

TABLE 2. STIMULI IN STUDY 1 AND STUDY 2

Conditions	Manipulation
Advice-only	The chatbot only responded with advice without expressing any perspective-taking or compassion for the user's distress. Only factual information or advice is provided such as "The best way is to go to see a doctor before taking any medicine," "Many factors other than STD could cause these symptoms, such as allergy, fungus infection or skin irritation," etc.
Sympathy	In this condition, a sentence indicating that the agent felt bad or sorry for the user was added in the beginning of each response, such as "I am sorry to hear that," "I feel sorry for your pain," etc.
Cognitive empathy	In this condition, a sentence suggesting that the agent recognized and acknowledged the user's feelings and situation was added in the beginning of each response, for example, "genital issues could be annoying," "itchiness could be quite disturbing," etc.
Affective empathy	In this condition, a sentence expressing that the agent understood how and why the user feels a certain way were added, such as "I could imagine how annoying genital issues can be," "I understand your anxiety about being infected," etc.

STD, sexually transmitted diseases.

TABLE 3. MEASURES OF STUDY 1 AND STUDY 2

	Variables	Items
Studies 1 and 2	Perceived sadness	How much do you think the chatbot felt bad because of the user's suffering?
	Perceived recognition	How much do you think the chatbot successfully recognized the user's feeling and situation?
	Perceived understanding	How much do you think the chatbot understood the user's feelings?
	Message supportiveness ⁵² ($\alpha = 0.89/0.90$)	Rate the chatbot's response on a four-item semantic differential scale with items "sensitive-insensitive," "caring-uncaring," "understanding-not understanding," "supportive-unsupportive"
	Message effectiveness ⁵² ($\alpha = 0.95/0.90$)	Rate the chatbot's response on a four-item semantic differential scale with items "effective-ineffective," "helpful-unhelpful," "beneficial-not beneficial," "adequate-inadequate"
	Sincerity ($\alpha = 0.82/0.85$)	"Sincere-insincere," "genuine-artificial," "heartfelt-performed"
	Spine-tingling perception ⁵³ ($\alpha = 0.90/0.92$)	"Uninspiring-spine-tingling," "boring-shocking," "predictable-thrilling," "bland-uncanny," and "unemotional-hair-raising"
Study 2	Eeriness ⁵³ ($\alpha = 0.73/0.83$)	"Reassuring-eerie" "natural-freaky," "ordinary-supernatural"
	Belief in robotic feelings	"How much do you believe robots can have real feelings?"
	Felt supported ¹⁶ ($\alpha = 0.84$)	The degree to which participants felt supported during the interaction was assessed with a five-item semantic differential scale with items "supported-unsupported," "attended to-not attended to," "appreciated-unappreciated," "praised-criticized," and "not alone-alone."
	Likeability ¹⁶ ($\alpha = 0.89$)	Perceived chatbot's likeability was measured with a three-item semantic differential scale with items "unlikeable-likeable," "unpleasant-pleasant," and "unappealing-appealing."
	Intelligence ¹⁶ ($\alpha = 0.92$)	Perceived chatbot's intelligence was measured with a three-item semantic differential scale with items such as "dumb-smart" and "incapable-capable."
	Attitude ⁵⁶ ($\alpha = 0.91$)	Attitude toward the overall interaction experience was measured with a three-item semantic differential scale with items, "Negative-Positive," "Unpleasant-Pleasant," and "Unenjoyable-Enjoyable"
	Novelty ⁵⁷ ($\alpha = 0.86$)	Perceived novelty of the overall interaction was measured with a three-item Likert scale with items "I find the interaction I just had a very novel experience," "The interaction I just had felt new and refreshing," and "The interaction I just had represents a novel way of offering social support."
	Belief in robotic intelligence	"How much do you believe robots can be intelligent?"

Note: α is for Cronbach's α ; numbers separated by "/" are Cronbach's α of the scale in Study 1 and Study 2, respectively.

TABLE 4. HYPOTHESES TESTING IN STUDY 1

	Advice-only		p
H1a		Sympathy	
Perceived sadness	1.94 (0.32)	4.30 (0.30)	0.000
Emotion recognition	4.70 (0.25)	5.73 (0.23)	0.003
Understanding	2.24 (0.31)	3.38 (0.30)	0.009
Supportiveness	4.53 (0.20)	5.40 (0.19)	0.002
H2a		Affective empathy	
Perceived sadness	1.94 (0.32)	3.42 (0.29)	0.001
Understanding	2.24 (0.31)	3.07 (0.28)	0.049
Supportiveness	4.53 (0.20)	5.26 (0.18)	0.006
H3		Cognitive empathy	
Perceived sadness	1.94 (0.32)	2.87 (0.27)	0.027
Supportiveness	4.53 (0.20)	4.99 (0.17)	0.076
H4		Sympathy	
Spine-tingling	3.34 (0.20)	3.39 (0.19)	0.870
Eeriness	2.75 (0.19)	3.00 (0.18)	0.346
H5		Affective empathy	
Spine-tingling	3.34 (0.20)	3.68 (0.18)	0.215
Eeriness	2.75 (0.19)	3.20 (0.17)	0.088

To test H6 and H7 and RQ1–4, we conducted mediation analyses using 5,000 bootstrap samples, with effect coefficients and bias-corrected 95 percent confidence intervals, estimated with Model 4 of the PROCESS macro.⁵⁴ Perceived sadness, recognition, and understanding were tested together as parallel mediators.

H6 and H7 were not supported because the indirect effect of sympathy and affective empathy through perceived sadness was not significant for spine-tingling perception and eeriness. Instead, sympathy increased spine-tingling perception and decreased perceived eeriness through perceived recognition (Figs. 1 and 2). Expression of affective empathy increased eeriness through perceived understanding (Fig. 3).

To test H8 and H9 about the moderating effect of an individual's belief in robotic feelings, regression analyses were conducted with ModProbe Macro.⁵⁵ H8a was not supported because belief in robotic feelings did not moderate the effect of sympathy on spine-tingling or eeriness perceptions. As shown in Table 5, H9a was supported such that individuals who believe in robotic feelings found affective empathy more spine-tingling; H8b and H9b were not supported as disbelievers found the chatbot's sympathy and affective empathy less effective.

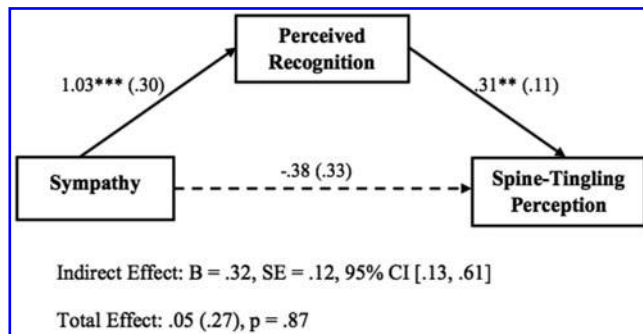


FIG. 1. Indirect effect of sympathy on spine-tingling perception in Study 1. $^{*}p < 0.01$, $^{***}p < 0.001$.

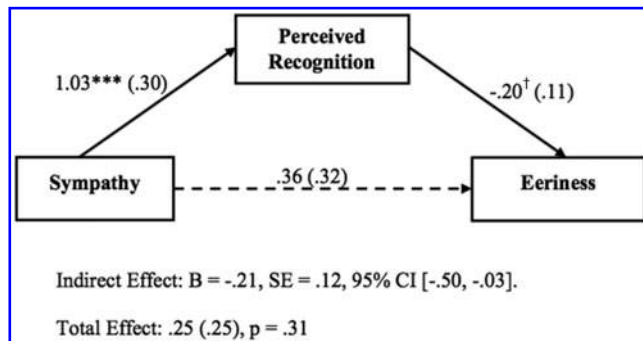


FIG. 2. Indirect effect of sympathy on perceived eeriness in Study 1. $^{†}p < 0.1$, $^{***}p < 0.001$.

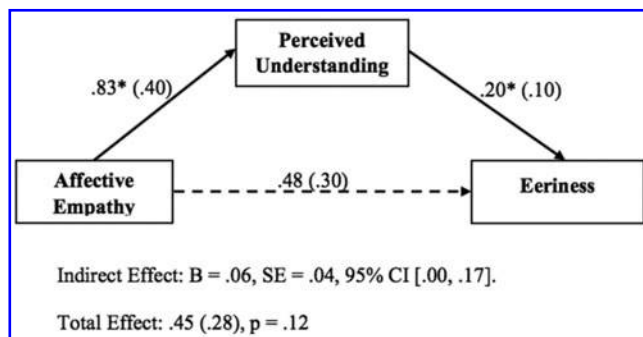


FIG. 3. Indirect effect of affective empathy on perceived eeriness in Study 1. $^{*}p < 0.05$.

Discussion

Study 1 found support for CASA such that expressions of sympathy, cognitive empathy, and affective empathy by a chatbot were all perceived as communicating more compassion, and expressions of sympathy and affective empathy were perceived as more supportive than advice-only condition, consistent with findings in the literature on interpersonal informational support.

As predicted by the UVM (that perceived affective experience of technological artifacts leads to perceptions of uncanniness), those who believe in robotic feelings see the expression of affective empathy by a chatbot as more spine-tingling, as this signals the exciting possibility of an underlying affective process.

However, mediation analyses in Study 1 suggest that it is not the perceived chatbot's sadness, but the perception of its understanding and recognizing emotion that contributed to both spine-tingling and eeriness perceptions, which suggests that a chatbot's emotion might not be the only source of "uncanniness" perceptions. A chatbot's intelligence, that is, the ability to recognize and understand human emotion and language in the current context, might also lead to perceptions of "uncanniness," which will be tested in Study 2 (RQ5 and RQ6 in Table 1).

Study 2

Study 2 replicated Study 1 with a real chatbot and added measures assessing perceptions of the interaction overall, including feeling supported,¹⁶ attitude to the interaction,⁵⁶ and novelty of the experience,⁵⁷ and the chatbot's likeability¹⁶ and intelligence¹⁶ (Table 3). Participants ($N = 88$) were college students and MTurkers (student = 37, 42 percent, female = 64, 72.7 percent, age ranging from 18 to 52, $M_{age} = 25.75$, $SD_{age} = 6.78$).

Stimuli

We used the same scenario as in Study 1, but instead of reading about an interaction, participants interacted with a chat agent (Appendix 2). We developed four script-based chatbots using Chatfuel (<https://chatfuel.com>), a chatbot developing tool using artificial intelligence (AI) to recognize keywords in a user's input and providing a programmed response linked to those keywords (for details in designing, see Appendix 3). We asked participants to help us test the prototype of an online health service chatbot by following

TABLE 5. EFFECT OF SYMPATHY AND AFFECTIVE EMPATHY AS BELIEF IN ROBOTIC FEELINGS VARIES IN STUDY 1

		B (SE)	Low	Medium	High
H8b (Sympathy)	Effectiveness	0.43* (0.19)	—	n.s.	
			[1–1.83]	[1.83–7]	
H9a (Affective empathy)	Spine-tingling	0.12* (0.05)	n.s.	+	
			[1–3.28]	[3.28–7]	
H9b (Affective empathy)	Effectiveness	0.17** (0.06)	—	n.s.	+
			[1–1.84]	[1.84–5.52]	[5.52–7]

$^{*}p < 0.05$, $^{**}p < 0.01$.

+, Sympathy or affective empathy had a positive effect; –, sympathy or affective empathy had a negative effect; [], ranges of belief in robotic feelings; n.s., sympathy or affective empathy had no significant effect; SE, standard error.

standardized instructions designed to ensure that participants enter the keywords associated with scripted responses (Appendix 4).

Results

Planned comparisons between experimental and control conditions showed no significant differences on the criterion variables except for a significant difference in perceived sadness between sympathy ($M = 5.12$, $SE = 0.41$) and advice-only condition ($M = 3.60$, $SE = 0.36$), $p = 0.006$. Therefore, H1, H2, and H3 were not supported.

Expression of sympathy or affective empathy did not increase spine-tingling and eeriness perceptions. Therefore, H4 and H5 were not supported.

Mechanism/mediation

In support of H6 (Fig. 4), expression of sympathy had a positive indirect effect on eeriness through perceived sadness. H7 was not supported because expression of affective empathy had no indirect effect on spine-tingling or eeriness perceptions through perceived sadness, recognition, or understanding.

As found in Study 1, regardless of whether the expression is sympathy, cognitive empathy, or affective empathy, the chatbot was perceived as feeling more sadness than when it was simply providing advice. It suggests that although these processes are conceptually different, they all indicate a certain level of sadness and concern for the support seeker. Therefore, we decided to combine the three and labeled them as “empathic expression,” because sympathy is often considered as empathy-related and a natural outcome of empathy,^{42,58,59} and compared it against the control condition. As shown in Figures 5 and 6, through perceived sadness, empathic expression had a positive indirect effect on both spine-tingling and eeriness perceptions.

Effect of belief in robotic capabilities

Results of moderation analyses with ModProb did not support H8a because belief in robotic feelings did not moderate the effect of sympathy on spine-tingling or eeriness perceptions; H8b was supported as shown in Table 6. Overall, expression of sympathy had a negative effect for users who believe in robotic feelings.

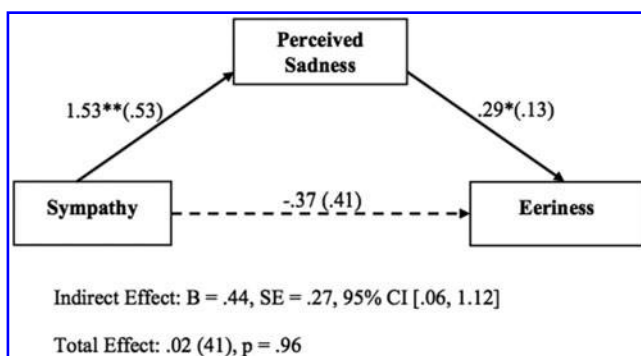


FIG. 4. Indirect effect of sympathy on perceived eeriness in Study 2. * $p < 0.05$, *** $p < 0.01$.

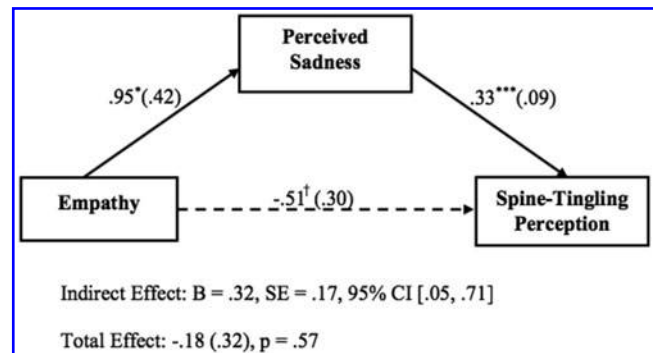


FIG. 5. Indirect effect of empathic expression on spine-tingling perception in Study 2. † $p < 0.8$, ** $p < 0.05$, *** $p < 0.001$.

H9 was not supported because belief in robotic feelings did not moderate the effect of affective empathy on users' perceptions.

In response to RQ5 and RQ6 regarding the effect of belief in robotic intelligence, expression of sympathy increased spine-tingling perception for disbelievers but decreased it for believers. Affective empathy had a positive effect for disbelievers and had negative or no effect for believers (Table 7).

Comparison Between Two Studies

We combined the data from the two studies to detect the effect of method (script vs. real chatbot) and expression of sympathy or empathy on the common perceptual variables. We found no interaction effect. As shown in Table 8, interaction with the real chatbot led to more intense perceptions than script reading. As shown in Table 9, we found patterns that support H1a, H2a, and H3 in the combined dataset.

Overall discussion

Overall, data show that expression of sympathy and affective empathy is perceived as more supportive than advice-only, which is consistent with findings in interpersonal supportive communication, and therefore in line with CASA. Although the statistical significance is attributable to Study 1, the pattern in Study 2 is in accordance with that in Study 1, and the statistical non-significance in Study 2 may be attributed to its smaller sample size. Consistent with recent research which discovered that uncanny valley is sensitive to individuals' beliefs,⁴⁹ both experiments found that pre-existing beliefs about robotic capabilities influence individuals' reactions to a chatbot's sympathy and empathy. Study 1 found that for believers in robotic feelings, expression of affective empathy is more spine-tingling, as UVM suggests. Study 2 found that expression of sympathy and affective empathy enhanced positive perceptions only for disbelievers; whereas for believers, seeing the potential actualized elicited negative perceptions but not perception of uncanniness. It could be that in Study 2 high believers see the overt expression of sympathy and empathy as imperfectly implemented rather than unnerving, due to the lack of human likeness of the chatbot in other aspects, such as fast response rate, mechanical icon, etc. Overall, these findings suggest that CASA is more applicable for disbelievers in robotic

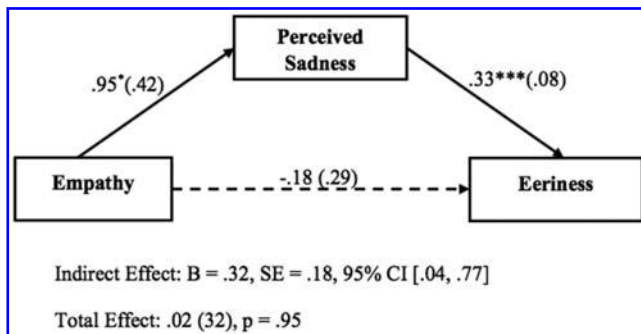


FIG. 6. Indirect effect of empathic expression on perceived eeriness in Study 2. * $p < 0.05$, *** $p < 0.001$.

socioemotional capabilities, who constituted the majority of the current samples.

We also found differences in the mechanisms underlying uncanniness across the two studies. In Study 2, perceived chatbot's sadness mediated the effect of empathic expressions on perceived eeriness and spine-tingling perception, consistent with existing research on UVM using videos of robots as stimuli. However, Study 1, with the method of script reading, found that perceived emotion recognition and understanding were the major reasons for spine-tingling perception and eeriness, rather than perceived chatbot's feelings. The difference might be attributed to the modality difference between the two experiments.

TABLE 6. EFFECT OF SYMPATHY AS BELIEF IN ROBOTIC FEELINGS VARIES IN STUDY 2

	<i>B (SE)</i>	<i>Low</i>	<i>Moderate</i>	<i>High</i>
Sadness	−0.74* (0.29)		+	n.s.
			[1–4.00]	[4.00–7]
Sincerity	−0.64** (0.21)	+	n.s.	−
		[1–3.00]	[3.00–6.50]	[6.50–7]
Supportiveness	−0.64** (0.18)	[1–2.04]	[2.04–4.45]	[4.45–7.00]
Likeability	−0.60* (0.23)		n.s.	−
		[1–5.22]		[5.22–7]

* $p < 0.05$, ** $p < 0.01$.

+, Sympathy had a positive effect; −, sympathy had a negative effect; [], ranges of belief in robotic feelings; n.s., sympathy had no significant effect.

TABLE 7. EFFECT OF AFFECTIVE EMPATHY AND SYMPATHY AS BELIEF IN ROBOTIC INTELLIGENCE VARIES IN STUDY 2

	<i>B (SE)</i>	<i>Low</i>	<i>Moderate</i>	<i>High</i>
Spine-tingling (sympathy)	−0.56* (0.23)	+	n.s.	−
		[1–1.46]	[1.46–5.82]	[5.82–7]
Spine-tingling	−0.33*** (0.08)	[1–3.67]	[3.67–5.39]	[5.39–7]
Likeability	−0.27** (0.08)	[1–3.61]	[3.61–5.89]	[5.89–7]
Attitude	−0.25** (0.08)	[1–1.78]	[1.78–5.17]	[5.17–7]
Novelty	−0.33*** (0.07)	[1–3.87]	[3.87–5.41]	[5.41–7]
Sadness	−0.24* (0.12)		+	n.s.
			[1–4.28]	[4.28–7]
Sincerity	−0.18* (0.08)		[1–4.36]	[4.36–7]
Supportiveness	−0.16* (0.07)		[1–3.84]	[3.84–7]
Felt supported	−0.18* (0.08)		n.s.	−
			[1–5.78]	[5.78–7]
Effectiveness	−0.15* (0.07)		n.s.	

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

+, Sympathy or affective empathy had a positive effect; −, sympathy or affective empathy had a negative effect; [], ranges of belief in robotic feelings; effect of sympathy is specified with "(sympathy)," with the rest being the effect of affective empathy; n.s., sympathy or affective empathy had no significant effect.

TABLE 8. EFFECT OF METHOD

	<i>Script</i>	<i>Chatbot</i>	<i>F</i>	<i>p</i>	<i>Partial η^2</i>
Perceived sadness	3.17 (0.15)	4.30 (0.20)	18.83	<0.001	0.074
Perceived sincerity	4.35 (0.12)	5.08 (0.16)	12.93	<0.001	0.052
Perceived supportiveness	5.01 (0.10)	5.32 (0.13)	3.40	0.066	0.014
Spine-tingling	3.51 (0.10)	4.01 (0.13)	9.29	0.003	0.037
Eeriness	3.03 (0.10)	4.05 (0.13)	41.50	0.000	0.145

Note: age is controlled as covariate.

TABLE 9. EFFECT OF EMPATHY AND SYMPATHY WITH COMBINED DATA

	Advice-only		P
		Sympathy	
Perceived sadness	2.60 (0.25)	4.58 (0.25)	0.000
Perceived recognition	4.83 (0.19)	5.56 (0.19)	0.007
Perceived sincerity	4.41 (0.19)	4.93 (0.20)	0.059
Perceived supportiveness	4.82 (0.15)	5.32 (0.16)	0.023
		Affective empathy	
Perceived sadness	2.60 (0.25)	3.70 (0.23)	0.001
Perceived supportiveness	4.82 (0.15)	5.38 (0.14)	0.008
		Cognitive empathy	
Perceived sadness	2.60 (0.25)	3.35 (0.23)	0.027

Note: age is controlled as covariate.

Comparing the two methods, interaction with a real chatbot was a more intense experience and led to more perceived sadness, sincerity, supportiveness, and spine-tingling and eerie perceptions (Table 8), suggesting that real interaction is more engaging, probably because participants were better able to take a first-person perspective. In real-time interaction, the comprehension aspect of the communication (recognition and understanding) might be less attended to as long as no frustration occurs. Instead, the socioemotional aspect might be more salient. However, when reading a script, more attention might be paid to the logic of the content, where the intelligence aspect of the chatbot was perhaps scrutinized more, which can also be unnerving given the common theme in popular media that the public feels threatened by intelligent machines.⁶⁰

Besides its theoretical implication, this study was motivated by providing practical suggestions on robot dialogue design by identifying the best way to communicate empathy. In terms of perceived supportiveness, cognitive empathy does not seem to add much compared with sympathy and affective empathy. Probably the detached tone is not satisfying, even though it seems to match well with the nature of the chatbot as an objective machine.¹⁹ Therefore, expression of cognitive empathy is not recommended. Instead, expression of sympathy and affective empathy is recommended especially for users who do not believe in robotic emotions and intelligence.

A major limitation of this study is that we only used one scenario, that is, STD, as our research context, where information-seeking is the primary goal. In this context, emotional support may be superfluous and, therefore, not expected. However, in scenarios where emotional support is more intrinsic to the topic of the chat, such as for a psychotherapy chatbot or a companion chatbot, a chatbot's emotions might be perceived as eerie. Findings from this study should be interpreted in light of this limitation.

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References

- Birch S, Ladd G, Juvonen J, et al. (1996) *Social motivation: understanding children's school adjustment*. Cambridge, England: Cambridge University Press.
- Burleson BR. (2003) Emotional support skills. In Greene JO, Burleson BR, eds. *Handbook of communication and social interaction skills*. Mahwah, NJ: Lawrence Erlbaum Associates, pp. 551–594.
- Burleson BR. (2008) What counts as effective emotional support? Explorations of individual and situational differences. In Motley MT, ed. *Studies in applied interpersonal communication*. Thousand Oaks, CA: SAGE Publications Ltd., pp. 207–228.
- Clark AJ. Empathy and sympathy: therapeutic distinctions in counseling. *Journal of Mental Health Counseling* 2010; 32:95–101.
- Levinson W, Gorawara-Bhat R, Lamb J. A study of patient clues and physician responses in primary care and surgical settings. *JAMA* 2000; 284:1021–1027.
- Wentzel KR. Student motivation in middle school: the role of perceived pedagogical caring. *Journal of Educational Psychology* 1997; 89:411–419.
- Weizenbaum J. Eliza—a computer program for the study of natural language communication between man and machine. *Communications of the ACM* 1966; 9:36–45.
- Leahu L, Sengers P. (2014) Freaky: performing hybrid human-machine emotion. In *Proceedings of the 2014 Conference on Designing Interactive Systems (DIS'14)*. Vancouver, BC: ACM, pp. 607–616.
- Matsumoto K, Ren F, Kuroiwa S, et al. (2007) Emotion estimation algorithm based on interpersonal emotion included in emotional dialogue sentences. In Gelbukh A, Kuri Morales ÁF, eds. *MICAI 2007: advances in artificial intelligence. MICAI 2007. Lecture Notes in Computer Science, Vol. 4827*. Berlin, Heidelberg: Springer, pp. 1035–1045.
- Nass C, Moon Y. Machines and mindlessness: social responses to computers. *Journal of Social Issues* 2000; 56: 81–103.
- Nass C, Steuer J, Tauber ER. (1994) Computers are social actors. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI'94)*. Boston, MA: ACM, pp. 72–78.
- Reeves B, Nass C. (1996) *The media equation: how people treat computers, television, and new media like real people and places*. Cambridge, UK: CSLI Publications and Cambridge University Press.
- Isbister K, Nass C. Consistency of personality in interactive characters: verbal cues, non-verbal cues, and user characteristics. *International Journal of Human-Computer Studies* 2000; 53:251–267.
- Lee KM, Nass C. (2003) Designing social presence of social actors in human computer interaction. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI'03)*. Ft. Lauderdale, FL: ACM, pp. 289–296.
- Bickmore TW, Picard RW. (2004) Towards caring machines. In *Proceedings of the CHI'04 Extended Abstracts on Human Factors in Computing Systems (CHI EA '04)*. Vienna, Austria: ACM, pp. 1489–1492.
- Brave S, Nass C, Hutchinson K. Computers that care: investigating the effects of orientation of emotion exhibited by an embodied computer agent. *International Journal of Human-Computer Studies* 2005; 62:161–178.

17. Klein J, Moon Y, Picard RW. This computer responds to user frustration: theory, design, and results. *Interacting with Computers* 2002; 14:119–140.
18. Partala T, Surakka V. The effects of affective interventions in human-computer interaction. *Interacting with Computers* 2004; 16:295–309.
19. Sundar SS. (2008) The MAIN model: a heuristic approach to understanding technology effects on credibility. In Metzger MJ, Flanagin AJ, eds. *Digital media, youth, and credibility*. Cambridge, MA: The MIT Press, pp. 72–100.
20. van der Zwaan J. An empathic virtual buddy for social support. Doctoral dissertation, Delft University of Technology, 2014.
21. Heckman CE, Wobbrock JO. (2000) Put your best face forward: anthropomorphic agents, e-commerce consumers, and the law. In *Proceedings of the Fourth International Conference on Autonomous Agents (AGENTS '00)*. Barcelona: ACM, pp. 435–442.
22. Moon Y. Intimate exchanges: using computers to elicit self-disclosure from consumers. *Journal of Consumer Research* 2000; 26:323–339.
23. Fogg BJ, Nass C. Silicon sycophants: the effects of computers that flatter. *International Journal of Human-Computer Studies* 1997; 46:551–561.
24. Jo D, Han J, Chung K, et al. (2013) Empathy between human and robot? In *Proceedings of the 8th ACM/IEEE International Conference on Human-Robot Interaction (HRI'13)*. Tokyo: IEEE, pp. 151–152.
25. Nass C, Foehr U, Brave S, et al. (2001) The effects of emotion of voice in synthesized and recorded speech. In *Proceedings of the AAAI Symposium Emotional and Intelligent II: The Tangled Knot of Social Cognition*. North Falmouth, MA: AAAI.
26. Stein JP, Ohler P. Venturing into the uncanny valley of mind—the influence of mind attribution on the acceptance of human-like characters in a virtual reality setting. *Cognition* 2017; 160:43–50.
27. Gray HM, Gray K, Wegner DM. Dimensions of mind perception. *Science* 2007; 315:619.
28. Gray K, Wegner DM. Feeling robots and human zombies: mind perception and the uncanny valley. *Cognition* 2012; 125:125–130.
29. Nass C, Lombard M, Henriksen L, et al. Anthropocentrism and computers. *Behaviour & Information Technology* 1995; 14:229–238.
30. Chismar D. Empathy and sympathy: the important difference. *The Journal of Value Inquiry* 1988; 22:257–266.
31. Feshbach ND. Empathy in children: some theoretical and empirical considerations. *The Counseling Psychologist* 1975; 5:25–30.
32. Hoffman ML. (2001) *Empathy and moral development: implications for caring and justice*. New York, NY: Cambridge University Press.
33. Vossen HG, Piotrowski JT, Valkenburg PM. Development of the adolescent measure of empathy and sympathy (AMES). *Personality and Individual Differences* 2015; 74:66–71.
34. Nummenmaa L, Hirvonen J, Parkkola R, et al. Is emotional contagion special? An fMRI study on neural systems for affective and cognitive empathy. *Neuroimage* 2008; 43: 571–580.
35. Shamay-Tsoory SG, Aharon-Peretz J, Perry D. Two systems for empathy: a double dissociation between emotional and cognitive empathy in inferior frontal gyrus versus ventromedial prefrontal lesions. *Brain* 2009; 132:617–627.
36. Cline VB, Richards JM, Jr. Accuracy of interpersonal perception: a general trait? *The Journal of Abnormal and Social Psychology* 1960; 60:1–7.
37. Kerr WA, Speroff BJ. (1951) *The measurement of empathy*. Chicago: Psychometric Affiliates.
38. Mehrabian A, Epstein N. A measure of emotional empathy. *Journal of Personality* 1972; 40:525–543.
39. Stotland E. Exploratory investigations of empathy. *Advances in Experimental Social Psychology* 1969; 4:271–314.
40. Gribble J, Oliver G. Empathy and education. *Studies in Philosophy and Education* 1973; 8:3–29.
41. Switankowsky I. Sympathy and empathy. *Philosophy Today* 2000; 44:86–92.
42. Eisenberg N, Fabes RA. Empathy: conceptualization, measurement, and relation to prosocial behavior. *Motivation and Emotion* 1990; 14:131–149.
43. Galloway SC, Graydon JE. Uncertainty, symptom distress, and information needs after surgery for cancer of the colon. *Cancer Nursing* 1996; 19:112–117.
44. Gustafson D. Impact of a patient-centered, computer-based health information/support system. *American Journal of Preventive Medicine* 1999; 16:1–9.
45. Lazarus RS. Coping with the stress of illness. WHO Regional Publications, European Series 1991; 44:11–31.
46. Feng B. Testing an integrated model of advice giving in supportive interactions. *Human Communication Research* 2009; 35:115–129.
47. Feng B. When should advice be given? Assessing the role of sequential placement of advice in supportive interactions in two cultures. *Communication Research* 2014; 41: 913–934.
48. Burleson BR. (1994) Comforting messages: significance, approaches, and effects. In Burleson BR, Albrecht TL, Sarason IG, eds. *Communication of social support: messages, interactions, relationships, and community*. Thousand Oaks, CA: Sage, pp. 3–29.
49. Macdorman KF, Entezari SO. Individual differences predict sensitivity to the uncanny valley. *Interaction Studies* 2015; 16:141–172.
50. Cassell M, Jackson C, Chevrant B. Public health interventions on the internet: a persuasive channel for health behavior change. *Journal of Health Communication* 1998; 3:71–79.
51. Keller S, LaBelle H, Karimi N, et al. Talking about STD/HIV prevention: a look at communication online. *AIDS Care* 2004; 16:977–992.
52. Holmstrom AJ, Burleson BR, Jones SM. Some consequences for helpers who deliver cold comfort: why it's worse for women than men to be inept when providing emotional support. *Sex Roles* 2005; 53:153–172.
53. Ho CC, MacDorman KF. Measuring the uncanny valley effect: refinements to indices for perceived humanness, attractiveness, and eeriness. *International Journal of Social Robotics* 2017; 9:129–139.
54. Hayes AF. (2013) *Introduction to mediation, moderation, and conditional process analysis: a regression-based approach*. New York, NY: Guilford Press.
55. Hayes AF, Matthes J. Computational procedures for probing interactions in OLS and logistic regression: SPSS and SAS implementations. *Behavior Research Methods* 2009; 41:924–936.

56. Bellur S, Sundar SS. Talking health with a machine: how does message interactivity affect attitudes and cognitions? *Human Communication Research* 2017; 43:25–53.
 57. Wells JD, Campbell DE, Valacich JS, et al. The effect of perceived novelty on the adoption of information technology innovations: a risk/reward perspective. *Decision Sciences* 2010; 41:813–843.
 58. Eisenberg N, Wentzel M, Harris JD. The role of emotionality and regulation in empathy-related responding. *School Psychology Review* 1998; 27:506–521.
 59. Funk J, Fox C, Chan M, et al. The development of the children's empathic attitudes questionnaire using classical and Rasch analyses. *Journal of Applied Developmental Psychology* 2008; 29:187–196.
 60. Markoff J. (2009) Scientists worry machines may outsmart man. www.nytimes.com/2009/07/26/science/26robot.html?_r=0 (assessed Feb. 21, 2018).
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Stimuli in Study 1 (Advice-Only Condition)

Robot: How long have you been like this? How bad is it right now?

User: The itchiness has lasted for 3 months. Sometimes the itchiness went so bad that I could not even work or sleep. What medicine can I take to feel better?

Robot: The best way is to go to see a doctor before taking any medicine.

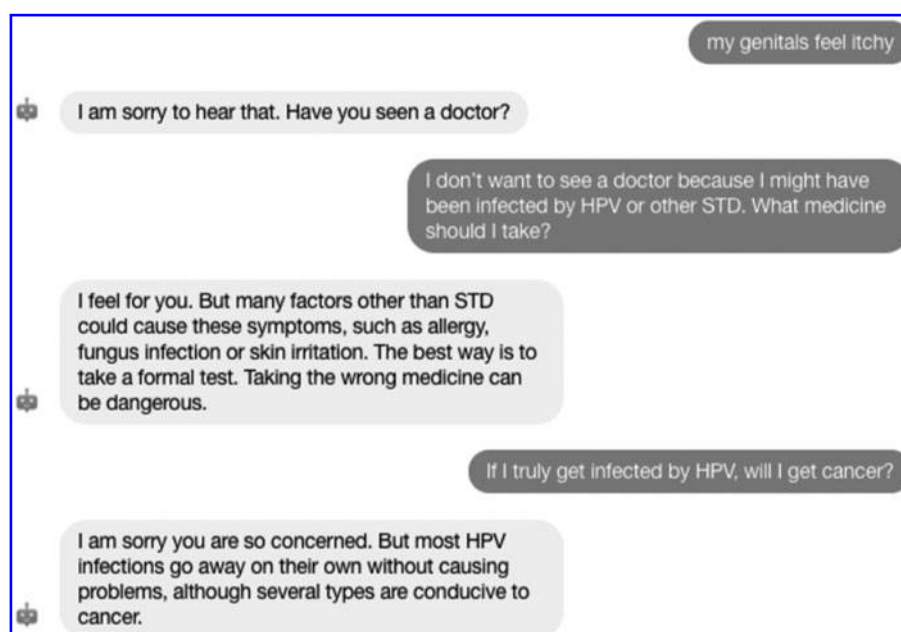
User: I don't want to see a doctor because I think I might have been infected by HPV or other STD.

Robot: Many factors other than STD could cause these symptoms, such as allergy, fungus infection or skin irritation. The best way is to do a medical test at hospital. If you are not infected, you may consider taking the HPV vaccine to reduce the chance of future infection.

User: If I truly get infected, will I get cancer? I heard many people say so.

Robot: Most HPV infections go away on their own without causing problems, although several types are conducive to cancer. The first step is to take a medical test.

Stimuli in Study 2
See Appendix Figure A1.



APPENDIX FIG. A1. Screenshot of participant's conversation with the chatbot in Study 2 (sympathy condition).

Appendix 3

Procedures of Building the Chatbots in Study 2

In Chatfuel.com, a chatbot building platform, after creating an account, one user can create several chatbots that can be activated at the same time. For this study, the researchers created four chatbots following the same procedure.

The logic of building this chatbot is very simple, such that once certain prescribed key words were put in by the participants, they triggered corresponding responses that were prepared beforehand by the researchers. The entire conversation was initiated by the chatbot greeting the user “Hello! I am a robot, how can I help you?”

The conversation was divided into four rounds.

Round 1: Participants describing their symptoms → chatbot asking if the user has seen a doctor.

Round 2: Participants expressing privacy concerns regarding HPV infection and sexually transmitted diseases (STD) → chatbot responding with information about alternative factors other than STD that could cause the symptoms and recommend taking a formal test.

Round 3: Participants expressing concerns with the outcomes of HPV (i.e., cancer) → chatbot responding with information related to outcomes of different types of HPV infections.

Round 4: Participants thanking the chatbot to end the conversation → chatbot responding with “You are welcome! Please go back to Qualtrics and finish the questionnaire.”

Within each round of communication, participants' input initiated the conversation. The content of their input was suggested in the instructions they received. To make the conversation feel more realistic and appear to be less scripted and manipulated, participants were allowed to deliver the same content in their own ways. However, to deliver the focal content in each round, they had to use certain key words, such as “genitals” and “feel itchy” in Round 1, and “I don't want to see a doctor” in Round 2. We tried to be inclusive when specifying the key words by listing all the possible ways of saying the same content and stored them as keywords linked with corresponding responses from the chatbot.

The AI technology used by Chatfuel allows for fuzzy matching when linking the keywords and the corresponding responses such that even though participants' input and the keywords specified beforehand were not exactly the same, as long as they share some overlap, the corresponding responses would still be triggered. This technology guaranteed that participants' input was appropriately responded to, regardless of the variance in how they ask their questions. We double-checked all the participants' actual conversation with the chatbot and did not spot any errors, that is, there was no mismatch between the participants' inquiries and the chatbot's responses.

Appendix 4

Instructions in Study 2

Scenario

To test the chatbot's performance in a standardized way, you are randomly assigned to a specific scenario that happened in the past, where a 21-year-old user has some concerns about STD, as shown later.

Symptoms

Genitals often feel itchy; rash on surrounding skin; itchiness has lasted for 3 months.

Concern 1

I don't want to see a doctor because I might have been infected by HPV or other STD (It's a bit embarrassing to talk about STD with a stranger, so I would prefer to take some medicine by myself). What medicine should I take?

Concern 2

If I truly get infected by HPV, will I get cancer? (many people say so).

Chatting Instructions

(a) Following the routine of online health consultation, please follow these steps by sequence when chatting.

Step 1: report the symptoms to the chatbot.


Step 2: tell the chatbot your concern 1.

Step 3: tell the chatbot your concern 2.

Step 4: say “thank you” to the chatbot to terminate the conversation.

- (b) Imagine you are this person with these symptoms and concerns. You can phrase the symptoms and concerns in full sentences such as “my genitals often feel itchy,” “There also is some rash on surrounding skin” etc. Please DO NOT tell the chatbot the content in the parentheses (), which is just to brief you about the situation of the patient. Please avoid typos.
- (c) Please DO NOT tell the chatbot anything other than the information provided in the scenario. We will not collect your personal information in any manner.

Procedures

- (a) Copy and paste this link to the browser: <https://m.me/1795238177363199>
- (b) As the chatbot is built on the Facebook Messenger platform, it will ask  to sign in with your Facebook account. After signing in, press the button “Get Started” to start the conversation.
- (c) Chat with the chatbot as instructed earlier.
- (d) Please go back to Qualtrics to finish the questionnaire after chatting. The chatbot will remind you to go back to Qualtrics after you type in “thank you.”

***You will need to keep this page open as you may need to refer to the instructions during the interaction.