2022 10th International Conference on Affective Computing and Intelligent Interaction Workshops and Demos (ACIIW)

Perception of Multimodal Hedges in Communicative Behavior of a Companion Robot

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***Abstract*—We examine "hedges" – speech and nonverbal communication strategies that can reduce the categorical nature of the messages, connected with social face loss by the speaker or a face threatening act to the hearer. In the REC multimodal corpus, these speech acts and corresponding nonverbal actions (automanipulations, lip biting, etc.) are used (a) as politeness strategies, and (b) as an expression of the speaker's uncertainty. We reproduced these gestures on a companion robot in a situation, where the robot is answering exam questions by the user and makes minor mistakes. We have compared the perception of (a) a robot, using hedges, and (b) a robot, addressing the hearer after an utterance. The robot, using hedges, is perceived as more friendly and sympathetic, while nervous and hesitating, and the robot using the addressive expression is perceived as clearer, but detached.**

***Index Terms*—affective robot companions, emotional attachment, politeness theory, human-robot interaction**

I. Introduction

The linguistic theory of politeness [1] describes communication strategies in the situations of *social face loss* – when, for example, a speaker has to acknowledges his own mistake – or in the cases of *face threatening acts* – when, for example, the speaker asks or commands the hearer, thus attacking his social face. The use of *hedges* is one of the politeness strategies to make the utterance less definitive and meeting the criteria of politeness. For a speech hedge the speaker can use the adverbs, like *probably*, *perhaps*, phrases *like that*, *in a way* – in order to make his utterance more polite, even if he is quite sure about the truthfulness of the utterance. However, these speech markers can also be used to indicate the uncertainty of the speaker about the proposition.

The goal of this study is to assess the difference between the perception of the interlocutor – a companion robot – that uses hedges and the one that uses a more neutral communicative strategy (like, addressive cues) in similar cases. Within this study we departed from two hypotheses. Our first hypothesis was that using combinations of verbal and nonverbal hedges helps a robot to sound less flat and more polite, while using verbal and nonverbal means to address the opponent makes a robot sound more self-assured and less polite. Our second hypothesis was that politeness strategies (e.g., hedges) make communication more emotional, and an interlocutor – *friendlier*, and more *sympathy provoking*. Thus, we expect, that the use of hedge can have positive and negative influence of the perception of the speaker: (a) people can feel the emotional attachment, or (b) hedges can underline and make evident the possible mistakes, made by the speaker, where a more direct communication strategy can hide the inaccuracies.

The research is supported by the grant of the Russian Science Foundation No. 19-18-00547, https://rscf.ru/project/19-18-00547/

II. Methods

To test hypotheses, we have executed an experiment, where two emotional companion robots F-2 [2] have been answering real exam questions of a university course to the user. Both robots were making slight mistakes in their answers, thus, experiencing face loss in their propositions. For the contrasting communication strategy, we have suggested *the strategy of appeal* or *addressive strategy* – where a person after his main utterance says *Here!* or *That's it!* – and makes a slight gesture or head movement to the hearer in order to support or underline the meaning of his previous utterance [3]. This is a neutral communication strategy, which, unlike hedges, is quite definitive and does not express any hesitation.

Each answer of the robot consisted of three parts: (a) hesitation – robot moves his head, looks aside or up (similar types movements for the two experimental conditions), (b) answer with no gestures (eye movements allowed on this stage) and (c) multimodal hedge (1st condition) or multimodal addressive behavior (2nd, control condition). Speech synthesis was supported by Yandex speech API service – state of the art text-to-speech system. All the answers were cached in advance in order to avoid the delays during the experiment. When robots were not engaged in answering, they were constantly maintaining slight inactive behavior: hands and head movements to imitate breathing, slight changes in gaze direction.

A. The allocation and design of multimodal hedges

We considered speech and gesture hedges based on the material of real emotional communication of REC multimodal corpus [4]. A part of this corpus is dedicated to real oral university exams, so the observed patterns directly corresponded to the experimental situation. Speech hedges include adverbs and phrases, indicating uncertain denotative status of the judgement, like *maybe, as I believe, perhaps, probably, in my opinion*. These hedges may appear before, after or within the hesitation pause of the main utterance. For the multimodal expression of hedges, we have considered the gestures, accompanying these speech expressions in REC. The following movements are considered as nonverbal hedges: shrugs, biting the lip, smile or slight laughter after the statement, combined facial expression with squinting one's eyes (Action Unit 7, according to FACS) and lowering one's eyebrows (AU4) with simultaneous wrinkling of nose (AU9) and lip tension (AU24).

978-1-6654-5490-2/22/$31.00 ©2022 IEEE

Each of the two robots had been using addressive actions or hedges as a combined *verbal+nonverbal* piece of behavior after the main answer. The robot that used hedges uttered one of the hedge-expressions (*maybe, it seems to me, probably, I think*) and performed one of the following nonverbal hedges: (a) dynamically raised and then lowered both of his hands, imitating a shrug, (b) bit his lip and looked to the right/left and down, (c) stretched his lips in an involuntary smile and made a sound similar to a giggle, (d) showed the above indicated face pattern: moved his eyebrows a little closer and raised them at the same time with squinting his eyes and pulling the corners of his lips into a slight smile. While making facial expressions the robot was automanipulating with his hands. The addressive robot in the post-position of the main utterance pronounced an addressive phrase (*Here! That's it!* or *Yeah*) and made a hand gesture to the side of the hearer. To reproduce these types of behavior on a robot, we have created two protocols of communicative behavior in Behavior markup language [5]. Table 1 represents the examples of the BML protocols and actual performance for the two robots, while answering a question *What is the main object of studies by semiotics?*

saying *Hello!* The robots were controlled from another room via the Wizard-of-Oz scheme: the experimenter had been starting the answer of the robot to a specific question with the preliminary hesitation and hedge/addressive action in post-position. After the first enquiry the participant was asked to evaluate the 1st robot via a computer form, and then – ask the same questions to the 2nd robot. He was informed, that robots are programmed not to listen to the answers of each other. The order of the robots in the experiment was randomized. After the second enquiry the participant was asked to evaluate the second robot and compare the robots in a computer form.

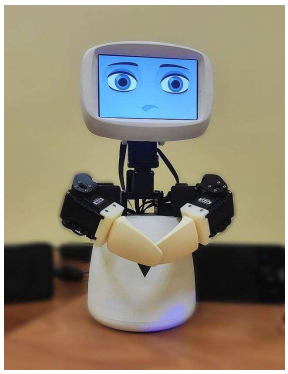
In their answers the robots were not precise or were making slight mistakes, by replying *in XX century*, where a specific year was required, confusing the middle name of a linguist, indicating three principles out of four, etc. Both robots made similar mistakes.

After each enquiry a participant had to estimate the robot according to the following list of questions: *Has the robot prepared well enough for the test? Did he answer the questions confidently? Was it comfortable to communicate with the robot? Did the robot hesitate? Did he make a lot of mistakes? Did he answer clearly? Was he nervous, while answering? Did he try to make a contact with you?* The participant also had to evaluate each robot as *friendly, polite, clever, sympathy provoking, apathetic* and *emotional*. All the answers were accepted on 5 points scale from *very unlikely* to *very likely*.

TABLE I. DIFFERENCES BETWEEN THE EXPERIMENTAL CONDITIONS

Distinctive domains	**Experimental conditions**	
	Condition 1 – Robot with hedges	***Condition 2 – Robot with addressive actions***

BML protocols	`<scenario id="hedge">`
	`  <bml>`
	`  <figure lexeme="breath1"/>`
	`  </bml>`
	`  <bml>`
	`  <eyes lexeme="hap7"/>`
	`  <speech text="Signs"/>`
	`  </bml>`
	`  <bml>`[a]
	`  <speech text="It seems"/>`
	`  <mouth id="1" lexeme="lip-bite"/>`
	`  <hands id="2" lexeme="avtoman2"/>`
	`  </bml>`
	`</scenario>`
		`<scenario id="addressive">`
		`  <bml>`
		`  <figure lexeme="breath1"/>`
		`  </bml>`
		`  <bml>`
		`  <eyes lexeme="hap7"/>`
		`  <speech text="Signs"/>`
		`  </bml>`
		`  <bml>`
		`  <speech text="Yes"/>`
		`  <figure id="1" lexeme="appeal3"/>`
		`  </bml>`
		`</scenario>`

Nonverbal behavior		

[a] The distinctive elements of the BML protocol are highlighted.

B. *The procedure of the experiment*

21 participants took part in the experiment (mean age 20). Each participant sat at a table with the two robots. The robots and the experiment procedure were introduced to the participant. The participant had the list of exam questions with the correct answers available at the table during the experiment, and could familiarize him/herself with the questions beforehand. The real questions for the university course *Introduction to linguistics* were used – 8 questions total. The participant was instructed to ask consecutively the questions to the robot, who would enter the conversation by

III. RESULTS

According to the results, the robot with hedges was rated as more *hesitating* (Mann-Whitney U Test, $p < 0.01$) and *nervous* (Mann-Whitney U Test, $p < 0.05$), while the

addressive robot – as answering *clearly* ($p < 0.05$). At the same time, the robot that uses hedges is perceived as more *friendly* and *sympathy provoking* (Mann-Whitney U Test, $p < 0.01$), while the addressive robot – as more *detached* (Mann-Whitney U Test, $p < 0.05$). It was also found that the robot, which uses hedges, is estimated as a more *good-hearted* (Mann-Whitney U Test, $p < 0.01$) and more *comfortable to communicate with* (Mann-Whitney U Test, $p < 0.05$).

IV. Discussion

According to the results, the hypothesis that the robot with hedges is more polite was not proved. Although some participants have indicated in their self-reports, that the robot was more polite (so, this expressive feature was observed by some participants), in the exam situation the hedges did not contribute to politeness.

The participants did not indicate, that the robots were different in their mistakes. So, hedges do not underline the mistakes and the addressive strategy does not conceal the mistakes – possibly, a more compound exam procedure is required to test the influence of the presentation strategy on the number of subjectively perceived mistakes.

The robots have demonstrated a clear distinction between hesitating and nervous manner (for the robot with hedges) and clear answers (for the robot with addressive strategy). At the same time, the core result lies in the preference of the robot with hedges on the scales of *friendly*, *good-hearted* and *sympathy provoking*. Hedges did contribute to the perception of this robot as *friendly* and *sympathetic*. As we see in self-reports, some participants did identify themselves with the robot with hedges, stating, that *within the exams we* [*students*] *act in the same way*. So, hedges may contribute to the mechanism of identification, where the robot is considered as a protagonist in a difficult situation. Or, hedges may "reveal" the emotions of the robot and provoke compassion (as stated by some participants in their self-reports), thus, maintaining the emotional contact.

V. Conclusion

The results show that the use of verbal and nonverbal hedges allows the speaker to create an image of a more friendly and sympathy provoking interlocutor. In the field of applied robotics, hedges can be used in situations, where the robot cannot execute a human request perfectly and is forced to be partially incorrect or incomplete. In these cases, communicative hedges by the robot leave the impression of friendly interlocutor and make the robot *more comfortable to communicate with.*

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