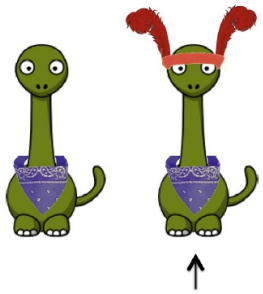
Inferring word meanings by assuming that speakers are informative
Frank and Goodman (2014)

Introduction

Gavagai problem: for any known referent, there are many conceptually natural referring expressions that include the referent in their extension.

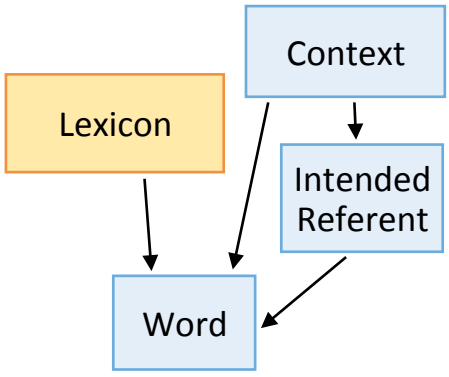
Frank & Goodman argue that pragmatic inference can also be used, by considering the communicative context and the goals of the speaker.



The distinguishing feature of the dinosaur on the right is its headband, so if a speaker describes the dinosaur on the right as "a dinosaur with a dax," a pragmatically-savvy learner could assume "dax" means HEADBAND.

Modeling pragmatic inference in word learning

The word uttered by a speaker is determined by a combination of the context (C), the speaker's intended referent (r_s), and the lexicon of their language (L), as shown below:



In the case of a language learner trying to make inferences about the meaning of a word uttered, the lexicon must be derived given the context, intended referent, and word uttered:

$$P(L|w, r_S, C) \propto P(w|L, r_S, C)P(L)$$

Assuming that:

- The speaker's intended referent r_s has two truth-functional features f_1 and f_2
- There are two words w_1 and w_2 in the language
- Each word in the language has only one meaning
- The possible lexicons are therefore:
  - $L_1 = \{w_1 = f_1, w_2 = f_2\}$
  - $L_2 = \{w_1 = f_2, w_2 = f_1\}$
- These lexicons are equally probable

Therefore,

$$P(L_1|w_1, r_S, C) = \frac{P(w_1|L_1, r_S, C)}{P(w_1|L_1, r_S, C) + P(w_1|L_2, r_S, C)} = \frac{\frac{|f_1|^{-1}}{|f_1|^{-1}+|f_2|^{-1}}}{\frac{|f_1|^{-1}}{|f_1|^{-1}+|f_2|^{-1}} + \frac{|f_2|^{-1}}{|f_2|^{-1}+|f_1|^{-1}}} = \frac{|f_1|^{-1}}{|f_1|^{-1} + |f_2|^{-1}}$$

where $|f|$ indicates the number of objects with feature f.

This model predicts that in the case of the dinosaurs above, learners should be 67% confident that w ("dax") means headband (f_1) as opposed to bandanna (f_2):

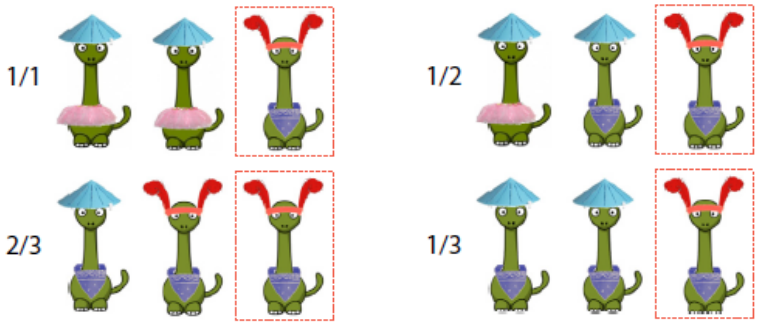
$$P(w = f_1|M_S, C) = \frac{|\text{HEADBAND}|^{-1}}{|\text{HEADBAND}|^{-1} + |\text{BANDANNA}|^{-1}} = \frac{\frac{1}{1}}{\frac{1}{1}+\frac{1}{2}} = \frac{2}{3}$$

Experiment 1

Can adult word learners make inferences about word meaning based on the relative informativeness of a word in context?

Materials and methods

Participants completed a four-question survey. Each question showed an array of three objects such as the arrays below.



A novel word was used to refer to the boxed object, and participants were asked to make bets out of $100 on which feature the word referred to.

Four kinds of trials:

- **1/1 trial:** target object had two features, each unique to that object
- **1/2 trial:** one of the target object's features was unique and the other was shared with one other object
- **1/3 trial:** target with a single unique feature and a second feature shared by all three objects
- **2/3 trial:** target had no unique features, but had one feature shared with one other object, and one feature shared by all objects

Results

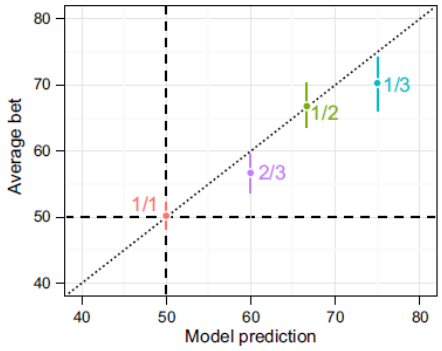


Table 1
Summary statistics and two-tailed one-sample *t*-tests against chance performance ($50) for each condition in Experiment 1. *M*, and *SD* denote the mean and standard deviation of bets on the target feature. Degrees of freedom vary from condition to condition due to exclusions (see text for more details).

Trial	Model prediction	*M*	*SD*	*t*	*df*	*p*
1/1	50.0	50.2	14.1	0.21	193	.83
1/2	66.7	66.8	23.1	10.01	189	<.0001
1/3	75.0	70.3	27.7	10.19	193	<.0001
2/3	60.0	56.7	19.8	4.65	188	<.0001

Experiment 2

Can preschool children use the informativeness of features to learn the meanings of novel adjectives?

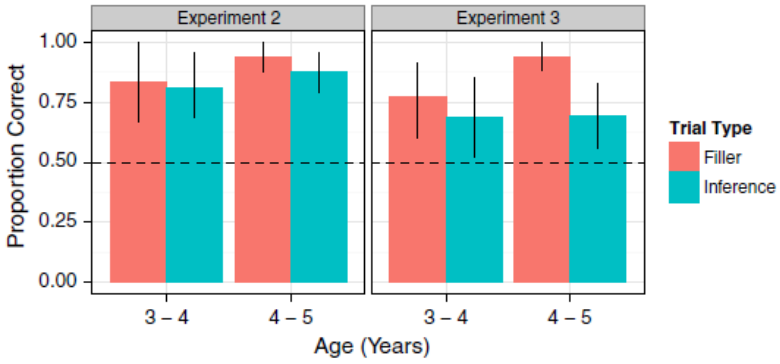
Materials and methods

Children completed 8 trials distributed into two conditions, filler and inference.

- **Inference trials:** used two-object arrays similar to the one on p.1 of this handout
- **Filler trials:** used two-object arrays in which the target object had only one feature that was not shared with the distractor (e.g. a headband but not a bandanna)

For each trial, the experimenter pointed to the target object and said e.g. "This is a dinosaur with a dax! How neat! A dinosaur with a dax!" The child was then shown an additional array in which only one object had each feature and asked e.g. "Which of these dinosaurs has a dax?"

Results



Experiment 3

The term "this" is often used exclusively for providing a label. To ensure that wording had not influenced results, Experiment 2 was replicated using the frame "Here is a —" rather than "This is a —."

Performance in the inference trial was lower than in Experiment 2 but still above chance.

Experiment 4

Did the children in Experiments 2 and 3 actually map the novel word to the most pragmatically likely feature, or did they simply select the unique feature because it was the most salient?

Materials and methods

Experiment 3 was replicated with the addition of two more conditions.

- **Disambiguation condition:** children were taught a novel word using the procedure from Experiment 3 but were asked for a different novel word at test phase
    - If children had mapped the first novel word to the informative feature, they should choose the uninformative feature at test
- **Non-Linguistic Salience condition:** children were asked to "find another one" at test
    - If children were relying on linguistic inference rather than choosing the most salient feature, they would select features at chance in this condition

Results