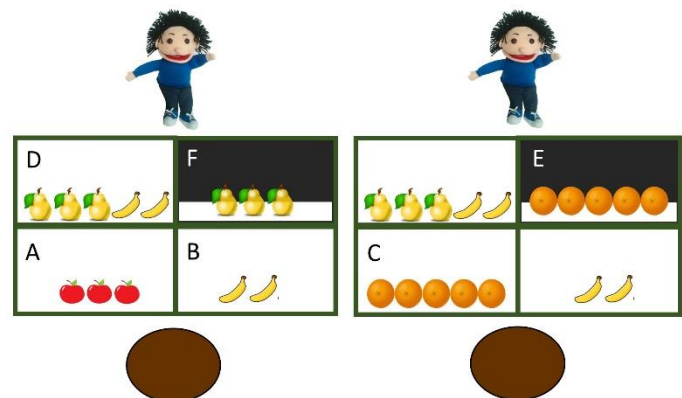


## The role of visual perspective-taking in pragmatic inferencing

**Background** Tracking and integrating common ground, including visual perspective-taking, forms an integral part of the inferencing process in many models of pragmatic inferencing (e.g. the Epistemic Step in implicatures, Sauerland, 2004; neo-Gricean approaches more generally, e.g. Frank & Goodman, 2012). This has been extensively investigated in referential communication with adults (e.g. Heller, Grodner & Tanenhaus, 2008; Epley, Morewedge & Keysar, 2004) and, to a lesser extent, children (e.g. Nilsen & Graham, 2009); findings indicate both egocentric as well as altercentric biases that may be weighted by a variety of contextual factors (Hawkins & Goodman, 2016). The majority of work on implicatures, meanwhile, has employed experimental contexts in which informativeness and common ground align – where speaker and hearer share all relevant information that renders an utterance equally informative for both. In these situations, children become competent from 3 years with ad hoc quantity implicatures (e.g. Stiller, Frank & Goodman, 2015). Only a few studies have examined what happens when the speaker or hearer has privileged ground; these suggest adult hearers are able to integrate the speaker’s perspective and informativeness (Bergen & Grodner, 2012; Breheny, Ferguson, Katsos, 2013; Goodman & Stuhlmüller, 2013). Children, meanwhile, are sensitive to the speaker’s perspective, and able to match an otherwise under-informative utterance to a speaker who does not share all relevant information in common ground (e.g. Papafragou, Friedberg & Cohen, 2018; Kampa and Papafragou, 2019). However, no studies have investigated whether children can – like adults – *not* derive an implicature when critical information that would have licensed the implicature is in their privileged ground.

**In this series of studies**, we address the overarching question: how are common ground and expectations of informativeness integrated in inferencing of implicatures? Firstly, we look at whether children can appropriately not derive an implicature when the contrastive referent that would have licensed the implicature is in privileged ground. We then further investigate the cost of integrating conflicting sources of information in an online reaction time study with neurotypical adults. Throughout we use a paradigm which combines a classic ‘director task’ with a picture-matching quantity implicature task.

**Study 1A and 1B** We tested English-speaking children (Study 1A aged 5;3-6;4 N=33; Study 1 B aged 5;11-7;11 N=25) and adults (Study 1A N=36, Study 1B N=18). Study 1B improved upon the design of Study 1A with some small modifications, and replicated the results in the critical condition, and we report only 1B here. Participants collected double-sided picture cards and put them in a ‘card box’, following the puppet’s instructions ‘pick the card with Xs’. There were four conditions (6 trials per condition) – see Fig. 1. In the critical privileged ground ad hoc condition, the card with only Xs was in privileged ground, while the card with Xs and Ys was in common ground. If participants take into account the puppet’s perspective, they would not derive an ad hoc implicature, and instead choose the card



Condition	Utterance	Correct card	Distractor card
Common ground unambiguous	Pick the card with apples	A*	-
Common ground ad hoc implicature	Pick the card with bananas	B	D
Privileged ground ambiguous	Pick the card with oranges	C	E
Privileged ground ad hoc implicature	Pick the card with pears	D	F

Figure 1 Study 1B example display and items

\* Half of the items displayed two types of object, still with an unambiguous utterance

with Xs and Ys – as far as the puppet knows, ‘the card with Xs’ is an optimally informative description for the card with Xs and Ys. **Results** As the data was bimodally distributed, we coded participants as passers (scoring 5/6 or 6/6) or failers (otherwise). There were more child passers in the privileged ground ambiguous than privileged ground ad hoc condition (McNemar’s  $\chi^2 = 10.08$ ,  $p = .001$ ), and more adult passers than child passers in the privileged ground ad hoc condition (Fisher’s exact  $p = .005$ )<sup>1</sup>.

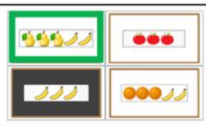
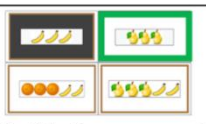
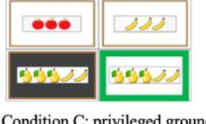
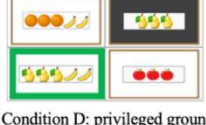
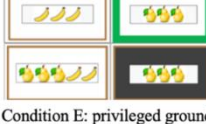
Table 1 Study 1B number of child and adult failers and passers in each condition

	Common ground unambiguous		Common ground ad hoc implicature		Privileged ground ambiguous		Privileged ground ad hoc	
	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass
Child	0	25	2	23	5	20	17	8
Adult	0	18	0	18	1	17	4	14

**Discussion** In contrast to adults, children mostly persisted in deriving ad hoc implicatures when the speaker was ignorant of the relevant picture (choosing the one the puppet could not see), despite excelling in ad hoc implicatures when relevant information is in common ground and being able to reason correctly about someone’s perspective. Integrating knowledge of the speaker’s epistemic state into utterance interpretation therefore seems to be a challenge for children, perhaps particularly when these are in conflict. Our findings suggest that children at first either assume common ground or do not reason about the speaker’s perspective.

**Study 2** We used a very similar paradigm in an online study with adults (N=59) – see Figure 2. The results showed a significant difference in the proportion of passers and non-passers across conditions (Cochran's Q,  $\chi^2(4) = 47.512$ ,  $p < .001$ ). Post hoc analysis with McNemar tests with a Bonferroni correction (significance level set at  $p < 0.005$ ) indicated that the proportion of passers was significantly lower in the privileged ground implicature condition (D) compared to the other four conditions ( $p < .001$ ). This suggests that in fact for all speakers, deriving an implicature may be a result of a constraint-based process (Degen & Tanenhaus, 2019), in which many factors, including utterance, visual context and common ground, are considered, and may be weighted differently. In contrast to the traditional Gricean view, information being in privileged ground does not necessarily prevent an implicature from being derived, and may instead be taken into account in utterance interpretation (Heller, Parisien & Stevenson, 2016).

Table 2 Study 2 example displays and results  
In all cases the utterance is “Pick the card with pears”.  
Passers score at least 7/8.

Condition	Proportion of passers (%)
 Condition A: common ground unambiguous	98.31
 Condition B: common ground implicature	98.31
 Condition C: privileged ground ambiguous	89.83
 Condition D: privileged ground implicature	69.49
 Condition E: privileged ground and common ground implicatures	91.53

<sup>1</sup> A model with condition and age as fixed effects (treatment coding with child age-group and privileged ground ad hoc condition as baselines), and item and subject random intercepts, indicated an effect of age for privileged ground ad hoc condition ( $\beta = 3.85$ ,  $p < .001$ ) – adults performed better than children – and an effect of condition in children (privileged ground ambiguous  $\beta = 3.07$ ,  $p < .001$ ; common ground ad hoc  $\beta = 6.62$ ,  $p < .001$ ).