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ARTICLE

How speaker cooperation and knowledge prime scalar implicatures

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Abstract
Pragmatic theories generally agree that the derivation of implicit meaning depends on the assumption that the speaker is cooperative and knowledgeable, as well as the contextual relevance of the implicature. Studies on scalar implicature priming have investigated the latter, but the influence of the first two factors remains understudied. Here, we investigated the effect of the presence (or absence) of a cooperative and knowledgeable interlocutor on the derivation of both lexical and ad-hoc scalar implicatures. We found an effect of implicature priming within and across different scales. The presence of an interlocutor increased implicature derivation overall and partially enabled priming effects across lexical and ad-hoc scales. These results provide some support for the existence of a scalar implicature derivation mechanism shared by lexical and ad-hoc scales, and they highlight the importance of the speaker's cooperative attitude and knowledgeability as part of this process. Moreover, they show the importance of psycholinguistic investigations to be carried out using rich conversational contexts that include intentional agents.

Keywords: experimental pragmatics; priming; scalar implicatures; speaker cooperation; speaker knowledge

1. Introduction

Everyday language, as well as literature or political discourse, is rife with implicit meanings big and small. When surveying the supplies for a tea party, for instance, one might utter (1), and they would be likely to be understood as intending to communicate (2).

(1) *Utterance*: John ate some of the cookies.
(2) *Implicature*: John ate some, but not all, of the cookies.

The fact that the speaker chose to utter (1) instead of a more informative alternative, such as 'John ate all the cookies', leads the listener to assume that, as far as the speaker knows, it is not the case that John ate all of the cookies, or they would have said so. Note, however, that (2) is not the literal meaning of (1) but a part of the content communicated implicitly, since 'John ate some of the cookies' could easily be followed by the sentence 'And maybe he ate all of them' without contradiction. We process implicatures such as (2) routinely. Yet, despite much research in this domain over the past few decades, the mechanism that allows us to reach these interpretations and the factors that trigger it, sometimes but not others, are still not fully understood.

The type of implicature generated by utterances like (1) arises from the use of expressions on a lexical scale, such as the quantifiers <some, most, all>. In these scales, the stronger expressions (i.e., <all>) are inherently more informative than the weaker ones (i.e., <some, many, most>; Horn, 1972). While in this type of implicatures, the stronger alternative is linguistically determined, others can be generated by appealing to the context of utterance, which gives rise to an ad-hoc scale, as in the example below.

In a context where there are two boxes: one with a hat and another with both a hat and a scarf.

(3) *Utterance*: Give me the box with a hat.
(4) *Implicature*: Give me the box with a hat and no scarf.

The utterance (3) is taken to convey that the person wants the box which contains only a hat (4) since the stronger contextual alternative (i.e., <a hat *and* a scarf>) is not mentioned. Following Grice (1975), who categorises ad-hoc implicatures as particularised and lexical ones as generalised, the process behind the derivation of the former may be thought to be akin to the one described for the latter, a hypothesis that is supported by data on implicature priming (Bott & Chemla, 2016, but see: Foppolo et al., 2020 for differences found in development).

In the study presented here, we used implicature priming to investigate this mechanism further, and more specifically, whether it involves taking into account the speaker's cooperative intention and knowledge state, as well as whether it is the same for lexical and ad-hoc implicatures.

Following Grice (1975), it is generally agreed that three fundamental ingredients are involved in what Geurts (2010) dubs the 'Standard Recipe' for implicature derivation, including that of lexical or ad-hoc scalar implicatures:

(i) The speaker's cooperativeness
(ii) The speaker's knowledge
(iii) The relevance of the implicature in the context

Grice's (1975) famous cooperative principle, supplemented by a set of conversational maxims, clearly set the tone for the importance in contemporary pragmatics of speaker cooperation, as speakers are expected to make their contribution such as is required for the purpose of the exchange. Additionally, scalar implicatures, such as (2) and (4), cannot arise if the hearer believes the speaker to be agnostic about the state of affairs they describe (the quantity of cookies eaten, or the content of the

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boxes). If this were the case, the utterances in (1) and (3) would give rise to ignorance implicatures (e.g., the speaker does not know whether John ate all the cookies). To reach the scalar implicatures, an additional – 'epistemic' – step is required: the hearer must assume that the speaker is knowledgeable, or is at least opinionated, on the topic at stake (Breheny et al., 2013; Geurts, 2010; Sauerland, 2004). Finally, implicatures are not part of the linguistically encoded content of an utterance and, as mentioned earlier, they can be denied or not arise at all if they are not relevant in a particular context. For instance, in a context where John is known to be severely allergic to the peanuts in the cookies, the utterance of (1) while discussing why John is not feeling well is unlikely to trigger the implicature (2) that he did not eat all of the cookies. Despite some terminological differences, there is a general agreement in post-Gricean pragmatics that the likelihood of an implicature being derived should be affected by these three factors: (i) the speaker's cooperativeness and (ii) their knowledgeability, as well as (iii) the relevance of the implicature in context (Carston, 1998; Geurts, 2010; Horn, 1972, 1984; Recanati, 2004; Wilson & Sperber, 2004; Sperber & Wilson, 1986, 1995).

1.1. Implicature priming

One of the key factors in the standard recipe has been extensively investigated experimentally: priming paradigms have been used to investigate the implicature derivation mechanism by probing the role of the relevance of the implicature in the context (iii) in various ways.

Bott and Chemla (2016) first explored the possibility of priming implicature interpretation. They developed a paradigm to investigate whether implicatures shared a derivation mechanism across different linguistic expressions and if such a mechanism could be primed. In their task, participants were given a sentence such as 'Some of the symbols are clubs' and asked to select, between two cards, the one that fits the description best. They saw sets of two prime trials followed by a target trial. The two prime trials induced either a strong (that is, implicature-bearing) or a weak interpretation (that is, compatible with stronger alternatives), then in the target trials, participants had to choose the best card to fit a sentence with a scalar term: either a visible card compatible with the weak interpretation or a potentially better picture that was not visually accessible. The choice of the inaccessible card was taken as a measure of implicature derivation. Three types of scales were investigated – a lexical scale ('some of the symbols are Xs'), an ad-hoc scale ('there is an X') and a numeral scale ('There are four Xs') – and priming was performed both within the same scale (e.g., lexical scale for primes – lexical scale for target) and across different scales (lexical scale for primes – ad-hoc scale for target). Their results suggest that priming the desired interpretation is possible, especially within the same scale. The authors also found a main effect of prime across different scales. However, in their model, the effect of across-scale priming was assessed with an overall analysis (including all possible combinations between the three scales they had). Since there was no analysis of specific across-scale effects (ad-hoc prime to lexical target, or vice versa), it provides no insight into the specific combinations or target scales.

Subsequently, Rees and Bott (2018) used the same priming paradigm to assess whether the effect found by Bott and Chemla (2016) in the within-scale condition might be due to the scale being made salient, rather than priming of the implicature

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mechanism. To do so, they added a condition – the alternative prime – in which the first two elements of their triad of stimuli were not strictly priming, but simply examples of proper use of the more informative alternative (i.e., the quantifier <all>). In this new condition, participants produced implicatures at the same rate as in the strong prime condition, thus suggesting that the salience of the alternative is indeed relevant to implicature derivation, an effect also later confirmed by Bott and Frisson (2022).

Other studies, such as Waldon and Degen (2020) and Marty and colleagues (2024), replicated Bott and Chemla's (2016) original design but introduced a key baseline condition, assessing scalar interpretation in the absence of priming. This enabled them to show that the contrast between strong and weak priming is driven not only by strong primes increasing implicature derivation but also by weak primes decreasing it. Based on their results, and in line with a hypothesis originally made by Bott and Chemla (2016), Marty and colleagues (2024) proposed that the effect found for strong and weak primes is one of inverse preference: the weak prime affects participants who show a preference for the strong interpretation in baseline trials, while the strong prime influences participants who have an initial preference for the weak interpretation.

In all the experiments described above, participants saw sentences on the screen which they had to match with a card picture. However, there was no indication that these sentences were produced by an interlocutor with their own perspective or intentions. Cooperativeness and knowledge were, therefore, not assessed in previous studies. To the best of our knowledge, Meyer and Feiman (2021) conducted the only implicature priming study including a narrator; however, in their paradigm, the narrator was construed as an inconsistent informant, neither reliably cooperative nor knowledgeable.

Overall, scalar priming experiments have established quite convincingly that the likelihood of an implicature being derived relies crucially on its relevance in context, a conclusion also more generally supported by both adult (Yang et al., 2018) and developmental findings (Rees et al., 2023; Skordos & Papafragou, 2016). None of them, however, can vouch for the importance of the two other ingredients of the 'Standard Recipe' for implicature derivation: the speaker's cooperativeness and knowledge. An empirical investigation focusing precisely on these is, therefore, called for, as the presence (or absence) of an interlocutor may also prove to be of methodological consequence.

1.2. Speaker influence on implicature derivation

As discussed in Section 1.1, there is a fair amount of theoretical agreement on the Standard Recipe and the importance of speaker cooperativeness (i) and knowledge (ii), as well as the implicature's relevance in context (iii) for implicature derivation. Existing priming data strongly support the effect of relevance in context on the likelihood of implicature derivation, yet it should not be the only contender. Indeed, the speaker's mental states may systematically impact implicature derivation; alternatively, they could be considered *only* in those specific cases in which knowledge and/or cooperation are directly at stake.

Experimental evidence has shown that speaker cooperation and speaker knowledge do impact implicature derivation when they are directly at stake: the absence of

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either hinders the process. Participants will derive more implicatures in a game when their (virtual) interlocutor is presented as a cooperator than when they are competitors (Dulcinati, 2018), as well as adjust their implicature *production* depending on whether they communicate within a competitive or cooperative game (Franke et al., 2019). The interpretation of the same utterance containing the quantifier <some> can also vary depending on whether the speaker is consistently fully informative or consistently under-informative (Yildirim et al., 2016). Similarly, consideration of speaker knowledge has been shown to influence implicature derivation (Bergen & Grodner, 2012; Spychalska et al., 2021; but see Katsos et al., 2023). Developmental studies also indicate that whether the speaker is knowledgeable about the relevant state of affairs will impact the interpretation of a scalar implicature (Kampa & Papafragou, 2019; Papafragou et al., 2018; but see Wilson et al., 2022). Whether a speaker is thought to be motivated by politeness (Mazzarella et al., 2018) or considered reliable (Grodner & Sedivy, 2011) will also influence implicature endorsement. These results lend support to the view that the attribution of knowledge states and communicative intentions to the speaker influences scalar implicature derivation.

It is important to note, however, that in previous designs a contrast between two different types of speakers was presented, making an evaluation of each speaker's mental state necessary to the resolution of the task. It is, therefore, impossible to disentangle whether participants engage in mental state reasoning because it is required by the task structure or because it is inherently part of the implicature derivation process. It is not yet established whether the speaker's knowledge or cooperativity would still influence participants' derivation of implicatures in a task that does not require consideration of the speaker's mental state to be solved, and whether a difference can be found between the presence of an explicit speaker, cooperative and knowledgeable and the absence of its mention. If considerations about the speaker are indeed fundamental for the implicature derivation mechanism, mental state reasoning should, in principle, be employed regardless of its necessity. Furthermore, if a derivation mechanism that employs mental state reasoning is shared by ad-hoc and lexical implicatures, priming implicatures across the two scales should be facilitated by the presence of a cooperative and knowledgeable speaker, as this should add to the likelihood of the mechanism being used and the implicature being derived.

We, therefore, propose to experimentally investigate how the presence of a speaker, specifically one who is knowledgeable and cooperative, influences the likelihood of the hearer deriving a scalar implicature in a priming task. Given the literature presented above, we expect it to have a facilitating effect on implicature processing. Demonstrating the role of these two factors would inform theories on implicature derivation and could shed light on whether different types of scalar implicatures (lexical or ad-hoc) are derived through a shared mechanism. We used the priming paradigm so that all three main elements of the standard recipe for scalar implicature derivation are represented. Priming is uniquely well-suited to probe the cognitive architecture underlying implicature derivation, as it provides insight into whether certain interpretive processes are facilitated based on prior exposure. By introducing a cooperative and knowledgeable interlocutor into a priming paradigm, we aim not merely to test participants' sensitivity to speaker-related cues (as prior studies have done) but also to assess whether these cues modulate the likelihood of an implicature being derived when the task does not demand reasoning about the

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speaker. In doing so, we aim to establish whether speaker-related factors are part of the implicature derivation mechanism itself, rather than simply recruited when they are pragmatically required by the task.

2. Experiment 1

We manipulated the presence (or absence) of a knowledgeable and cooperative interlocutor in a structural priming task inspired by Bott and Chemla's design (2016), where we expected the presence of an interlocutor to have two effects.

First, if we assume, following post-Gricean theories and recent empirical data, that the mechanism by which a listener derives implicatures is reliant on speaker cooperativeness and knowledgeability, we should expect an overall change in implicature derivation rates, with implicatures being derived more often in the presence of a cooperative and knowledgeable interlocutor than in its absence. Crucially, this prediction holds under the assumption that the implicature is relevant in the context: when relevance is granted, a cooperative and knowledgeable speaker is expected to license the implicature. This entails that an increase in implicature derivation is not necessarily expected after weak interpretation priming, which decreases the relevance of the implicature.

Second, we should observe a stronger effect of implicature priming across different scales (lexical and ad-hoc) in the presence of an interlocutor: if both types of implicature are derived through a shared mechanism involving intention-reading and perspective-taking, the presence of a cooperative and knowledgeable speaker should facilitate the priming of this mechanism across different scales. Based on this assumption, we predicted that an effect of interlocutor in across-scale priming should be seen when the strong or weak interpretation of the scalar term is being primed, directly affecting a potentially shared implicature derivation mechanism, but not in the case of alternative priming (as introduced by Rees & Bott, 2018), which only amounts to making the most informative alternative *on the specific scale* more salient.

2.1. Method

2.1.1. Participants

Participants were recruited using the online Prolific.com platform. They did the experiment anonymously after providing informed consent and were compensated at a rate of 6£/h. We collected data from 208 UK resident English native speakers aged between 18 and 60, who declared no cognitive impairments and had normal or corrected-to-normal vision. The sample size was estimated based on previous experiments using similar methodologies (Bott & Chemla, 2016; Dulcinati, 2018; Marty et al., 2024; Rees & Bott, 2018; Waldon & Degen, 2020). Participants who answered incorrectly to more than 25% of the filler items were excluded ($n = 13$). The analysis was therefore carried out on a total of 195 participants (145 female, 46 male, 4 preferred not to say or declared their gender to be other than female or male; 74 aged 18–30; 85 aged 31–45 and 38 aged 46–60): 95 participants were assigned to the Interlocutor Present condition and 100 to the Interlocutor Absent condition. In the Interlocutor Present condition, participants were led to believe that they were interacting with another person when the responses had in fact been pre-programmed. This was disclosed in a short debrief at the end of the session, and

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participants were asked to confirm their consent again. One participant did not give consent after the debriefing phase; they were excluded from the study, and another participant was recruited in their place.

2.1.2. Materials

Participants played a game in which they were shown two cards and had to choose the winning one based on a description. We used a modified version of previous implicature priming tasks, to which we added elements from Dulcinati's (2018) design. In each trial, participants were presented with a written sentence and pictures of two cards. As in previous priming experiments, the task included two types of trials: primes and targets. Each target trial was preceded by two prime trials, in which both cards were visible. In the target trials, only one of the two cards was visible, while the other was covered. The description of the winning card in the critical trials included either a lexical or an ad-hoc scalar expression – see example in (5) for a lexical scale trial.

(1) On the winning card, some of the symbols are stars.

Crucially, in target trials, this would be an acceptable description of the visible card only if the participant interpreted it without deriving the scalar implicature (e.g., because on the visible card, all symbols would be stars). If participants did derive the implicature, they would have to choose the covered one. The numeral scale, which was previously tested in priming designs, was omitted.[1] Before target trials, participants were exposed to four types of prime trials: Strong, Weak, Alternative and Baseline. The two trials preceding any given test trial were always of the same type. Trials priming a Strong interpretation induced a strong reading of the sentence, requiring the derivation of a scalar implicature to guess the winning card. For instance, for a sentence like (5), it would consist of a card where only some of the symbols are stars and a card where all of them are. On the contrary, the trial priming a Weak interpretation elicited a weak reading of the scalar item ('some and possibly all' for *some*). Thus, for a sentence like (5), it would involve a card where all of the symbols are stars and a card where none of them are. Contrary to Weak and Strong priming, which primed participants with a specific interpretation of the scalar term, the Alternative prime trials provided a more informative alternative to the scalar item used in the target. In this case, for (5), the sentence presented would contain the quantifier *all* instead of *some.* Finally, the Baseline trials aimed to inform us of how participants understood the target trials in the absence of direct priming; the information provided in these trials did therefore not refer to the symbols on the cards but to the colour on the card (e.g., 'The winning card is green').

An example of the materials in the two scales used (lexical and ad-hoc) is given in Figures 1 and 2.

Following Bott and Chemla's (2016) original design, priming could occur within the same scale (e.g., two primes presenting lexical scalar expressions followed by a target on the same scale) or across different scales (e.g., two primes presenting ad-hoc

[1]This choice was made for two reasons: first, there is evidence that numerals do not prompt the derivation of implicatures in the same way as lexical or ad-hoc scales (Marty & Chemla, 2013). Additionally, numerical expressions describe sets of items very precisely, more so than the quantifier 'some' or the indefinite article, and it has been shown that naturalness ratings for 'some' applied to small sets of objects decrease if numerical expressions are contextually available (Degen & Tanenhaus, 2015).

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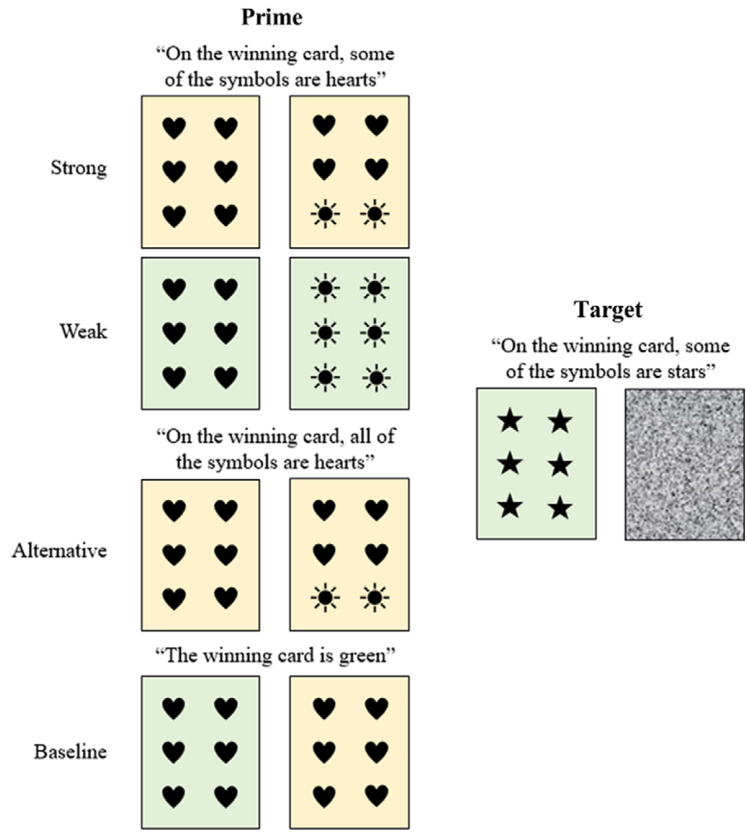

Figure 1. Example of items in the lexical scale (Experiment 1).

scalar expressions followed by a target containing a lexical scalar expression). The two primes preceding a given target, however, were always on the same scale.

The experiment also contained filler trials. Filler items presented the same structure and the same two scales of the experimental items, but they did not present any under-informative or pragmatically ambiguous expressions (for the lexical scale, fillers only contained <all> and <none>, while for the ad-hoc scale, they only contained <there is an X and a Y> or <there are no Xs>).

The main difference with previous designs was the introduction of an 'Interlocutor' between-subject condition: half the participants were led to believe they were interacting with other players, while the other half did not. To make this possible, we emphasised that the task was a game where participants had to find a winning card – unlike designs of previous studies where they were asked to imagine a potential 'Better picture' to fit the description (e.g., Bott & Chemla, 2016; Marty et al., 2024; Rees & Bott, 2018).

In the Interlocutor Present condition, the belief that the participant was playing with an interlocutor was induced in the following way: participants were told that they were playing a cooperative game with other players who had pre-recorded descriptions for the cards after being introduced to the game. These (imaginary)

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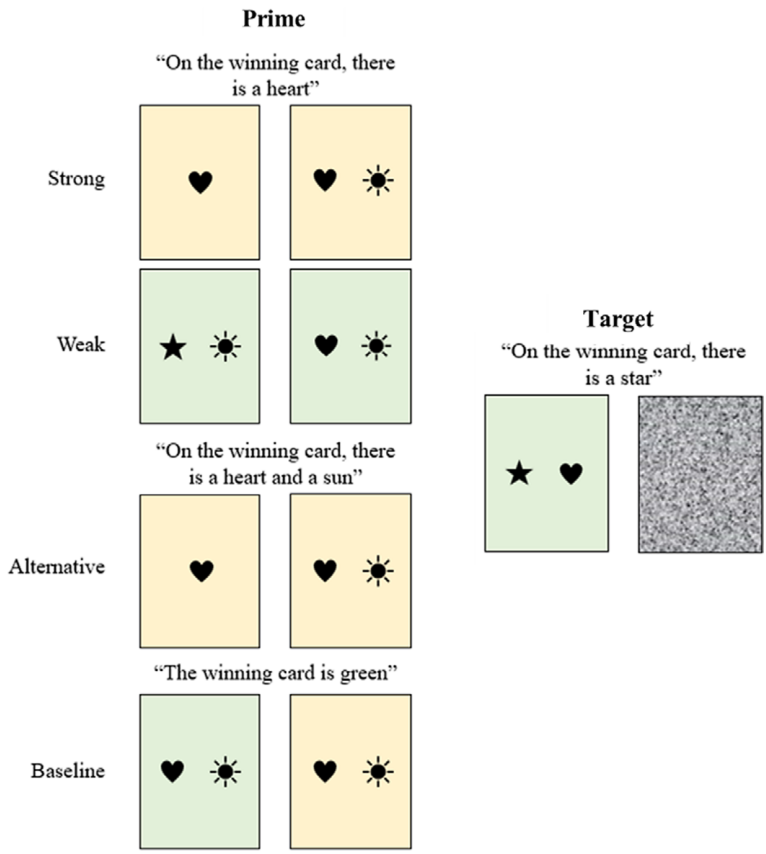

Figure 2. Example of items in the ad-hoc scale (Experiment 1).

interlocutors had been shown pictures of the two cards and told which one was the winning one. They were instructed to write down a helpful description for the participant, their aim being to get the participant to pick as many winning cards as possible. The interlocutors were said to always see both cards but did not know which card would ultimately be invisible to the participant, since the covered card was chosen randomly by the computer programme after they had written their description. This way of introducing interlocutors aimed to lead participants to believe they were communicating with knowledgeable players who were actively trying to help them win the game. In our task, ingredients (i) and (ii) of the Standard Recipe were, therefore, implemented together, since the interlocutors were portrayed as both cooperative and knowledgeable.

The Interlocutor Absent condition, on the other hand, followed the presentation of previous experiments. While the experimental items were the same, no interlocutor was introduced: participants were simply told that in the game they would play, they had to find the winning card out of two with the help of a description that would appear on the screen. They were, furthermore, warned that sometimes they would have access to both cards visually, while other times the computer programme would randomly cover one of the two cards.

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Weak interpretation priming trials featured under-informative descriptions, which could appear surprising in a cooperative setting such as the Interlocutor Present condition. The production of both fully informative and under-informative descriptions by the same interlocutor might seem even more surprising. For this reason, we led the participants in the Interlocutor Present condition to believe that they were informed by more than one interlocutor. Four anonymous (imaginary) interlocutors were implemented using a coloured circle positioned next to the describing sentence. This circle was of a different colour and featured a different set of initials to identify the interlocutor it was meant to represent (e.g., JC in a blue circle; common initial letters for name and surname not associated with any specific gender were chosen). Participants were made aware that the author changed in different trials from the change of circle colour and initials next to the describing sentence. There was no aim in this design that participants should consciously recognise whether an interlocutor was fully informative or not, but introducing more than one interlocutor was meant to allow for the alternating between weak and strong primes without apparent contradiction in willingness to cooperate. A single interlocutor (same initials, same colour circle) authored all descriptions of any triplet (two primes and target). One of the four interlocutors was always presented as the author of strong primes, another of weak primes and a third of alternative primes, while the fourth was only assigned to filler trials. To underline the presence of an interlocutor further, in the Interlocutor Present condition, the appearance of the describing sentence on the screen was preceded by the three dots usually signalling typing. The Interlocutor Absent condition did not include this feature. Nonetheless, the coloured dot appeared in this condition, too, with the change of colour following the same pattern as in the Interlocutor Present condition, but they did not feature initials. An exemplification of how the coloured dots were shown in both interlocutor conditions can be seen in Figure 3.

2.1.3. Design

Our design includes one between-subjects and three within-subjects independent variables. The first within-subjects variable is the scale presented on the target: Lexical <none/some/all> (e.g., 'Some of the symbols are stars') or Ad-hoc (e.g., 'There is a star'). The scale could then remain the same in any prime-target pair, or the scales can interact; a second within-subjects variable pertains to whether the prime and target trials used the same scale (within-scale priming) or different scales (across-scale priming). The last within-subjects variable is the prime type: strong interpretation, weak interpretation, alternative or prime-less baseline. The type of instructions involving the presence or absence of an interlocutor is a between-subjects variable (Interlocutor Present/Absent).

Figure 3. An example of a coloured dot in the interlocutor present (on the left) and in the interlocutor absent (on the right) conditions. Coloured dots were presented on the left of each description of the winning card.

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Each participant completed 70 trials of triplets; each composed of two primes and one target. A first practice block of eight trials of filler items was used to familiarise the participants with the game. A block of 10 baseline trials followed: four experimental (two baseline trials for each scale) and six fillers (in filler items, participants were only given sentences about the colour of the card). To pace the participants, the remaining 52 trials were presented in two blocks of 26, each including 12 experimental trials and 14 filler trials. To present all the conditions, of the 12 experimental trials, 4 were in the Strong, 4 in the Weak and 4 in the Alternative condition; for each of these sets of 4, two were Within and two were Across scale, one with Lexical and one with Ad-hoc scale in each case. The same three symbols were presented within each prime–prime–target triad (e.g., moons, hearts and suns), but the symbols were different for all triads in the same block.

2.1.4. Procedure

Participants were asked to complete the experiment in a quiet environment, free from distraction. Each participant completed the practice block and received feedback on the percentage of rounds they had won. Then, they were warned that the experiment was about to begin and that it would be divided into three blocks. They were asked to only take breaks in between blocks and received their total percentage of winning cards after they completed the three blocks. Participants were randomly assigned to one of the two between-subjects conditions (Interlocutor Present or Absent). Within each block, the items were presented in random order. The baseline block was presented first to all participants to avoid their answers being influenced by previous instances of priming. The order of the other two blocks was counterbalanced between participants. The position of the correct card in the primes and targets was also counterbalanced between participants.

2.2. Results

2.2.1. Analysis procedure

The choice of the covered card in target trials was interpreted as a measure of implicature derivation labelled as 1 against the choice of the visible one (0), and a measure of the proportion of implicature derivation was calculated based on these values. Implicature derivation on target trials was then the dependent variable. Generalised linear mixed models with binomial distribution were fitted to analyse the data using the lme4 package in R (Bates et al., 2015). Two separate models were used: one to analyse only data in trials in the Within condition scale (Within GLMM) and another to analyse data in trials in the Across condition (Across GLMM). The fixed structure for both GLMMs consisted of the three independent variables (Interlocutor, Target scale and Prime type), as well as their interaction as fixed factors. The random structure was selected in a data-driven procedure, starting with the most simple models including only intercepts for subject variability and item[2] variability, then adding slopes and comparing the AIC of different models to choose the one that was the best fit for the data and did not lead to a singularity fit. In coding the fixed factors, the Target scale was sum-coded as −1 (Ad-hoc scale) and + 1 (Lexical scale), the Interlocutor variable was sum-coded as −1 (Interlocutor Absent) and + 1 (Interlocutor Present). Finally, contrast coding was employed for the Prime

[2]Each triad, consisting of two primes and one target was classified as an item.

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type variable to ensure that each priming condition was tested relative to the baseline, allowing for a straightforward interpretation of model coefficients. Following the GLMMs, post-hoc analyses were also performed to compare implicature proportions in the different conditions directly.

The full outputs of the GLMM can be found in the Supplementary Materials. The data, analysis codes and stimuli for the present study, as well as its pre-registration, are available through the Open Science Framework (https://osf.io/ug4b2/).

2.2.2. Analysis

Figure 4 shows the proportion of implicature derivation in target trials.

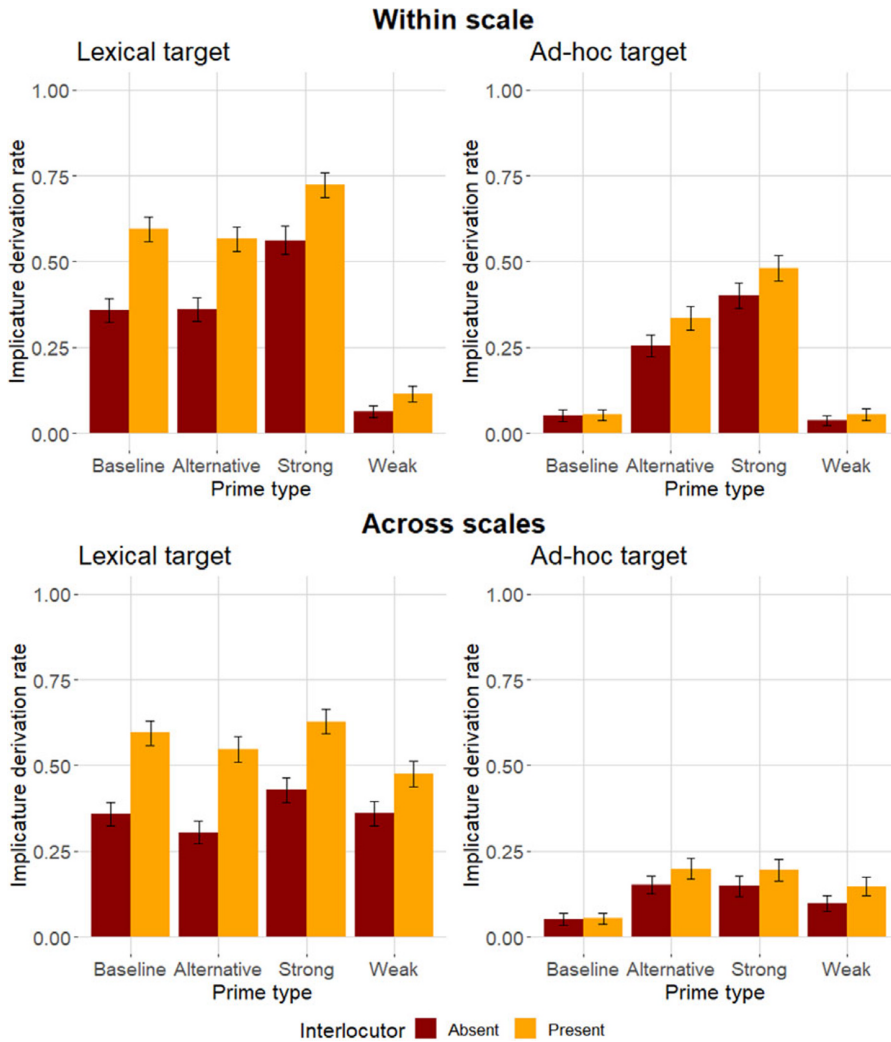

Figure 4. Proportion of implicature derivation for each condition in Experiment 1, with error bars based on standard errors.

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2.2.3. Within GLMM results

The results of the GLMM show a positive effect of the target scale (β = 0.787, $p < 0.001$) and of interlocutor presence (β = 0.338, p = 0.037), as well as their interaction (β = 0.186, p = 0.027). Concerning priming, all three contrasts produce a significant effect, positive for strong interpretation (β = 1.700, $p < 0.001$) and alternative priming (β = 0.795, $p < 0.001$) and negative for weak interpretation priming (β = −2.062, $p < 0.001$). Interestingly, negative interactions between all three prime types and the target scale are also found (for alternative: β = −0.286, p = 0.002; for strong interpretation: β = −0.265, p = 0.011; for weak interpretation: β = −0.447, p = 0.002).

The results show that the priming paradigm was very effective within scales and that different priming patterns can be observed for the two scales. To further investigate the interactions detected between the target scale and priming condition, we conducted post-hoc pairwise comparisons using estimated marginal means. The analyses of these contrasts confirmed a hypothesis previously made by Marty and colleagues (2024): for the ad-hoc scale, it is mainly the alternative (Z *ratio* = −8.603, $p < 0.001$) and strong interpretation (Z *ratio* = −11.149, $p < 0.001$) primes that have an effect in increasing implicature derivation, while for the lexical scale, it may be that the strong interpretation prime increases implicature derivation (Z *ratio* = −4.393, $p < 0.001$) or that the weak interpretation prime decreases it (Z *ratio* = 11.460, $p < 0.001$).

2.2.4. Across GLMM results

The model for across priming replicated some of the effects of the Within GLMM. In terms of simple effects: a positive effect of target scale (β = 1.278, $p < 0.001$), interlocutor (β = 0.416, $p < 0.001$) and strong interpretation prime (β = 0.423, $p < 0.001$). In terms of two-way interactions, a positive interaction between interlocutor presence and target scale (β = 0.190, p = 0.031), and a negative interaction between target scale and alternative prime type (β = −0.406, $p < 0.001$). These effects provide evidence that priming across different scales is possible.

There is a main difference between the Across and Within GLMMs, which regards weak interpretation priming. It would appear that in the Within-scale condition, the effect of the weak interpretation is visible regardless of the presence of the interlocutor, while in the case of the Across condition, there is a marginally significant negative interaction between weak interpretation prime, interlocutor and target scale (β = −0.189, p = 0.054). This three-way interaction was not detected in the Within GLMM. The connection between the presence of the interlocutor and the possibility of across-scale priming was one of the main research questions of this study; therefore, a further analysis concentrating on the Across-scale condition was performed.

A pairwise comparison using emmeans was performed post hoc on this interaction. The results showed that for ad-hoc targets, an effect of alternative and strong interpretation priming in increasing implicature derivation is seen in both interlocutor conditions, and unexpectedly, the same effect is seen for weak priming, but only for the interlocutor condition (Z *ratio* = −1.379, p = 0.006). In the case of lexical targets, there are no significant differences between baseline and any of the priming conditions in the Interlocutor Absent condition, but in the Interlocutor Present condition, there is a significant difference between baseline and weak interpretation

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prime (*Z ratio* = 2.688, $p = 0.036$). This result is particularly relevant for our purposes: one of the two effects of priming that were evident in the Within GLMM, both in the presence or in the absence of an interlocutor, can be detected in across-scale priming only in the presence of an interlocutor – that is, the effect of weak interpretation priming in decreasing implicature derivation for the lexical scale.

2.3. Discussion

In Experiment 1, we added the presence of a knowledgeable and cooperative interlocutor as a between-subjects variable in a structural priming paradigm to assess the role of speaker knowledge and cooperation in implicature derivation and whether a single implicature derivation mechanism is at play for both lexical and ad-hoc scales. Our two main hypotheses were that the presence of an interlocutor would increase implicature derivation overall but also promote implicature derivation across different scales. Both predictions were, in part, borne out: we found that the presence of a knowledgeable and cooperative interlocutor in a structural priming paradigm increases implicature derivation and also enables priming across scales on lexical scale targets.

These results, however, leave open some questions, especially one concerning the difference between lexical and ad-hoc scales. In line with previous results, we found different patterns for the two scales. More importantly, setting aside the effect of priming, the results suggest that the presence of an interlocutor affects the derivation of lexical implicatures more than ad-hoc implicatures, as shown by the interaction detected in both models, as well as the priming patterns in the Across GLMM. Should we conclude then that speaker knowledge and cooperation are not involved to the same extent in ad-hoc quantity implicature derivation?

Before engaging with this question directly, let us consider a difference between lexical and ad-hoc scales, which might have influenced responses. While for lexical scales the more informative alternative is provided by the lexicon stored in memory (e.g., <all> for <some>), for quantity implicatures it is provided by the context. This may have given rise to an unintended bias in our experimental design, where there is an impoverished communicative context. The absence of a rich context created an imbalance, as context is necessary to the construction of alternatives in ad-hoc scalar implicature, while the lexical alternative remains accessible. We tried to address this potential confound by modifying the experimental items to restrict the range of possible alternative scenarios available in the ad-hoc scale items.

3. Experiment 2

To control for a potential effect of the setup of the experimental items on the results of Experiment 1, we ran a follow-up study with modified materials. In Experiment 2, a limitation of the potential contextual alternatives available for ad-hoc trials was achieved by modifying the representation of the covered card: from fully covered to partially covered, where only the symbols represented on the card are covered instead of the whole surface (see Figure 5). If our hypothesis is correct, the Interlocutor effect should increase for ad-hoc implicature trials and become comparable to the effect seen for lexical implicatures. Alternatively, the proportion implicature derivation for ad-hoc scales could increase with this type of item, regardless of the

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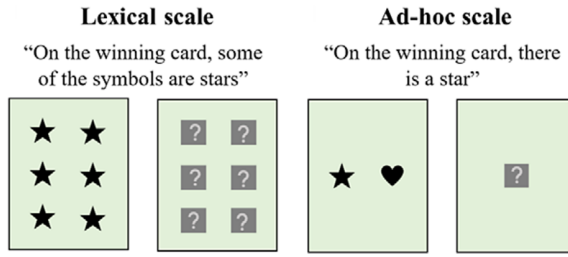

Figure 5. Example of target items in Experiment 2.

interlocutor. The results could indicate that design-related features led previous experiments to underestimate ad-hoc implicature derivation.

In Experiment 2, we reduced the number of variables – and therefore of items – by only including Withing scale priming.

3.1. Method

3.1.1. Participants

Participants were recruited and tested as in Experiment 1. Since Experiment 2 included fewer conditions and items, we reduced the number of participants roughly by half, and we collected data from a total of 112 neurotypical native English speakers residing in the UK, aged between 18 and 60. Again, participants who answered incorrectly more than 25% of the filler items were excluded (2). The analysis was carried out on 110 participants (82 female, 27 male, 1 preferred not to say or declared their gender to be other than female or male; 33 aged 18–30; 52 aged 31–45 and 25 aged 46–60): 56 were assigned to the Interlocutor Present condition and 54 to the Interlocutor Absent condition.

3.1.2. Materials

We modified the materials to limit potential alternatives in the ad-hoc target trials: only the symbol(s) of the 'covered' card in target trials would be covered, rather than the entire card. This way of partially covering the card enables the participant to deduce that the covered card in the ad-hoc target trials features only one (hidden) symbol. In the lexical scale condition, six symbols were covered on the partially covered card, and this was not predicted to change the results significatively. An example of new target items for both scales is given in Figure 5.

3.1.3. Design

The Sameness variable was omitted in Experiment 2 and participants only saw the Within-scale condition of this variable. Experiment 2, therefore, presented only three independent variables: one between-subjects variable (Interlocutor) and two within-subjects variables (Target scale and Prime type).

3.1.4. Procedure

The procedure was the same as Experiment 1, the only difference being that the blocks contained fewer items, as Experiment 2 contained fewer variables.

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3.2. Results

3.2.1. Analysis plan

For Experiment 2, the same strategy for data analysis was implemented as for Experiment 1. However, as priming was performed only within the same scale, only one model was fitted.

3.2.2. Analysis

In Experiment 2, the presence of an interlocutor had a significant effect in increasing overall implicature derivation ($\beta = 0.405$, $p = 0.009$), but in contrast with Experiment 2, no significant interaction between interlocutor presence and target scale was detected ($\beta = -0.035$, $p = 0.702$).

Figure 6 shows implicature derivation in target trials. The other simple effects found in the Within GLMM of Experiment 1 were also seen in Experiment 2: the positive effects of the target scale ($\beta = 0.713$, $p < 0.001$), alternative prime ($\beta = 0.935$, $p < 0.001$) and strong interpretation prime ($\beta = 1.557$, $p < 0.001$) and the negative effect of weak interpretation prime ($\beta = -1.874$, $p < 0.001$). Concerning the interactions between the target scale and prime type, we again found a negative interaction of the target scale with alternative primes ($\beta = -0.237$, $p = 0.044$), but not of the other two prime types.

The modification proposed in Experiment 2 affected the results, as the interaction between target scale and interlocutor presence is no longer detected within this model, and additionally, fewer interactions between target scale and prime types are detected.

3.3. Discussion

In Experiment 2, we implemented a modification of the paradigm meant to address a potential confounding factor of Experiment 1. Following our predictions, after this

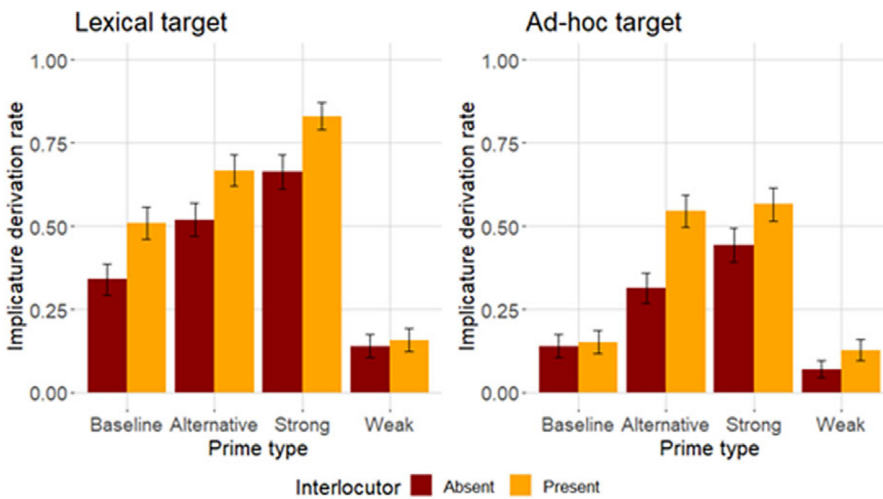

Figure 6. Proportion of implicature derivation for Experiment 2, with error bars based on standard errors.

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modification, we only found an effect of interlocutor presence on implicature derivation, with no interactions between interlocutor presence and target scale. The effect of the interlocutor is, therefore, present in Experiment 2, regardless of the scale being used. This result is important, as it suggests that speaker knowledge and cooperation play a part in both types of scalar implicatures, contrary to what might have been concluded from the results of Experiment 1. These findings further suggest that our hypothesis regarding the importance of context and available alternatives in a task with ad-hoc implicature was sensible. It is possible that previous studies underestimated ad-hoc implicature derivation due to the methodological issue investigated here.

The results of this second experiment regarding the role of the interlocutor bring further support to the idea that ad-hoc and lexical implicatures share a derivation mechanism, and to the idea that this mechanism is, to some extent, dependent on intention-reading and perspective-taking, which enable the hearer to assess speaker knowledge and cooperation. Still, in this paradigm, as well, we seemed to detect very little effect of the presence of an interlocutor in the baseline trials for the ad-hoc scale. Note, however, that while our manipulation reducing the number of potential alternatives in Experiment 2 had an effect, this modification still left the context partially undefined. Consider the example in Figure 5: in the ad-hoc target, the question mark could cover another bell, but also a third, different symbol; such a scenario would then license the use of the sentence 'there is a star' to describe the visible card felicitously. The context-driven character of ad-hoc implicature makes the issue not entirely solvable in a task such as the present one.

4. General discussion

The two experiments presented here aimed to investigate the role of speaker cooperation and speaker knowledge in scalar implicature derivation, as well as clarify whether implicatures elicited by lexical and ad-hoc scales can be accounted for by the same process. To do so, we manipulated the (imaginary) presence of a knowledgeable and cooperative interlocutor as a between-subjects variable in a priming paradigm.

Our two main hypotheses were that the presence of an interlocutor should increase implicature derivation overall but also promote implicature derivation across different scales. In Experiment 1, our predictions were partially met: a positive effect of interlocutor presence, both overall and in across-scale priming, was detected. Unexpectedly, in Experiment 1, we also found a positive interaction between the presence of an interlocutor and the target scale used, which was interpreted as showing that the interlocutor had more of an effect on the lexical scale than on the ad-hoc one. A modification of the paradigm in Experiment 2, which restricted the number of possible alternative scenarios in target items, provided evidence that this interaction could be imputed to design features. These results establish that considerations about speaker knowledge and cooperation feed into the implicature derivation process both for lexical and ad-hoc scales. A conclusion which, in turn, informs theoretical approaches to scalar implicatures. The findings also yield important methodological implications for experimental pragmatics: the presence or absence of an interlocutor was shown to be a highly relevant variable in tasks on pragmatic interpretation. Additionally, the effectiveness of the modification made in Experiment 2 provides evidence that little changes

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in the mode of presentation of the stimuli, and thus the conversational context, can have a significant impact on participants' performance.

Overall, the results are consistent with previous findings on implicature priming and provide new insights on the two issues we focused on: the role of an interlocutor in the task, which highlights the importance of speaker cooperation and knowledge in the implicature derivation process, and whether lexical and ad-hoc scalar implicatures can be accounted for by the same derivation mechanism, which relies on intention-reading and perspective-taking. We will discuss these points, in turn, in more detail.

4.1. Replications of previous studies

Our study replicates most of the findings of previous research on implicature priming. As in other studies, in Experiments 1 and 2, we found significant priming effects when primes and targets were on the same scale as well as across different ones (Bott & Chemla, 2016). We also found that ad-hoc implicatures were derived less often than lexical ones by adults (Bott & Chemla, 2016; Marty et al., 2024; Rees & Bott, 2018; Waldon & Degen, 2020). In line with previous experiments that included a baseline measure, we found that in the case of ad-hoc implicatures, it is the priming of the strong interpretation and the presentation of the more informative alternative that drove the increase in the proportion of implicature derivation. In the case of lexical implicature, on the other hand, both weak and strong priming affect implicature derivation, but not alternative priming (Marty et al., 2024; Waldon & Degen, 2020). This difference in priming patterns will be further explored below in the 'Lexical versus ad-hoc scales' section.

In addition to introducing an interlocutor – a factor we will discuss in the next section – our study also differed from previous work in how the task was framed. Specifically, participants engaged with the task as part of a game, potentially introducing different stakes or motivations compared to the more neutral task framing involving a potential 'Better picture' used in earlier studies. Despite this variation, however, we replicated the main effects reported in prior research. This suggests that the game-like context did not substantially alter participants' pragmatic inferences, which, in turn, supports the robustness of implicature priming effects across different task framings.

4.2. Speaker influence on implicature derivation

Our results demonstrate that introducing an interlocutor in a scalar implicature structural priming task has a significant effect: it increases implicature derivation and can facilitate priming across different scalar expressions. Thus, communicative context in general, and the presence of a speaker in particular, modulate pragmatic processing. The explicit presence of a communicative partner likely prompts listeners to engage in mental state reasoning. In line with the Standard Recipe for implicature derivation, then, if this communicative partner is cooperative and knowledgeable, considering their mental states (such as beliefs, intentions and communicative goals) enhances the likelihood of pragmatic enrichment. An effect of interlocutor presence on the participants' responses had already been detected in experimental linguistics paradigms using a range of tasks and investigating a variety of linguistic phenomena

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(Cai et al., 2021; Kapiley & Mishra, 2019; Molnar et al., 2015; Schoot et al., 2019; Symeonidou et al., 2016). Additionally, the presence of another person has even been found to affect task performance in non-conversational contexts with no apparent need for perspective-taking (e.g., the Simon task, Sebanz et al., 2003). Based on the latter data, one could argue that in our paradigm, the effect of the interlocutor is unrelated to perspective-taking or intention-reading. Nonetheless, the present results do not seem to support this explanation. In Experiment 1, we found significant interactions between interlocutor presence and target scale in both GLMMs, as well as an interaction between interlocutor presence, target scale and prime type in the Across GLMM. Yet, an effect of interlocutor presence independent from pragmatic meaning interpretation should have affected both scales equally, and there would be no reason for the presence of an interlocutor to interact with priming if the effect was not related to implicature interpretation.

Our findings are in line with previous findings on speaker adaptation (e.g., Schuster & Degen, 2020). Importantly, the interlocutor effect on scalar implicature interpretation echoes the findings of Ronderos and Noveck (2023). In their Experiment 3, they use reaction times to investigate the processing cost of underinformative sentences containing the quantifier <some>. When such sentences are presented several times, participants' reaction times tend to decrease after the first presentation when the speaker remains the same, but they increase again – signalling additional processing cost – when later sentences are produced by a new speaker. Ronderos and Noveck (2023) take this to suggest that intention-reading is, in part, responsible for the processing cost imposed by scalar implicature derivation (Bott & Noveck, 2004). In line with other studies that hinted at the influence of speaker knowledge (Bergen & Grodner, 2012; Papafragou et al., 2018) and cooperativeness (Dulcinati, 2018; Franke et al., 2019; Grodner & Sedivy, 2011) on implicature processing – and as hypothesised – our participants interpreted scalar terms with an implicature more readily when they were uttered by an interlocutor who was both knowledgeable and aimed to help them win the game. Our results bring relevant novelty to the field: they show that effects of cooperativeness and knowledgeability can be detected not only by leveraging their absence versus presence in a speaker but also by contrasting the presence of speakers in the task with their absence. In addition, the results show that previous findings can be replicated with a priming paradigm and suggest that an effect of speaker knowledge and cooperativeness on implicature derivation can be detected across two different scale types.

Overall, our findings lend empirical support to the Standard Recipe of implicature derivation: speaker cooperativeness (i), speaker knowledge (ii) and context relevance (iii) all modulate the likelihood of implicature derivation. They underline the importance of including the speaker's perspective and intentions in accounts of scalar implicatures. As mentioned in the Introduction, post-Gricean theories already do account for such factors as contributors to pragmatic language interpretation (e.g., Carston, 1998; Geurts, 2010; Horn, 1972, 1984; Recanati, 2004; Wilson & Sperber, 2004). Relevance Theory, for instance, maintains that speaker preferences (e.g., cooperativeness) and abilities (e.g., knowledge) are fundamental to language interpretation (Sperber & Wilson, 1986/1995). The data presented here, however, can also inform accounts of scalar implicatures that are not strictly defined as post-Gricean, such as grammatical approaches to scalar implicatures (e.g., Chemla & Singh, 2014a, 2014b; Chierchia, 2004; Chierchia et al., 2012; Fox, 2007). These models maintain that an exhaustification process may optionally place a silent 'only' operator before

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scalar items, and lead to implicature derivation. Proponents of grammatical theories put forward different means to disambiguate between structures with or without this silent 'only': some assume that scalar term interpretation is established at the level of syntax and led by a principle of meaning strengthening (Chierchia, 2004), while others underline the role of the Question under Discussion (QuD) and how the chosen sentence interpretation is the one addressing it best (Fox, 2007). Our findings may constrain these models, and particularly how the exhaustification process enabling scalar implicature derivation operates. Indeed, they suggest that the speaker's knowledge and cooperative intent should be integrated as determining factors in this disambiguation.

Importantly, the speaker effect our data bring to light also has non-negligible methodological consequences. Considering the clear difference between speaker presence and absence in our study, we can reasonably assume that the proportion of implicature derivation in studies with no interlocutor (to the best of our knowledge, the majority of previous adult studies) is lower than it would be in naturalistic contexts, as such contexts tend to include interlocutors (mostly cooperative and often knowledgeable). Previous studies may have assumed that even if the presence of an interlocutor is not made explicit, participants may still implicitly *presume* that they are interacting with a 'Gricean' communicator. However, our result underlines the importance of explicitly introducing interlocutors in tasks assessing pragmatic processing. Future experiments should therefore consider including explicit interlocutors or acknowledging how their absence might impact implicature derivation in their data. While our findings highlight the crucial role of interlocutor presence in pragmatic experimental paradigms, it is important to note that they do not put into question the conclusions of previous priming studies. Indeed, these relied on the differences between priming conditions (replicated in the present study) and not on overall implicature derivation rates (Bott & Chemla, 2016; Bott & Frisson, 2022; Marty et al., 2024; Rees & Bott, 2018; Waldon & Degen, 2020).

Overall, our manipulation brought about a methodologically relevant effect, and our findings support the Standard Recipe. Yet, speaker cooperation and speaker knowledge were confounded in our paradigm, and future studies could try to tease apart their respective contribution to implicature derivation.

4.3. Lexical versus ad-hoc scales

In our Experiment 1, the presence of an interlocutor affected lexical and ad-hoc scales differently. Even taking into account other possible explanations for this result, one cannot exclude the possibility that the two types of scalar implicature might have different processing mechanisms. Such a conclusion would also align with findings suggesting a different developmental trajectory for the two scales (e.g., Foppolo et al., 2020). The modification implemented in Experiment 2, however, lends support to the hypothesis that the difference might be attributable to methodological factors. The modification made to the stimuli was undoubtedly an improvement: to the best of our knowledge, this is the first experiment where the ad-hoc implicatures reach a 0.5 proportion. Yet, the modification did not entirely solve the imbalance between scale presentations discussed in the Experiment 1 Discussion. In the case of the lexical scale, there is no possible content of the covered card that would make the description

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used an optimal one to describe the visible card. For ad-hoc scales, on the other hand, even in Experiment 2, some scenarios could make the sentence used a felicitous description of the visible card.

Replicating previous experiments, we detected a difference in priming patterns between the two types of scales, which also points to a contrast between the two. Marty and colleagues (2024) explain this difference, which they find too, in terms of prior expectation (or prior probability of a certain interpretation) and inverse preference. They hypothesised that the prior expectation that a given term is to be interpreted strongly is different for different scalar terms, and participants may also display individual differences for the same scalar term. Prior expectations for 'some' display a bimodal distribution: in baseline trials, participants can be divided between those who prefer the weak interpretation and those who prefer the strong one. For ad-hoc implicatures, on the other hand, the prior expectation is the weak interpretation in most cases. In their experiment, Marty and colleagues show that the effect of priming amounts to inverting this preference by modulating the QuD, which, in terms of the Standard Recipe, can be assimilated to modulating the contextual relevance of the implicature. Our results are compatible with this explanation. Furthermore, within this approach, the modulation provided by the QuD is framed in terms of enhancing the probability of the implicature being derived; it could, therefore, easily integrate both speaker knowledge and cooperative intent as additional factors modulating this probability.

Interestingly, in Experiment 1, we only found an effect of the interlocutor in across-scale priming with lexical targets after weak priming. In the baseline of this condition, participants already displayed a strong interpretation of lexical targets; it is, therefore, unsurprising that we found no effect of strong priming for lexical targets in the interlocutor present condition, following Marty and colleagues' (2024) reasoning outlined above. Our across-scale priming results for lexical scale targets are, therefore, in line with our predictions, as well as previous data on implicature priming; nevertheless, we did not anticipate our findings for ad-hoc targets. Indeed, both strong *and* alternative lexical primes increased ad-hoc targets' implicature derivation regardless of the presence of an interlocutor, as did weak priming in the presence of an interlocutor. This pattern might be accounted for if we consider that the two main factors inducing higher implicature derivation in our paradigm were the presence of an interlocutor on the one hand, and the lexical scale on the other – their combined effect is thus likely to be particularly strong. All lexical scale primes would, therefore, have prompted an increase of implicature derivation in ad-hoc targets, including weak priming – although, in the case of weak priming, when there was no interlocutor, the drive was not sufficient to reach significance.

Our results show that both implicature types can be primed in this paradigm, both are influenced by the presence of an interlocutor, and, most importantly, that priming occurred across the two scales (in line with Bott & Chemla's 2016 results). Additionally, an account along the lines of that put forward by Marty and colleagues (2024) explains the different patterns detected for lexical and ad-hoc scales. Our findings are, therefore, compatible with a unified processing account based on contextual information for both types of scalar implicatures. Yet, they do not provide incontestable evidence for it, and future work should further investigate similarities and differences between lexical and ad-hoc scales in adult processing in more detail.

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4.4. Conclusions

Our findings show the importance of having an intentional agent as an interlocutor in structural priming tasks investigating implicature derivation. Importantly, by demonstrating this interlocutor effect, our results substantiate pragmatic theories that uphold the role of speaker cooperation and knowledge in the derivation of both lexical and ad-hoc scalar implicatures. They provided some support for a unified processing mechanism for scalar implicature derivation, which relies on perspective-taking and intention-reading. Our study also yields methodological consequences: adding an explicit conversational context with intentional agents influences empirical results and should, therefore, be considered a non-trivial factor in future research on linguistic meaning.

Supplementary material. The supplementary material for this article can be found at http://doi.org/10.1017/langcog.2025.10025.

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