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Priming the production of implications

Alice Rees (reesa34@cardiff.ac.uk)
Department of Psychology, Tower Building, 70 Park Place
Cardiff, CF10 3AT UK

Lewis Bott (Bottla@cardiff.ac.uk)
Department of Psychology, Tower Building, 70 Park Place
Cardiff, CF10 3AT UK

Abstract

We present two experiments investigating the production of implicit constructions. Using a confederate scripting paradigm we find that after making an inference participants were more likely to subsequently produce an implicature. This effect occurred at a global and a local level and was unaffected by the perceived role of the conversational partner. Our findings demonstrate that the choice of whether to be implicit is determined by the activation levels of representations specific to implicatures and that inference and implications have overlapping processing representations.

Keywords: Priming; Scalar Implicatures; Speech Production; Inferring

Producing implications

During conversations speakers have to make a variety of decisions about the message they wish to convey. These decisions include what lexical material to include, what syntactic forms to use, and whether or not to communicate explicitly or implicitly. When communicating implicitly the onus is on the listener to enrich the utterance to reach the speaker's intended meaning.

Research into language production has predominantly focused on speaker's choices of explicit material. That is, their choices of which lexical items to use or which syntactic constructions to use (e.g. Bock & Levelt, 1994; Levelt, Roelofs, & Meyer, 1999; Pickering & Branigan, 1998). In this paper, we focus on the speaker's decision to be implicit or explicit in their speech. Consider the following:

1. A: "Did John eat the cookies?"
    B: "He ate some of them."
    => *John ate some but not all of the cookies.*
2. A: "Have you met Lucy's new boyfriend? He's handsome and intelligent!"
    B: "He's handsome."
    =>*He's not intelligent.*

In these exchanges B's utterance conveys more than what is explicitly coded. In (1) B's utterance leads to the inference *John ate some but not all of the cookies*. This inference arises through the following steps (based on Grice, 1989): (i) speaker A recognises that B could have said "he ate all of them." (ii) Since B did not say this, and assuming B is cooperative, A can infer that "he ate all of them" is not true; (iii) combining what is said with the negation of the

alternative leads to the inference that "John ate some *but not all* of the cookies." Similar reasoning can be used for (2). Speaker B could have said "Yes, I agree" or "He is handsome and funny." By not saying these A could infer that B thinks Lucy's boyfriend is not handsome. The result of this reasoning process was termed *implicatures* by Grice (1989).

Since Grice's seminal work, implicatures have been analysed in great detail. For example, there are analyses from the perspective of theoretical semantics (e.g., Chierchia, 2004), acquisition (e.g., Noveck, 2001), clinical disorders (e.g. Chevallier, Wilson, Happé, & Noveck, 2010), and sentence processing (e.g., Bott & Noveck, 2004). What all previous work has in common, however, is that they are from the perspective of the listener, and not the speaker. Here we ask how the speaker makes the choice about whether to make an implication[1].

Why imply?

Why does a speaker imply when they could be explicit? One reason is that using implicatures is efficient for a speaker. Since articulation is much slower than speech preparation processes, reducing the amount of material to be articulated reduces this articulatory bottleneck and arguably minimises speaker effort while maximising their benefits (Grice, 1989; Horn, 2004; Levinson, 2000; Wheeldon & Levelt, 1995). Another reason is that implicatures are used out of politeness. Implicatures can be used to maintain face (Bonnefon, Feeney, & Villejoubert, 2009; Brown & Levinson, 1987; Feeney & Bonnefon, 2013; Goffman, 1967; Holtgraves & Perdew, 2016). In face threatening contexts listeners interpret the use of implicatures as a speaker's attempt at politeness.

Efficiency and politeness provide intuitive explanations for why people use implicatures. However, it is unclear how these socio-pragmatic factors interact with the language processor. One possibility is that social factors modulate the activation of representations specific to the implicature process. That is, there are representations specific to implicatures and the activation of said representations underlie the production and comprehension of implicatures. We present two experiments to investigate this.

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[1] We refer to implicit utterances made by the speaker as *implications* and inferences made by the listener as *inferences*.

Implicit representations

During conversations interlocutors tend to repeat linguistic structures that they have recently heard or produced. This repetition is known as structural priming (e.g. Bock, 1986). Structural priming occurs throughout the language system in production (Brennan & Clark, 1996; Bock, 1986; Levelt & Kelter, 1982; Branigan, et al, 2000; 2005) and comprehension (Sturt, Keller, & Dubey, 2010; Thothathiri & Snedeker, 2008), and in different languages (Hartsuiker & Westenberg, 2000; Scheepers, 2003). There is a general consensus that successful priming of a particular structure indicates the presence of a corresponding representation within the language system whereas unsuccessful priming indicates the absence of such a representation (Branigan, Pickering, Liversedge, Stewart, & Urbach, 1995; Pickering & Ferreira, 2008).

Priming is not restricted to explicit linguistic forms; Raffray, Pickering, Cai, & Branigan (2013) found that after encountering a coerced sentence individuals were more likely to subsequently produce a coerced sentence than after a fully-formed sentence. Sentences involved coercion are ambiguous. For example, "The author finished the book" is ambiguous; the verb *finish* requires a complement that specifies an event. For a comprehender to interpret the sentence they must undertake an enrichment process which coerces the noun into the correct semantic type. Since individuals were more likely to subsequently produce a coerced sentence after comprehending or producing a coerced sentence than after a full-formed sentence Raffray et al. suggested that there are distinct representations corresponding to coerced and full-form sentences i.e. there are distinct representations involved in implicit and explicit language. While the sort of implicit language used by Raffray et al. is very different to Gricean implicatures, their study nonetheless demonstrates that it is possible to prime the choice between using more or less linguistic material.

Further support comes from Bott and Chemla (2016). They showed that that after deriving a Gricean enrichment participants were more likely to subsequently derive an enrichment. This held both within and between enrichment categories. They suggested that there was a mechanism which underlies the derivation of enrichment and after making an enrichment these mechanisms retain some activation which increases the likelihood of making a subsequent enrichment. However, their findings relate to comprehension (and not production), and so do not illustrate how the speaker chooses between an implicit and an explicit construction.

The success of communication can, in part, be ascribed to priming. Representations that are shared between the comprehension and production system reciprocally activate each other so that after comprehending a particular structure the speaker is more likely to use that structure. Consequently interlocutors develop similar representations of linguistic structures and thus become aligned via priming (Pickering & Garrod, 2004). We propose that the same occurs for the production of implicit and explicit constructions. There are specific representations which underlie implicit communication and the activation level of these determines whether or not a speaker produces an implicit construction. Thus in a dialogue if one speaker is using implicit constructions it is likely that their conversational partner will also produce implicit constructions since the representations used to comprehend the utterance will have an activation advantage over other representations that were not used. Thus these representations can be primed. We test this using a confederate-scripting priming paradigm adapted from Branigan, Pickering & Cleland, 2000).

Experiment 1

A participant and a confederate took turns describing and identifying a referent card from a set of four. These cards consisted of rectangles containing either one or two images (see Figure 1). Cards were displayed on two separate screens (one for the participant and one for the confederate), and neither party could see each other's screen. The referent card was identified to the speaker by being embedded in a bold square, but not to the listener. The task for the speaker was to communicate to the listener which of the cards was the referent card.

The structure of the images in the display were the same on each trial. Figure 1 shows the structure (left panel) and an example trial. The experimental cards were the A and AB cards. Here, one of the images was duplicated (a pencil in the example). This meant that to communicate that the A card was the referent, the speaker could choose between an implicit construction, "The card with the pencil," in which they relied on the listener making an inference, or an explicit construction, "The card with the just the pencil," in which a modifier removed the ambiguity about which image was the referent. Whether the participant (as speaker) chose an explicit or an implicit form was the dependent measure.

There were two forms of priming. The first was a between subjects manipulation in which one group of participants were exposed to predominantly implicit constructions and the other to predominantly explicit constructions. The second was a within-subjects manipulation in which the sequence of trials was designed to prime an implicit or an explicit construction from the participant.

Our hypotheses were as follows. If there are representations corresponding to implicatures, and if they can be activated or deactivated during conversation, we expect more explicit constructions in the explicit global priming condition than in the implicit condition. Similarly, if implicature representations can be activated at a local level, trials in which the confederate uses an implicit construction should be followed by more implicit constructions than trials where the confederate used an explicit construction.
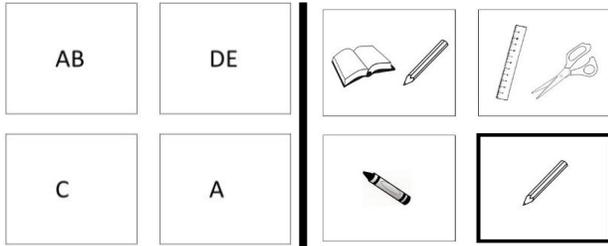
Figure 1. Example trials. Left panel shows the object structure. Right panel shows an example trial.

Method

Participants. 35 Cardiff University undergraduate students participated for either payment or course credit.

Materials and Design. On each trial the interlocutors were presented with four cards, each containing one or two images. Images were organized in the same structure (see Figure 1). Both interlocutors would see the same set of four cards however, on prime trials the confederate's screen would also display the description to use. The confederate's descriptions always named a single image, e.g. in Experimental trials the confederate would describe the AB card as "The card with the [B]". Experimental trials referred to either the A or the AB card and filler trials referred to the C or DE card.

All trials were organized into pairs such that the confederate described a prime trial and the participant described a target trial. For experimental items there were A, and AB primes and targets, thus there were 4 prime-target combinations. There were 8 examples of each combination resulting in 32 experimental pairs. Filler items were 32 pairs of C and DE trials. An additional 8 practice pairs were presented at the start of the experiment to allow participants to get used to the experimental procedure. Consequently there were 32 experimental pairs + 32 filler pairs + 8 practice pairs = 144 items in total.

Items were presented in a fixed pseudorandom order. Experimental pair presentation was alternated with filler pairs. To prevent any findings from being attributable to order effects we reversed the presentation order of the pairs to make two separate lists.

The dependent variable was the construction used by participants to describe the card in target trials. Responses which used a single, unmodified referent were coded as implicit and responses that used two referents or a modified single referent were coded as explicit.

Global priming. Global priming tested whether participants would imitate the conversational style of their partner. Since the A item was duplicated across the A and AB cards, describing the A card was potentially ambiguous. The confederate could either use an implicit description "The card with the [A]", which required the participant to derive an inference (*A and nothing else*), or use an explicit description "The card with just the [A]". In the implicit condition the confederate described the A card implicitly, using an unmodified referent. In the explicit condition the confederate always used a modifier.

Local priming. Local priming tested whether we could prime the implicature representations on a trial by trial basis. This was achieved by manipulating the sequence of prime-target trials. There were two prime types (A cards, AB cards) and two target types (A cards, AB cards), thus there were four prime-target sequences: A->AB, A->A, AB->AB, AB->A. In the implicit condition the confederate's description of A cards required participants to make an implicature and consequently raised the activation levels of the implicature representations. The confederate's descriptions of AB cards, conversely, blocked the implicature (since there was no card equivalent to *B and nothing else*) and therefore lowered the activation levels of the implicature representations. Consequently A->A sequences should yield higher proportions of implicature production (unmodified single referent descriptions) than AB->A sequences. The reverse should hold for A->AB descriptions; rates of implicatures should be high following A trials, participants would avoid unmodified single item descriptions for AB cards and instead use a conjunction ("The card with the scooter and skateboard").

Procedure

The confederate was a female native-English speaking student from the Cardiff University student population. The participant and confederate were sat at opposite sides of a table facing a computer screen. They could not see the other person's screen. The confederate and participant were told that they were "playing a game where they will take turns describing and identifying cards. The same set of cards will be displayed on both computer screens. If you see one with a bold border it is your turn to describe. To make a guess about which card your partner was describing press one of the four keys corresponding to the position of the card on the screen. Do not speak to your partner except to describe the card". Participants were not allowed to describe the position of the card on the screen but, if they needed their partner to, they could ask for their partner to repeat their description.

Results

Each participant produced 32 target responses. Of the 1120 responses 22 were excluded due to experimenter error. To ensure that participants were paying attention to the confederate's descriptions we looked at key press responses to prime trials. Participants selected the correct card 98% of the time. Therefore we can be confident that they were paying attention to the confederate.

Data underwent a logit transformation and were analysed using a 2x2x2x2 Mixed ANOVA. Prime type (A-card and AB-card) and target type (A-card and AB-card) were within-subjects factors and description form (implicit and explicit) and list were between-subjects factors.

Global priming. Participants adopted the conversational style of their partner. When their partner was using implicatures, participants were more likely to also use implicatures ($F(1, 31) = 125.11$, $p < .001$).
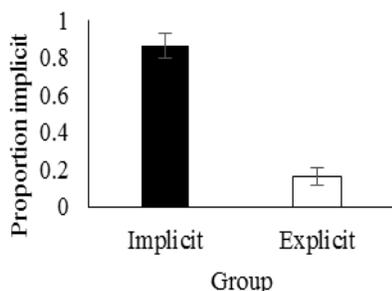

Figure 2. Proportion of implicit responses in implicit and explicit group.

Local priming. We also manipulated which card was described. Whilst there was no effect of prime ($F(1, 31) = 1.98$, $p = .169$) or target ($F(1, 31) = 1.88$, $p = .180$) there was an interaction between prime and target ($F(1, 31) = 8.08$, $p=.008$). When participants had to describe an A-card target they produced more implications after they had made an inference (A-prime). When participants had to describe an AB target they produced fewer implications after they had made an inference. This is consistent with there being specific representations involved in producing implicatures.
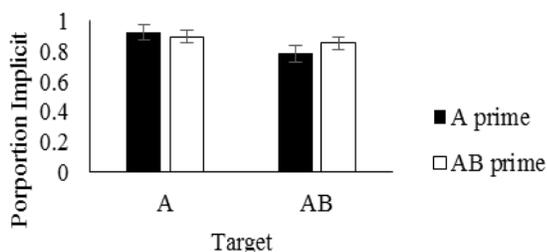

Figure 3. Proportion of implicit responses to A and AB targets by participants in implicit group.

Discussion

The results suggest that there are representations corresponding to implicatures that can be activated and deactivated during conversation. After comprehending an implicature the representations involved had an activation advantage over other representations that were not used. Consequently these implicature representations were more likely to be used in subsequent speech production. After cancelling an implicature, the implicature representations' activation was suppressed thereby reducing the likelihood of them being used for subsequent production.

Experiment 2

Experiment 1 used a confederate as the interlocutor. However, we have no way of knowing whether participants believed our deception. Our results could therefore be a consequence of participants believing that the conversational partner was an experimenter. In Experiment 2 we tested this by manipulating whether the partner was presented as an experimenter or another participant.

There is range of evidence suggesting that the participant could be influenced by the interlocutor's speech characteristics and social status (e.g. Bergen & Grodner, 2012; Grodner & Sedivy, 2011; Holtgraves & Yang, 1990; 1992). For example, Grodner & Sedivy showed that listeners were less likely to derive an inference when their interlocutor was judged to be an unreliable speaker. We therefore reasoned that our manipulation could have several possible effects on participants' utterances. One was that participants might imitate their partner more in the experimenter condition. Since the partner would be in a position of authority, participants may feel that the best strategy would be to do exactly as the experimenter did. Previous work has shown that imitation is more likely when the partner has higher authority (e.g. Bandura & Kupers, 1964; McGuigan, 2013). Alternatively, there may be less imitation in the experimenter condition. Since the partner would now be in the participant's social outgroup, there would be less pressure to conform (e.g. Bourgeois & Hess, 2008; Yabar et al. 2006).

Orthogonal predictions can be reached about the overall levels of implicit language use. Participants might choose to use more implications overall in the experimenter condition. Since the experimenter would generally be in a position of knowledge, there would be little risk of miscommunication by using implications. Alternatively, participants might use fewer implications because if the partner were the experimenter, participants might feel they have to be particularly informative and precise in their responses.

The basic design was exactly the same as Experiment 1. The only difference was that one group of participants were told that the partner was an experimenter and in the other group they were not. In the latter group, there was an experimenter and a confederate, whereas in the former group one experimenter played the role of both experimenter and conversational partner.

Method

Design and materials were the same as in Experiment 1. **Participants.** 35 Cardiff University undergraduate students participated for either payment or course credit. **Partner manipulation.** There were two roles that the conversational partner could play: participant or experimenter. When the conversational partner took the role of a participant the participant was unaware of their partner's involvement in the experiment, just as in Experiment 1. However, when the conversational partner took the role of experimenter, the participant was fully aware of this. The experimenter informed the participant that they would be playing a communication game together and instructed the participant of their task.

Results

Each participant produced 32 target responses. Of the 1280 responses 49 were removed due to experimenter error.

Partner role. Numerically, participants produced more implicit descriptions when they knew their conversational partner was the experimenter compared to when they thought their partner was another participant (see Fig. 1). Despite the numerical difference this was not statistically significant ($F (1, 36) = 1.13, p = 30.$). However, experiments investigating social influences often have a larger sample than that of Experiment 2. It is possible that our manipulation was not strong enough, or that our sample size is too small. This is borne out following a Bayesian analysis (Dienes, 2011; 2014; Rouder et al., 2009). Using the default JZS prior we obtained a Bayes Factor of 0.4. This indicates that our data may not be sensitive enough to draw a strong conclusion about the partner role manipulation.
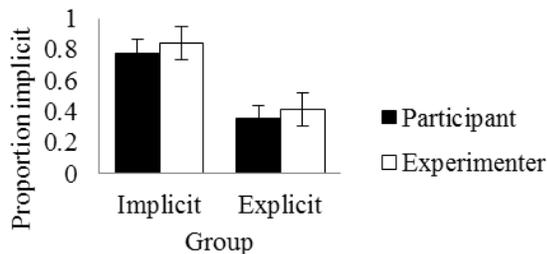

Figure 4. Proportion of implicit descriptions in implicit and explicit group with confederate as participant or experimenter.

There was no interaction between interlocutor role and conversational style ($F (1, 36) = .13, p = .73$, BF = 0.3).

Global priming. We replicated the findings from Experiment 1. Participants in the implicit condition produced more implicit utterances than those in the explicit condition ($F (1, 36) = 45.72, p < .001$, 95% CI = 1.97 – 3.65). This was found irrespective of interlocutor role. The global priming effect was found both when the interlocutor was the experimenter ($F (1, 16) = 19.25, p < .001$, 95% CI = 1.53 – 4.39) and the participant ($F (1, 16) = 30.06, p < .001$, 95% CI = 1.65 – 3.68).

Local priming. As in Experiment 1 there was no effect of prime ($F (1, 32) = .016, p = .90$) or target ($F (1, 32) = 3.58$, p=.068). However, there was an interaction between prime type and target ($F (1, 32) = 6.64$, p=.015). Following an A-card prime participants descriptions of A-card targets were more implicit but when the target was an AB-card descriptions were more explicit.

The general pattern of results was the same when taking each partner role separately. However, there was no significant interaction when the partner was a participant ($F (1, 16) = 3.01$, p=.10, BF = 0.5) or when the partner was an experimenter ($F (1, 16) = 4.18$, p=.058, BF = 0.4). The Bayes Factors give no reason to suggest that these nonsignificant results were anything else but a lack of power.

Discussion

The main findings from Experiment 1 were replicated: Participants were more likely to produce implicit constructions when their interlocutor was using implicit constructions than when they were using explicit constructions. These effects were shown for local and global priming manipulations.

There appeared to be no influence of the social status of the conversational partner. We found no significant main effects or interactions of the partner manipulation. Global priming effects occurred regardless of the partner role, and local priming effects showed similar patterns in both conditions but were narrowly nonsignificant. Overall, we can conclude that the priming effects we observed in Experiment 1 were not due to particular strategies adopted by participants disbelieving that the partner was another participant.

General discussion

We presented two experiments demonstrating that the production of implicatures can be primed. After comprehending an implicature participants were more likely to subsequently produce an implicature. This effect was replicated across two studies and was found both within and between participants. Whilst implicatures are an ostensibly pragmatic phenomenon these experiments suggest that there are distinct representations underlying implicatures and it is the activation levels of these representations that are responsible for the production of implicatures.

Previous research has suggested that socio-pragmatic factors influence the decision about whether to use implicit constructions. For example, people might use implicit language to be more polite or to be more efficient (e.g. Holtgraves & Yang, 1990, 1992; Levinson, 2000). Whilst these factors are likely to be important, our experiments show that they cannot be the only factors involved. In Experiment 1 we did not manipulate any social factors yet participants systematically varied their choice of construction across conditions. In Experiment 2 we manipulated the social status of the conversational partner but found no difference in rates of implicature production as a consequence. Taken together the experiments suggest that there are distinct representations underlying implicatures and their use is not determined entirely by socio-pragmatic factors. Instead, we propose that socio-pragmatic factors may modulate the activation levels of the implicature representations but further work is needed to address this.

Finally, the priming effects we demonstrate speak to the interaction between deriving an inference and producing an implication. Inferring and implying must necessarily use different representations (since one involves comprehension and the other production) but if they were entirely separate we would not have observed priming effects. That deriving an inference primes the production of an implication shows that the representations involved in the two processes overlap. Exactly which representations are used in both, and

which are restricted to the individual processes, is a topic for future research.

Conclusion

Our study makes three novel contributions. We have shown (1) that people can be primed to produce Gricean implicatures (2) that there are factors other than the socio-pragmatic that determine whether a speaker uses an implicit construction (3) that inferring and implying share overlapping mechanisms.

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