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Multimodal Hedges for Companion Robots: A Politeness Strategy or an Emotional Expression?

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Abstract

We examine the use of multimodal hedges (a politeness strategy, like saying *A kind of!*) by companion robots in two symmetric situations: (a) user makes a mistake and the robot affects user's social face by indicating this mistake, (b) robot makes a mistake, loses its social face and may compensate it with a hedge. Within our first hypothesis we test the politeness theory, applied to robots: the robot with hedges should be perceived as more polite, threat to its social face should be reduced. Within our second hypothesis we test the assumption that multimodal hedges, as the expression (or simulation) of internal confusion, may make the robot more emotional and attractive. In our first experiment two robots assisted users in language learning and indicated their mistakes by saying *Incorrect!* The first robot used hedges in speech and gestures, while the second robot used gestures, supporting the negation. In our second experiment two robots answered university exam questions and made minor mistakes. The first robot used hedges, while the second robot used addressive strategy in speech and gestures, e. g. moved its hand to the user and said *That's it!* We have discovered that the use of hedges as the politeness strategy in both situations makes the robot *comfortable to communicate with*. But robot with hedges looks more *polite* only in the experiment, where it affects user's social face, and not when the robot makes mistakes. However, the usage of hedges as an emotional cue works in both cases: the robot with hedges seems to be *cute* and *sympathy provoking* both when it attacks user's social face or loses its own social face. This spectrum of hedge usage can demonstrate its transition from an expressive cue of a negative emotion (nervousness) to a marker of speaker's friendliness and competence.

Keywords: multimodal communication; companion robots; emotional computing; face threatening acts; theory of politeness

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Мультимодальные хеджи для роботов-компаньонов: стратегия вежливости или эмоциональная экспрессия?

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Аннотация

Мы исследуем использование мультимодальных хеджей (стратегия вежливости, например, во фразе *Типа того!*) роботами-компаньонами в двух симметричных ситуациях: (а) пользователь совершает ошибку, и робот угрожает социальному лицу пользователя, указывая на эту ошибку, (б) робот совершает ошибку, теряет своё социальное лицо и может компенсировать это хеджем. В рамках нашей первой гипотезы мы проверяем теорию вежливости в применении к роботам: робот с хеджами должен восприниматься как более вежливый, угроза его социальному лицу должна быть снижена. В рамках нашей второй гипотезы мы проверяем предположение о том, что мультимодальные хеджи, как выражение (или имитация) внутреннего замешательства, могут сделать робота более эмоциональным и привлекательным. В нашем первом эксперименте два робота помогали пользователям в изучении языка и указывали на их ошибки, говоря *«Неправильно!»* Первый робот использовал хеджи в речи и жестах, в то время как второй робот использовал жесты, поддерживающие отрицание. В нашем втором эксперименте два робота отвечали на вопросы университетского экзамена и допускали незначительные ошибки. Первый робот использовал хеджи, в то время как второй робот использовал стратегию апелляции в речи и жестах, например, махал рукой в сторону пользователя и говорил: «Вот так!» Мы обнаружили, что использование хеджей в качестве стратегии вежливости в обеих ситуациях делает общение с роботом более комфортным. При этом робот с хеджами выглядит более вежливым только в эксперименте, где он угрожает социальному лицу пользователя, но не когда сам робот совершает ошибки. Однако использование хеджей для выражения эмоций работает в обоих случаях: робот с хеджами кажется симпатичным и вызывает сочувствие, когда он угрожает социальному лицу пользователя или когда он теряет собственное социальное лицо. Этот спектр использования хеджей может продемонстрировать переход хеджа от средства выражения негативной эмоции (неуверенности) к средству обозначения дружелюбия и компетентности говорящего.

Ключевые слова: мультимодальная коммуникация; роботы-компаньоны; эмоциональные компьютерные системы; угроза социальному лицу; теория вежливости

1 Introduction

Robots may encounter different communicative tensions while failing to execute a user's instruction, and thus, failing a user's trust, or while correcting a user, and thus, deprecating his competence. The linguistic theory of politeness [1] describes these situations as a *threat to social face* – of the speaker or of the hearer – which can be compensated by the use of politeness strategies. These strategies may mitigate the face loss and make the communication more polite and pleasant, while still permitting to transfer the required message. Hedge is an expression of approximation: *You are quite right*. The theory of politeness describes hedges as a strategy of negative politeness [1: 145] and prefers these utterances to direct judgements, like *You are right!* At the same time, hedge can also serve as a discourse marker of (a) uncertainty and hesitation, when the speaker is not confident about the judgement and adds a hedge to make it less definite, (b) dialogue turn taking, when a speaker says *I guess* to gain people's attention [2]. In multimodal behavior hedges can be combined with nonverbal signs of hesitation or confusion. In our study we want to evaluate the perception of multimodal hedges in two different situations: where the speaker threatens the social face of the hearer or his own social face – see [1: 67]. We shall execute these studies in interactive communications with two companion robots, as a robot can precisely reproduce the required behavioral patterns in interactive situations. Although the experimental talks with robots may not exactly imitate natural human communication, robots may maintain interactive communication with people in exact and determined way that cannot be achieved in interactive human-to-human experiments.

In our study within human communication with companion robots, we put forward two hypotheses: (1) the expression of verbal and non-verbal hedges makes the speaker more *polite* and *comfortable to communicate with*, (2) multimodal hedges are the expression of emotions that can make a communication *friendlier*, and the speaker – more *sympathy provoking*. Our goal is to find the boundaries of the theory of politeness, applied to communication with robots, and study the conditions, where a hedge is perceived as (a) a mean of politeness, or (b) a marker of internal nervousness and hesitation. The application of politeness strategies to the robots giving advice may have very promising perspectives [3]. Robots communicating with people may naturally fail (be corrected by humans) or correct a human, thus, requiring some politeness strategies to support natural communication.

To test the hypotheses, we have executed two experiments, where (a) robot affects user's social face by correcting user's mistakes, and (b) robot loses its social face by making slight pre-programmed mistakes in its answers. In each experiment, one of the robots uses hedges, while the other does not. We evaluated human perception of the robots via surveys. As the two robots are identical in their behavior

(except for the hedges), we are able to justify the differences in evaluations by the usage of hedges by one the robots.

We have been concentrating on the situations of communication, where success or failure is linked to some oral production. For the first experiment we were looking for a setup, where the user makes real mistakes and the robot has to indicate these mistakes to the user. We have chosen a situation of word learning, where the human participant practices memorizing words of a foreign language, while the robot corrects its mistakes. For the symmetric experiment we were looking for a situation, where the robot fails in its oral production. We have selected an exam situation, where a participant asks the robot some exam questions, and the robot answers with slight mistakes in its statements. Each experiment was performed with two robots, where the first robot used hedges, while the second robot used gestures and speech, supporting its judgement: addressive strategy or negation.

2 Experiment 1: Robot affects user's social face by indicating his mistakes

To study the situation where a speaker affects the social face of the hearer, we have simulated a word learning environment, where the user (hearer) was learning Latin words with the companion robot (speaker). 38 participants took part in the experiment, mean age 19. Each participant started the experiment with one of the two robots, the order was randomized for each participant. The experiment with each robot was divided into two stages: word acquisition and word training (see Figure 1). During the acquisition phase each of the Latin words was introduced to the participant on a screen with a translation into Russian. Pre-recorded pronunciation of a Latin word by a professional Latin teacher was transmitted via the speakers. The robot then announced a keyword to help remember the Latin word. Keywords were phonetically similar Russian words, selected in a preliminary survey (n = 42, mean age 22, 28 females). The robot used Yandex speech API service for speech production.

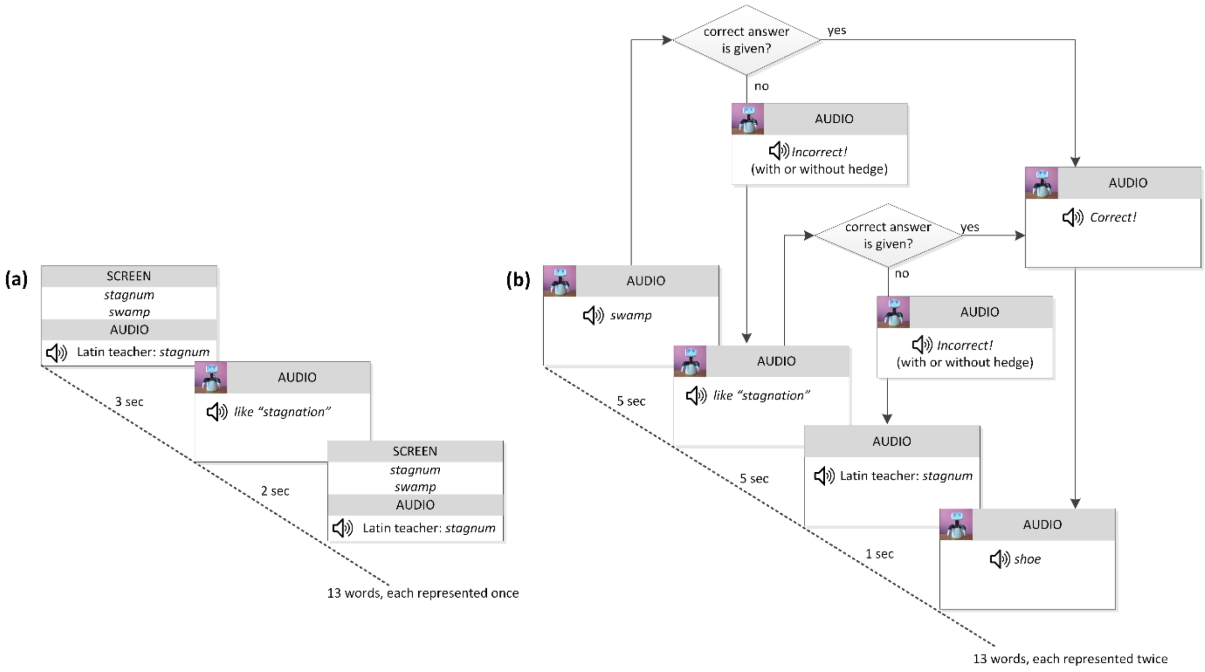


Figure 1: Scheme of Experiment 1 for a single condition. Words with keywords (hints) are introduced on the acquisition phase (a). On the training phase (b) the robot asks to translate each word and replies with a negative reaction (*Incorrect!*) with or without hedge – or with a positive reaction (*Correct!*).

During the training phase the robot announced a word in Russian and waited 5 seconds for the translation into Latin. If no correct answer was given within 5 seconds (silence was treated as *an incorrect answer*), the robot announced that the answer is not correct, offered the keyword and waited another 5 seconds. If no correct answer was given, the robot reacted as to an incorrect answer, the correct translation was announced by the Latin teacher (pre-recorded audio via the speakers) and the robot moved to

the next word in 1 second. Correct answers were marked by the experimenter from another room via Wizard-of-Oz scheme to start the "positive" reaction, while robot's reactions to errors/silence were automatic. The order of words was randomized; on the training phase each word was offered twice. Computer screens were not used on the learning phase, participants only communicated with robots: they saw the robots and heard robots' speech as well as the correct pronunciation of the words by the Latin teacher via the speakers.

Two robots differed in two experimental conditions: the first robot accompanied its reactions to incorrect answers by multimodal hedges, for example, by saying *No! A bit incorrect!* and manipulating its hands, while the other robot said only *Incorrect!* and used gestures, supporting the negation, like shaking its head or hand. The gestures were selected from the Russian Emotional Corpus [4, 5, 6] as typical multimodal behavioral patterns for the corresponding utterances; gestures were reproduced on the robot to be used in the experimental protocols. Behavioral protocols for the robots were designed in the Behavior Markup Language [7].

After word learning with one of the robots, participants filled out a questionary to evaluate the interaction and moved to the table with the other robot to study the next batch of Latin words. After the sessions with the two robots, participants were invited to another room to check the learned words and fill out the final questionary to compare the robots.

The experiment did not show any significant difference in the efficiency of word learning. However, the robot with hedges was preferred as a potential learning partner: 42% of the participants chose the robot with hedges, 21% with negations, and 37% evaluated robots equally. Not all the participants noticed the difference between the two robots, but many of them implicitly preferred the one with multimodal hedges. At the same time, several subjects explicitly noticed the differences, but have preferred the "strict" robot that clearly corrected the errors, as this type of control suited them and corresponded to the traditional role of a "strict teacher".

3 Experiment 2: Robot loses its social face by making mistakes

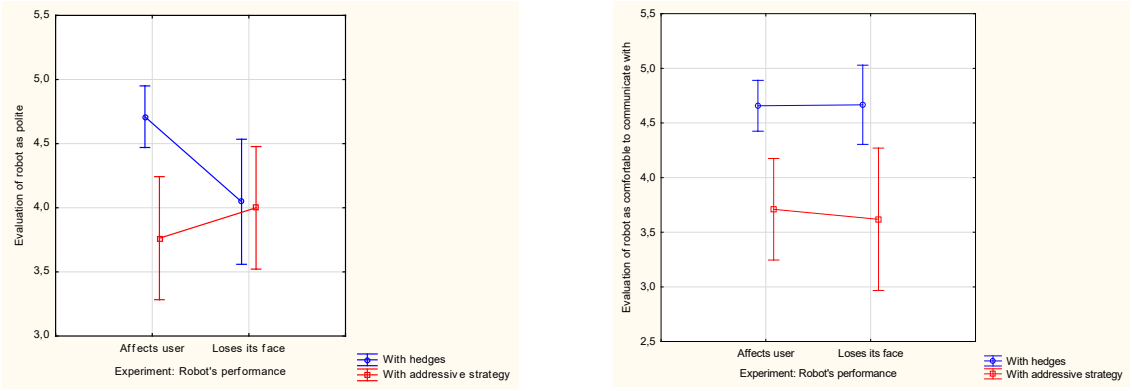
Within the second experiment the robot had to experience failures in its speech production and compensate it with a hedge. We have selected a situation, where students interviewed the robot on the questions of an actual university course "Introduction to Semiotics". 21 participants took part in the experiment with mean age 20. The list of 8 exam questions with the correct answers was reviewed by participants before the experiment and remained on the table during the experiment. Participants had to interview one of the robots, asking one question after another, and then – the other robot. The order of robots was randomized for each participant. After user's question, the corresponding answer to be given by the robot was selected by the experimenter via Wizard-of-Oz scheme. So, the robot could answer questions in randomized order, as it was, indeed, suggested by some participants. The questions were similar for the two experimental conditions. Each answer contained a slight pre-programmed inaccuracy: the robot indicated *century* (instead of the exact year), indicated only one option out of three, or made a mistake in the second name of a scientist. The mistakes were similar for the two experimental conditions. Users had the ability to control robot's mistakes as they had the correct answers on the table during the whole experiment. Robot's answer consisted of three parts, the robot (a) hesitated – looked aside or upward, joined its hands, (b) reported the answer with no gestures (eye movements were allowed), (c) for the 1st condition – demonstrated a hedge with speech and gestures, for example, said *I think so*, bit its lip and manipulated hands (see Figure 2a), and for the 2nd condition – demonstrated addressive strategy, for example, said *That's it* and waved its hand towards the human (see Figure 2b). Parts (a) and (b) of the reaction, including answers and mistakes, were identical for the two conditions. Between the answers robots demonstrated slight movements, typical for inactive behavior. After the interaction with each robot a participant had to fill out a questionary, reporting, if the robot *hesitated, was nervous, made a lot of mistakes, answered confidently, was comfortable to communicate with,* etc. Participants had also to evaluate the perceived psychological characteristics of the robot, by rating it as *friendly*, *competent*, *sympathy provoking*, *apathetic, emotional* (etc.) on 5 points scale from *very unlikely* to *very likely*.

(a) (b)

Figure 2: F-2 Robot with (a) hedge – biting the lip and manipulating hands, or (b) addressive gesture

4 Results

Regarding the usage of hedges within the politeness theory (the first hypothesis), in the first experiment, **the robot, attacking user's social face and using hedges,** was perceived as more *polite* ($p < 0,01$, Mann-Whitney U Test) (Fig. 3a), on the contrary, **robot without hedges** was evaluated as *more hostile* ($p < 0,01$), *indifferent* ($p < 0,01$) and *condemning* ($p < 0,01$); its corrections were *more confusing* to a user ($p < 0,01$). Robot with hedges was evaluated as *more trying to establish contact* ($p < 0,05$), as compared to the robot without hedges. In the second experiment, **the robot, making mistakes and using hedges,** did not appear to be *more polite* (no significant results). While the evaluation of the robot with hedges *as polite* was significant only for the first experiment, robots with hedges in both experiments were evaluated as more *comfortable to communicate with* (Mann-Whitney U Test, $p < 0,05$) (Fig. 3b).



(a) (b)

Figure 3: Hedges within the politeness theory. Robot seems *polite* when it uses hedges while affecting a user, not when it's losing its face (a). Robot seems *more comfortable to communicate with*, when it uses hedges in both conditions (b).

Regarding the usage of hedges to establish an emotional contact (the second hypothesis), in the first experiment, **the robot, attacking user's social face and using hedges,** is considered as *competent* ($p < 0,05$), *responsive* ($p < 0,01$), *caring* ($p < 0,05$). Also, this robot was evaluated *as calm* ($p < 0,01$), as compared to the robot without hedges.

In the second experiment: **robot, making mistakes and using hedges,** was evaluated as *hesitating* ($p < 0,01$) and *nervous* ($p < 0,05$), while **the robot with addressive strategy** was *answering clearly* ($p < 0,05$) and more *detached* ($p < 0,05$).

In both experiments, robots with hedges are perceived as *friendly* (Mann-Whitney U Test, $p < 0,01$) (Fig. 4), *sympathy provoking/cute* (Mann-Whitney U Test, $p < 0,01$) and *good-hearted* (Mann-Whitney U Test, $p < 0,01$).

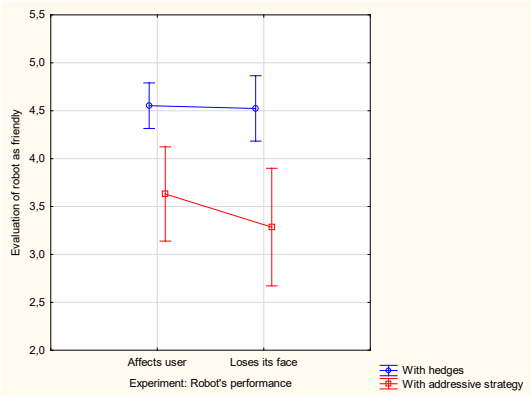


Figure 4: Hedges to establish an emotional contact: robot seems *friendly*, when it uses hedges in both conditions.

5 Discussion

Our verification of hedges as a strategy of politeness in its "strong" definition (*the usage of hedges makes speaker sound more polite*) applies only to the situation, where the speaker attacks the social face of the hearer: e. g., corrects hearer's mistakes. At the same time, the understanding of hedges as a politeness strategy in more "moderate" definition (*the usage of hedges makes conversation more comfortable*) applies to both situations: when the speaker attacks social face of the opponent or loses his face due to his own mistake.

The first observation may seem trivial: indeed, the robot using *politeness strategy* seems more *polite*. At the same time, this starting point testifies that the politeness strategy does apply to robots (at least, within the modelled setup), as some people (schoolchildren) prefer the robot without politeness strategies and consider it as more modern, close to the speech of school children [8]. As an ambiguous expressive pattern, a hedge may contribute not only to the expression of politeness, but also to the expression of emotional and cognitive states: *nervousness* and *hesitation*. Our verification of hedges as a mean to convey the internal emotional state gave quite compound results. Indeed, the robot, giving wrong answers, is perceived as *hesitating* and *nervous*, so hedges can indicate the internal emotional state. At the same time, hedges (as an indication of internal confusion) can provoke some complementary emotions of the hearer, like compassion and sympathy. Some experiment participants – students – did underline that they associated themselves with the robot, who makes mistakes in exam answers and hesitates. So, a negative emotional state (nervousness) can provoke a positive emotional state of the hearer and establish the emotional contact in general: robots with hedges we perceived as *friendly/cute/good-hearted* in both situations.

At the same time, in the situation where the speaker (the robot) controls the hearer by asking the lexical questions and indicating hearer's mistakes, the speaker's hedges make him *competent* and *responsive*. We suggest that its use of hedges naturally allows a human to assign to the speaker *locus of control* (teacher's role) and, thus, treat the speaker as more *competent* and *responsive*. This observation contributes both to the first and second hypotheses.

While the robot with hedges in the second experiment was *more nervous*, in the first experiment it was, on the contrary, considered as *calmer*. We suggest that while in the second experiment hedges played their primary expressive role (the expression of hesitation and nervousness), in a situation, where the speaker governs the hearer, hedges (as voluntary usage of a politeness strategy) indicate speaker's degree of self-control, thus, he is considered as *calmer*, as compared to the speaker without hedges.

In the experiment 2, we have compared hedges with addressive gestures. The robot with addressive gestures was considered as *answering clearly*, which can be treated as a contribution of addressive gestures (as compared to hedges). At the same time, addressive strategies in this condition cannot be considered as a form of positive politeness, as they made the robot look *detached* – not *empathetic*, as it could be suggested, if the addressive gestures contributed to positive politeness.

5 Conclusion

As can be demonstrated in the experiments with companion robots, multimodal hedges contribute to the politeness in different situations by making the speaker more *comfortable to communicate with*. At the same time, hedges make the speaker more *polite* only when he affects the social face of the hearer, e. g. corrects hearer's mistakes.

The compared results of the two experiments allow us to suggest the following spectrum of communicative functions for hedges. Hedges, as a language formula, prototypically express inexactness and tentativeness. They initially correspond to the emotional expression of *hesitation* and *nervousness* of the speaker. Indeed, a speaker, who makes mistakes and uses hedges is evaluated as *nervous* and *hesitating*. This emotional state can invoke the compassion of the hearer and make him perceive the speaker as a friendly interlocutor in a wide range of situations: where speaker loses his face or attacks the faces of others. This usage of hedges corresponds to a wider definition of politeness strategies, as a hedge makes communication more **comfortable** – both, when the speaker loses his social face or has to attack the social face of the hearer. The ability of the speaker to use hedges in a situation, where he governs and corrects the hearer, makes him sound *caring* and *responsive*: i. e. the hearer agrees with the transfer of control to the speaker, who uses hedges. Moreover, the hearer considers a speaker with hedges as *more competent*. And finally, hedges contribute to making the speaker more polite – the core function of hedges, as described by the theory of politeness. However, this applies only to the situations, when the speaker threatens the social face of the hearer. This corresponds to the narrow understanding of a hedge as a politeness strategy.

This spectrum demonstrates the transition of hedge from an expressive negative emotional reaction (*nervousness*, *hesitation*) to a marker of speaker's *care* and *competence* and finally – to a politeness strategy.

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