Mentioning Atypical Properties of Objects is Communicatively Efficient

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Introduction

- **Problem of content selection**: which factors determine the information that speakers include in referring expressions?[1]

1. **(over)informativeness**[2]
   - say "*blue* banana" when only one banana
2. **cost**
   - less likely to say long or infrequent property
3. **typicality**[3,4,5]
   - "*blue* banana" more likely than "*yellow* banana"

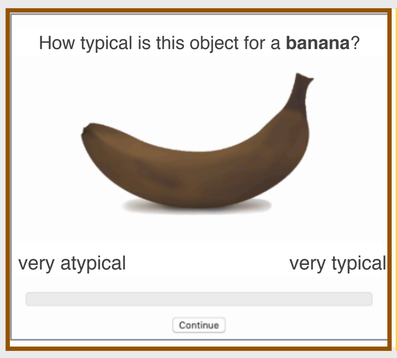
- Unified account of overinformative referring expressions lacking

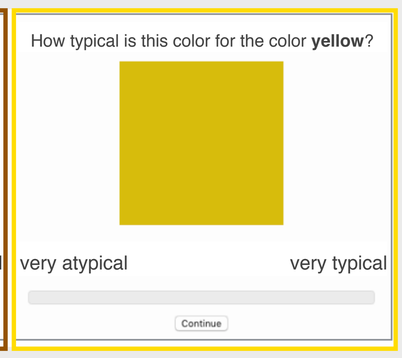
- **Our approach**: when should a *rational* speaker mention an object's color?

Typicality norming study

- Collect empirical typicality values for each utterance-object pair

- 3 separate studies
  1. adjective + noun ("brown banana")
  2. noun ("banana")
  3. adjective ("yellow")





Results

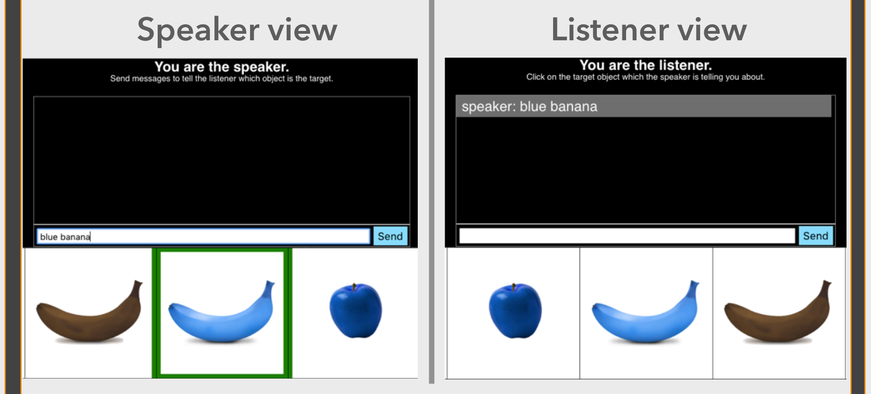
Example typicality values for the banana case; numbers shown in bold are "correct" pairings.

$\mathcal{L}(u,c)$	Banana items			Other
Utterance	yellow	brown	blue	
banana	**.98**	**.66**	**.42**	.05
yellow banana	**.98**	.33	.17	.05
brown banana	.28	**.90**	.18	.04
blue banana	.20	.18	**.91**	.06

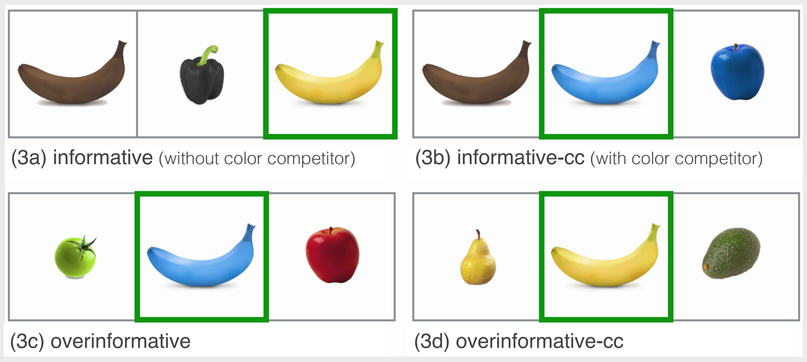
Production study

- Collect freely produced referring expressions through chatbox in two-player reference game
  - *Speaker* aim: Communicate target
  - *Listener* aim: Click on target

- Recruited 60 pairs on Amazon Mechanical Turk



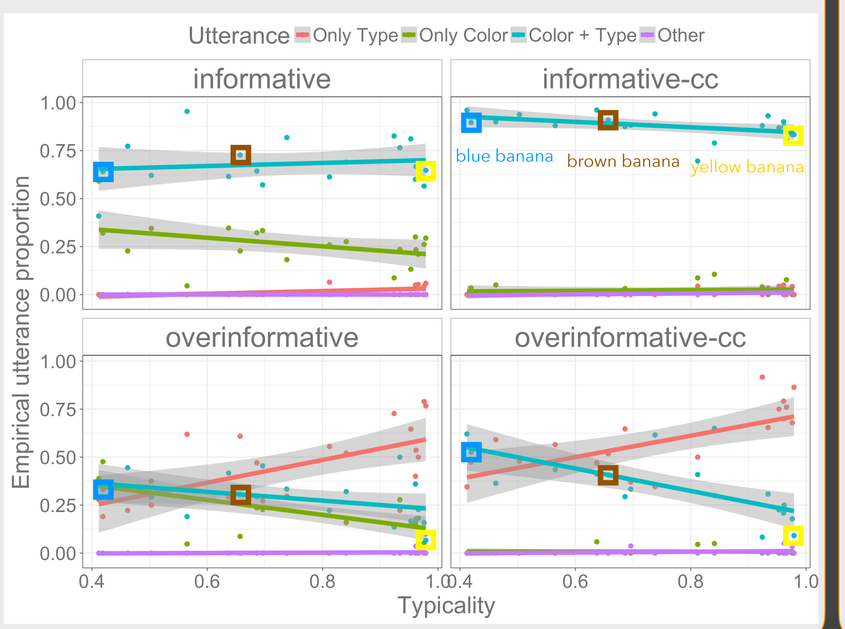
Conditions



Results

- Replicated typicality effect in overinformative conditions (more overinformative mentions of atypical colors)
- Also found typicality effect in informative conditions

Empirical Results ("COLOR banana" cases marked)



Computational model

- Formalize in Rational Speech Act (RSA) framework[6]
- Literal listener L_0 selects between contextual referents according to lexicon $\mathcal{L}$:

$$L_0(c|u,C) \propto \exp(\lambda_{typ}\mathcal{L}(u,c))$$

- Pragmatic speaker S_1 selects utterance to communicate an intended referent c_i by trading off *informativity* with *cost*:

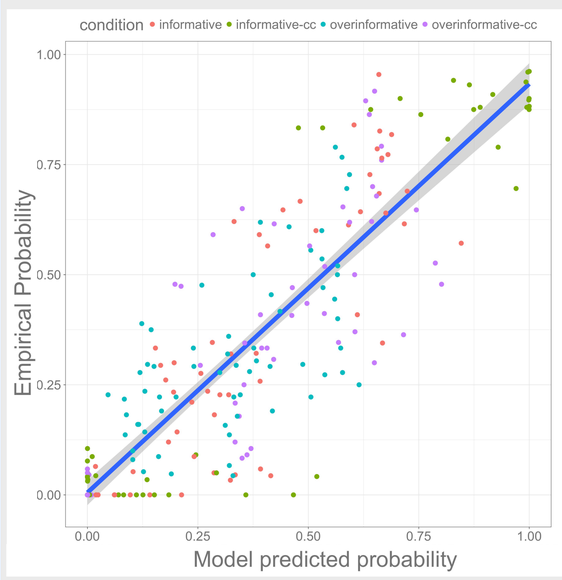
$$S_1(u|c_i) \propto \exp(\alpha \log(L_0(c_i|u,C)) - \text{cost}(u)$$

- Cost is defined as a function of an utterance's length and its corpus frequency

$$\begin{aligned}\text{cost}(u) \quad = \quad & \beta_{freq}\hat{c}_f + (1-\beta_{freq})\hat{c}_l + \\ & \beta_{adj}\delta_{adj\in u} + \\ & \beta_{noun}\delta_{noun\in u}\end{aligned}$$

- Critically, we use a real-valued lexicon

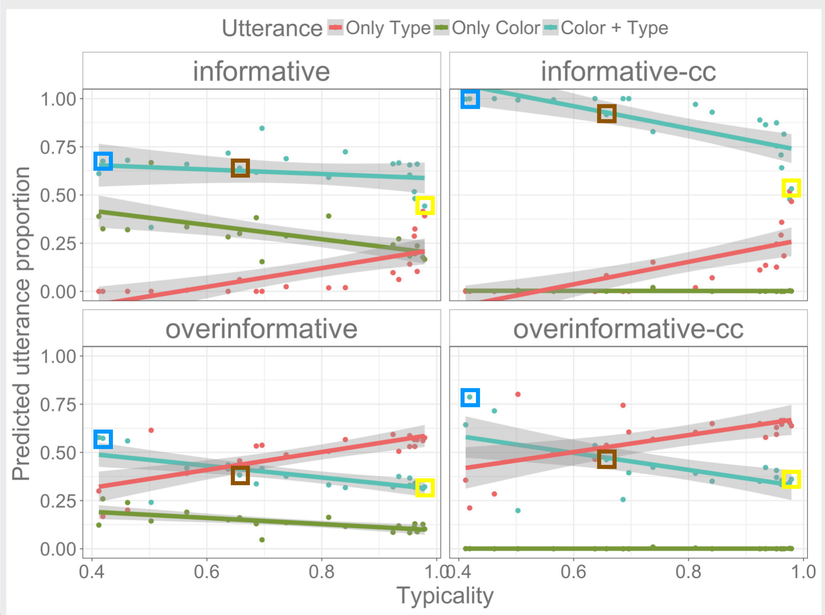
Correlation Empirical vs Predicted
(R^2 = .75; error bars are high but not displayed)



Parameter Values

Alpha: 10
Color-Cost: 0
Type-Cost: -1.5
LengthWeight: 0.5
TypicalityWeight: 6

Model Predictions ("COLOR banana" cases marked)



Conclusion

- Speakers redundantly mention color when confusability of intention is otherwise high
- RSA with continuous semantics captures this
- ~~overinformative~~ referring expressions

↑

rationally redundant

Try it yourself
Play around with our model! Change parameters and see how the fit and the correlation with the empirical values changes.

https://overinformativeness-model.shinyapps.io/OVERINF-MODEL/

Discussion

- Informative and overinformative condition work against each other
  - In informative condition "Only Type" utterances are overpredicted, In overinformative condition "Only Color" utterances are underpredicted

- Extension of the model
  - Incorporating that speaker thinks listener has uncertainty about what is in the context
  - Add noise to context by either exchanging or adding an object to context that is similar to the target (for "blue banana" add blue or banana objects)

References

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