



Managing dialogue: How information availability affects collaborative reference production

Dominique Knutsen*, Ludovic Le Bigot

University of Poitiers & CNRS (CeRCA, UMR 7295), France

ARTICLE INFO

Article history:

Received 9 August 2011
revision received 9 June 2012
Available online 3 August 2012

Keywords:

Dialogue
Collaboration
Egocentrism
Information availability
Common ground

ABSTRACT

Two experiments investigated how both shared and privileged knowledge affect reference production during dialogue. Dyads of participants jointly established routes for an imaginary person. Each participant was given a map featuring shared landmarks (i.e., they also appeared on the partner's map) and privileged landmarks (i.e., they did not appear on the partner's map). Analyses focused on which references participants included in their utterances. Results showed that the production of references that had previously been explicitly accepted and hence added to the speakers' common ground was affected by information availability. Furthermore, the participants compensated for the influence of information availability by keeping track of the information their partners were likely to lack and producing it when necessary. Results are discussed with regard to collaboration and the influence of privileged knowledge during dialogue.

© 2012 Elsevier Inc. All rights reserved.

Introduction

Dialogue is a joint activity, during which speakers interact to achieve a common goal (Clark, 1996). Each speaker contributes to the establishment of mutual knowledge, which can then be reused to produce or interpret utterances in a partner-oriented way. Speakers thus coordinate with each other on the basis of what has previously been said (Clark & Schaefer, 1989; Gambi & Pickering, 2011). The present study focused on *dialogue management*, looking at how both shared and privileged knowledge affect the selection of references to be included in utterances throughout the whole dialogue.

Dialogue as a collaborative activity

The collaborative approach to dialogue assumes that speakers take their partners' belief state and knowledge

into account when producing or interpreting utterances (Brown-Schmidt, 2009a, 2009b; Brown-Schmidt, Gunlogson, & Tanenhaus, 2008; Clark, Schreuder, & Buttrick, 1983; Fussell & Krauss, 1989, 1992; Isaacs & Clark, 1987; Lockridge & Brennan, 2002). This promotes the speakers' mutual understanding. Indeed, speakers are more likely to be understood by their addressees if they use their estimation of the latter's level of knowledge as a basis for utterance production (Fussell & Krauss, 1989).

Even before a dialogue has begun, the speakers may already share a certain amount of information, either because of shared community membership (Fussell & Krauss, 1992; Krauss & Fussell, 1991), because they are in the same dialogue environment (Clark & Krych, 2004; Hund, Haney, & Seanor, 2008; Lockridge & Brennan, 2002) or because of previous interactions (Brennan & Clark, 1996; Brown-Schmidt, 2009a; Galati & Brennan, 2010; Metzger & Brennan, 2003). This information is used to produce addressee-tailored utterances on the basis of a process called audience design (Clark & Murphy, 1982), whereby Speaker A takes into account Speaker B's perspective in order to produce utterances that B is able to understand. This process also affects comprehension (Clark et al.,

* Corresponding author. Address: Centre de Recherches sur la Cognition et l'Apprentissage – CeRCA, CNRS UMR 7295, MSHS Bât A5, 5, rue Théodore Lefebvre, F-86000 Poitiers, France. Fax: +33 (0)5 49 45 46 16.

E-mail addresses: dominique.knutsen@univ-poitiers.fr, dom.knutsen@gmail.com (D. Knutsen).

1983), in that when B interprets an utterance, he or she assumes that it has been produced on the basis of audience design and interprets it in relation to the common ground.

The amount of information shared by A and B increases throughout the dialogue. Mutual information – that is, information that A and B share and are aware of sharing – forms their common ground (Clark & Wilkes-Gibbs, 1986). Each speaker seeks to present his or her addressee with any information relevant to the task that he or she may lack in order to increment mutual knowledge during dialogue (Bard et al., 2007). According to Clark and Schaefer's contribution model (1989; see also Cahn & Brennan, 1999), once a piece of information has been presented by a speaker, the addressee can either accept it immediately, indicating that the piece of information has been understood, or initiate a repair sequence, during which both the speaker and the addressee work at reestablishing the speaker's initial meaning. In any event, once the piece of information has been understood by the addressee, it is deemed to have been accepted and added to the speakers' common ground. Acceptance can be more or less explicit, depending on whether or not it is important that the speakers clearly establish that they have understood each other (e.g., McInnes & Attwater, 2004). Once a piece of information has been accepted and hence added to the common ground, it can be reused by either speaker for the purposes of addressee adaptation (Brennan & Clark, 1996), as speakers are capable of keeping track of their common ground and exploiting it throughout a dialogue (Brown-Schmidt, 2009a, 2009b; Brown-Schmidt et al., 2008). In sum, both the speaker and the addressee are responsible for establishing mutual comprehension during dialogue: the speaker by producing partner-tailored utterances and the addressee by providing feedback on his or her level of comprehension.

References can be presented and accepted just like any other piece of information. For instance, Brennan and Clark (1996) investigated reference use in an experiment during which pairs of speakers referred repeatedly to the same objects. The context in which these objects appeared was manipulated so that initially chosen references sometimes became over-specific. However, as long as the references allowed the intended referents to be identified, speakers continued to reuse the same references throughout the whole interaction, despite their over-specificity. The authors suggested that conceptual pacts (i.e., mappings between references and the objects they can be used to refer to) are added to the common ground and can therefore be used to produce utterances in an addressee-tailored way (see also Metzger & Brennan, 2003; Van der Wege, 2009). Establishing conceptual pacts affects not only reference production, but also reference comprehension (Brown-Schmidt, 2009a). For instance, when an addressee tries to interpret a temporarily ambiguous reference, he or she can resort to previously established conceptual pacts to anticipate which object the speaker is likely to refer to.

Using audience design and common ground to produce and interpret references helps to minimize collaborative effort, that is, the total amount of work both speakers have to put in until a reference is accepted (Clark & Brennan, 1991; Clark & Wilkes-Gibbs, 1986). For instance, if A

produces a reference that B is capable of interpreting immediately and unambiguously, A and B will not have to engage in a costly, time-consuming acceptance phase, repair sequence, or both. Rather, B can accept the reference implicitly by initiating the next relevant speech turn. Such collaborative behavior leads to dialogue success (Harris, Begg, & Upfold, 1980). However, perspective-taking is individually costly. This leads to speakers putting as much effort into collaboration as is needed for dialogue to succeed while at the same time trying to minimize this effort at the individual level. For instance, Schober (1995) had participants perform a dialogue task during which directors described spatial locations to matchers. Results showed that participants often used a neutral perspective (i.e., neither their own perspective nor that of their partners) to produce the description. This suggests that the directors tried to minimize their partners' effort (by producing descriptions that they would be able to interpret unambiguously) as well as their own (by producing descriptions that did not involve any perspective-taking). Furthermore, if one of the speakers is already performing a task that is especially difficult for him or her, he or she may not be able to collaborate, and this may ultimately lead to dialogue failure. The costs associated with collaboration are therefore divided between speakers, depending on who bears the greatest cognitive burden. If A deems that B is incapable of collaborating, because he or she lacks either the resources or the information needed to do so, A and B will probably both use B's perspective (Duran, Dale, & Kreuz, 2011; Mainwaring, Tversky, Ohgishi, & Schiano, 2003).

In sum, the collaborative approach suggests that speakers work together at building up mutual knowledge during dialogue. This knowledge is then exploited to try to produce and interpret language in a flexible, partner-tailored fashion, all the while minimizing collaborative effort.

Alternative approaches to production and comprehension during dialogue

According to the approach outlined above, dialogue is above all collaborative, with each speaker trying to produce and understand utterances in relation to his or her partner's state of mind. However, a number of alternative theoretical approaches to dialogue have focused on the extent to which speakers are actually capable of taking their partners' conversational needs into account. These approaches have shown that utterance production during dialogue can sometimes be guided by the speaker's state of mind rather than by the addressee's.

First, the memory-based approach suggests that the production of partner-tailored utterances is affected by audience design being based on ordinary processes of memory encoding and retrieval (Horton, 2007, 2008; Horton & Gerrig, 2002, 2005a, 2005b; Horton & Slaten, 2012). The initial encoding of any piece of information takes place with regard to the context, including who is present at encoding time. A dialogue partner may therefore act as a cue for retrieving associated information in memory. Once activated, this partner-specific information may constrain language processing just as the common ground would. This implies that audience design is subject to ordinary

memory limitations. When partner-specific associations are not available in memory, speakers are less capable of producing partner-tailored utterances (Horton & Gerrig, 2005b).

Second, the egocentric approach (e.g., Barr & Keysar, 2002; Keysar, 1997, 2007) claims that the early steps of language processing are not necessarily collaborative, but rather are based on the speaker's own perspective – in this sense, such behavior is referred to as egocentric – and are thus affected by information availability from his or her own point of view. For instance, Barr and Keysar (2002) demonstrated that previous exposure to a given reference makes that reference more readily available than others in memory. This facilitates subsequent processing of the same reference, regardless of whether or not it is part of the common ground. Likewise, Horton and Keysar (1996) showed that visually salient contextual information is incorporated into early utterance planning even when this information is irrelevant for the addressee (see also Wardlow Lane & Ferreira, 2008). These findings have led to the development of an approach which considers that taking the common ground into account is optional and occurs solely in the later steps of language processing – and then only when the speakers have sufficient time and motivation (Rossnagel, 2000). The early steps of language processing are egocentric, being affected mainly by information availability, regardless of the other speaker's knowledge and beliefs. In other words, language production and comprehension during dialogue is egocentrically anchored (e.g., Epley, Keysar, Van Boven, & Gilovich, 2004).

Third, the probabilistic approach suggests that language processing during dialogue is simultaneously affected by both shared and privileged knowledge from the very outset. However, their respective influences are distinct (Brennan & Hanna, 2009; Brown-Schmidt & Hanna, 2011). For instance, when an addressee interprets a reference, he or she is faced with both linguistic and extralinguistic information, including information associated with his or her own perspective and that of the speaker. This generates several competing interpretations for the same reference. These interpretations are then weighted according to their saliency and relevance to the task (Hanna & Tanenhaus, 2004; Hanna, Tanenhaus, & Trueswell, 2003). Their influence on language processing is proportional to their relative weighting, in that the more heavily weighted a source of information is, the more likely the corresponding interpretation is to be chosen. The distinct but simultaneous influence of shared and privileged knowledge could help to explain why both kinds of behavior can be observed in dialogue. Although only one interpretation is ultimately chosen, this does not mean that other interpretations were not considered beforehand.

In sum, all three approaches emphasize that reference production during dialogue can be locally egocentric – that is, it is locally guided by the speakers' own state of mind, regardless of (or at the same time as) the common ground. This may sometimes run counter to collaboration, with speakers producing and interpreting utterances in a maladapted way. However, little is known about how such behavior affects dialogue as a whole. The current study focuses on how information availability affects dialogue

management (i.e., on which references the speakers choose to include in their utterances during dialogue) to determine how the speakers' adaptive behaviors, whose aim is to contribute to dialogue success, are affected by the speakers' local egocentric tendencies.

Current study

Rationale

The collaborative approach suggests that reference production during dialogue is shaped by the fact that speakers intend to contribute to dialogue success. In order to do this, they establish references as being mutual, which requires them to present and accept references as described by Clark and Schaefer (1989). Once a reference has been accepted, speakers are capable of keeping track of their common ground throughout the dialogue (Brown-Schmidt, 2009a, 2009b; Brown-Schmidt et al., 2008). Then, previously accepted references can then be reused by either partner to produce partner-tailored utterances (Brennan & Clark, 1996). As such, the collaborative approach offers a framework for dialogue management in that it describes the evolution of the use that the speakers make of a reference during the interaction, as they adapt to each other (e.g., Clark & Wilkes-Gibbs, 1986; Isaacs & Clark, 1987).

Alternative approaches to dialogue have nonetheless suggested that reference production during dialogue is sometimes based on the speakers' state of mind, rather than on the addressees' (Horton & Keysar, 1996; Rossnagel, 2000; Wardlow Lane & Ferreira, 2008). In such cases, reference production is mainly guided by information availability from the speakers' point of view. This egocentric behavior can be attributed to speakers not taking into account their partners' state of mind, or only taking it into account to a certain extent. However, as pointed out by Horton and Gerrig (2005a, 2005b), the production of partner-adapted references depends on the availability in memory of the corresponding representations. Thus, even when speakers try to take their partners' state of mind into account, their adaptive behavior is constrained by information availability.

Contrary to the collaborative approaches, the studies on egocentrism in dialogue have focused less on dialogue as a whole, and more on local phenomena, looking at how the unavailability of the information necessary for adaptation at the time of production might cause speakers to produce maladapted references. In the current study, we argue that this has an influence on the way in which dialogue is managed as a whole. Speakers working together towards a common goal try to enhance dialogue success by establishing knowledge as mutual and by mainly reusing accepted references, because they have evidence that their partners are capable of understanding them (Clark & Schaefer, 1989). However, although reference reuse is collaborative, the choice that speakers make to reuse one reference rather than another (provided that both can be used for adaptation purposes) is guided by information availability from the speakers' own point of view. This study should allow bridging the collaborative approach and the other approaches – to a certain extent – by showing how information availability affects partner-adaptation throughout the interaction.

The current study investigated the construction of common ground through reference explicit acceptance and looked at how the reuse of previously explicitly accepted references is affected by information availability. Note that although non-explicitly accepted references are theoretically considered as part of common ground by virtue of the linguistic copresence heuristic (Clark & Marshall, 1981), the status of these references with regard to common ground is ambiguous for they might have been accepted implicitly, but they might also not have been accepted. Thus, the term “common ground” hereafter refers to explicitly accepted references only. It should also be noted that although non-explicitly accepted references were not the focus of this study, the corresponding data were nonetheless analyzed for comparison purposes.

Two experiments were conducted in which pairs (or dyads) of participants performed a dialogue task where they had to jointly establish a tourist route. To do this, both participants were given maps of the same area. Whereas some of the landmarks they needed to refer to in order to achieve their goal appeared on both speakers' maps (in which case these landmarks were shared by both partners), some appeared on only one of them (in which case these landmarks were privileged to that particular speaker). The prediction was that speakers jointly build up mutual knowledge during dialogue (Clark & Schaefer, 1989). Once a reference is presented, it can be explicitly accepted or not. When it comes to reusing explicitly accepted references, the speaker's choice is affected by the availability of the corresponding referent from this his or her point of view – here, by whether or not the corresponding referents featured on his or her own map.

Overview of the experiments

In both experiments, dyads performed a dialogue task during which they had to jointly establish a tourist route for an imaginary person who was unfamiliar with the route environment. A spatial dialogue task was chosen because this type of task elicits reference use (Anderson et al., 1991; Bard et al., 2007; Hund et al., 2008). Dyad members were each given a map of the same area. The streets and major buildings (hereafter referred to as landmarks) featured on the maps varied across speakers. These landmarks (or referents), and therefore the corresponding references, were either shared (i.e., they appeared on both maps), privileged-to-self (i.e., they appeared on the speaker's own map but not on the partner's) or privileged-to-other (i.e., they appeared on the partner's map but not on the speaker's). When a landmark appeared on a map, the corresponding reference was also systematically specified on the map (see Figs. 1 and 3). All participants were informed that the landmarks varied in status – i.e., in whether they appeared on both maps or only on one of them. Then, depending on the experimental condition (see below), the participants could also be given further information on landmark status at the beginning of the interaction, that is, on which landmarks were shared, privileged-to-self or privileged-to-other. It should be noted that because the meaning of the terms privileged-to-self and privileged-to-other varied across speakers – a reference that was privileged-to-self from Speaker A's point

of view was privileged-to-other from Addressee B's point of view, and vice versa – these terms are systematically used from the point of view of the participant accepting or reusing a reference in the remainder of the study. For instance, accepting a privileged-to-other reference meant that the participant accepted a reference corresponding to a landmark that appeared on his or her partner's map, but not his or her own. Likewise, reusing a privileged-to-self reference meant that the participant was re-referring to a landmark that appeared on his or her own map, but not his or her partner's. Once the dialogue was over, participants individually wrote out the route that had been established.

Whereas participants were unfamiliar with the map environment in Experiment 1, they were familiar with the map used in Experiment 2. This allowed ruling out the possibility that the results obtained in Experiment 1 were attributable to the participants' lack of familiarity with the task environment.

Experiment 1

The aim of Experiment 1 was to show that the reuse of common ground (i.e., of explicitly accepted references) depends on the availability of this information to the speaker. For this purpose, the landmarks that could be used to perform the task (establishing a tourist route for an imaginary person) were divided into three categories (shared, privileged-to-self, privileged-to-other). This manipulation allowed distinguishing between readily available information (i.e., privileged-to-self and shared landmarks and their corresponding references) and less readily available information (i.e., privileged-to-other landmarks and their corresponding references) from each speaker's point of view. Ultimately, though, all three types of references could be explicitly accepted.

Furthermore, the dyads were divided into three different conditions. In the first condition (“map plus structured list” condition), participants were given the full list of landmarks that could be used during the task in addition to the map. Landmarks were divided into the three aforementioned categories: shared, privileged-to-self and privileged-to-other. Within a given dyad, both participants were given the same list, simply reversing the privileged-to-self and privileged-to-other categories. Landmarks were arranged in alphabetical order within each category. It should be noted that the references corresponding to landmarks that did not appear on the speaker's own map nevertheless appeared on the list given to that speaker, under the privileged-to-other heading. Thus, in this condition, participants were given a means of determining the status of each landmark. In the second condition (“map plus unstructured list” condition), participants were again given the full list of landmarks in addition to the map, but this time the landmarks were simply arranged in alphabetical order (both participants were therefore given exactly the same list). Finally, in the third condition (“map only” condition), participants were just given the map. Thus, in the last two conditions, participants had no way of

determining landmark status before the dialogue began. The aim of this manipulation was to determine whether making references available to speakers would help to counter the effects of information availability during the task.

Hypotheses

Explicit acceptance hypothesis

The first aim of this study was to confirm Clark and Schaefer's (1989) claim that speakers build mutual knowledge through reference presentation and acceptance. According to these authors' model, when a speaker presents a reference, it must be accepted by the addressee for the dialogue to continue. Acceptance, however, can be either explicit (e.g., verbatim or anaphoric repetition) or implicit (e.g., initiation of the next relevant speech turn), and therefore does not necessarily involve the addressee producing feedback.

The hypothesis here concerned acceptance explicitness. In this experiment, participants could be presented with a reference corresponding either to a landmark that featured on their own map (in which case it was shared) or to a landmark that did not appear on their own map (in which case it was privileged-to-other). In the former case, explicit acceptance was not necessary, for when a speaker presents a reference and the addressee does not inform him or her that a misunderstanding has occurred, the speaker simply assumes that he or she has been understood (Clark & Schober, 1992). Thus, non-explicit acceptance can be used by addressees as a means of informing the speaker of their understanding. In the latter case, however, addressees were more likely to accept references explicitly, as explicit acceptance can be used by addressees not only to display their understanding of the reference produced by the speaker (Clark & Brennan, 1991; Clark & Schaefer, 1989), but also to provide speakers with an opportunity to correct any misunderstanding. Thus, explicit acceptance constituted a means by which the partners could achieve mutual understanding in a situation where miscomprehension was likely to occur. All in all, this led to the prediction that privileged-to-other references are more likely to be explicitly accepted than shared references, for whereas the latter can be accepted implicitly, the former require more explicit acceptance.

Reuse hypothesis

Once a reference had been presented, it could be reused by either partner, regardless of whether it had been accepted explicitly or not. The second aim of this study was to show that information availability shapes the use that speakers make of common ground during the remainder of the interaction. As stated above, because we wanted to make sure that we only looked at references which were considered as part of the common ground by the speaker, we mainly focused on the reuse of explicitly accepted references. From each speaker's point of view, these references were more or less readily available depending on the status of the corresponding landmarks. More precisely, privileged-to-self and shared landmarks (and their associated references) were more salient than privileged-to-

other landmarks, as the latter did not appear on the participants' own maps. As speakers are sensitive to information availability when producing references during dialogue (Horton & Keysar, 1996; Wardlow Lane & Ferreira, 2008), the first reuse hypothesis was that privileged-to-self and shared references are more likely to be reused than privileged-to-other ones. In addition, because privileged-to-self and shared landmarks were equally available to speakers, no prediction could be formulated with regard to the likelihood of reusing the corresponding references.

Furthermore, in this experiment, the dyads were divided into three conditions depending on the amount of information they were given about the references they could use to perform the task. If, as predicted, reusing explicitly accepted references depends on information availability from the speakers' point of view, making this information available to them should help counter the effects of information availability on reference production. The second reuse hypothesis was thus that the influence of information availability is at its weakest in the "map plus structured list" condition, where the entire pool of references was available, together with information about the partner's state of mind (i.e., which landmarks featured on his or her map and which did not). It is also weaker in the "map plus unstructured list" condition than in the "map only" condition, as the references associated with privileged-to-other landmarks were just as available as the shared and privileged-to-self references.

Method

Participants

Forty-two dyads of undergraduate and graduate students initially took part in Experiment 1. However, one of these dyads was discarded because one of the participants presented too few references during the whole dialogue (two only). This dyad was in the "map only" condition. All participants were native French speakers. Each of them signed an informed consent form at the beginning of the experiment. During an informal posttest interview, all the participants stated that they were unfamiliar with the city represented on the maps they had used during the experiment.

Apparatus

Dialogues were recorded using a dual-input digital voice recorder. Two PCs equipped with Microsoft Office Word 2007 were used by the participants to type out the routes they had established.

Experimental stimuli

A map representing a European city served as the basis for the stimuli used in this experiment. The map featured 60 landmarks, including 21 major monuments, six squares and 33 street names. Landmarks were randomly divided into three blocks (Blocks 1, 2 and 3) of seven major monuments, two squares and 11 street names. Three maps were then created, each of them including two blocks of landmarks. Maps were paired such that each dyad had access to the complete pool of landmarks.

Some of the landmarks appeared on both maps, whereas others appeared on only one of them. For instance, if A was given the map corresponding to Blocks 1 and 2, and B was given the map corresponding to Blocks 2 and 3, the dyad has access to all three blocks, but only Block 2 landmarks were shared: Block 1 landmarks were privileged to A (and thus unknown to B) and Block 3 landmarks were privileged to B (and thus unknown to A). The distribution of blocks within each dyad was counter-balanced across dyads. Fig. 1 shows two of the maps used in Experiment 1.

Two landmark lists were created. The first list contained all the landmarks that appeared on both maps, arranged in alphabetical order, and was used in the “map plus unstructured list” condition. Two copies of this list, one for each dyad member, were printed on A4 sheets. The second list again contained all the landmarks that appeared on both maps, this time arranged according to their status (privileged-to-self, privileged-to-other, shared) and was used in the “map plus structured list” condition. Twelve versions of this list (each pair corresponding to a different distribution of blocks within a dyad) were printed on A4 sheets, each corresponding to a different distribution of blocks within the each dyad.

Task

The experiment was divided into two phases. During the first phase (or dialogue phase), two partners had to establish a tourist route together, using the maps they had been given. They had to agree on a route going from Point A to Point B, from Point B to Point C and finally from Point C back to Point A. Points A, B and C were shown on both maps and their location remained constant across maps. Participants were asked to establish a tourist route: there was therefore no “correct” or “incorrect” itinerary. This is because Experiment 1 focused on speakers’ spontaneous behavior rather than on their performance. Thus, even though the routes had to include Points A, B and C, participants were free to choose whichever itinerary they liked between these points. Each participant knew that

the landmarks which appeared on his or her map were either shared or privileged to him or her, and that some landmarks appeared on his or her partner’s map but not on his or her own. With the exception of the “map plus structured list” condition, however, participants did not initially know which landmarks were shared and which were not among those on their map.

In one third of the dyads, participants were only given a map to perform the task. In another third of the dyads, participants were given a map plus a structured landmark list. In the final third of the dyads, participants were given a map plus an unstructured landmark list. Participants could interact freely for a maximum for 15 min to establish the required route.

In the second phase of the experiment (drafting phase), participants individually typed out the route they had jointly established. They had a maximum of 10 min to do this. They could not communicate during this phase and did not have access to the map (or to any list they might have been given in the first phase). The routes produced in this phase were not in the prime concern of this study and were therefore not analyzed. Participants were fully debriefed at the end of the experiment.

Experimental design and procedure

Two independent variables were defined for this experiment:

Reference status (shared, privileged-to-self, privileged-to-other).

Status knowledge (map only, map plus structured list, map plus unstructured list).

Participants sat in the same room on either side of a partition so that they could not communicate using nonlinguistic cues such as facial expressions (see for example Clark & Krych, 2004, who showed that speakers make use of facial expressions to add information to their common ground when they are given the opportunity to do so). They were told that the experiment concerned route pro-

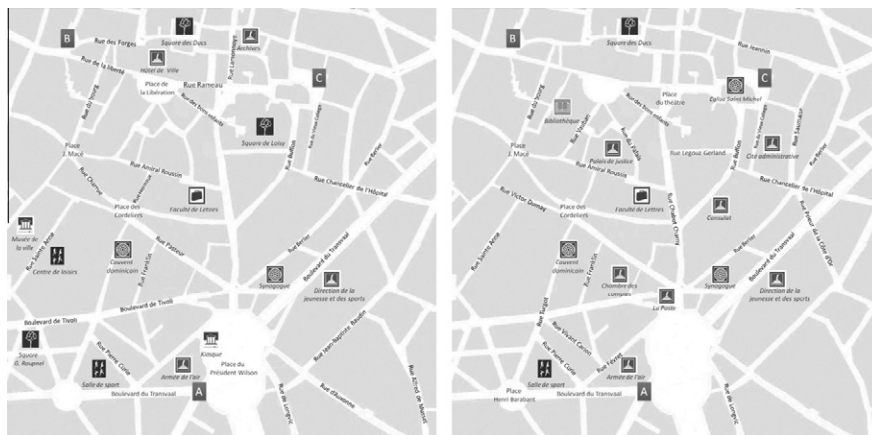


Fig. 1. Two maps used in Experiment 1. Symbols correspond to major monuments (churches, museums, etc.), “Boulevard [...]” and “Rue [...]” indications correspond to street names, “Place [...]” indications correspond to square names.

duction and comprehension, and that their route would actually be used by another student to navigate through the city. Knowing that the route they produced would actually be used by a fellow student was supposed to motivate participants to be as precise as possible. They were then told that the maps they had been given each represented the same area, but that each was slightly different. More specifically, the participants knew that the landmarks were either shared or privileged. They also knew that they would have to type out the route on their own in the second phase of the experiment. Two thirds of the dyads were also informed that because the task was difficult, each participant had also been given a complete list of references to use during the experiment, if necessary. Participants were not, however, told that they would not have access to their map (or list) during the second phase of the experiment.

Data coding and dependent variables

Dialogues were transcribed and coded for two dichotomous dependent variables: explicit reference acceptance and reference reuse (see examples in Table 1). As a reference could only be accepted and reused once it had been presented, dialogues were also coded for presentation, although no analyses were performed on this variable.

During the dialogue phase, a reference could be a) presented (or not), b) explicitly accepted (or not) and c) reused (or not). For each dyad, a reference was coded as presented as soon as it was used by at least one of the participants. In Table 1 (1) Paul uses the reference “post office” for the first time: it was therefore deemed to be presented. At the individual level, it was coded 1 for Paul and 0 for Anne; at the dyad level, it was coded 1 for both participants. A reference could only be presented once within a dyad. Any other occurrence counted either as an explicit acceptance or a reuse.

Explicit acceptance. Accordingly to the rationale set out above, verbatim or anaphoric repetition of a reference was taken to be a marker of explicit acceptance. Following Clark and Schaefer’s (1989) model, we considered that a given reference could only be accepted by the participant who did not initially present this reference. Furthermore, because a reference could be accepted several speech turns after it was presented, a reference could be explicitly accepted as long as its initiator did not produce another (different) reference in the interim. This allowed catching occurrences where it took several speech turns for the addressee to accept a reference – for instance, because the speakers discussed the location of the referent before accepting the corresponding reference. Also, because a potential acceptance phase came to an end when the initial speaker produced another reference, but not when the addressee did so, this criterion also allowed catching occurrences where the initial addressee produced references before potential explicit acceptance in order to help establish mutual understanding (e.g., A: “is there a church on your map?”, B: “next to the library?”, A: “yes”, B: “yes I can see the church”; in this example, B produced the reference “library” between the presentation of the reference “church” by A and its acceptance – it also should be noted

here that the reference “library” may be accepted by A in the following speech turns). Finally, explicit acceptance did not necessarily occur after the initial presentation of a reference: some references were accepted later on in the dialogue, after they had been reused at least once. As long as this did not imply that a reference was accepted by its initiator, these occurrences were regarded as explicit acceptances as well. For instance, A might present the reference “the church” at the very beginning of the dialogue, but B might not accept it at that point. If A produced the same reference again, later on in the dialogue, giving B another opportunity to accept it, that occurrence would be coded in the same way as the occurrences of explicit acceptance of a reference presented for the first time.

In Table 1, (2) Anne produces the reference “post office” after (1) it has been presented by Paul. This verbatim repetition caused this reference to be deemed to be explicitly accepted. At the individual level, it was coded 0 for Paul and 1 for Anne; at the dyad level, it was coded 1 for both participants. The same coding was used regardless of whether a reference was accepted through verbatim or anaphoric repetition (see (4) and (5) for an example of anaphoric repetition). Later, (10) Anne presents the reference “Pasteur Street”, which (11) is not immediately explicitly accepted by Paul, nor is it explicitly accepted later in the dialogue. Thus, this reference was coded 0 for explicit acceptance.

Reuse. Reuse corresponded to occurrences of reference use that corresponded neither to presentation nor to explicit acceptance. A reuse criterion was established in order to distinguish genuine reuse from simple repetition. A reference was deemed to be reused if the speech turn in which it occurred was preceded by a minimum of two speech turns during which this reference did not occur. In the above example, (12) Anne produces the already presented reference “post office” in a speech turn preceded by two speech turns during which this reference is not produced neither by Anne nor by Paul, and it was therefore classified as reused and coded 1 for her. However, in the extract, Paul does not reuse this reference, which was therefore coded 0 for him. Conversely, the reference “synagogue” (4) is presented by Anne but is never reused. It was therefore coded 0 for both speakers within the dyad. Although a speaker might reuse the same reference several times, the reference in question was still coded 1 for reuse. A reference could be reused by either both speakers, one of the speakers or neither of them.

Results

The mean number of references presented per dialogue, the number of words and speech turns per dialogue and the average number of words per speech turn as a function of status knowledge are reported in Table 2. ANOVAs with status knowledge as a between-dyads factor showed no significant effect of status knowledge on the mean number of references presented per dialogue, $F < 1$, the number of words per dialogue, $F(2,38) = 1.079$, $p = .350$, the number of speech turns per dialogue, $F(2,38) = 1.784$, $p = .182$, or the number of words per speech turn, $F < 1$. Status knowl-

Table 1

Experiment 1 – Short dialogue example and coding sample.

Speech turn	Speaker	Utterance content (English translation)	Original content (French)
(1)	Paul	I have the post-office a bit further up	j'ai la poste un peu plus haut
(2)	Anne	the post-office	la poste
(3)	Paul	at the top of the square the post-office is on the left	en haut de la place t'as la poste sur la gauche
(4)	Anne	no I have the synagogue on the right	non bah moi j'ai la synagogue à droite
(5)	Paul	yeah I have that too	oui ça je l'ai aussi
(6)	Anne	ok this is President Wilson Square	d'accord c'est la place du Président Wilson
(7)	Paul	ok the name isn't indicated but hm that must be it	d'accord y a pas le nom mais euh ça doit être ça
(8)	Anne	ok so	d'accord donc
(9)	Paul	so to get to point B	donc pour aller au point B
(10)	Anne	Pasteur Street do you see	rue Pasteur tu vois
(11)	Paul	hm no	hm non
(12)	Anne	ok so you have the post-office on the left is that it of the Square	d'accord donc toi t'as la poste à gauche c'est ça de la place

Landmark	Ref. code	Dyad code	Status	Speaker	Pres./ individual	Pres./ dyad	Expl. acceptance/ individual	Expl. acceptance/ dyad	Reuse
Post-office	R01	D01	Priv. for self	Paul	1	1	0	1	0
Post-office	R01	D01	Priv. for other	Anne	0	1	1	1	1
Synagogue	B01	D01	Shared	Paul	0	1	1	1	0
Synagogue	B01	D01	Shared	Anne	1	1	0	1	0
Pasteur street	R02	D01	Priv. for other	Paul	0	1	0	0	0
Pasteur street	R02	D01	Priv. for self	Anne	1	1	0	0	0

Note: The speakers' names were changed for the purpose of this example. In the coding sample, presentation and explicit acceptance are coded twice: once at the individual level and once at the dyad level. The first coding allowed determining who, in the dyad, had presented or explicitly accepted a reference; the second coding allowed determining if a reference had been presented or explicitly accepted within the dyad, regardless of who had actually presented it or accepted it explicitly.

Table 2

Experiment 1 – Descriptive statistics for each condition.

	Map only	Map plus unstructured list	Map plus structured list
References presented per dialogue	24.54 (6.827)	25.21 (5.010)	25.79 (6.204)
Words per dialogue	1694 (548.5)	1829 (544.9)	1538 (483.8)
Speech turns per dialogue	208.3 (70.54)	233.3 (83.59)	185.1 (56.11)
Words per speech turn	7.863 (1.212)	8.007 (1.202)	8.384 (1.249)

Note: Standard deviation is given in brackets.

edge manipulation therefore did not seem to significantly affect the length of the dialogues.

The total number of explicitly accepted and reused references per condition is reported in Table 3. Analyses were conducted using SPSS Statistics 19.0. Hypotheses were tested with mixed logistic models (see Baayen, Davidson, & Bates, 2008; Jaeger, 2008) using a variance components covariance matrix. Mixed models allow for the inclusion of random intercepts to account for intercept variability across items (here, landmarks) and participants, and random slopes to account for the fact that items and participants might differ in sensitivity to fixed effects. As the current study implied looking at dyadic data, the models also included by-dyad intercepts and slopes (see Heck, Tho-

mas, & Tabata, 2010, for modeling of clustered data; see also McMahon, Pouget, & Tortu, 2006, for dealing with dyadic data). The random effects structure used in mixed models should be kept maximal, that is, it should include all random intercepts and random slopes relevant to the data (Barr, Levy, Scheepers, & Tily, in preparation). This may however cause model convergence issues which would prevent us from exploiting the parameters returned by the model (Bell & Grunwald, 2004). Such cases lead to dropping the random slopes and intercepts which seem to cause the non-convergence. Nonetheless, random slopes should be included whenever possible because they allow minimizing the type I errors (Schielzeth & Forstmeier, 2009).

As for the current study, we proceeded as follows to determine which random effects structure to use. Preliminary analyses revealed that models including both a by-dyad – or a by-participant – slope and a by-item slope only seldom converged. Since the lack of convergence seemed to be caused by the inclusion of by-dyad or by-participant slopes, these were dropped from the analyses. The resulting random effects structure thus included three intercepts (by-dyad, by-participant and by-item) and a by-item slope. It allowed accounting for intercept variability across dyads, participants and items as well as for the fact that each item may differ in sensitivity to the fixed effects used in this study. However, using this structure did not systematically cause models to converge. When analyses using this structure did not converge, one of the random intercepts was dropped. More precisely, two separate analyses were performed, one of which

Table 3

Experiment 1 – Number of references accepted and reused in each condition out of the total 1031 references presented.

	Map only			Map + structured list			Map + unstructured list		
	Privileged to self	Shared	Privileged to other	Privileged to self	Shared	Privileged to other	Privileged to self	Shared	Privileged to other
Explicitly accepted	–	68 (.48)	119 (.58)	–	65 (.53)	117 (.63)	–	74 (.54)	139 (.58)
Total reused	123 (.60)	150 (.53)	50 (.24)	101 (.53)	126 (.52)	35 (.19)	140 (.59)	145 (.53)	52 (.22)
– Explicitly accepted	93 (.78)	88 (.65)	43 (.36)	77 (.66)	75 (.58)	29 (.25)	106 (.76)	92 (.62)	45 (.32)
– Non-explicitly acc.	30 (.34)	62 (.42)	7 (.08)	24 (.33)	51 (.45)	6 (.08)	34 (.34)	53 (.41)	7 (.07)
– Initially presented by oneself		81 (.57)			63 (.52)			72 (.52)	
– Initially presented by other		69 (.49)			63 (.52)			73 (.53)	

Note: Corresponding proportions are given in brackets. These correspond (a) to the proportion of privileged to other (from the addressee's point of view) and shared references which were accepted out of the total number of privileged to self (from the speaker's point of view) and shared references presented and (b) to the proportion of privileged to other, privileged to self and shared references reused out of the total number of privileged to other, privileged to self and shared references presented in the dyad. Note that whereas this table presents the actual proportions whereas the statistical analyses were carried out on estimated proportions.

including two intercepts (by-dyad and by-item) and a by-item slope and the other including two intercepts (by-participant and by-item) and a by-item slope. When both analyses converged, only the former was reported. When only one of them converged, only the convergent results are reported. Finally, in cases where both models failed to converge, the random slope was dropped, using a two intercept (by-dyad and by-item) only structure. In any event, the structure which was used is specified below whenever the three intercepts plus by-item random slope structure was not used.

One of the parameters returned by logistic models is the odd ratio. An odd compares two probabilities by forming the ratio of the probabilities (Jaccard, 2001). For instance, the current study compared the probability of explicitly accepting privileged-to-other and shared references: it thus focused on the odds of explicitly accepting privileged-to-other references. In a similar way, an odd ratio compares two odds. For instance, the current study compared the odds of explicitly accepting privileged-to-other references in the “map only” condition and in the “map plus structured list condition”.

Analyses were performed solely on presented references, as the odds of accepting and reusing non-presented references were necessarily nil. When a model included reference status as a fixed effect, the odds of accepting or reusing a shared reference were used as the baseline. These models allowed calculating the odds of explicitly accepting and reusing references depending on the independent variables. All initial models included status knowledge as a fixed effect, as well as reference status, previous explicit acceptance or reference initiator identity, depending on which analysis was being conducted. However, only final models (i.e., models including significant effects) are reported below. (In fact, status knowledge systematically failed to reach significance. Thus, this factor was included in none of the final models.) Additional comparisons were conducted using paired comparisons (sequential Bonferroni).

Analyses on reuse were performed in two steps. A preliminary analysis was performed, which implied building an initial model that included previous explicit acceptance (explicitly vs. non-explicitly accepted) as the only fixed factor. Then, in order to simplify the interpretation of the

results, separate analyses were performed on explicitly accepted references and non-explicitly accepted references for the effect of reference status and status knowledge.

Effects of reference status and status knowledge on explicit acceptance

The total number of references presented during the experiment was 1031. Of these, 582 were explicitly accepted (56%). As mentioned above, a given reference could only be accepted by the participant who did not initially present it. This led us to consider only explicit acceptance of shared and privileged-to-other references from the addressee's point of view. Indeed, an addressee could not accept privileged-to-self references because this would have implied accepting references which he or she had him- or her-self presented. The model revealed that reference status significantly predicted explicit acceptance of references, $F(1, 1029) = 5.205$, $p = .023$. The odds of explicitly accepting a privileged-to-other reference were greater than those of explicitly accepting a shared one, $OR = 1.384$, $CI_{.95} = 1.047, 1.831$, $p = .023$.

Effects of reference status and status knowledge on reuse

The total number of references reused during the experiment was 922. The proportion of reuse as a function of reference status for explicitly accepted and non-explicitly accepted references is presented in Fig. 2.

The first model revealed that explicit acceptance significantly predicted reference reuse, $F(1, 2066) = 72.09$, $p < .001$. The odds of reusing an explicitly accepted reference were higher than those of reusing a non-explicitly accepted one, $OR = 2.565$, $CI_{.95} = 2.064, 3.189$, $p < .001$. This was true for privileged-to-self references ($F(1, 631) = 61.73$, $p < .001$, $OR = 4.930$, $CI_{.95} = 3.309, 7.345$, $p < .001$), for privileged-to-other references ($F(1, 631) = 31.71$, $p < .001$, $OR = 5.053$, $CI_{.95} = 2.872, 8.889$, $p < .001$) and for shared references ($F(1, 800) = 17.15$, $p < .001$, $OR = 2.065$, $CI_{.95} = 1.464, 2.192$, $p < .001$) taken separately. A second analysis was performed on explicitly accepted references only. The corresponding model revealed that reference status significantly predicted reference reuse, $F(2, 1161) = 70.02$, $p < .001$. The odds of reusing a privileged-to-other reference were lower than

those of reusing a shared one, $OR = .227$, $CI_{.95} = .161, .319$, $p < .001$. The odds of reusing a privileged-to-self reference were higher than those of reusing a shared one, $OR = 1.809$, $CI_{.95} = 1.281, 2.555$, $p = .001$. A paired comparison revealed that privileged-to-self references were reused more often than privileged-to-other references, $p < .05$. A third analysis was performed on non-explicitly accepted references. The corresponding model, whose random effects structure included two intercepts (by-dyad and by-item) and a by-item slope, revealed that reference status significantly predicted reference reuse, $F(2,901) = 32.39$, $p < .001$. The odds of reusing a privileged-to-other reference were lower than those of reusing a shared one, $OR = .111$, $CI_{.95} = .065, .190$, $p < .001$. The odds of reusing a privileged-to-self reference were not significantly different from those of reusing a shared one, $p = .070$. A paired comparison revealed that privileged-to-self references were reused more often than privileged-to-other references, $p < .05$.

Effect of presenter identity on reuse of shared references

When participants reused privileged references (either to self or to other), they were reusing either references they had presented themselves (privileged-to-self) or references that had been presented by their partners (privileged-to-other). Results so far have shown that privileged-to-self references were reused more often than privileged-to-other references, which might be construed as implying that reference initiator identity affected reference reuse. To explore this possibility, a complementary analysis was run which included the identity of the presenter of a reference (self or other) and status knowledge as fixed factors. This analysis was performed on shared references only (either explicitly accepted or non-explicitly accepted), as these could be presented by either one of the partners, unlike privileged ones. The models, whose random effects structure included two intercepts (by-dyad and by-item), showed no significant effect of status knowledge, presenter identity or the interaction between the two (all F s < 1).

Discussion

First, the results of Experiment 1 revealed that explicit acceptance was affected by reference status. The hypothesis that privileged-to-other references are more likely to be

explicitly accepted than shared references was thus confirmed. Addressees use acceptance as a means not only of informing speakers of their own state of mind at the point when a reference is produced (i.e., the type of feedback provided depends on whether or not the addressees are already familiar with the reference), but also to indicate that the reference has been understood (Clark & Brennan, 1991; Clark & Schaefer, 1989) and to give speakers the opportunity to correct any potential misunderstanding. Thus, acceptance allows partners to build up mutual knowledge, as predicted (Clark & Wilkes-Gibbs, 1986).

Second, the preliminary analysis of reference reuse revealed that explicitly accepted references were more likely to be reused than references that had not been explicitly accepted. One possible explanation is that this reflected audience design (Clark & Murphy, 1982; Isaacs & Clark, 1987), with speakers mainly reusing references which had been explicitly established as known by both partners, but another plausible explanation is that participants tended to explicitly accept references whenever these seemed relevant to the task, simply dropping the irrelevant ones. This would cause explicitly accepted, relevant references to be reused more often (see Brennan & Hanna, 2009; Brown-Schmidt & Hanna, 2011, for a discussion on how information relevance may affect language processing). In any event, this result suggests that speakers perceived explicitly and non-explicitly accepted references as having a different status, which led us to analyze each type of reference separately for the influence of reference status and status knowledge.

As for explicitly accepted references, the results confirmed that references corresponding to readily available landmarks were more likely to be reused than references corresponding to less readily available landmarks (Horton & Keysar, 1996; Wardlow Lane & Ferreira, 2008). Furthermore, an additional result revealed that explicitly accepted privileged-to-self references were more likely to be reused than explicitly accepted shared ones, even though speakers had no a priori reason to do this. Indeed, both kinds of references were as readily available to them, for both kinds of landmarks appeared on their maps, and the level of feedback by the speakers was the same for both kinds of references, for this analysis included explicitly accepted references only. One possible explanation is that partici-

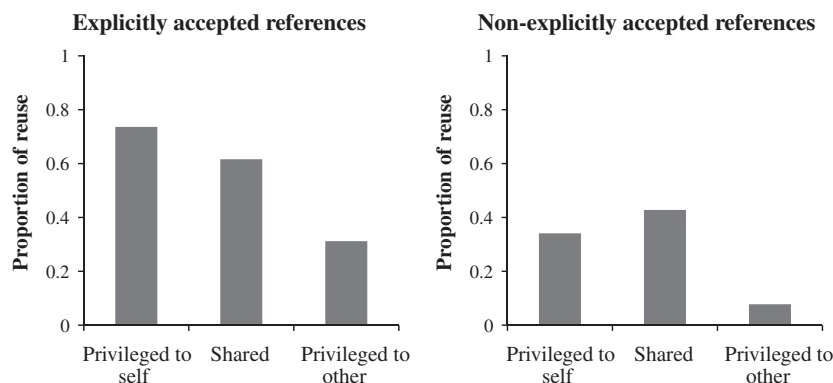


Fig. 2. Experiment 1 – Proportion of reuse for accepted (left) and non-accepted (right) references as a function of initial status.

pants somehow became able to tell which of the referents that appeared on their own maps were shared, and which were privileged. For instance, they may have obtained this information during the acceptance phase, using cues such as intonation or the initiation of a repair phase. Participants then might have been aware that their partners would have difficulty producing privileged-to-other references. (Indeed, the corresponding landmarks did not feature on the partners' maps and the privileged-to-other references would therefore have to be retrieved from memory.) To overcome this difficulty, speakers reused privileged-to-self references – that is, privileged-to-other references from the addressees' point of view – more often to maintain their availability at the dyad level. It thus seems that the reuse of explicitly accepted references was not guided solely by information availability. This may be interpreted with regard to Duran et al. (2011) and Mainwaring et al.'s (2003) work on repartition of effort within a dyad. These authors showed that perceiving their partners as likely to have difficulty collaborating causes speakers to take on the burden of perspective-taking to ensure dialogue success. In line with this, our results suggest that perceiving their partners as likely to have difficulty retrieving references from memory leads speakers to keep track of which references their partners are likely to forget and to produce them whenever necessary. This furthermore implies that if both partners set up this strategy during the interaction, each speaker taken individually may behave egocentrically by reusing mainly readily available references – that is, privileged-to-self and shared – because he or she knows that his or her partner will provide him or her with the references he or she lacks – that is, privileged-to-other.

As for non-explicitly accepted references, references corresponding to readily available landmarks were more likely to be reused than references corresponding to less readily available landmarks. However, no significant difference was found between the likelihood of reusing shared references and that of reusing privileged-to-self ones. This null result means that the possibility that a difference exists, as with explicitly accepted references, cannot be excluded, nor can it be concluded that there is no difference. Thus, the results concerning the reuse of non-explicitly accepted references only partially replicate the results obtained for the reuse of explicitly accepted references, in that they show that reference reuse is guided by information availability.

Taken together, these results confirm the initial hypotheses which were (a) that speakers use acceptance to build up mutual knowledge with their partner and (b) that the reuse of explicitly accepted references is affected by information availability. The additional analysis on the effect of presenter identity did not allow concluding that this effect could be attributed to speakers preferentially reusing the references they initiated themselves. However, the reuse of explicitly accepted references is not guided solely by information availability: the analyses suggested that it is also guided by each speaker's attempts to make sure that the information his or her partner may have difficulty accessing remains available at the dyad level.

Lastly, the effect of status knowledge failed to reach statistical significance, preventing us from drawing any con-

clusions concerning the attenuation of the influence of information availability. This lack of significance can be explained in several ways. Using both the map and the list may have been too time-consuming, given that the first part of the experiment only lasted 15 min. Also, participants may have considered that the information contained in the lists was not part of the common ground and thus could not be used as a basis for audience design. Finally, participants may have deemed that the lists were unnecessary, given that the strategy they used – producing privileged references when they felt that their partners were likely to need them – was sufficient to perform the task.

To recap, Experiment 1 confirmed that the reuse of explicitly accepted references is affected by information availability. However, in this experiment, participants were unfamiliar with the city represented in the maps. Had this not been the case, they might have not spent so much time and effort ensuring that their own privileged information remained available at the dyad level, as speakers are less likely to take their partners' state of mind into account when they know that they share knowledge on a given topic (Savitsky, Keysar, Epley, Carter, & Swanson, 2011; Wu & Keysar, 2007). A second experiment was therefore conducted to verify whether the results obtained in Experiment 1 could be generalized to dialogue situations in which both partners are familiar with the dialogue environment.

Experiment 2

Experiment 2 replicated Experiment 1, but this time in a dialogue about a familiar environment. The maps used in Experiment 2 represented the university city in which the participants were living at the time of the experiment. As the results of Experiment 1 showed no significant effect of status knowledge, this factor was not manipulated in Experiment 2. Participants were only given a map to perform the task, which corresponded to the "map only" condition in Experiment 1.

Hypotheses

The hypotheses for Experiment 2 were the same as for Experiment 1, except that status knowledge was no longer manipulated.

Method

Participants

Twenty-two dyads of undergraduate students took part in Experiment 2. All the participants were native French speakers. They had been living in the city represented on the maps used in the experiment for at least 3 months prior to the experiment. Each participant signed an informed consent form at the beginning of the experiment.

Apparatus and experimental stimuli

The apparatus was identical to that of Experiment 1. A map representing the university city in which the participants were living served as the basis for the stimuli used



Fig. 3. Two maps used in Experiment 2. Symbols correspond to major monuments (churches, museums, etc.), “Boulevard [...]” and “Rue [...]” indications correspond to street names, “Place [...]” indications correspond to square names. The hotel (starting point) is represented by the gray square in the bottom left quarter of the map and the conference center (arrival point) is represented by the square in the bottom right quarter of the map.

in this experiment. It featured 84 landmarks, including 15 major monuments, six squares and 63 street names. These landmarks were randomly divided into three blocks of five major monuments, two squares and 21 streets. Three maps were then created and coupled as in Experiment 1. The distribution of the blocks within each dyad was counterbalanced across dyads. Fig. 3 represents two of the maps used in Experiment 2.

Task, procedure and experimental design

The task and procedure were similar to those of Experiment 1. However, in Experiment 2, participants had to establish a return tourist route between a hotel and a conference center. Thus, participants were free to choose whichever itinerary they liked between the two points. Both points appeared on all the maps and their location remained constant across maps. Other than status knowledge, which was not manipulated in Experiment 2, the independent variables were identical to those used in Experiment 1.

Data coding and dependent variables

The dialogues were transcribed and coded for the same dichotomous dependent variables as in Experiment 1.

Results

The mean number of words per dialogue was 2056 ($SD = 684.8$) and the mean number of speech turns per dia-

logue was 246.8 ($SD = 95.31$). The mean number of words per speech turn was 8.731 ($SD = 2.220$). Finally, the average number of references presented per dialogue was 32.76 ($SD = 6.177$). The total number of references explicitly accepted and reused is reported in Table 4. The analyses concerning reference acceptance and reuse were conducted using SPSS Statistics 19.0, as in Experiment 1, except that they did not include the status knowledge factor.

Effects of reference status on acceptance

The total number of references presented in the experiment was 709. Of these, 329 were accepted (46%). The corresponding model, whose random effects structure included two intercepts (by-dyad and by-item), revealed that reference status significantly predicted reference acceptance, $F(1,707) = 7.869$, $p = .005$. As in Experiment 1, the odds of explicitly accepting a privileged-to-other reference were higher than those of explicitly accepting a shared one, $OR = 1.561$, $CI_{.95} = 1.143, 2.131$, $p = .005$.

Effect of reference status on reuse

The total number of references reused in the experiment was 678. The proportion of reuse as a function of reference status for explicitly accepted and non-explicitly accepted references is presented in Fig. 4. The first model revealed that explicit acceptance significantly predicted reference reuse, $F(1,1438) = 37.42$, $p < .001$. The odds of reusing an explicitly accepted reference were higher than those of reusing a non-explicitly accepted one, $OR = 2.177$,

Table 4

Experiment 2 – Number of references accepted and reused out of the total of 709 references presented.

	Privileged to self	Shared	Privileged to other
Explicitly accepted	–	112 (.40)	217 (.51)
Total reused	266 (.60)	305 (.54)	107 (.24)
– Explicitly accepted	162 (.74)	142 (.63)	79 (.36)
– Non-explicitly accepted	104 (.47)	163 (.49)	28 (.13)
– Initially presented by oneself		150 (.54)	
– Initially presented by other		154 (.55)	

Note: Corresponding actual proportions are given in brackets.

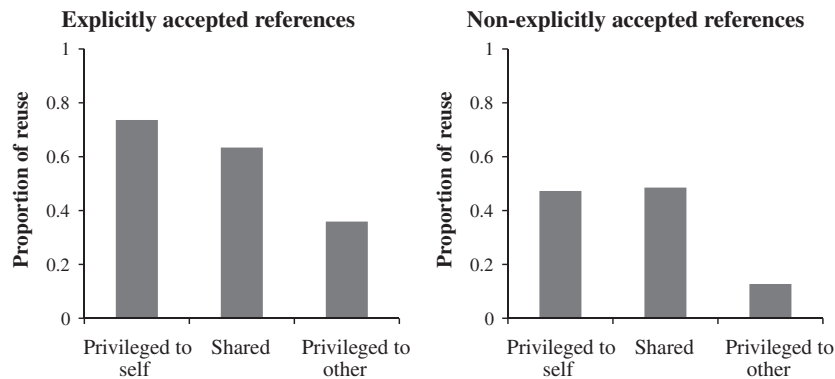


Fig. 4. Experiment 2 – Proportion of reuse for accepted (left) and non-accepted (right) references as a function of initial status.

$CI_{.95} = 1.696, 2.793, p < .001$. This was true for privileged-to-self references ($F(1,438) = 25.27, p < .001, OR = 3.074, CI_{.95} = 1.982, 4.769, p < .001$), for privileged-to-other references ($F(1,438) = 22.41, p < .001, OR = 3.632, CI_{.95} = 2.126, 6.205, p < .001$) and for shared references ($F(1,558) = 8.292, p = .004, OR = 1.804, CI_{.95} = 1.206, 2.699, p = .004$) taken separately. (It should be noted that the random effects structure used in the corresponding models included two intercepts (by-dyad and by-item).) The second analysis was performed on explicitly accepted references only. The model, whose random effects structure included two intercepts (by-dyad and by-participant), revealed that reference status significantly predicted reuse of explicitly accepted references, $F(2,661) = 36.15, p < .001$. The odds of reusing a privileged-to-other reference were lower than those of reusing a shared one, $OR = .263, CI_{.95} = .169, .408, p < .001$. The odds of reusing a privileged-to-self reference were higher than those of reusing a shared one, $OR = 1.638, CI_{.95} = 1.039, 2.582, p = .033$. A paired comparison revealed that privileged-to-self references were reused more often than privileged-to-other references. The third analysis was performed on non-explicitly accepted references only. The model, whose random effects structure included two intercepts (by-dyad and by-item) and a by-item slope, revealed that reference status significantly predicted reference reuse, $F(2,773) = 37.45, p < .001$. The odds of reusing a privileged-to-other reference were lower than those of reusing a shared one, $OR = .128, CI_{.95} = .079, .209, p < .001$. The odds of reusing a privileged-to-self reference were not significantly different from those of reusing a shared one, $p = .729$. A paired comparison revealed that privileged-to-self references were reused more often than privileged-to-other references, $p < .05$. These analyses replicated the results obtained in Experiment 1.

Effect of presenter identity on reuse of shared references

As in Experiment 1, an analysis was performed to explore the possibility that reference reuse might be affected by the identity of the speaker who initially presented the reference. The models, whose random effects structure included two intercepts (by-dyad and by-item), showed no significant effect of presenter identity ($F < 1$), as in Experiment 1.

Discussion

The results obtained in Experiment 2 replicated those obtained in Experiment 1, thus ruling out the possibility that the results obtained in Experiment 1 were due to participants having no background knowledge of the task environment. When managing a dialogue about a familiar environment, speakers build up mutual knowledge through reference acceptance, and the reuse of explicitly accepted references is affected by information availability, possibly as well as by the speakers' attempts to make privileged-to-self references available at the dyad level.

General discussion

The aim of both experiments reported above was to show how egocentrism shapes collaboration by investigating the influence of information availability on the way that references belonging to the common ground are reused. These experiments focused on the reuse of explicitly accepted references. The hypotheses were that (a) speakers build up mutual knowledge through reference presentation and explicit acceptance, and that (b) the availability of explicitly accepted references guides their later reuse in the dialogue. The results of both experiments confirmed these hypotheses. However, sensitivity to information availability did not systematically result in participants indifferently reusing shared and privileged-to-self references to perform the task. When references had previously been explicitly accepted, privileged-to-self references were reused more often than shared ones, even though the corresponding landmarks were equally salient. These results held in both an unfamiliar dialogue environment (Experiment 1) and a familiar one (Experiment 2).

Both experiments allowed building on key findings in the field of dialogue in two ways. First, the experiments that led to the development of the egocentric approach focused mainly on the early steps of language processing, the central idea being that speakers are capable of adjusting their utterances with regard to the common ground, providing they have sufficient time, resources and motivation (Barr & Keysar, 2002; Horton & Keysar, 1996; Rossnagel, 2000). The two experiments reported above, however,

suggested that the egocentric anchoring of language processing affects the whole course of dialogue, by biasing audience design towards the reuse of readily available explicitly accepted references. This is due to the fact that common ground exploitation is affected by information availability (Horton & Gerrig, 2002, 2005a, 2005b; Horton & Slaten, 2012) – and more specifically, in this case, by visual referent availability. As such, then, the influence of information availability is local, for it results from limited individual memory resources at the time of production; nonetheless, it affects dialogue management as a whole, for it shapes the production of partner-adapted references throughout the interaction.

Second, the results reinforced the probabilistic claim that language processing is affected by different sources of information, including privileged and shared information (Brennan & Hanna, 2009; Brown-Schmidt & Hanna, 2011). When references have been accepted explicitly, speakers make greater use of their own privileged knowledge. We have suggested that they do this in order to overcome their addressees' individual limitations by acting as external memory supports for them (see Intons-Peterson & Fournier, 1986; Schönplflug, 1986; Wegner, 1986). This would imply that shared responsibility between partners is not restricted to presenting privileged information at the right time, as suggested by Bard et al. (2007). Rather, responsibility may persist throughout the whole dialogue as its initiator remains responsible for maintaining its availability at the dyad level. This continuing responsibility would make it possible to overcome individual memory limitations by making each speaker's privileged information available not just to one but to both speakers, thereby contributing to the achievement of the common goal that underlies dialogue. This would be rendered possible by the fact that speakers keep track of their partners' state of mind throughout the dialogue (Brown-Schmidt, 2009a, 2009b; Brown-Schmidt et al., 2008).

Perspective-taking is costly (Rossnagel, 2000). However, a factor of central importance in these experiments is that for a speaker to produce references that were privileged-to-self (i.e., privileged-to-other from the addressee's point of view) implied processing readily available privileged information. One possibility is that doing this was less costly (and probably more efficient) than it would have been for each speaker to try to memorize privileged-to-other references. This is consistent with Schober's (1995) claim that speakers try to minimize individual effort during collaboration: relying on their partners' ability to evaluate their conversational needs spares speakers from having to memorize all their partners' privileged information. In the current study, speakers were behaving in a non-costly, egocentric way – they reused references depending on their availability from their own point of view – while all the while making an additional effort to keep track of which references, among the explicitly accepted ones, were privileged-to-self and which were shared to allow each speaker's privileged information to remain available for dyad use. Thus, both egocentrism and collaboration determined reference production during the interaction. However, the results do not allow determining whether this strategy is used

when references are added to the common ground in an implicit way.

In conclusion, these experiments showed that reference production during dialogue is shaped not only by one's partner's state of mind, as predicted by the collaborative approach, but also by information availability from one's own point of view. Thus, adaptation seems to be egocentrically anchored, which causes references which belong to common ground to be reused depending on their degree of availability to each speaker. Furthermore, it seems that speakers try to compensate for this egocentric anchoring of adaptation by preferentially reusing the explicitly accepted references they think their partners may lack, rather than individually taking on the burden of memorizing all their partners' privileged information. All in all, this study confirms that dialogue management is affected by egocentrism in at least two ways. First, egocentrism determines (at least partly) which partner-adapted references speakers reuse. Second, egocentrism seems to lead the speakers to set up an additional strategy to ensure dialogue success despite the fact that each of them tends to produce mainly readily available references. Thus, dialogue management is guided by both collaborative and egocentric influences.

Acknowledgments

This work was conducted as part of the first author's PhD program and was supported by the Direction Générale de l'Armement (DGA) and Région Poitou-Charentes. The authors would like to thank three anonymous reviewers for their helpful comments and advice on the previous versions of this manuscript.

References

- Anderson, A. H., Bader, M., Bard, E. G., Boyle, E., Doherty, G., Garrod, S., et al. (1991). The HCRC map task corpus. *Language and Speech*, 34, 351–366. <http://dx.doi.org/10.1177/002383099103400404>.
- Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language*, 59, 390–412. <http://dx.doi.org/10.1016/j.jml.2007.12.005>.
- Bard, E. G., Anderson, A. H., Chen, Y., Nicholson, H. B. M., Havard, C., & Dalziel-Job, S. (2007). Let's you do that: Sharing the cognitive burdens of dialogue. *Journal of Memory and Language*, 57, 616–641. <http://dx.doi.org/10.1016/j.jml.2006.12.003>.
- Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (in preparation). *Random effects structure in mixed-effects models: Keep it maximal*. <<http://idiom.ucsd.edu/~rlevy/papers.html>> Retrieved 22.03.12.
- Barr, D. J., & Keysar, B. (2002). Anchoring comprehension in linguistic precedents. *Journal of Memory and Language*, 46, 391–418. <http://dx.doi.org/10.1006/jmla.2001.2815>.
- Bell, M. L., & Grunwald, G. K. (2004). Mixed models for the analysis of replicated spatial point patterns. *Biostatistics*, 5, 633–648. <http://dx.doi.org/10.1093/biostatistics/kxh014>.
- Brennan, S. E., & Clark, H. H. (1996). Conceptual pacts and lexical choice in conversation. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 22, 1482–1493. <http://dx.doi.org/10.1037/0278-7393.22.6.1482>.
- Brennan, S. E., & Hanna, J. E. (2009). Partner-specific adaptation in dialog. *Topics in Cognitive Science*, 1, 274–291. <http://dx.doi.org/10.1111/j.1756-8765.2009.01019.x>.
- Brown-Schmidt, S. (2009a). Partner-specific interpretation of maintained referential precedents during interactive dialogue. *Journal of Memory and Language*, 61, 171–190. <http://dx.doi.org/10.1016/j.jml.2009.04.003>.

- Brown-Schmidt, S. (2009b). The role of executive function in perspective taking during online language comprehension. *Psychonomic Bulletin & Review*, 16, 893–900. <http://dx.doi.org/10.3758/PBR.16.5.893>.
- Brown-Schmidt, S., Gunlogson, C., & Tanenhaus, M. K. (2008). Addressees distinguish shared from private information when interpreting questions during interactive conversation. *Cognition*, 107, 1122–1134. <http://dx.doi.org/10.1016/j.cognition.2007.11.005>.
- Brown-Schmidt, S., & Hanna, J. E. (2011). Talking in another person's shoes: Incremental perspective-taking in language processing. *Dialogue and Discourse*, 2, 11–33. <http://dx.doi.org/10.1111/j.1756-8765.2009.01019.x>.
- Cahn, J. E., & Brennan, S. E. (1999). A psychological model of grounding and repair in dialog. *Proceedings, AAAI fall symposium on hological models of communication in collaborative systems*. North Falmouth, MA: American Association for Artificial Intelligence, pp. 25–33.
- Clark, H. H. (1996). *Using language*. Cambridge: Cambridge University Press.
- Clark, H. H., & Brennan, S. E. (1991). Grounding in communication. In L. B. Resnick, J. M. Levine, & S. D. Teasley (Eds.), *Perspectives on socially shared cognition* (pp. 127–149). Washington: APA Books.
- Clark, H. H., & Krych, M. A. (2004). Speaking while monitoring addressees for understanding. *Journal of Memory and Language*, 50, 62–81. <http://dx.doi.org/10.1016/j.jml.2003.08.004>.
- Clark, H. H., & Marshall, C. R. (1981). Definite reference and mutual knowledge. In A. K. Joshi, B. L. Webber, & I. A. Sag (Eds.), *Elements of discourse understanding* (pp. 10–63). Cambridge: Cambridge University Press.
- Clark, H. H., & Murphy, G. L. (1982). La visée vers l'auditoire dans la signification et la référence [Audience design in significance and reference]. *Bulletin de Psychologie*, 356, 767–774.
- Clark, H. H., & Schaefer, E. F. (1989). Contributing to discourse. *Cognitive Science*, 13, 259–294. [http://dx.doi.org/10.1016/0364-0213\(89\)90008-6](http://dx.doi.org/10.1016/0364-0213(89)90008-6).
- Clark, H. H., & Schober, M. F. (1992). Asking questions and influencing answers. In J. M. Tanur (Ed.), *Questions about questions: Inquiries into the cognitive bases of surveys*. New York: Russell Sage.
- Clark, H. H., Schreuder, R., & Buttrick, S. (1983). Common ground and the understanding of demonstrative reference. *Journal of Verbal Learning and Verbal Behavior*, 22, 245–258. [http://dx.doi.org/10.1016/S0022-5371\(83\)90189-5](http://dx.doi.org/10.1016/S0022-5371(83)90189-5).
- Clark, H. H., & Wilkes-Gibbs, D. (1986). Referring as a collaborative process. *Cognition*, 22, 1–39. [http://dx.doi.org/10.1016/0010-0277\(86\)90010-7](http://dx.doi.org/10.1016/0010-0277(86)90010-7).
- Duran, N. D., Dale, R., & Kreuz, R. J. (2011). Listeners invest in an assumed other's perspective despite cognitive cost. *Cognition*, 121, 22–40. <http://dx.doi.org/10.1016/j.cognition.2011.06.009>.
- Epley, N., Keysar, B., Van Boven, L., & Gilovich, T. (2004). Perspective taking as egocentric anchoring and adjustment. *Journal of Personality and Social Psychology*, 87, 327–339. <http://dx.doi.org/10.1037/0022-3514.87.3.327>.
- Fussell, S. R., & Krauss, R. M. (1989). The effects of intended audience on message production and comprehension: Reference in a common ground framework. *Journal of Experimental Social Psychology*, 25, 203–219. [http://dx.doi.org/10.1016/0022-1031\(89\)90019-X](http://dx.doi.org/10.1016/0022-1031(89)90019-X).
- Fussell, S. R., & Krauss, R. M. (1992). Coordination of knowledge in communication: Effects of speakers' assumptions about what others know. *Journal of Personality and Social Psychology*, 62, 378–391. <http://dx.doi.org/10.1037/0022-3514.62.3.378>.
- Galati, A., & Brennan, S. E. (2010). Attenuating repeated information: For the speaker, or for the addressee? *Journal of Memory and Language*, 62, 35–51. <http://dx.doi.org/10.1016/j.jml.2009.09.002>.
- Gambi, C., & Pickering, M. J. (2011). A cognitive architecture for the coordination of utterances. *Frontiers in Psychology*, 2, 1–14. <http://dx.doi.org/10.3389/fpsyg.2011.00275>.
- Hanna, J. E., & Tanenhaus, M. K. (2004). Pragmatic effects on reference resolution in a collaborative task: Evidence from eye movements. *Cognitive Science*, 28, 105–115. <http://dx.doi.org/10.1016/j.cogsci.2003.10.002>.
- Hanna, J. E., Tanenhaus, M. K., & Trueswell, J. C. (2003). The effects of common ground and perspective taking on domains of referential interpretation. *Journal of Memory and Language*, 49, 43–61. [http://dx.doi.org/10.1016/S0749-596X\(03\)00022-6](http://dx.doi.org/10.1016/S0749-596X(03)00022-6).
- Harris, G., Begg, I., & Upfold, D. (1980). On the role of the speaker's expectations in interpersonal communication. *Journal of Verbal Learning and Verbal Behavior*, 19, 597–607. [http://dx.doi.org/10.1016/S0022-5371\(80\)90650-7](http://dx.doi.org/10.1016/S0022-5371(80)90650-7).
- Heck, R. H., Thomas, S. L., & Tabata, L. (2010). *Multilevel and longitudinal analysis using SPSS*. New York: Routledge/Taylor & Francis.
- Horton, W. S. (2007). The influence of partner-specific memory associations on language production: Evidence from picture naming. *Language and Cognitive Processes*, 22, 1114–1139. <http://dx.doi.org/10.1080/01690960701402933>.
- Horton, W. S., & Gerrig, R. J. (2002). Speaker's experiences and audience design: Knowing when and knowing how to adjust utterances to addressees. *Journal of Memory and Language*, 47, 589–606. [http://dx.doi.org/10.1016/S0749-596X\(02\)00019-0](http://dx.doi.org/10.1016/S0749-596X(02)00019-0).
- Horton, W. S., & Gerrig, R. J. (2005a). Conversational common ground and memory processes in language production. *Discourse Processes*, 40, 1–35. http://dx.doi.org/10.1207/s15326950dp4001_1.
- Horton, W. S., & Gerrig, R. J. (2005b). The impact of memory demands on audience design during language production. *Cognition*, 96, 127–142. <http://dx.doi.org/10.1016/j.cognition.2004.07.001>.
- Horton, W. S. (2008). A memory-based approach to common ground and audience design. In I. Kecskes (Ed.), *Intention, common ground, and the egocentric speaker-hearer* (pp. 189–222). Berlin/New York: Mouton de Gruyter.
- Horton, W. S., & Keysar, B. (1996). When do speakers take into account common ground? *Cognition*, 59, 91–117. [http://dx.doi.org/10.1016/0010-0277\(96\)81418-1](http://dx.doi.org/10.1016/0010-0277(96)81418-1).
- Horton, W. S., & Slaten, D. G. (2012). Anticipating who will say what: The influence of speaker-specific memory associations on reference resolution. *Memory & Cognition*, 40, 113–126. <http://dx.doi.org/10.3758/s13421-011-0135-7>.
- Hund, A. M., Haney, K. H., & Seanor, B. D. (2008). The role of recipient perspective in giving and following wayfinding directions. *Applied Cognitive Psychology*, 22, 896–916. <http://dx.doi.org/10.1002/acp.1400>.
- Intons-Peterson, M. J., & Fournier, J. (1986). External and internal memory aids: When and how often do we use them? *Journal of Experimental Psychology: General*, 115, 267–280. <http://dx.doi.org/10.1037/0096-3445.115.3.267>.
- Isaacs, I. A., & Clark, H. H. (1987). References in conversation between experts and novices. *Journal of Experimental Psychology: General*, 116, 26–37. <http://dx.doi.org/10.1037/0096-3445.116.1.26>.
- Jaccard, J. (2001). *Interaction effects in logistic regression*. Thousand Oaks, CA: Sage.
- Jaeger, T. F. (2008). Categorical data analysis: Away from ANOVAs (transformation or not) and towards logit mixed models. *Journal of Memory and Language*, 59, 434–446. <http://dx.doi.org/10.1016/j.jml.2007.11.007>.
- Keysar, B. (1997). Unconfounding common ground. *Discourse Processes*, 24, 253–270. <http://dx.doi.org/10.1080/01638539709545015>.
- Keysar, B. (2007). Communication and miscommunication: The role of egocentric processes. *Intercultural Pragmatics*, 4, 71–84. <http://dx.doi.org/10.1515/IP.2007.004>.
- Krauss, R. M., & Fussell, S. R. (1991). Perspective-taking in communication: Representations of others' knowledge in reference. *Social Cognition*, 9, 2–24.
- Lockridge, C. B., & Brennan, S. E. (2002). Addressees' needs influence speakers' early syntactic choices. *Psychonomic Bulletin & Review*, 9, 550–557.
- Mainwaring, S. D., Tversky, B., Ohgishi, M., & Schiano, D. J. (2003). Descriptions of simple spatial scenes in English and Japanese. *Spatial Cognition and Computation*, 3, 3–42. http://dx.doi.org/10.1207/S15427633SCC0301_2.
- McInnes, F., & Attwater, D. (2004). Turn-taking and grounding in spoken telephone number transfers. *Speech Communication*, 43, 205–223. <http://dx.doi.org/10.1016/j.specom.2004.04.001>.
- McMahon, J. M., Pouget, E. R., & Tortu, S. (2006). A guide for multilevel modeling of dyadic data with binary outcomes using SAS PROC NLMIXED. *Computational Statistics and Data Analysis*, 50, 3663–3680.
- Metzing, C., & Brennan, S. E. (2003). When conceptual pacts are broken: Partner-specific effects in the comprehension of referring expressions. *Journal of Memory and Language*, 49, 201–213. [http://dx.doi.org/10.1016/S0749-596X\(03\)00028-7](http://dx.doi.org/10.1016/S0749-596X(03)00028-7).
- Rosnagel, C. (2000). Cognitive load and perspective-taking: Applying the automatic-controlled distinction to verbal communication. *European Journal of Social Psychology*, 30, 429–445.
- Savitsky, K., Keysar, B., Epley, N., Carter, T., & Swanson, A. (2011). The closeness-communication bias: Increased egocentrism among friends versus strangers. *Journal of Experimental Social Psychology*, 47, 269–273. <http://dx.doi.org/10.1016/j.jesp.2010.09.005>.
- Schielzeth, H., & Forstmeier, W. (2009). Conclusions beyond support: Overconfident estimates in mixed models. *Behavioral Ecology*, 20, 416–420. <http://dx.doi.org/10.1093/beheco/arn145>.
- Schober, M. F. (1995). Speakers, addressees, and frames of reference: Whose effort is minimized in conversations about locations?

- Discourse Processes*, 20, 219–245. Springer-Verlag. <http://dx.doi.org/10.1080/01638539509544939>.
- Schönpflug, W. (1986). The trade-off between internal and external information storage. *Journal of Memory and Language*, 25, 657–675. [http://dx.doi.org/10.1016/0749-596X\(86\)90042-2](http://dx.doi.org/10.1016/0749-596X(86)90042-2).
- Van Der Wege, M. M. (2009). Lexical entrainment and lexical differentiation in reference phrase choice. *Journal of Memory and Language*, 60, 448–463. <http://dx.doi.org/10.1016/j.jml.2008.12.003>.
- Wardlow Lane, L., & Ferreira, V. S. (2008). Speaker-external versus speaker-internal forces on utterance form: Do cognitive demands override threats to referential success? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 34, 1466–1481. <http://dx.doi.org/10.1037/a0013353>.
- Wegner, D. M. (1986). Transactive memory: A contemporary analysis of the group mind. In B. Mullen & G. R. Goethals (Eds.), *Theories of group behavior* (pp. 185–208). New York: Springer-Verlag.
- Wu, S., & Keysar, B. (2007). The effect of information overlap on communication effectiveness. *Cognitive Science*, 31, 169–181. <http://dx.doi.org/10.1080/03640210709336989>.