What common ground do we need (most) for speaking to a robot?

Kerstin Fischer, University of Southern Denmark
kerstin@sdu.dk

I. Introduction

There are many different approaches that aim to account for the nature of common ground (e.g. Heller et al. 2009; Galati & Brennan 2009; Sperber & Wilson 1986), yet the one offered by Clark (1996) is the most comprehensive. It divides common ground into two large categories: communal common ground, which comprises all background knowledge, social norms and cultural facts, and personal common ground, which concerns all knowledge acquired in previous interactions with the particular partner, including the discourse record, as well as the current perceptually available situation.

Previous research on common ground in human-robot interaction shows that participants indicate insecurity regarding all aspects of common ground when interacting with robots (Fischer 2001); that is, participants' clarification requests and communication breakdowns illustrate that all of the categories mentioned by Clark (1996) also play an important role in interactions with robots, thus confirming the relevance of the categories in Clark's typology. However, the question addressed here is whether certain aspects of common ground are more crucial than others, and whether participants may possibly easily adapt to the lack of some kinds of common ground whereas other aspects need to be present in order to avoid serious communicative problems. Furthermore, some kinds of common ground may also be more crucial in some situations than in others.

II. Evidence for privileged common ground

Some previous findings indicate that not all aspects of common ground are equally necessary for smooth human-robot interactions.

Interactions with autonomous cars

In two studies of interactions between a human driver and a simulated autonomous car (Sirkin et al. 2015, 2016) we found that drivers responded very differently to different announcements of the (simulated) system of what it perceived. The system initiated conversation frequently by stating facts about the joint environment, thus demonstrating situation awareness. Analyzing the preference organization of the interactions (Levinson 1983), i.e. the ways drivers responded to the initiations by the system, we showed that different types of topics had very different effects; for instance, car- and driving-related information, such as the request to fasten the seatbelt or calculations of the length of the trip, were responded to easily and unproblematically, indicating that such utterances were expected. By comparison, announcements of aspects of the environment outside the car related to driving, such as the speed limit or the name of the current location, were either not responded to at all, or they were treated as annoying or even patronizing. In contrast, announcements of observations of the environment that indicated that the car was perceiving pedestrians were responded to as unexpected but welcome, and drivers indicated afterwards that these statements put them very much at ease with the car. Thus, indicating situation awareness in the context of autonomous cars has very different effects depending on the aspects of the joint perceptual situation pointed out. Showing awareness of other people seems to be more important than showing awareness of other aspects of the perceptual common ground.

Navigating joint space

In a recent study (Fischer et al. 2016), we investigated whether people prefer a robot moving through joint space to indicate by means of eye gaze either where it is going or that it perceives them (at the expense of not being able to predict where the robot is going). The results show clearly that people rated the robot that looked at them higher than the robot that looked where it was going, and they also looked away significantly more often when the robot was looking at them, indicating that they were more at ease with this robot. Thus, indicating that the robot perceives them is rated highly, whereas indicating its path is not rated as equally important.

Note that in both conditions, the robot greets the person and announces its intention to come closer. Thus, human and robot are already participating in a joint action when the robot approaches. The difference between the two conditions is thus not likely to be due to uncertainty whether or not there is common ground at all, but rather due to different values assigned to different aspects of the joint perceptual situation, where the perception of the position of the human is clearly privileged.

III. Evidence for different degrees of gravity of problems

My previous work on common ground in human-robot interaction shows that people expect the robot to have some limitations, yet some other limitations catch them off-guard – and these may be the limitations that cause the worst problems. For instance, consistently across all data sets I have ever recorded (e.g. Fischer 2001, 2006, forthcoming), participants wonder whether the robot knows the words they use. Thus, they are highly aware that the robot may be limited in this respect, and the choice of words is among the first issues they change when an interaction fails, for instance:

(1) S042: rotate right. (laughter) (3) turn right.
(2) P073: go straight? – or drive straight?

Thus, when communication problems occur, participants expect that the reason could be their choice of words. Thus, they attend to the availability of a joint code as part of their common ground.

Other aspects of Clark's typology of common ground attended to are what the robot sees, what language it understands, what it knows about the task, and what functionalities it has, as is apparent from their off-talk or clarification questions, for instance:

(3) P075: does he understand English?

(4) A004: do you see the blue bowl there?
(5) S037: he (at=prominent)does(/a) know this routine?
(6) P072: can he see the, does he have as, a a visual sensor?

However, apart from these, there are also aspects of common ground that participants do not expect to be problematic such that they do not ask about them prior to the interactions, and they do not fix them, either, when a problem occurs. One such example was described in Fischer & Moratz (2001), where participants did not expect that the robot could know a complex instruction if it failed to understand the more basic one – contrary to the robot's real capability. This corresponds to Clark's 'ineffable background', i.e. to the background knowledge necessarily assumed to go with another bit of knowledge. For instance, it is inconceivable that someone lives in San Francisco without knowing Golden Gate Bridge. The same 'inconceivability' seems to be at work when people are faced with a robot that has been implemented with some high-level capabilities without the low-level capabilities – which is actually quite common in artificial agents. Thus, the communicative breakdowns participants in these interactions experience indicate that 'ineffable background' needs to be accounted for, but participants do not attend to it as a problem source.

IV. Open issues and research agenda

Questions regarding the amount and kind of common ground relevant in human-robot interaction only become an issue when the robot has fewer capabilities and is more restricted in the amount of common ground available than its human users, at least this is to be expected from interactions with next-to-perfect robots in science fiction, such as with Data from StarTrek or Sonny from "I, Robot" (cf. also Lotze forthcoming). These interactions are depicted as smooth and unproblematic and not much different from exchanges with communication partners from slightly different cultures. Correspondingly, much work in social robotics aims to endow robots with as much human capability as possible. Questions concerning the relative importance of different aspects of common ground are thus only relevant when not every capability can be presupposed.

The example studies on situation awareness above indicate that there may be privileged types of common ground such that of all possible aspects of the perceptual situation of which the robot needs to be aware, the most important seems to be that the robot can perceive people. This may sound trivial, yet a preference for the detection of humans is not necessarily guiding current vision systems.

Furthermore, the fact that some aspects of common ground are attended to as potentially missing or problematic by the participants themselves whereas others are not at all may suggest that those aspects participants are actually aware of do not need to be fixed in order for the interaction to be successful – since participants are aware of the potential problems, they can easily be jointly resolved in interaction. In contrast, those aspects of common ground that users are not aware of are those that are actually problematic since they occur unexpectedly, and recovery is very difficult (Fischer & Moratz 2001). On the other hand, even though the expected problems may not hinder the interaction, they may definitely influence participants' views of the respective robot and therefore influence the interaction because of too restricted mental models of the robot. So even though these aspects of common ground could easily be negotiated and adapted to by the human participant, it is possible that they should still be attended to by the system designer. Future work should show the limits of users' adaptability on the one hand and the impact of the need of such adjustments on their mental models on the other.

Moreover, since these attended-to aspects of common ground have been found to be actively elicited by the participants (for instance in clarification questions) and to be used for partner modeling (like Clark's 1998 membership categories, i.e. inference-rich categories), the system designer could use them intentionally for creating a particular mental model of the robot. The information elicited in this way could therefore be used for shaping participants' understanding of the robot and thus for guiding them implicitly into a behavior towards the robot that corresponds to the robot's real capabilities best. Future work will have to show the possibilities and limitations of such a mental model based approach to shaping.

References

Clark, H.H. (1996): *Using Language*. Cambridge University Press.

Clark, H.H. (1998): Communal lexicons. In K. Malmkjaer and J. Williams (Eds.), *Context in Language Learning and Language Understanding*, pp. 63–87. Cambridge: Cambridge University Press.

Fischer, K. (2001): How much common ground do we need for speaking? In: Kühnlein, Peter, Rieser, Hannes & Zeevat, Henk (eds.): *Proceedings of Bi-Dialog*, Bielefeld, Germany, 14-16 June 2001.

Fischer, K. (2006): *What Computer Talk Is and Isn't. Human-Computer Conversation as Intercultural Communication*. Linguistics – Computational Linguistics 17, Saarbrücken: AQ.

Fischer, K. (forthcoming): Designing Speech for a Recipient: The Roles of Partner Modeling, Alignment and Feedback in So-Called 'Simplified Registers'. Amsterdam: John Benjamins.

Fischer, K. and Moratz, R. (2001): From Communicative Strategies to Cognitive Modelling. *Proceedings of the First International Workshop on 'Epigenetic Robotics'*, Lund, Sweden.

Galati, A. and S. E. Brennan (2013). Speakers adapt gestures to addressees' knowledge: Implications for models of co-speech gesture. *Language, Cognition and Neuroscience*.

Heller, D., K. Skovbroten, and M. K. Tanenhaus (2009). Experimental evidence for speakers' sensitivity to common vs. privileged ground in the production of names. In PRE-CogSciWorkshop on the Production of Referring Expressions. Amsterdam, The Netherlands.

Levinson, S. (1983): *Pragmatics*. Cambridge University Press.

Lotze, N. (forthcoming): ChatBots: Eine linguistische Analyse. Peter Lang.

Sirkin, D., Fischer, K., Jensen, L.C.,and Ju, W. (2015): How effective an odd message can be: Appropriate and inappropriate topics in speech-based vehicle interfaces. In: *Proceedings of Human Computation and Crowdsourcing HCOMP'15.*

Sirkin, D., Fischer, K., Jensen, L.C. and Ju, W. (2016): Eliciting Conversation in Robot Vehicle Interactions. *2016 AAAI Spring Symposium Series*, Palo Alto, Ca., AAAI Publications.

Sperber, D. & Wilson, D. (1996): *Relevance: Communication and Cognition*. Oxford: Blackwell.