Epistemic reasoning during conversational inferences

Alyssa Kampa & Anna Papafragou
University of Delaware

Scalar implicatures are derived when a listener interprets a statement such as "Some plants can swallow insects" to mean that **not all** plants do, reasoning that the speaker would have chosen the stronger alternative (*all*) if it were true.[1] Adults derive implicatures according to the epistemic state of the speaker: for instance, adults are more likely to compute a 'not all' implicature if the speaker is knowledgeable.[2,3] Two studies have investigated the epistemic reasoning underlying the interpretation of scalar statements in children[4,5]: both found that 5-year-olds had some degree of success but 4-year-olds failed. The present study investigated whether a simpler paradigm inspired by referential communication could yield new insights into children's epistemic reasoning abilities.

In Exp. 1, 26 4-year-olds (M_{age}=4.5), 19 5-year-olds (M_{age}=5.3), and 26 adults saw pairs of nearly identical photographs. In each pair, a girl was sitting across the table with a two-compartment box containing two objects (Fig.1). The pictures differed only in whether the girl could see both or only one of the objects. The participants heard the girl's voice utter either a strong statement ("I see a spoon and a bowl") or a weak statement ("I see a spoon") and were asked which box she was describing. The weak trials are critical because they involve deriving the implicature that the speaker sees the stated object and nothing else. Thus, participants should link the strong statement to the full access box and the weak statement to the limited access box. Because most 4-year-olds received a mean score of 0 or 1 across trials, participants were divided into passers (score $\geq$ .75) and failers (score $\leq$ .50). For 4-year-olds, Fisher's exact test revealed a marginally significant difference between the strong vs. weak condition (p=.05, 2-tailed). Adults and 5-year-olds performed at ceiling in both conditions. Comparisons across age groups revealed a significant difference between adults and 4-year-olds (p=.01) and 5-year-olds and 4-year-olds (p=.03) in the weak condition, but no significant differences for the strong (p=1). Unlike past studies, the number of passers was significantly different from the expected ratio due to chance for 4-year-olds (strong-p=.002; weak-p=.029).

Exp. 2 was conducted to see if results would generalize to non-linguistic stimuli. 24 4-year-olds, 25 5-year-olds, and 25 adults were shown the same trials as in Exp.1, but instead of hearing a sentence, the objects from the boxes were presented and children were told that the girl would circle the objects that she saw in one of the boxes, and they would have to determine which box she was describing. She either circled both objects presented (e.g. a penguin and a pumpkin) or one object (e.g. a penguin) and crucially didn't circle the second object. Fisher's exact test revealed a significant difference between the weak and strong conditions for 4-year-olds(p<.001), but not adults or 5-year-olds, and no significant differences between age groups for the strong or weak conditions. Adults were significantly different from the expected ratio due to chance in the weak condition (p=.003), but 5-year-olds were only marginally so (p=.09) and 4-year-olds were not.

In sum, both 4- and 5-year-olds incorporate epistemic reasoning into the derivation of scalar implicatures. Nevertheless, this ability does not extend to non-linguistic stimuli. This could be due to increased processing cost in the 2nd experiment or ease of computing linguistic, as opposed to pictorial, alternatives. It is also possible that the 2nd experiment requires true implicature derivation (i.e. "I see this and not this") while Exp.1 requires merely sensitivity to informativeness. Further studies are being conducted to assess these possibilities.

Figures

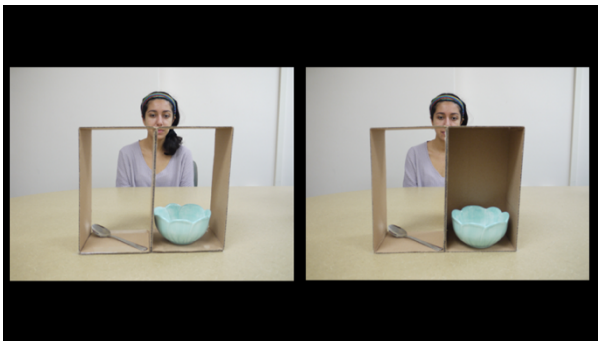

Figure 1. An example stimulus from Exp. 1.

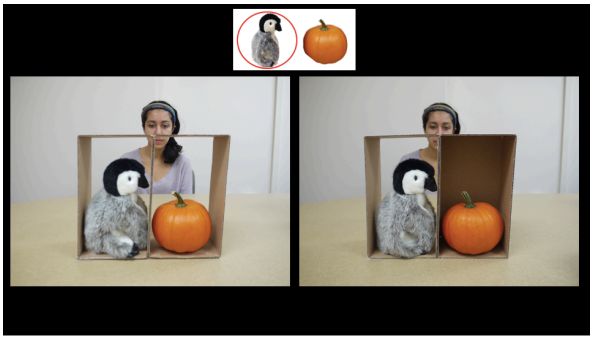

Figure 2. An example weak stimulus from Exp. 2.

Table 1: Task performance.

	Classification	Condition	
		Strong	Weak
Adults	Passers	26	26
	Failers	0	0
5-year-olds	Passers	16	16
	Failers	0	0
4-year-olds	Passers	25	19
	Failers	1	7

Table 1. Results from Exp. 1.

Table 2: Task performance.

	Classification	Condition	
		Strong	Weak
Adults	Passers	23	19
	Failers	0	4
5-year-olds	Passers	21	16
	Failers	2	7
4-year-olds	Passers	21	11
	Failers	0	10

Table 2. Results from Exp. 2.

References

1. Grice, P. (1989). *Studies in the way of words*. Cambridge, MA: Harvard University Press.
2. Bergen, L., & Grodner, D. J. (2012). Speaker knowledge influences the comprehension of pragmatic inferences. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *38*, 1450.
3. Breheny, R., Ferguson, H., & Katsos, N. (2013). Taking the epistemic step: Toward a model of on-line access to conversational implicatures. *Cognition*, 126, 423-440.
4. Papafragou, A., Friedberg, C., & Cohen, M. (in press). The role of speaker knowledge in children's pragmatic inferences. *Child Development.*
5. Hochstein, L., Bale, A., Fox, D., & Barner, D. (2016). Ignorance and Inference: Do Problems with Gricean Epistemic Reasoning Explain Children's Difficulty with Scalar Implicature? *Journal of Semantics, 33*, 107-135.
6. Stiller, A., Goodman, N. D., & Frank, M. C. (2015). Ad-hoc implicature in preschool children. *Language, Learning, and Development, 11*, 176-190.
7. Nadig, A.S., & Sedivy, J.C. (2002). Evidence of perspective-taking constraints in children's on-line reference resolution. *Psychological Science*, *13*, 329–336.
8. Sperber, D., & Wilson, D. (1986). *Relevance: Communication and cognition*. Cambridge, MA: Harvard University Press. 2nd ed. 1995.
9. Katsos, N., & Bishop, D. V. (2011). Pragmatic tolerance: Implications for the acquisition of informativeness and implicature. *Cognition, 120,* 67-81.
10. Zhao, X., Malle, B., & Gweon, H. (2016). Is it a 9 or a 6? Prosocial and selective perspective taking at age four. *Proceedings of the 38th Annual Conference of the Cognitive Science Society* (pp. 924-929). Austin, TX: Cognitive Science Society.