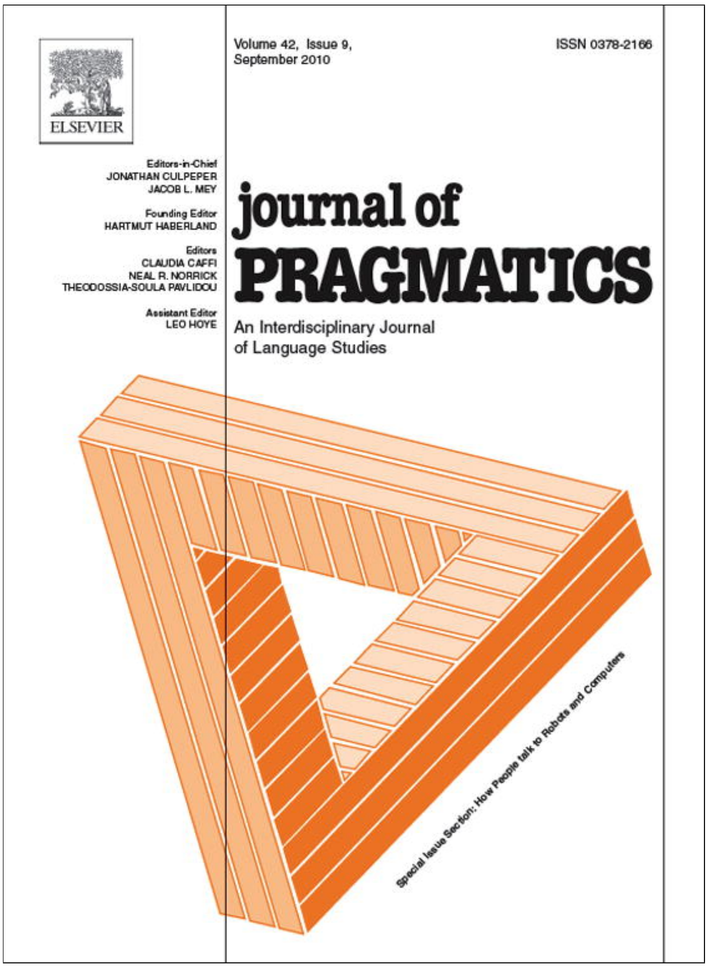
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Editorial

Why it is interesting to investigate how people talk to computers and robots: Introduction to the special issue

1. Communicating with artificial communication partners

The aim of this special issue is to bring together high quality, up-to-date research on how people interact with artificial communication partners that are equipped with natural language processing capabilities, such as dialogue systems, embodied conversational agents and speech-driven robots. In this introduction I address the question why anyone should set out to study how people talk to computers and robots at all and why this should be a topic for pragmatics in particular. I argue that, first, human–computer and human–robot interactions provide us with unique methodological resources which allow the systematic study of the effects of individual linguistic features as well as of general communicative resources and mechanisms otherwise very difficult to study. Second, interactions between humans and computers or robots constitute in many ways extreme conditions for communication to take place, which can provide us with useful insights into general cognitive, social and interactional factors relevant and the resources speakers make use of. Third, system designers need to know what to expect users to say and how to guide them into linguistic behaviour that in turn influences the system's behaviour positively. If the interactions are not pleasant, the systems are not accepted and thus do not sell well; there is therefore some practical relevance to the topic. In addition, human–computer speech interfaces are becoming more and more common, and while human–computer and human–robot interaction are still quite exceptional today, they are not going to be in the future. The sheer quantity of this speech register will therefore soon raise increasingly more attention. The main point, however, is that studying human–computer (HCI) and human–robot interaction (HRI) can contribute interesting facts to the discussion of genuinely pragmatic topics.

1.1. Methodological dimension

Many questions pragmaticians are concerned with are very difficult to study in natural environments. For instance, anecdotal evidence indicates that the communication partner's appearance may play a role in speakers' recipient design (e.g. Roche, 1989), and it has been suspected that the frequent use of tag questions makes speakers appear insecure (e.g. Lakoff, 1975). In natural interactions, we hardly ever get to compare situations with people who only differ in appearance or in their use of tag questions, and not also with respect to many other factors. In interactions with artificial communication partners, however, we can manipulate properties of these interactants in ways we cannot manipulate people, and we can study each feature in isolation systematically, even those that always correlate with other features in real life.[1] Moreover, artificial communication partners have the advantage over, say, confederate studies that they can be totally controlled. While we know that timing in milliseconds, body posture, eye gaze, etc. may play important roles in interactions (e.g. Goodwin, 2003; Duncan and Fiske, 1977), we also know that confederates, however well they are prepared, cannot consciously control these signal systems completely. With a robot or an embodied conversational agent, this is no problem at all. Thus, using HCI or HRI allows us to investigate systematically the effects of individual features in isolation. Examples of such features are the different components of apologies (Akgun et al., 2010), the emotional effect input mode may have on participants (Novielle et al., 2010), the conditions for alignment to occur (Branigan et al., 2010), or the effect of the timing of body movements on partners' recipiency (Yamazaki et al., 2010).

Besides allowing the controlled manipulation and study of discourse and context features, HCI and HRI also provide methodological means useful for studying speakers' reasoning processes as they are displayed in reformulations, clarification questions and asides. Reformulations may occur when the artificial system fails to understand the user's utterance. Since dialogues with artificial agents tend to be less than perfect, such misunderstandings are quite frequent.

[1] See, for example, Bailor at al.'s (2006) study for the impact of the appearance of an embodied conversational agent on users' attitude towards a subject.

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Interestingly, users, both naïve and experienced, do not expect interactions to be fluent. The frequent occurrence of reformulations however provides a useful methodological resource as a window into speakers' reasoning processes. For instance, consider the following dialogue between the robot 'Box' and a human user[2]:

(1) B031: move to your right, - towards the glass.
Box: (1) I did not understand.
B031: (1) move to the object on your right.

The speaker's choices in the reformulation reveal what she considers the problem to consist in, i.e. what her hypotheses are about the functioning of the system and possible causes for the miscommunication. In the example above, she exchanges a concrete term (*glass*) against the very abstract term *object*, thus revealing her hypothesis that the robot might be lexically restricted and that another, more general term may facilitate understanding. Alternatively, she might have raised her voice and repeated her utterance with hyperclear pronunciation, attributing the communication problem to problems of speech recognition instead. Her displays are available to the analyst (cf. Garfinkel, 1972; Sacks, 1984). While in principle many possible explanations may exist for systems' failure to understand, users' reformulations reveal which ones they believe to be likely themselves and thus reveal participants' partner models of their artificial interlocutor. The frequent miscommunication of HCI and HRI thus provide the analyst with useful tools into speakers' conceptualizations of their recipient (cf. Fischer, 2006). We can thus use interaction as a glimpse into cognition (cf. Drew, 2005).

Similarly revealing are clarification questions such as those that form first pair parts of insertion sequences and which contribute to the speaker's membership analysis (Schegloff, 1972). For instance, in example (2), the speaker produces a clarification question before producing a spatial instruction in reply to the robot's question:

(2) Box: should I go to the nolde east of the box?
B037: (2) which way is north? (2) ah::, no::, (2) move to the object which is closest.

In the example, the speaker considers a general orientation regarding the cardinal directions as a precondition to answering the robot's question and finally suggests a reference system based on proximity instead of the one based on the cardinal points of the compass employed by the robot.

Similarly, speakers may reveal in asides how they understand the current situation, including their artificial communication partner, for instance:

(3) Box: which object should I head towards?
B038: (1) to the same one as last time?
Box: (2) all right.
B038: (7) (laughter) it's smart, - (laughter)

Here the speaker shows that she believes an instruction based on dialogue history to be risky (presenting her instruction with rising intonation and acknowledging the robot's intelligence explicitly afterwards) and thus that she might have expected it not to be able to process such an instruction, revealing her initial, quite restricted partner model of the robot as well as letting us in on the updating process at the same time. Investigating speakers' asides thus contributes to membership categorization research free from the flaws outlined by Schegloff (2007), since it is the participants' own understanding of the situation which the categorization is built on.

The indirect evidence from reformulations, clarification requests and asides also provides insights into aspects of the communicative situation speakers draw on for formulating their utterances (cf. Meddeb and Frenz-Belkin, 2010). In conversation among humans, such evidence is rare since communication is usually much less troublesome, and asides commenting on the communication partner and his or her capabilities are generally regarded to be too impolite to be found very often.

Finally, the lack of transparency of the system's behaviour is also of great methodological advantage, since it allows the creation of scripted dialogue that is completely comparable across speakers and conditions. On the one hand, the fact that speakers cannot locate the origin of utterances can be exploited for experiments in which the same linguistic behaviour is created by supposedly different speakers (such as native and non-native speakers (as in Pearson et al., 2006b) or basic or advanced systems (as in Pearson et al., 2006a, see Branigan et al., 2010)). On the other hand, several different speakers may be confronted with identical verbal behaviours in identical situations–circumstances never to be found in natural dialogue. Self-evidently, general theoretical findings from studies using this methodology need to be compared with ecologically valid, real life data, but bringing the two sources of evidence together should indeed take us a good step further towards shedding light into hitherto dark areas.

[2] The dialogues were elicited in the framework of the SFB/TR8 'Spatial Cognition' at the University of Bremen. The transcription conventions are the following: (1) = pause of one second; – = short pause; wo:::rd = syllable lengthening; bold font = prominent realization.

1.2. Theoretical dimension

Communication with artificial agents is still a new, rather uncommon experience, and the applications available (e.g. dictation software, telephone-based dialogue systems, car navigation systems) differ so much in their demands on the user that there is no standard way of dealing with such agents yet. This means that many of those processes that have become highly entrenched in natural interactions have to be constructed on the fly in HCI and HRI, revealing the normative procedures carried into the interaction on the one hand and indicating flexible processes on the other.

One such extensive study is Wooffitt et al.'s (1997) investigation of central conversational procedures, such as turn-taking, dialogue openings and closings, repair, etc., in simulated human–computer interaction. The authors conclude their study stating that "the human participant will still be doing the things that humans do when they interact. That is, the full range of culturally available sense-making procedures will be brought to bear on any occasion, even if the other party to the interaction is a computer" (Wooffitt et al., 1997:166). Thus, confronted with the unusual communication situation, speakers make use of those rules and procedures that they use in conversation among humans.

Similarly, Hutchby finds that "social processes are involved in all aspects of technology" (Hutchby, 2001:193). His study shows that it is not justified to restrict conversation analytic investigations to the normative structures of conversation because speakers use these same resources in other kinds of interactional situations. Hutchby concludes that interacting with technology is constrained on the one hand by the affordances of the respective artefact, "functional aspects which frame, while not determining, the possibilities for agentic action in relation to an object" (2001:194), and by the pervasive normative structures of interaction on the other. The investigation of interactions with artificial communication partners therefore provides an extreme case in which the resources speakers make use of in interaction become apparent and at the same time informs us on how speakers extend these resources to other, less typical interactional situations.

One example of how the study of HCI and HRI can be used to elaborate theoretical concepts and general pragmatic mechanisms is Wrede et al.'s study in this issue. Their study concerns the functions feedback may fulfil in dialogical interaction, and their analyses show that previous models of feedback focus too much on certain communicative functions, presupposing certain speaker intentions and goals that are normal for normal, smooth conversation and task-oriented interaction (Allwood et al., 1992), but not necessarily in all contexts (cf. also Gardner, 2001). Thus, the unconventional nature of the communication with artificial communication partners reveals those aspects of pragmatic mechanisms that we normally take for granted. This allows us to revise models and to explicate the assumptions made. Theoretical concepts that have been introduced in the literature can thus be tested on HCI and HRI for their predictive and explanatory potential.

Theoretically interesting is also the investigation of those concepts proposed to account for the specific properties of speech directed towards artificial communication partners. One concept proposed to account for linguistic variation according to situational features is the notion of register (cf. Finegan and Biber, 2001). Register has therefore been evoked to account for the peculiarities observable in HCI and HRI; studies on how people talk to artificial communication partners have revealed numerous peculiarities in users' speech (Richards and Underwood, 1984; Morel, 1989; Amalberti et al., 1993; Johnstone et al., 1994; Hitzenberger and Womser-Hacker, 1995; Porzel and Baudis, 2004). For this reason, scholars have proposed human–computer interaction to be a particular, simplified, register, similar to other alleged simplified registers (e.g. Krause and Hitzenberger, 1992), such as *baby talk* or *foreigner talk* (Ferguson, 1975). However, the results of studies targeting the linguistic properties of the register are often inconclusive or even contradictory, reporting on opposing effects (cf. Fischer, 2006). Furthermore, speakers may react in different ways to their artificial communication partner, giving rise to both inter- and intrapersonal variation (Fischer, 2006, forthcoming). However, the special methodological conditions of interactions with artificial communication partners allow the systematic investigation of variation according to situational factors, and thus the dimensions of situational variation and influencing factors can be systematically explored. The special situation of HCI and HRI provides therefore a testbed for explanatory concepts such as the notion of register, pointing to limitations and outlining paths for extension and modification.

Another theoretically interesting possibility is to study how the nature of HCI and HRI and the mechanisms influencing its shape provide an exemplary case for our understanding about how speakers design their utterances for their communication partners in general. Two prominent theoretical notions involved in the discussion are alignment and partner modelling. These two processes are proposed to influence each other, but the exact nature of their interaction, as well as the exact nature of alignment and the contents and circumstances of partner modelling are still open issues. Alignment (Pickering and Garrod, 2004) refers to the process by means of which speakers take up linguistic material provided by their communication partners; because alignment on one level is supposed to lead to alignment on another, higher level, it is suspected to ease understanding by providing shared representations and thus to be mostly automatic. However, alignment has also been proposed to be strategic (Brennan and Clark, 1996), to be determined by sociolinguistic factors (Giles et al., 1991) and to depend on the partner model (Fischer, 2006). Also with respect to alignment in HCI, several different hypotheses on the relationship between alignment and partner modelling have been investigated (Branigan and Pearson, 2006); some studies have shown that speakers align more with computers because of low suspected capabilities of the system, and that they align less to computers than to humans because alignment is related to politeness and display of community membership (Branigan and Pearson, 2006). Others have suspected mindless transfer (Reeves and Nass, 1996; Nass and Moon, 2000; Nass and Brave, 2005), and again others suggest partner modelling to be prior, determining the range and limits of alignment (Fischer, 2006, forthcoming). Branigan et al. (2010) discuss the determining factors of alignment in HCI, aiming to bridge the gap between alignment and partner modelling discussed by Pickering and Garrod (2004) and their critics (e.g. Schober, 2004; Brown-Smith and Tanenhaus, 2004) in general.

To sum up, the study of HCI and HRI contributes to the development of core linguistic concepts and mechanisms, providing a testbed for their suitability to account for the linguistic behaviour observable and revealing the speakers' own sense-making efforts.

1.3. Practical dimension

System designers need to know what prospective users are likely to produce in order to adapt the limited resources of state-of-the-art systems to such probable input. For instance, current speaker-independent recognition systems[3] function the better the fewer words the recognizer needs to be trained with. Thus, the more accurately the lexicon speakers are really going to use can be determined in advance, the better the recognition results are going to be (cf. Meddeb and Frenz-Belkin, 2010). The problem is most pronounced for speech recognition, but also other system components may profit from predictable user behaviour. Furthermore, system designers need to know how interaction can be improved to make it more pleasurable, to recover from errors more gracefully and to anticipate speakers' strategies and inferences. This includes knowledge about the effects their design decisions may have on potential users in order to take these decisions in a maximally informed way. Asking the user, for instance, to interact with the system via typed input has numerous advantages by avoiding possible shortcomings of speech recognition systems, yet these advantages have to be traded against possibly negative effects (cf. Novielle et al., 2010). If there is a considerable mismatch between what potential users may expect the system to be able to do, say and understand and what it actually can do, say and understand, this leads to frustration from all sides. Thus, predicting users' linguistic behaviour may be extremely useful.

Finally, even though users' behaviour may not always be predictable, users may be guided into producing only those utterances that the system will be able to process, using our understanding of general pragmatic mechanisms, such as alignment and recipient design. Thus, further analysis of alignment in the communication with artificial agents is vital because its reverse side is user guidance; that is, dialogue designers may exploit users' alignment with their artificial communication partner to subtly guide them into using language in a way the computer or robot understands best; this strategy has been called *shaping* (Zoltan-Ford, 1991). Self-evidently, shaping could provide powerful means for dialogue design if we understood it better. Correspondingly, several studies in this special issue deal with the impact of certain features of the artificial communication partner's linguistic and non-linguistic behaviour on the way people design their utterances for this communication partner or on their attitude towards the interaction with it (notably Wrede et al., 2010; Akgun et al., 2010; Novielle et al., 2010; Yamazaki et al., 2010).

2. The special issue

The articles combined in this special issue exemplify different methodological, theoretical and practical considerations in the study of human users of artificial speech-based systems. In particular, the papers presented in this special issue concern the linguistic adaptations speakers make when talking to computers as communication partners and the relationship of such adaptations to speakers' attention to general conversational structures, alignment with the artificial communication partner, and adjustments based on stereotypical conceptions about such communication partners, thus providing insights in general pragmatic mechanisms.

Holly P. Branigan, Martin J. Pickering, Jamie Pearson, and Janet F. McLean investigate in how far people share linguistic representations with artificial interlocutors, dependent on different models of their communication partner. Moreover, they aim at disentangling the relationship between recipient design and alignment in human–computer interaction by discussing various different factors that may influence alignment: whether the communication partner is suspected to be human versus a computer, whether the partner is a native or a non-native speaker, or whether the partner is a basic versus an advanced computer. The authors conclude that interactions with computers are heavily influenced by considerations of communicative success, and that these considerations influence the amount of alignment to be found in an interaction.

Similarly, *Britta Wrede, Stefan Kopp, Katharina Rohlfing, Manja Lohse and Claudia Muhl* consider the functions of linguistic feedback in the interaction between humans and robots. They investigate the functions of feedback in two different conditions: when speakers attend to social interaction and when they attend to solving a task. They find that depending on speakers' communicative goals, feedback may play considerably different roles, thus strengthening previous findings (e.g. Novielli et al., this volume; Fischer, 2006, issue) that the understanding of the interaction as social or non-social is crucial to the way artificial communication partners are addressed. Wrede and her colleagues compare the functions they find in socially oriented human–robot interaction with self-reported strategies in the communication with hearing impaired communication partners and find that in socially oriented interactions grounding may be secondary to creating conversational flow. On the basis of a discussion of previous attempts to model feedback in dialogue systems, they develop recommendations for the possible uses of different types of feedback in human–robot interaction.

Next, *Nicole Novielli, Fiorella de Rosis and Irene Mazzotta* investigate how users design their utterances based on more or less social models of their communication partner, a so-called embodied conversational agent (ECA). The two different

[3] Speech recognition refers to the process of identifying automatically the words spoken by a speaker from the acoustic signal.

models in turn can be shown to be related to different input modes, spoken versus typed input. Thus, their study contributes to analysing the effect of particular system functionalities. They show that the interaction mode may have a considerable impact on the interaction, such that in spoken interaction there are more and longer utterances and that speakers tend to reveal more personal information about themselves. The different kinds of interaction styles can be recognized automatically using a Bayesian classifier.

Related to this is the study by *Akiko Yamazaki, Keiichi Yamazaki, Matthew Burdelski, and Yoshinori Kuno*. These authors address the effect of implementing naturally coordinated head movements and utterances into museum guide robots. They analyse interactions between human guides and visitors first, identifying the places at which guides gaze towards the visitors and studying the interactional functions of such behaviours. Starting from the coordination of action and language in human-to-human communication, they test the effect of implementing human-like behaviours in robots on users' communicative behaviour. In particular, they test the effect of the timing of head movements on visitors' engagement and responsivity. Thus, they study the influence of a single feature of non-verbal behaviour in isolation, using human–robot interaction as a controlled scenario to determine whether it is the gaze towards the recipient or its timing at transition relevance places (Sacks et al., 1974) that causes participants' reactions.

The study on speakers' strategies in dealing with dictation software by *Elizabeth Meddeb and Patricia Frenz-Belkin* addresses how speakers' preconceptions and their understanding of the situation determine how speakers deal with problems in automatic speech recognition. In particular, the authors show that speakers attend to the dictation software's activity as a second pair part to their speaking activity, and how this conception determines the phrasing. Moreover, they find numerous instances of phonetic, prosodic and lexical adaptations in users' speech directed at the system and show how these adaptations can be related to users' lay theories about the functioning of the software.

Finally, *Mahir Akgun, Kursat Cagiltay and Deniz Zeyrek* investigate the effect of apologetic error messages in human–computer interaction, considering the interdependencies between different types of apologies and users' mood states. In a discourse completion task, they first elicit those apologies that users' would prefer a system to display. After confirming users' understanding of selected apologetic error messages as apologies, they elicited users' mood states and their self-appraisal rates after the first, second and third display of particular apologetic messages. They demonstrate that the function of computer utterances cannot be considered as simple stimuli with predictable responses, but that the perception of verbal computer output depends largely on the users' predisposition, thus allowing a better view of the situational conditions for adaptations in speech directed at computers and robots.

Together, these studies provide information on central pragmatic topics, making use of unique advantages of the controllable scenarios of interaction with artificial communication partners. They furthermore provide detailed insights into the problems encountered in the ways people talk to computers and robots, into the factors conditioning users' linguistic choices, and a good overview of the current state of the discussion.

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