

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)informativeness²

- 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”

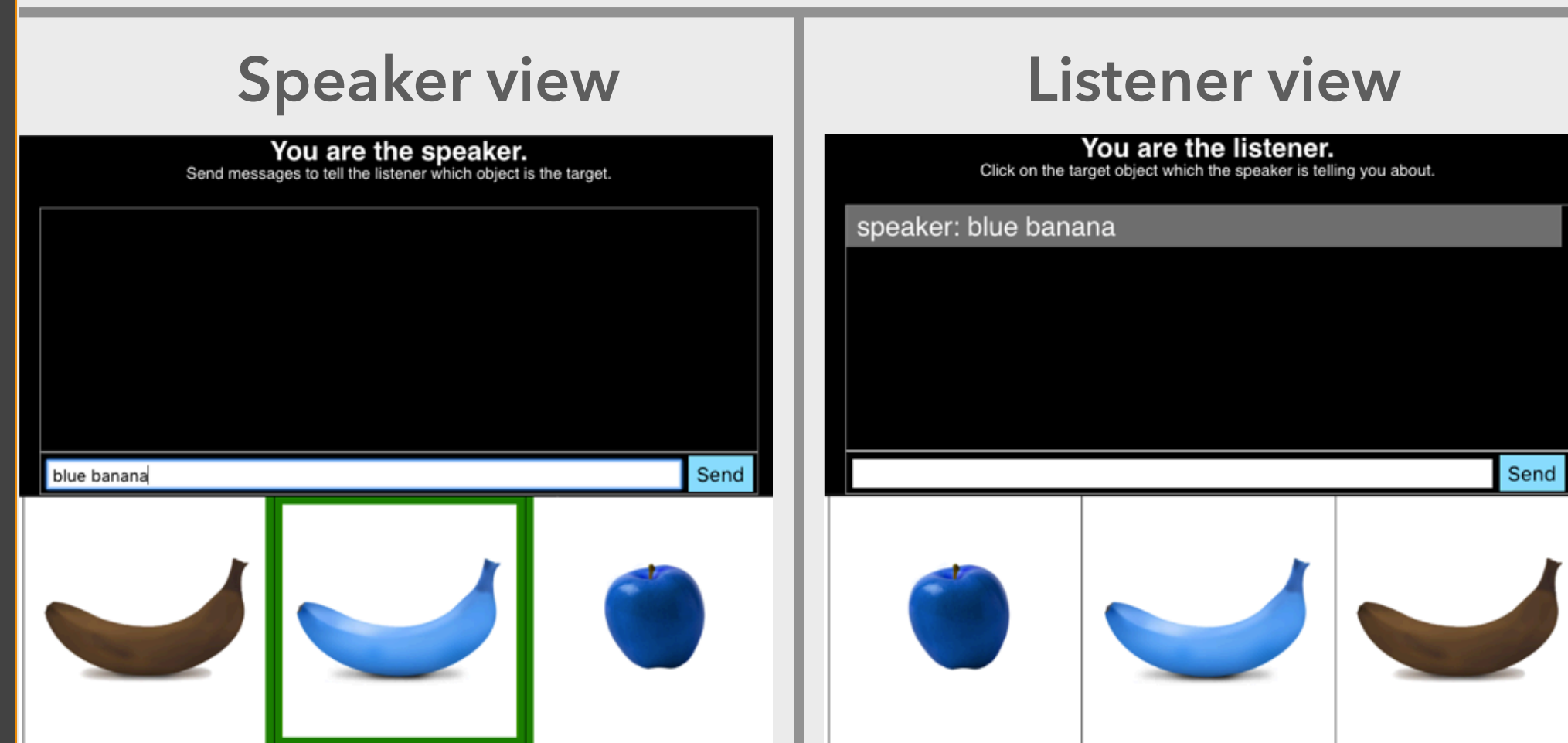
- Unified account of overinformative referring expressions lacking

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

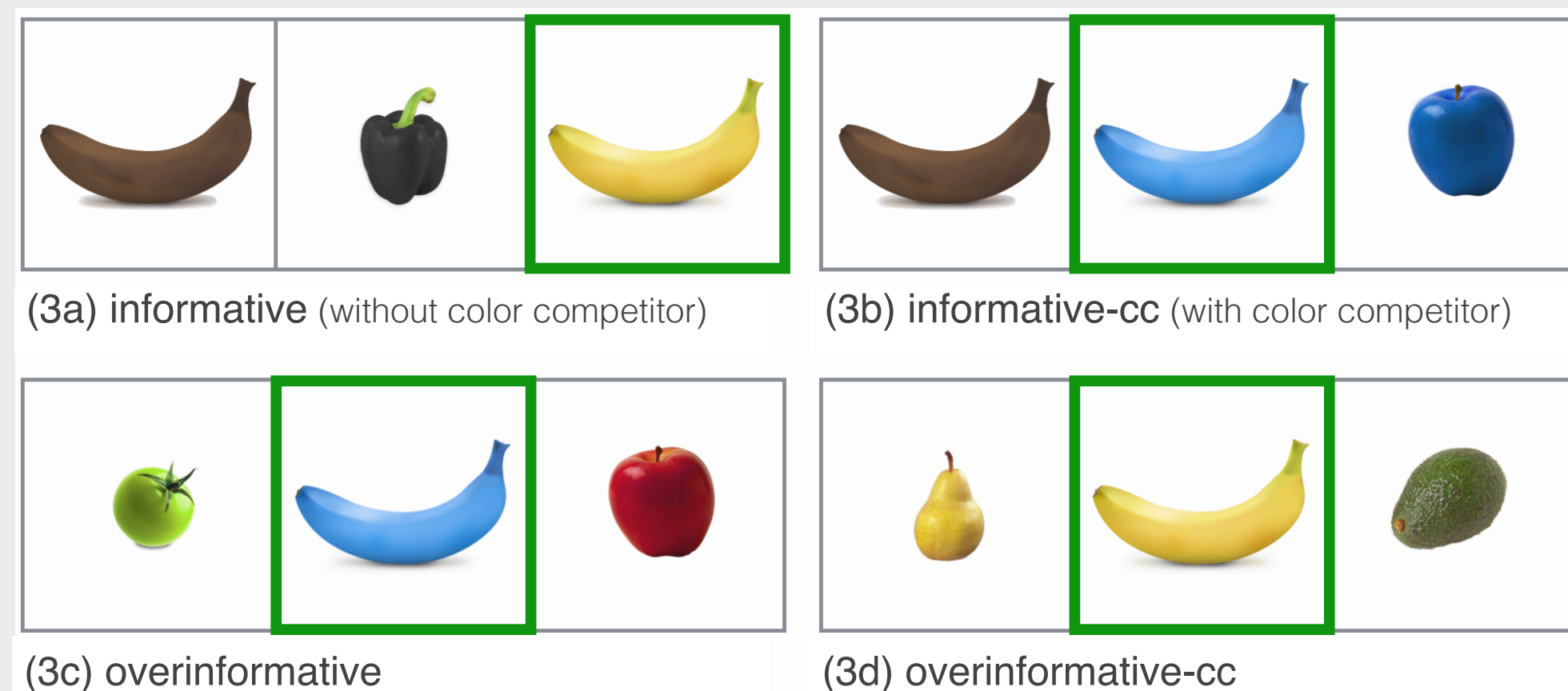
Production study

- 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



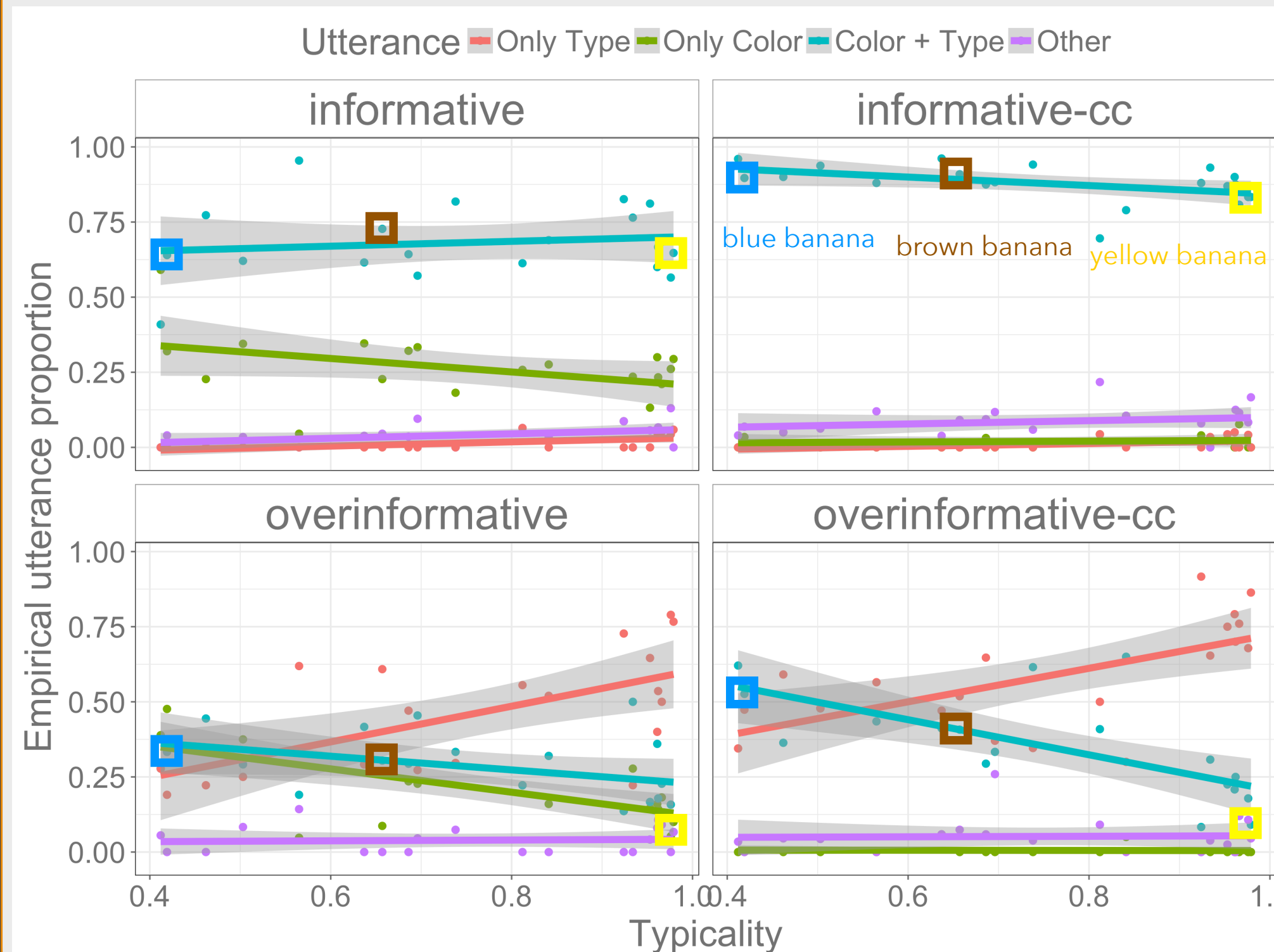
Conditions



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)

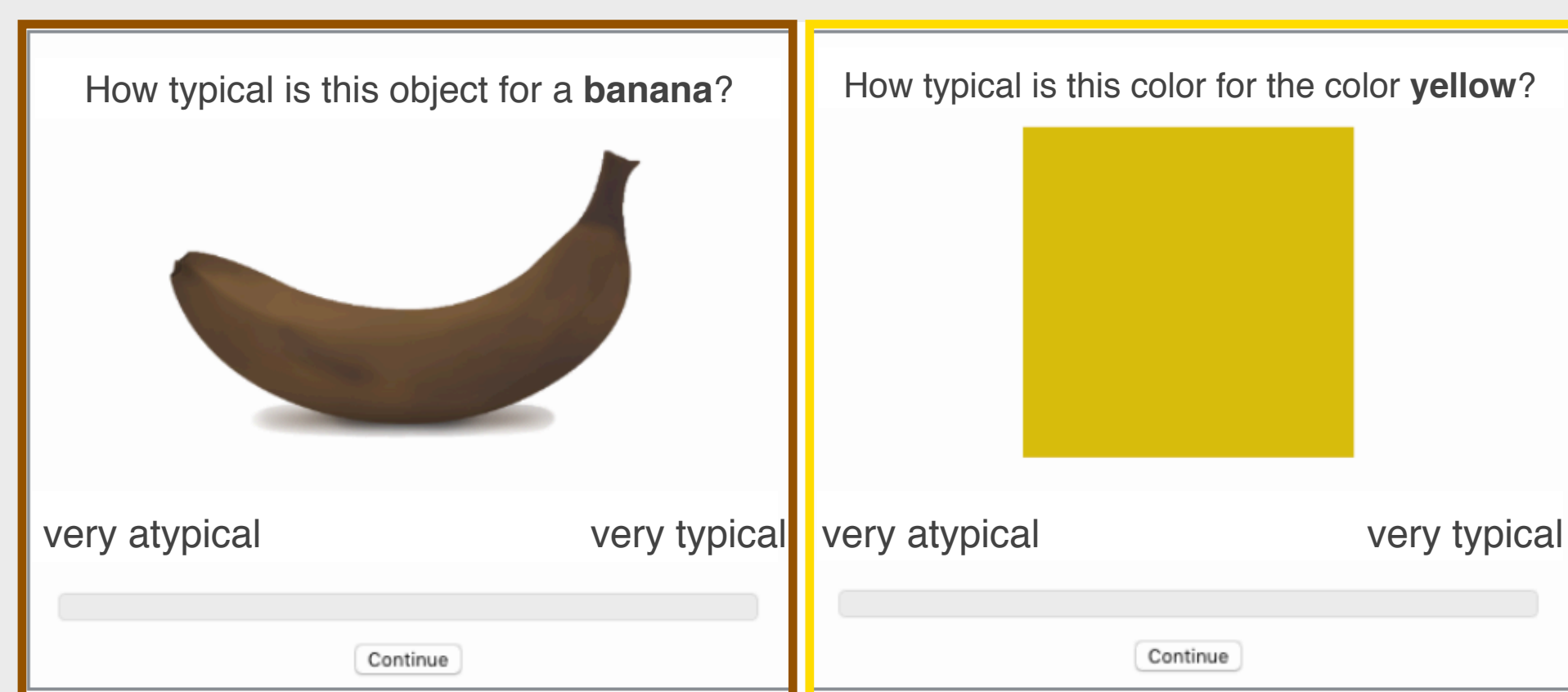


Typicality norming study

- 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	
	<i>banana</i>	.98	.66	.42	.05
	<i>yellow banana</i>	.98	.33	.17	.05
	<i>brown banana</i>	.28	.90	.18	.04
	<i>blue banana</i>	.20	.18	.91	.06

Conclusion

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

↑
rationally redundant

References

- ¹ Grice, H. P. (1975). Logic and Conversation. *Syntax and Semantics*, 3, 41–58.
- ² Pechmann, T. (1989). Incremental speech production and referential overspecification. *Linguistics*, 27(1), 89–110.
- ³ Rubio-Fernandez, P. (2016). How redundant are redundant color adjectives? An efficiency-based analysis of color overspecification. *Frontiers in Psychology*, 7 (153).
- ⁴ Sedivy, J. C. (2003). Pragmatic versus form-based accounts of referential contrast: evidence for effects of informativity expectations. *Journal of psycholinguistic research*, 32(1), 3–23.
- ⁵ Westerbeek, H., Koolen, R., & Maes, A. (2015). Stored object knowledge and the production of referring expressions: the case of color typicality. *Frontiers in Psychology*, 6(July), 1– 12.
- ⁶ Goodman, N.D. & Frank, M.C. (2016). Pragmatic language interpretation as pragmatic inference. *Trends in Cognitive Sciences*. 20(11), 818–829.

Computational model

- Formalize in Rational Speech Act (RSA) framework⁶
- 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*:

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

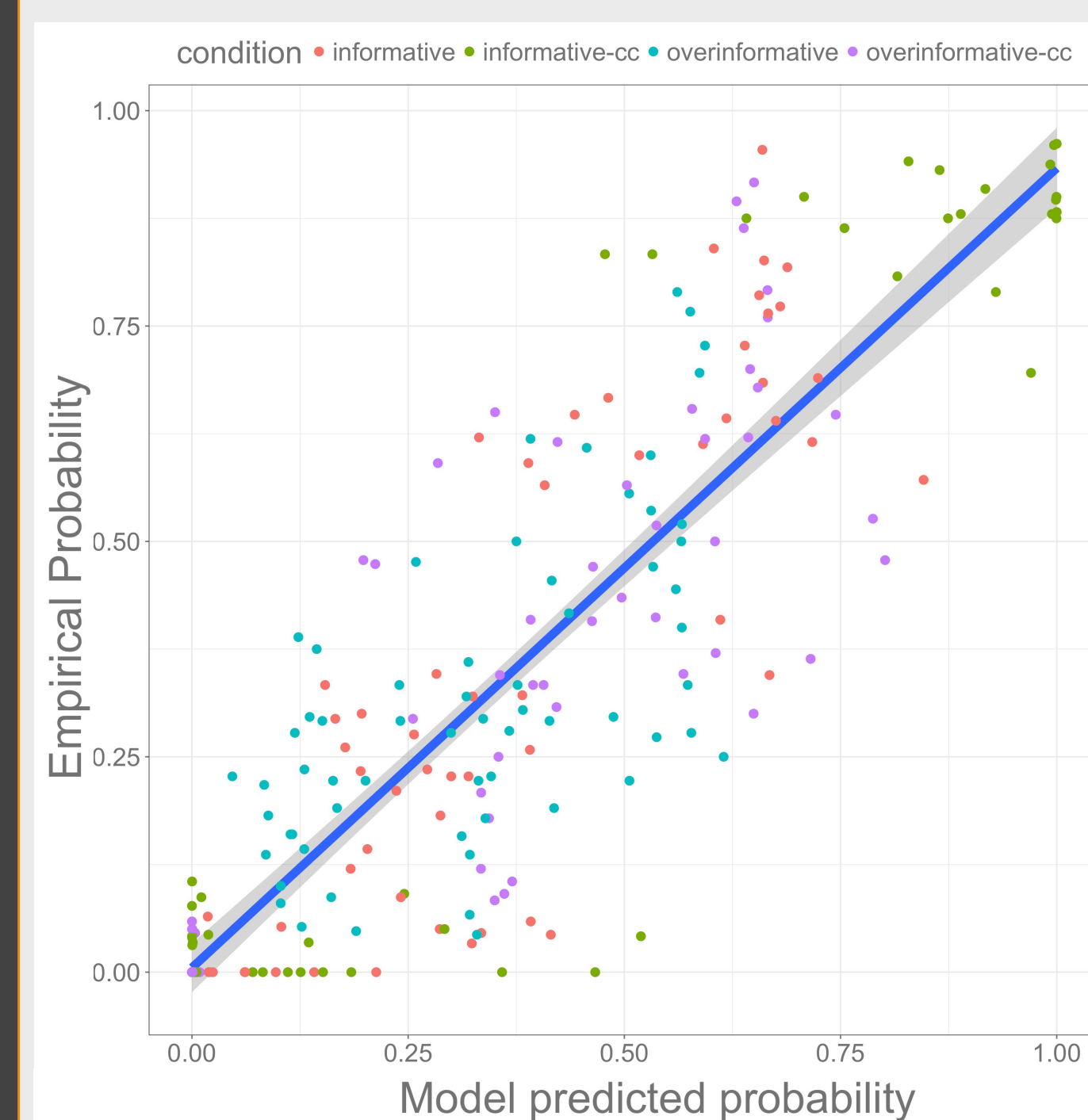
- Cost is defined as a function of an utterance’s length and its corpus frequency

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

- Critically, we use a real-valued lexicon

Correlation Empirical vs Predicted

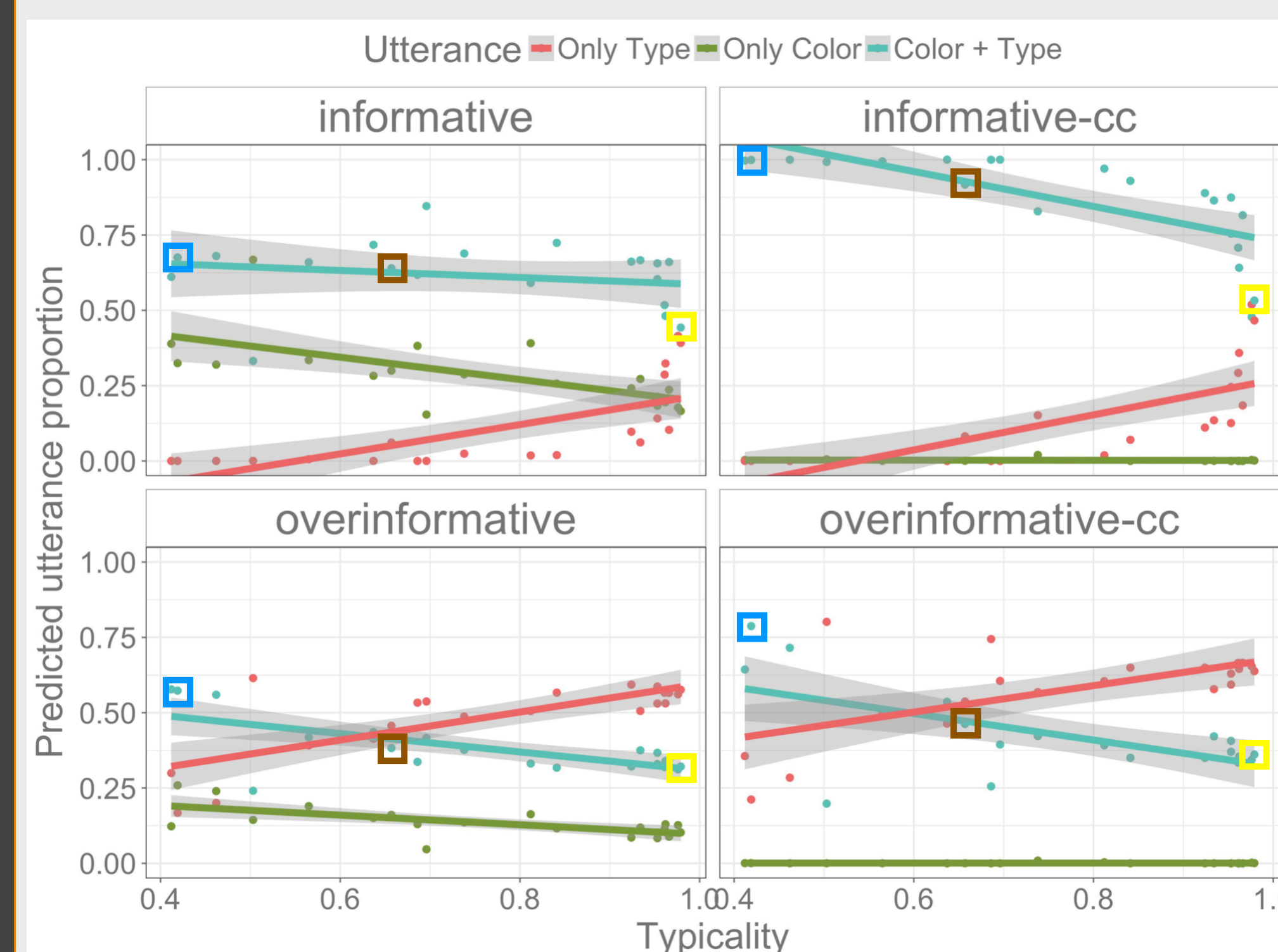
($R^2 = .75$; error bars are high but not displayed)



Parameter Values

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

Model Predictions (“COLOR banana” cases marked)



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)

Acknowledgments

James S. McDonnell grant & ONR grant N00014-13-1-0788 to NG

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/>

