Overinformativeness?
Rationally redundant reference

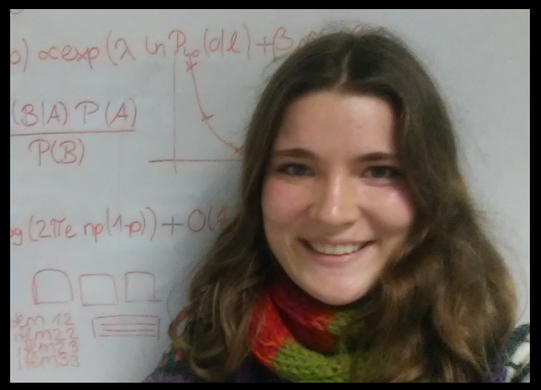
Judith Degen

09/14/2017

Philosophy Colloquium — CMU

Joint work with

Caroline Graf



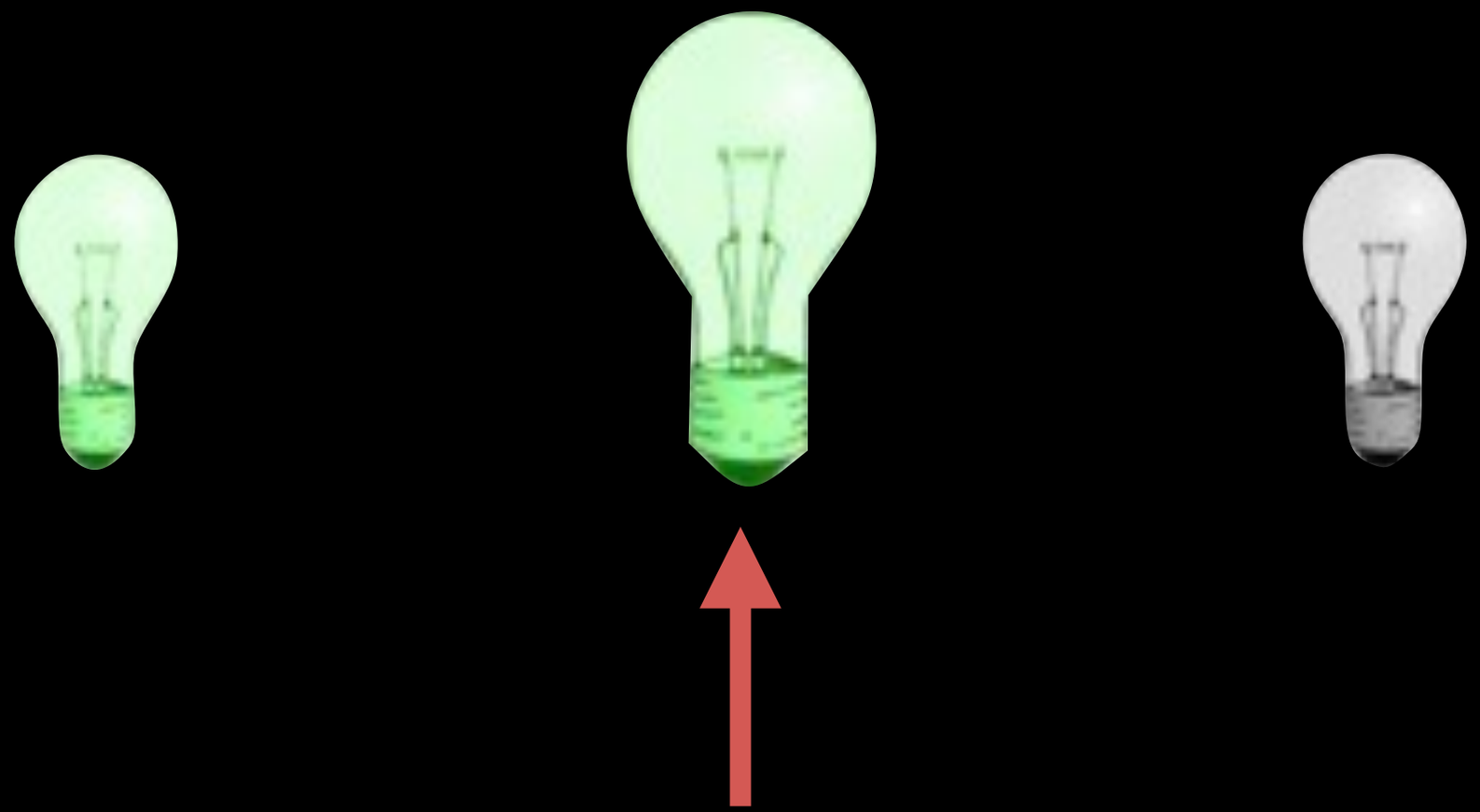
Elisa Kreiss

Robert Hawkins

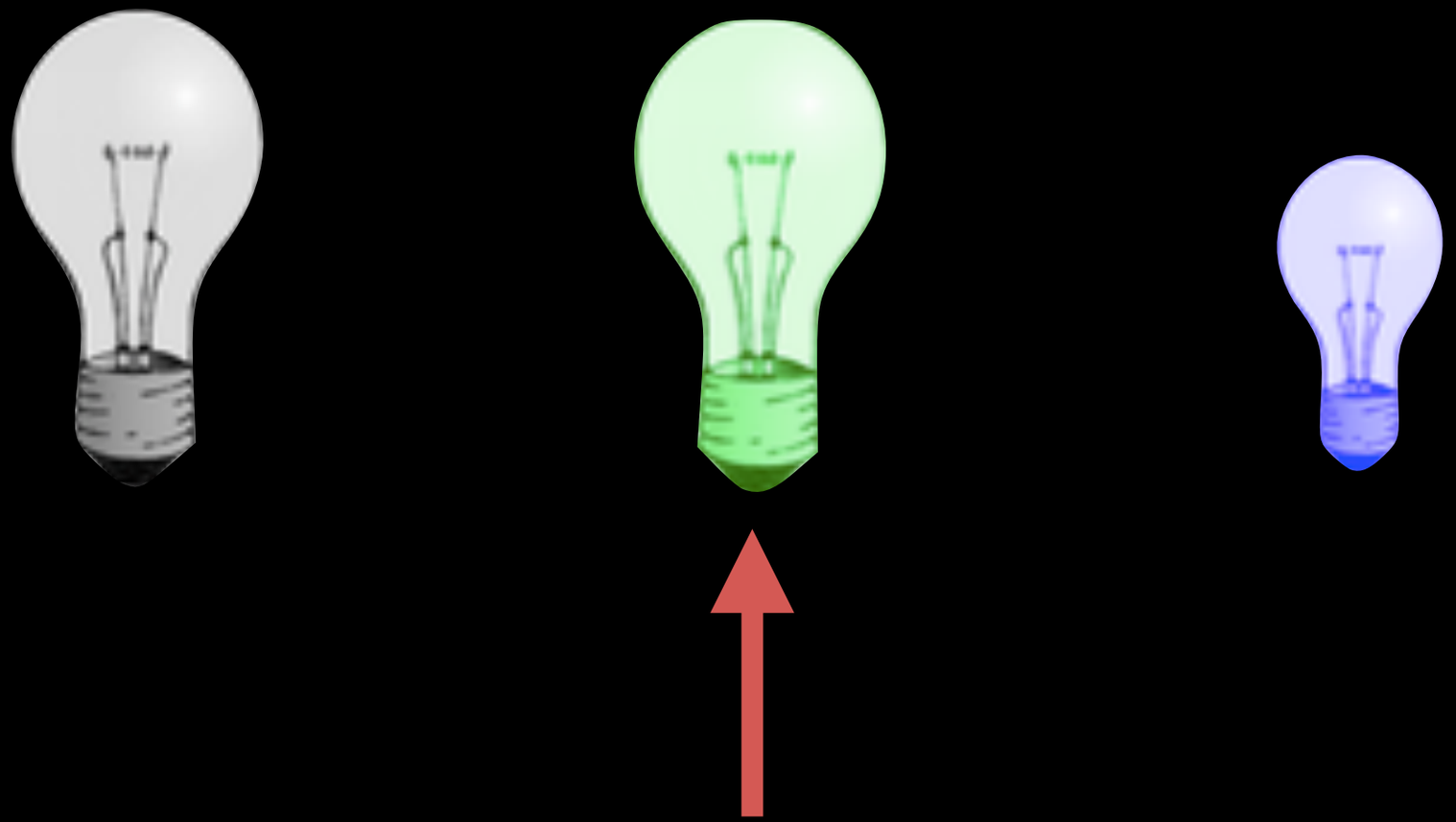
Noah Goodman

CONTENT SELECTION

Which features of an object should I mention?



Gatt et al. 2011



Gatt et al. 2011

The Cooperative Principle

Grice 1975

> “Make your conversational contribution such as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged.”

Quantity-1: Make your contribution as informative as required.
Quantity-2: Don’t make your contribution more informative than necessary.
Manner: Be brief and orderly; avoid ambiguity and obscurity.

Overinformative referring expressions — color/size asymmetry

size sufficient

the big lightbulb

75-80%

color sufficient

the green lightbulb

the big green lightbulb

8-10%

Deutsch 1976; Pechmann 1989; Sedivy 2003; Gatt et al. 2011; many others

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1. speakers produce overinformative referring expressions
2. more overinformative color than size mentions

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OVERINFORMATIVENESS

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Outline

I. Overinformativeness asymmetry for color and size modifiers

II. Typicality effects in overinformative referring expressions

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II. Typicality effects in overinformative referring expressions

```
var runModel = function(speake
  var speakerERP = speakerMode
  return Enumerate(function(){
    var utt = sample(speakerER
    factor(params.speakeroptim
    return utt;
  });
};
```

models

experiments

Computational models of REs

- Greedy Algorithm
  Dale 1989
- Incremental Algorithm
  Dale & Reiter 1995
- PRO
  Gatt et al 2013

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Informativeness

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Preferences

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Probabilities

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- Rational Speech Act (RSA)
  Frank & Goodman 2012

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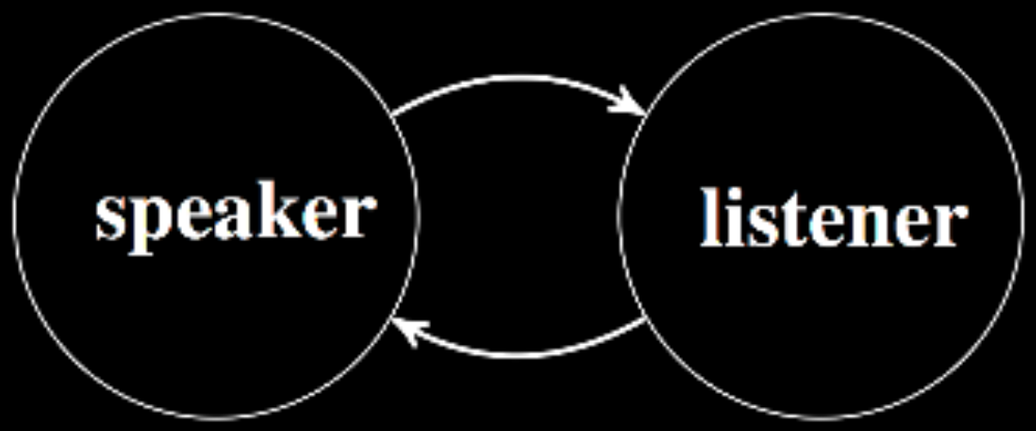
Probabilistic pragmatics

RSA models



In the works:

- collective predication Scontras & Goodman
- I-implicatures Poppels & Levy
- overinformativeness Degen & Goodman
- generics Tessler & Goodman
- modals Herbstritt & Franke
- vague quantifiers Schöller & Franke

Reference

Frank & Goodman, 2012; Qing & Franke, 2015; Degen & Franke, 2012; Stiller et al., 2011; Franke & Degen, 2015

Cost-based Quantity implicatures

Degen et al., 2013; Rohde et al., 2012

Scalar implicatures

Goodman & Stuhlmüller, 2013; Degen et al., 2015

Embedded implicatures

Potts et al., in press; Bergen et al., in press

M-implicatures

Bergen et al., 2012

Figurative meaning

Kao et al., 2013; 2014; 2015; Kao & Goodman, to appear

Gradable adjectives

Lassiter & Goodman, 2013; 2015; Qing & Franke, 2014

The RSA framework

Frank & Goodman 2012

$O = \{$, , $\}$

$U = \{\text{big}, \text{small}, \text{green}, \text{black}\}$

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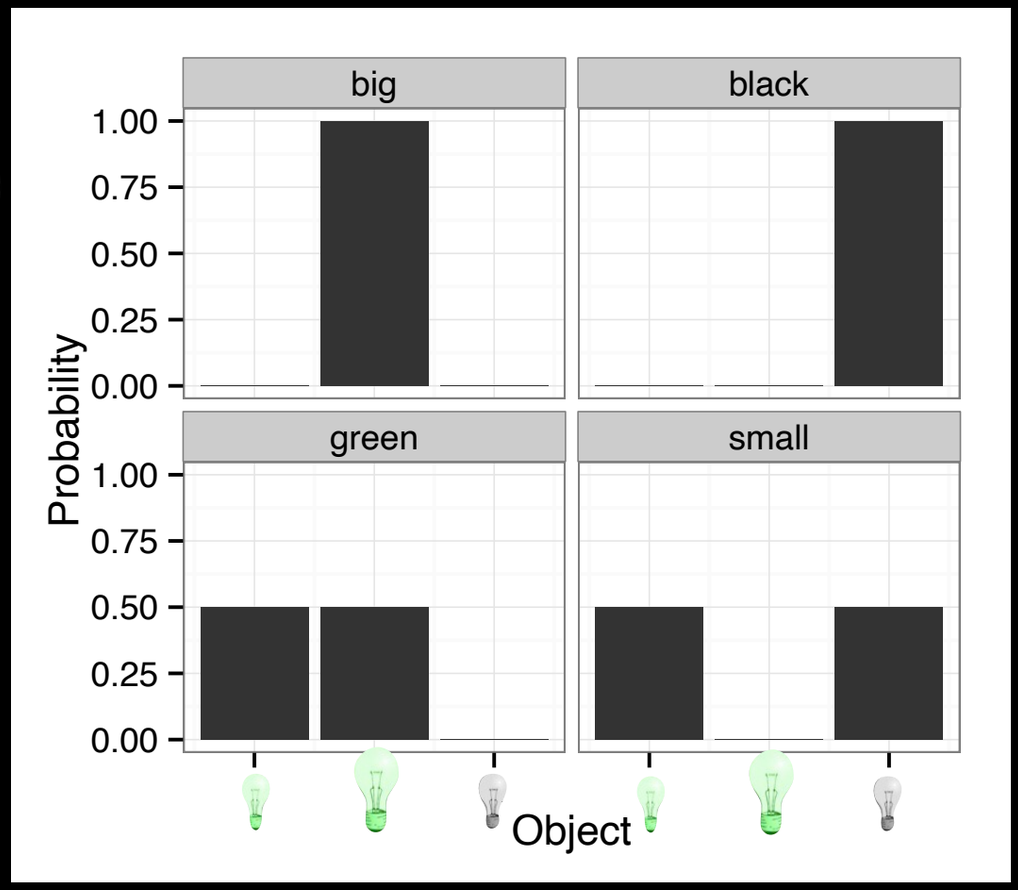

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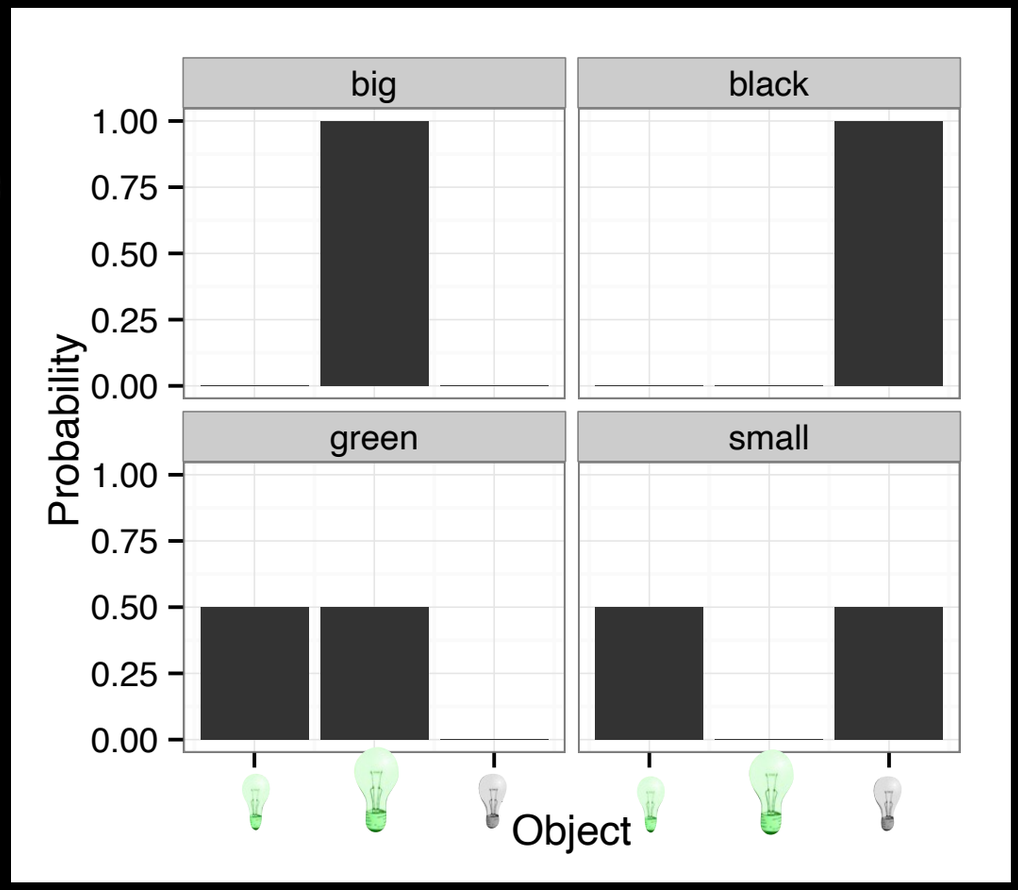

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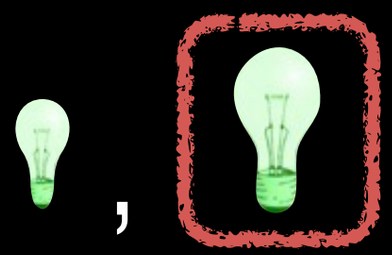
$O =$ {  }

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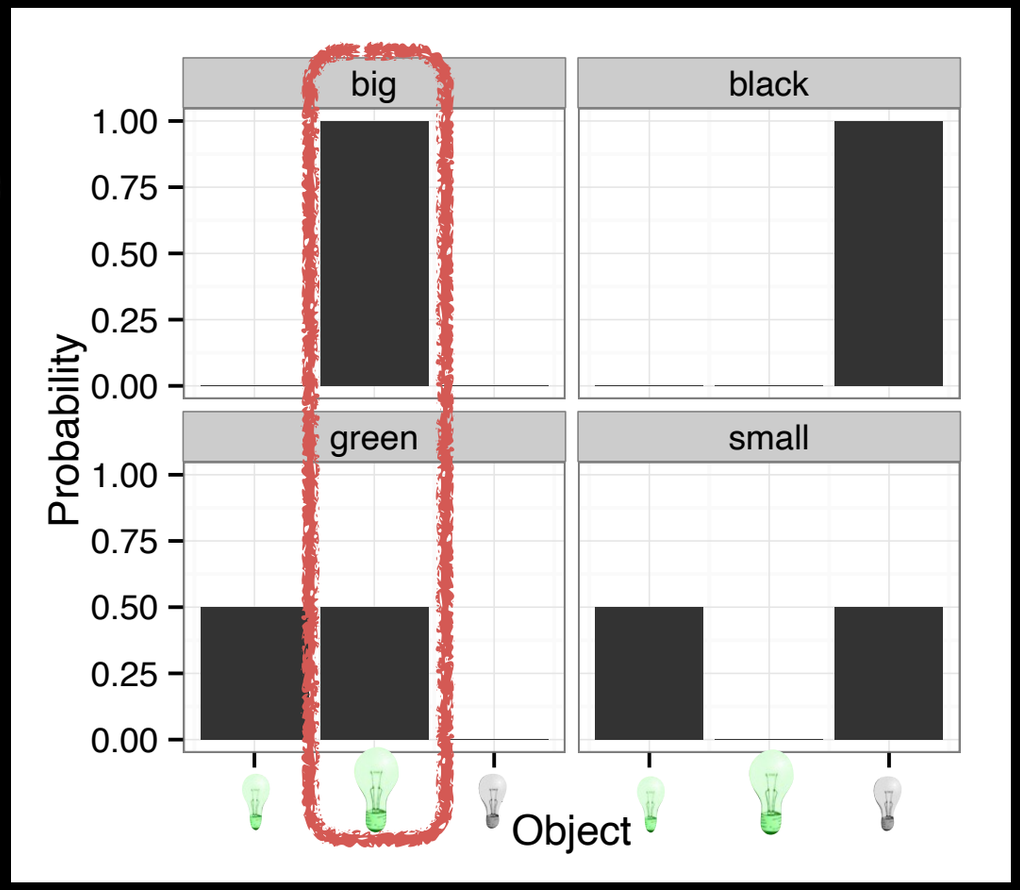

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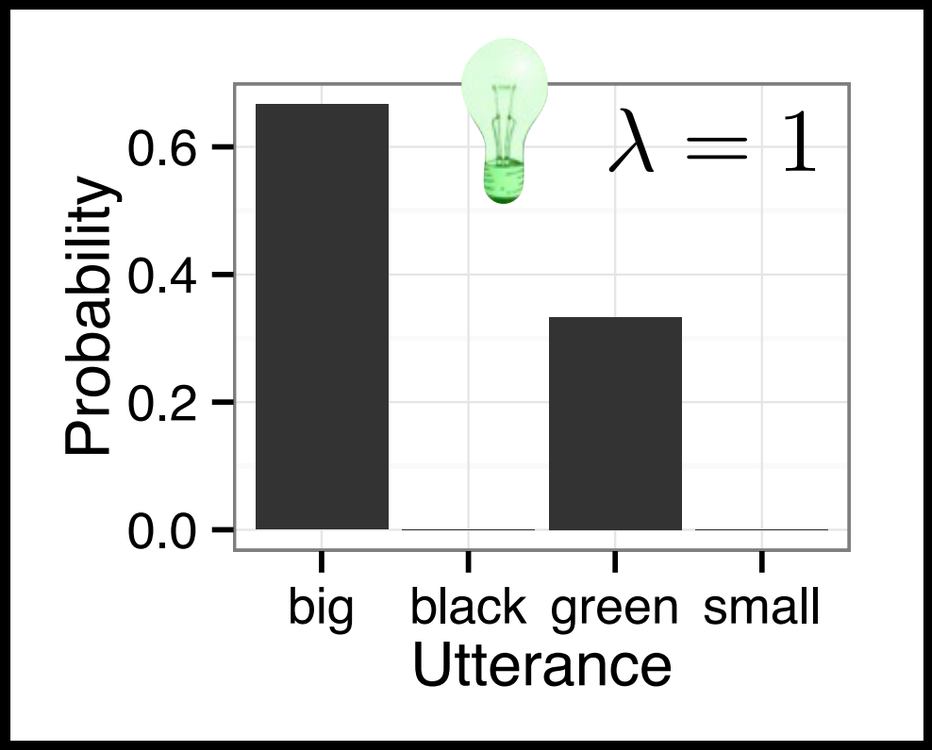

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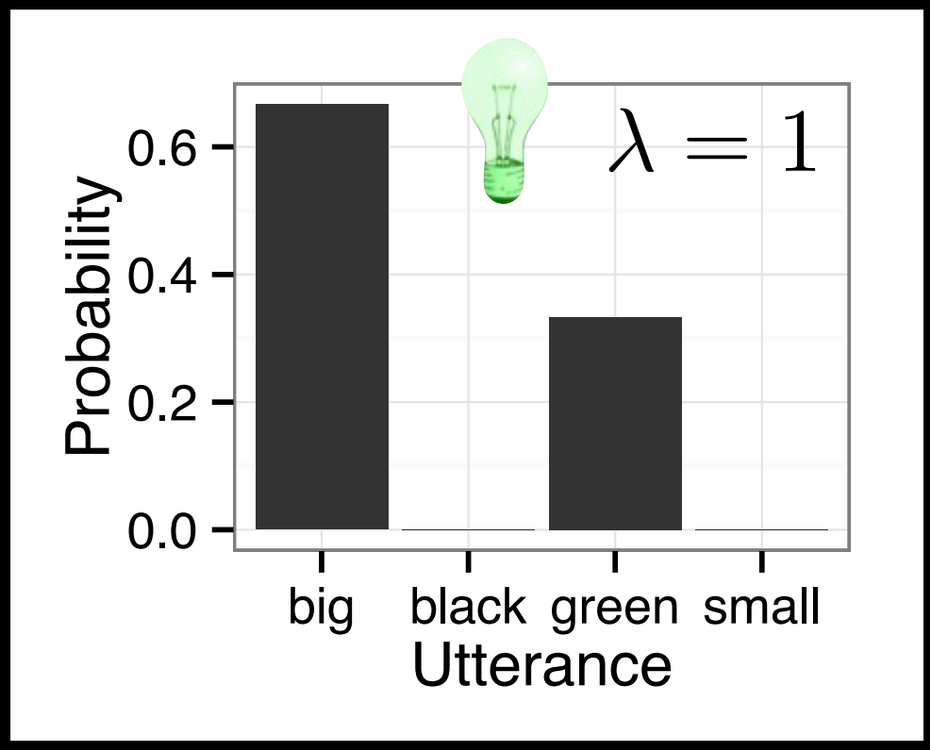

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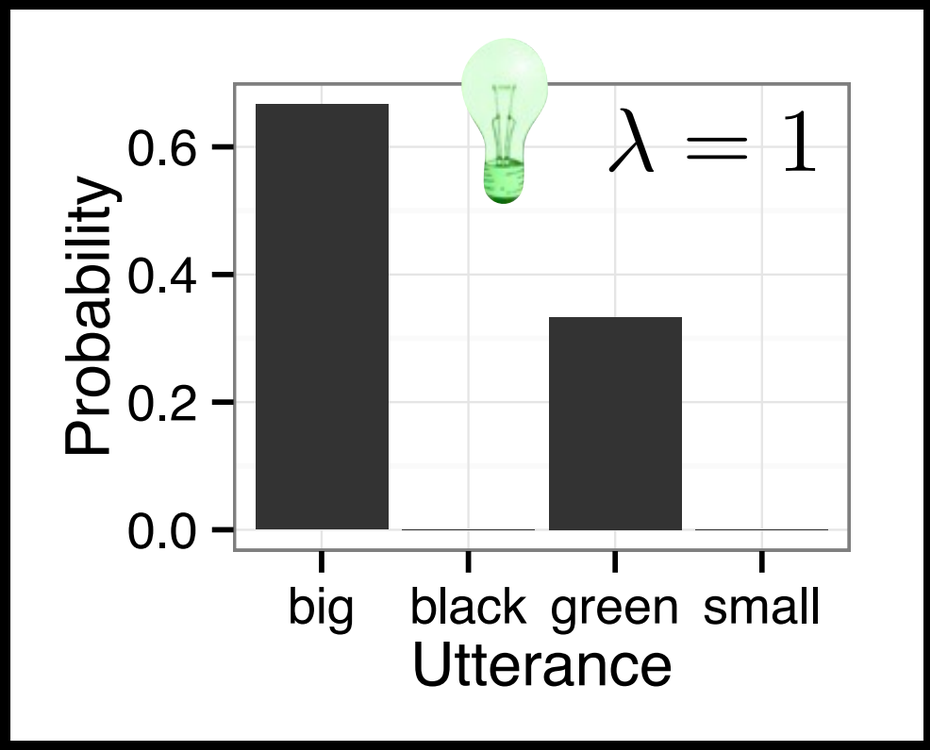

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obvious problem:
no complex utterances

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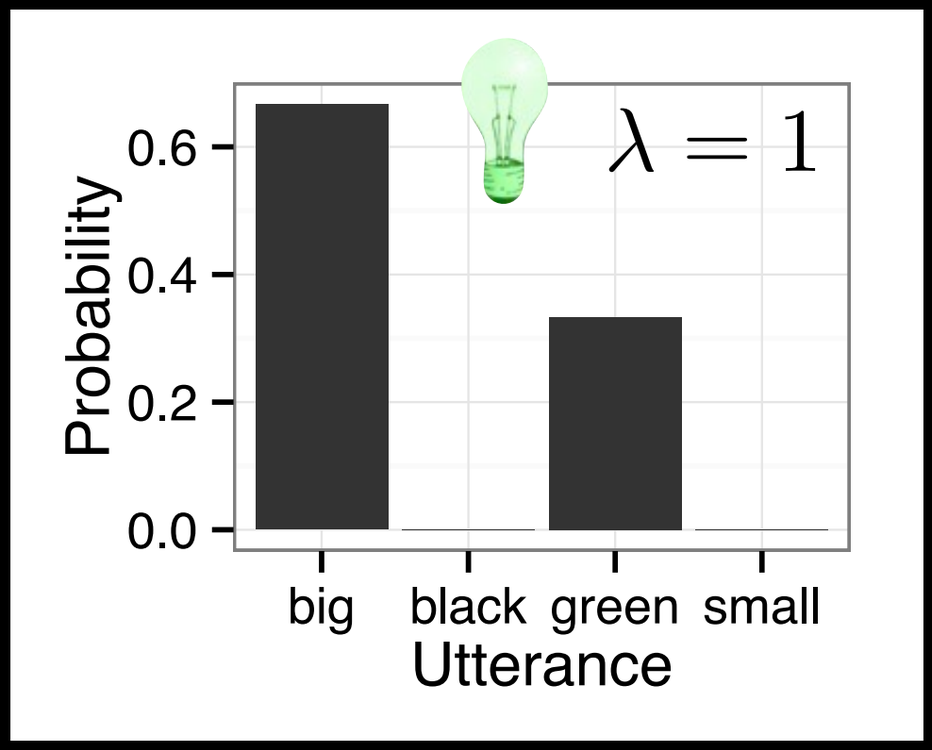

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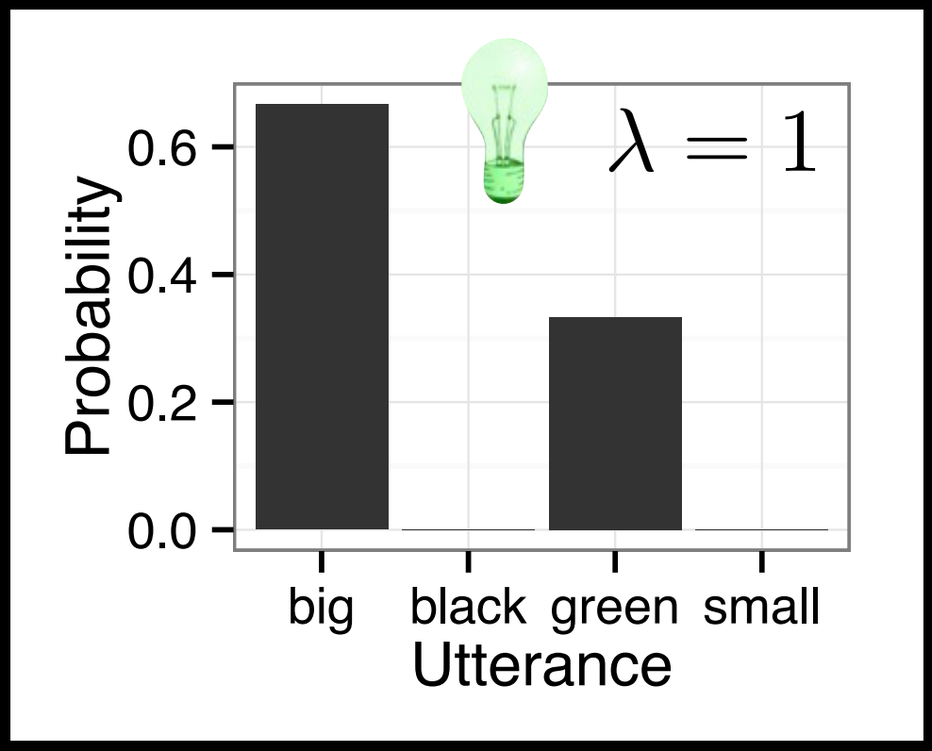

Utterance semantics & cost

Intersective semantics

$$[[u]] = [[u_1]] \wedge [[u_2]]$$

$$[[\text{big green}]] = [[\text{big}]] \wedge [[\text{green}]]$$

Cost

$$C(u) = C(u_1) + C(u_2)$$

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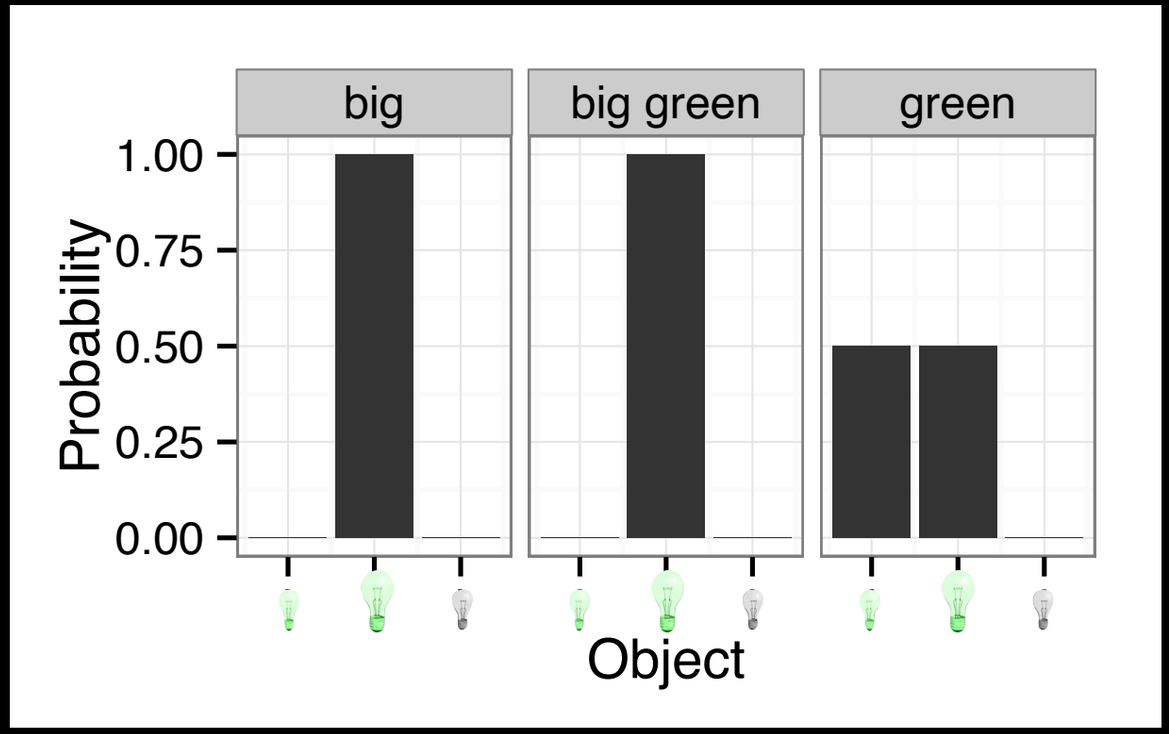

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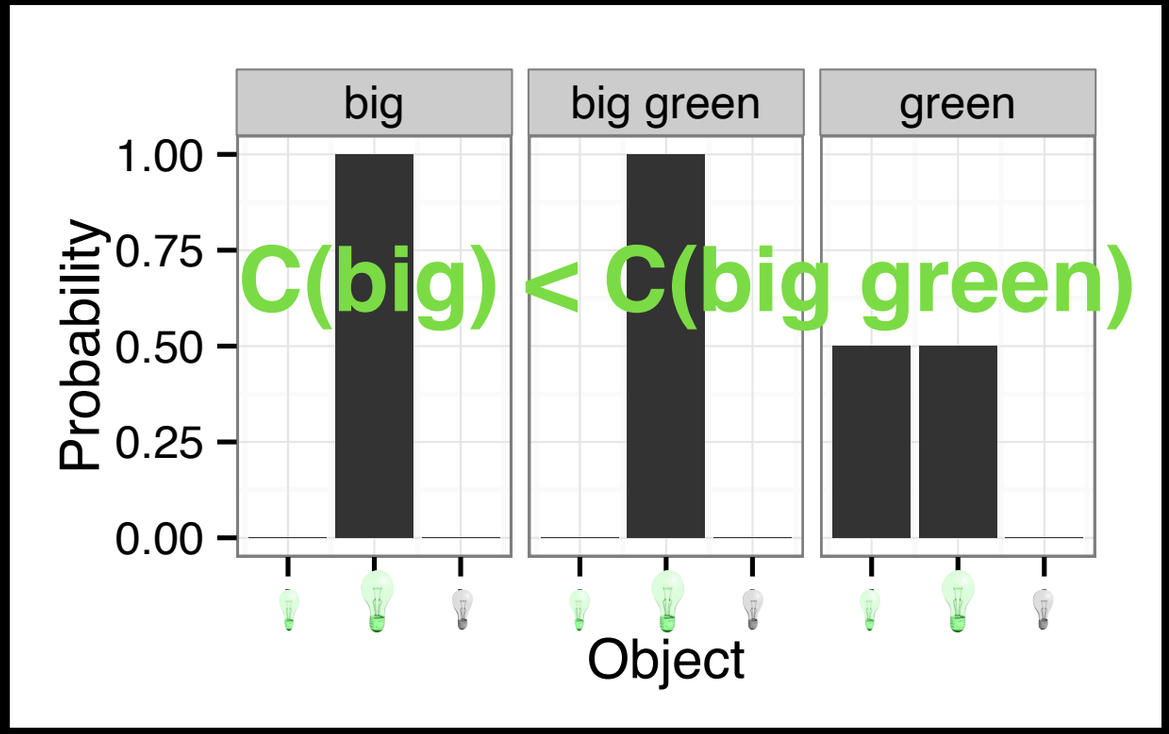

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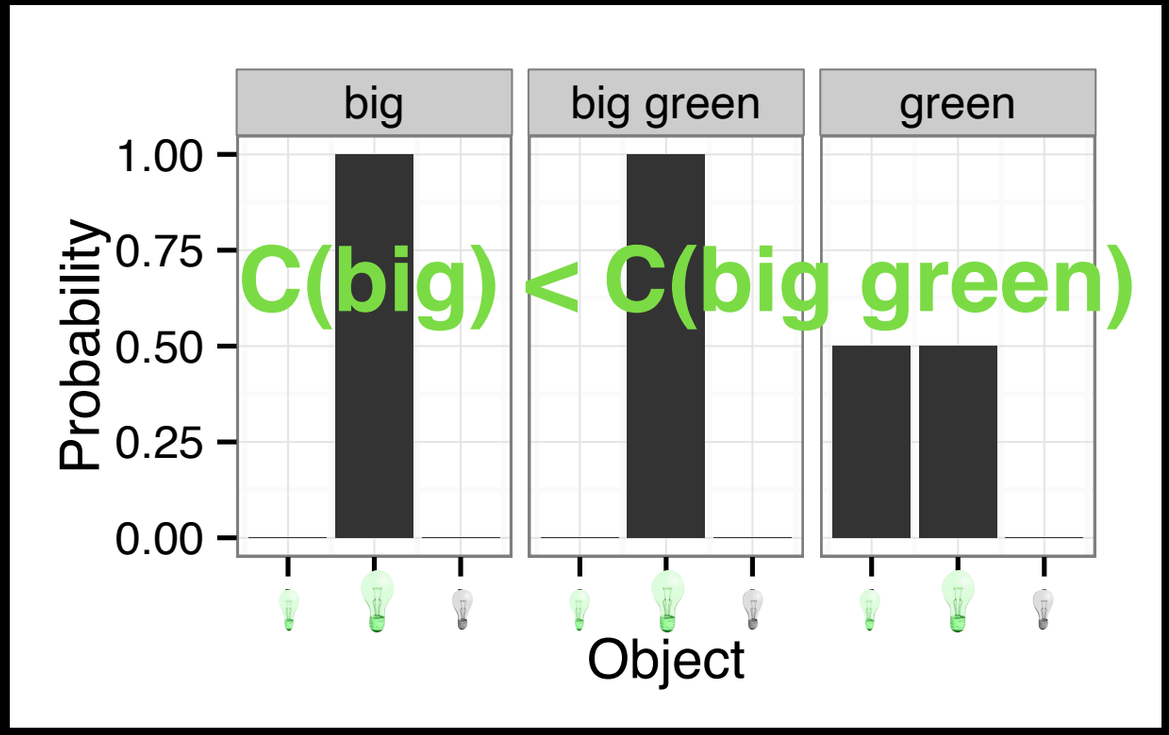
RSA will not produce overinformative REs…

Gatt et al 2013; Westerbeek et al 2015



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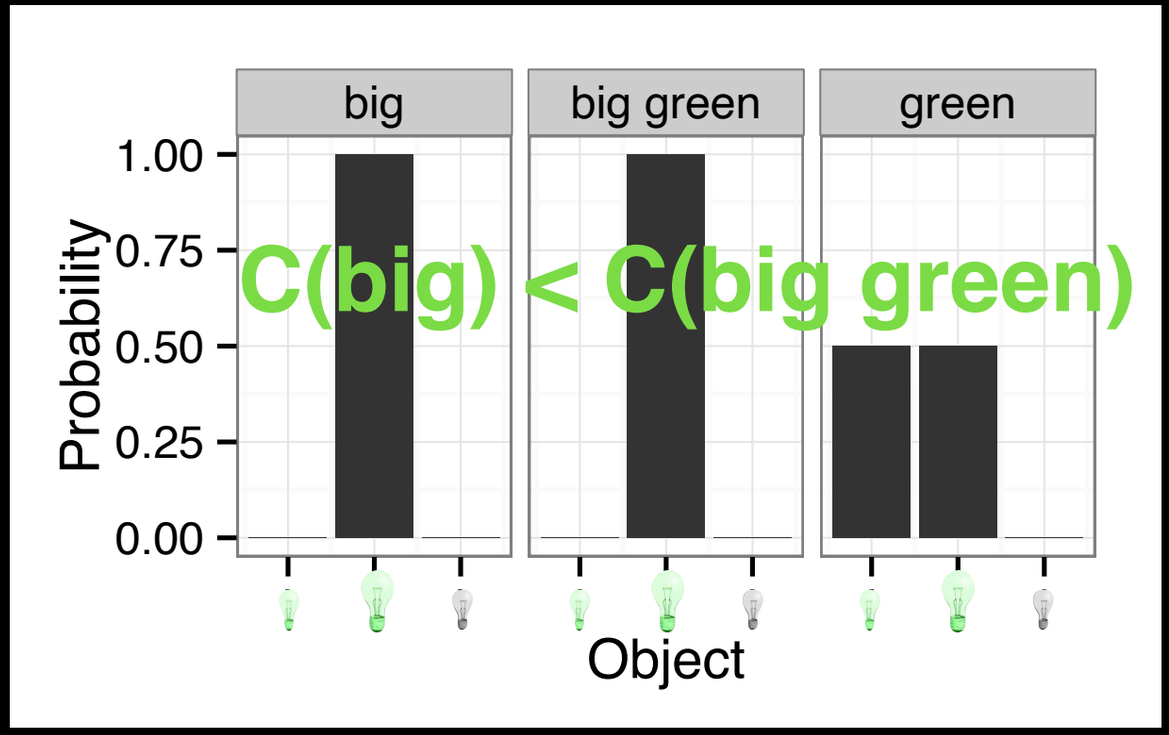
…with deterministic semantics



Motivation for non-deterministic semantics?

Modifiers differ:

size adjectives are vague and context-dependent
in a way that color adjectives are not
Kennedy & McNally 2005

color is intrinsically salient in a way that size is not
Arts et al 2011; Gatt et al 2013

size adjectives are judged to be more subjective
than color adjectives
Scontras, Degen, & Goodman in press

Non-deterministic semantics

Literal listener

$$P_{L_0}(o|u) \propto \begin{cases} 1-\epsilon & [[u]](o) = \text{true} \\ \epsilon & \text{otherwise} \end{cases}$$

Non-deterministic semantics

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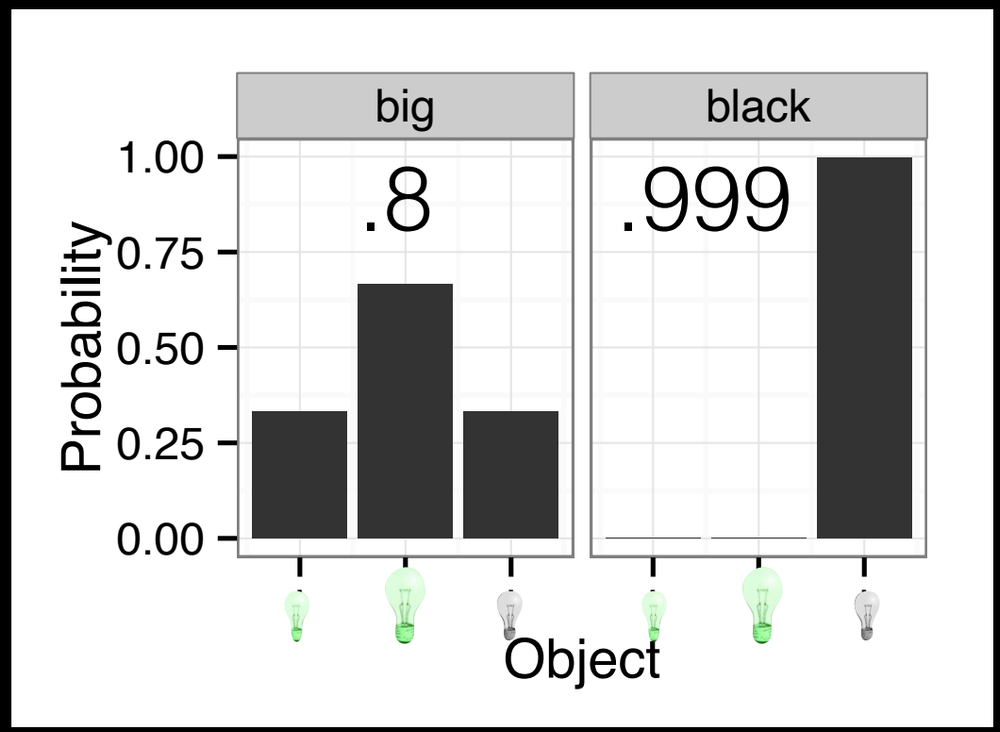

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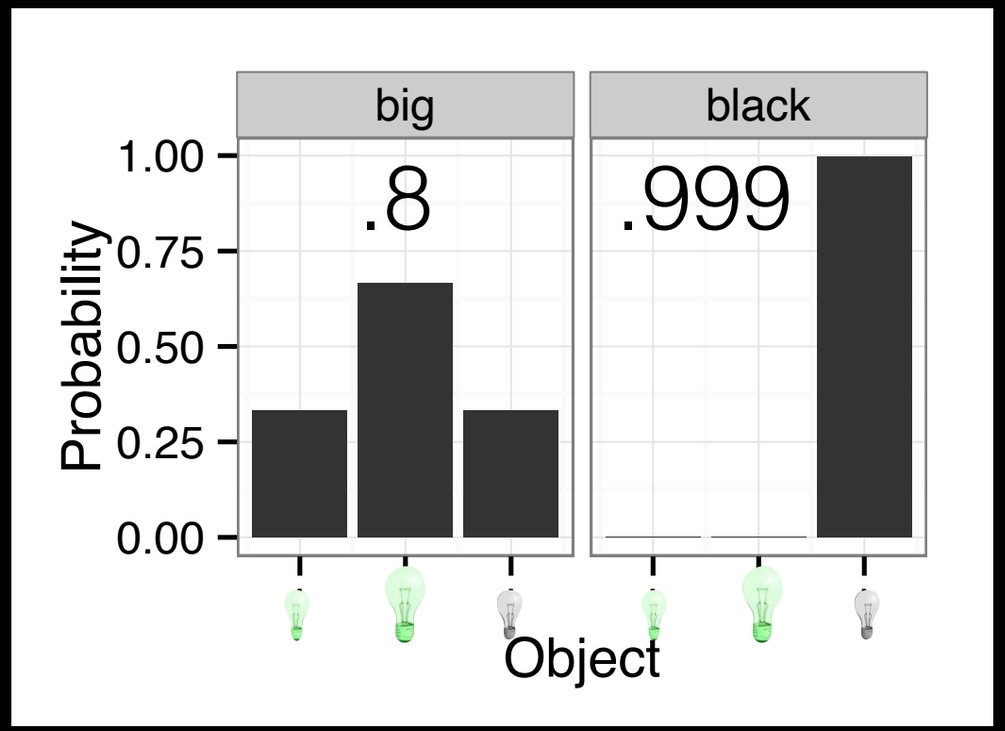

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Two free fidelity parameters:

$\text{fid}(size)$ $\text{fid}(color)$

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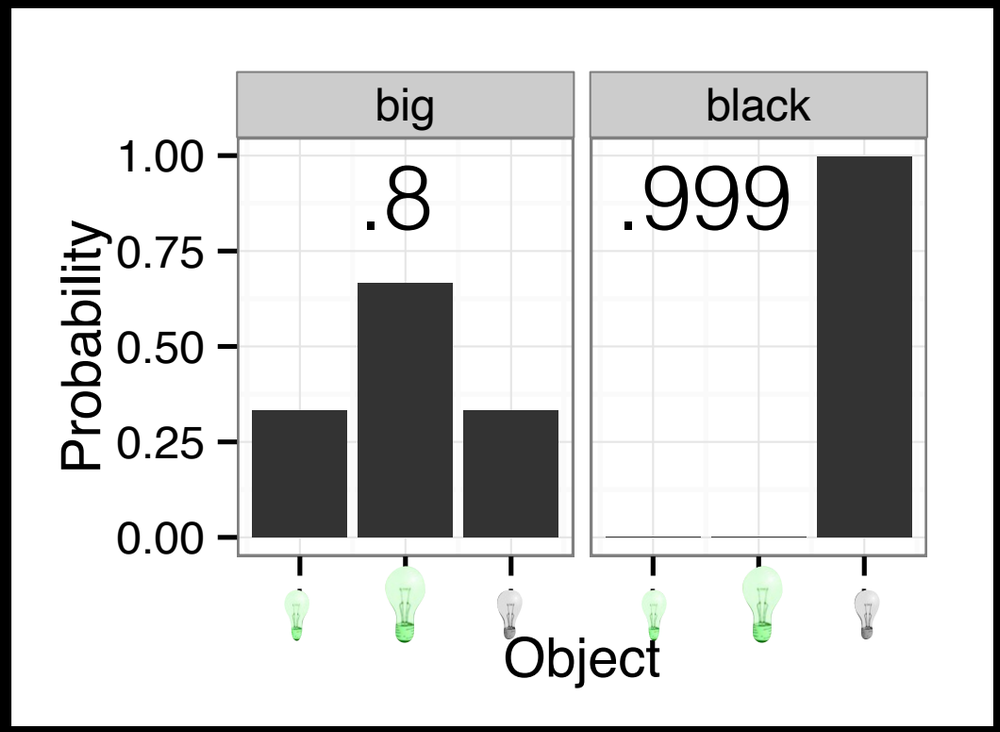

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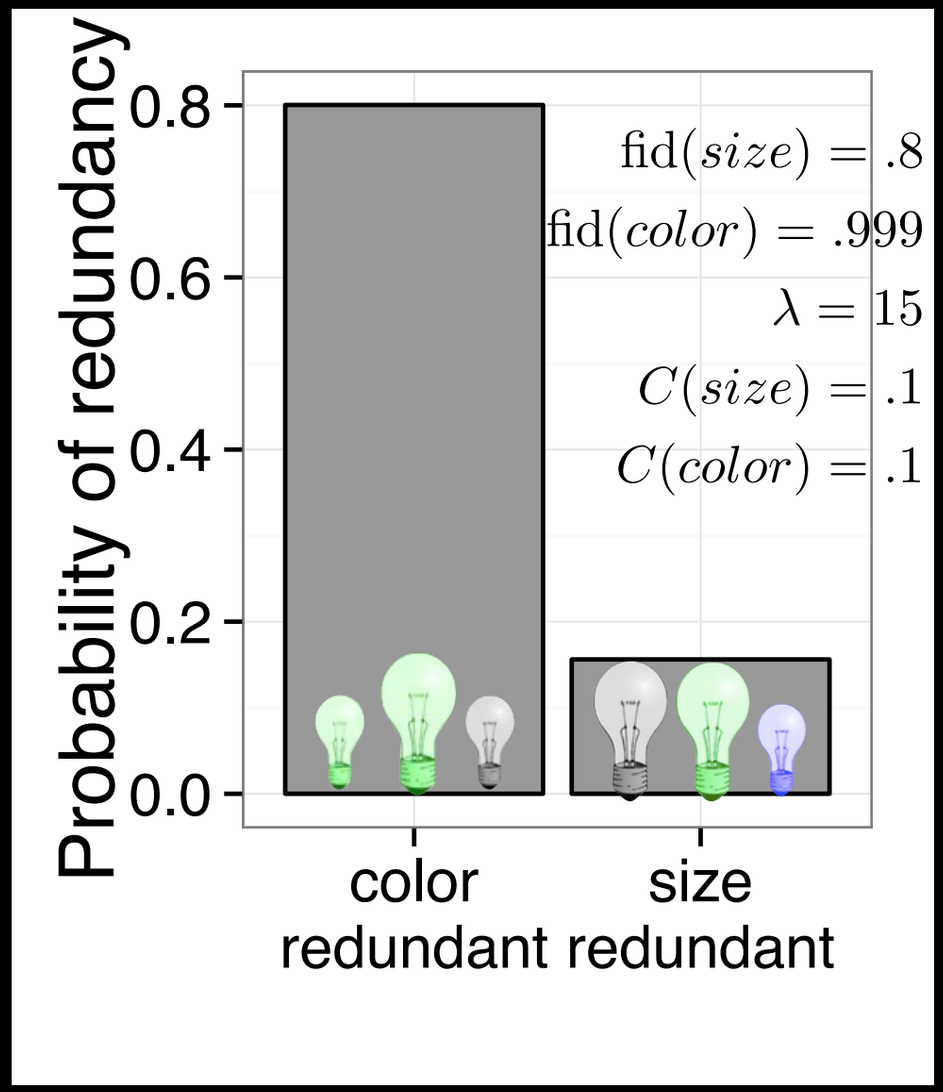

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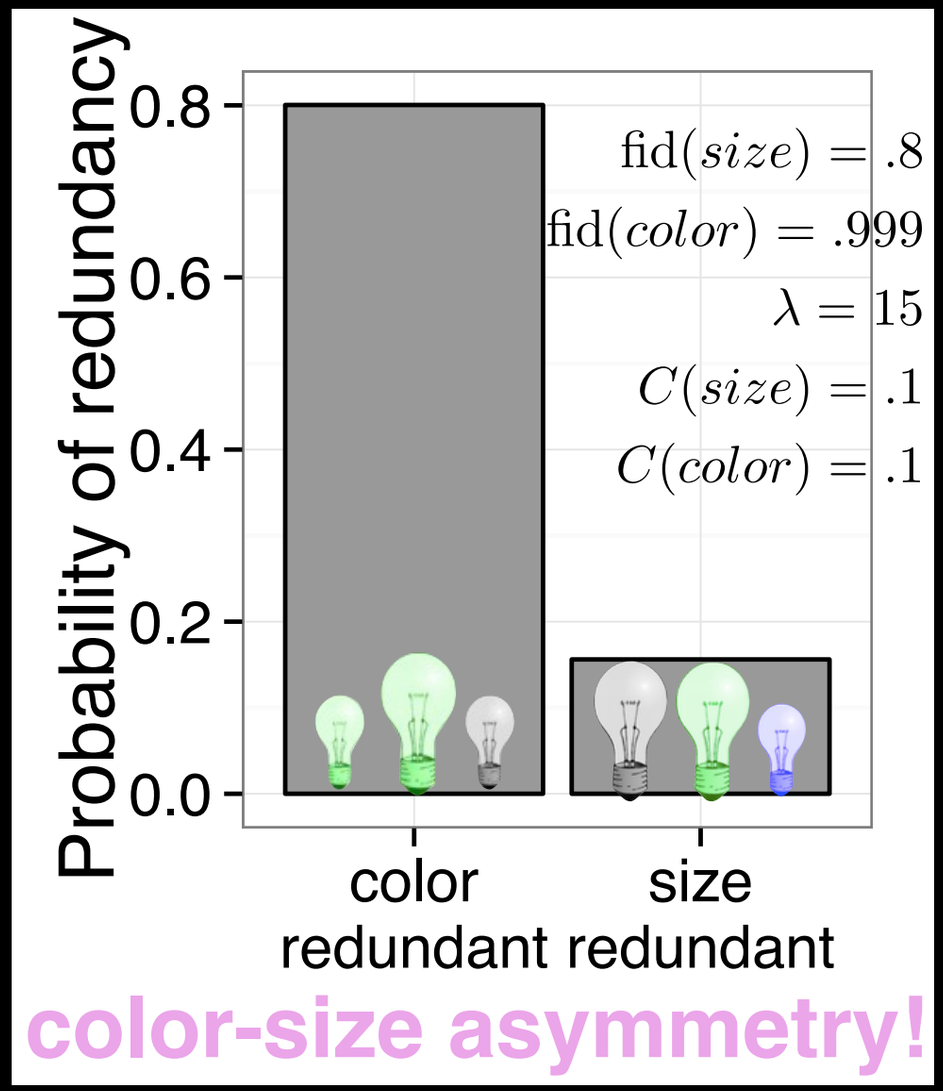

color-size asymmetry!

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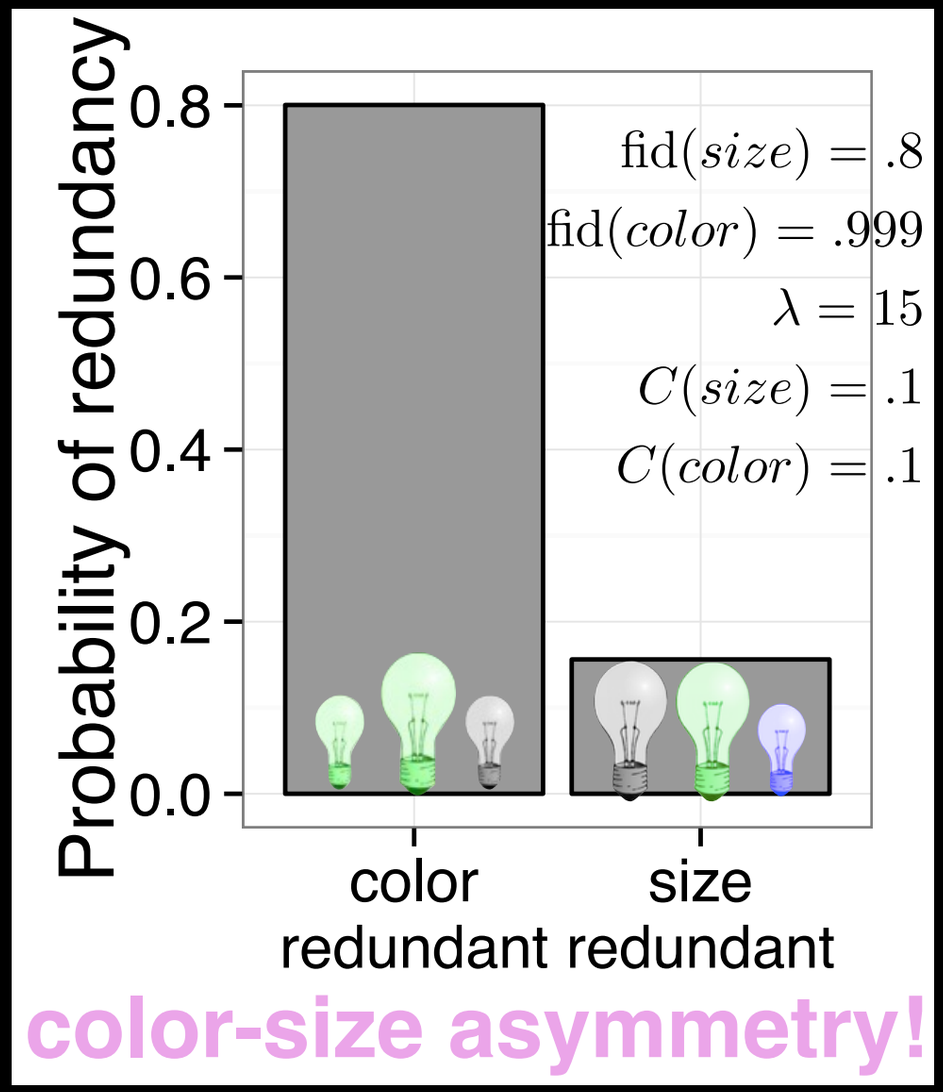


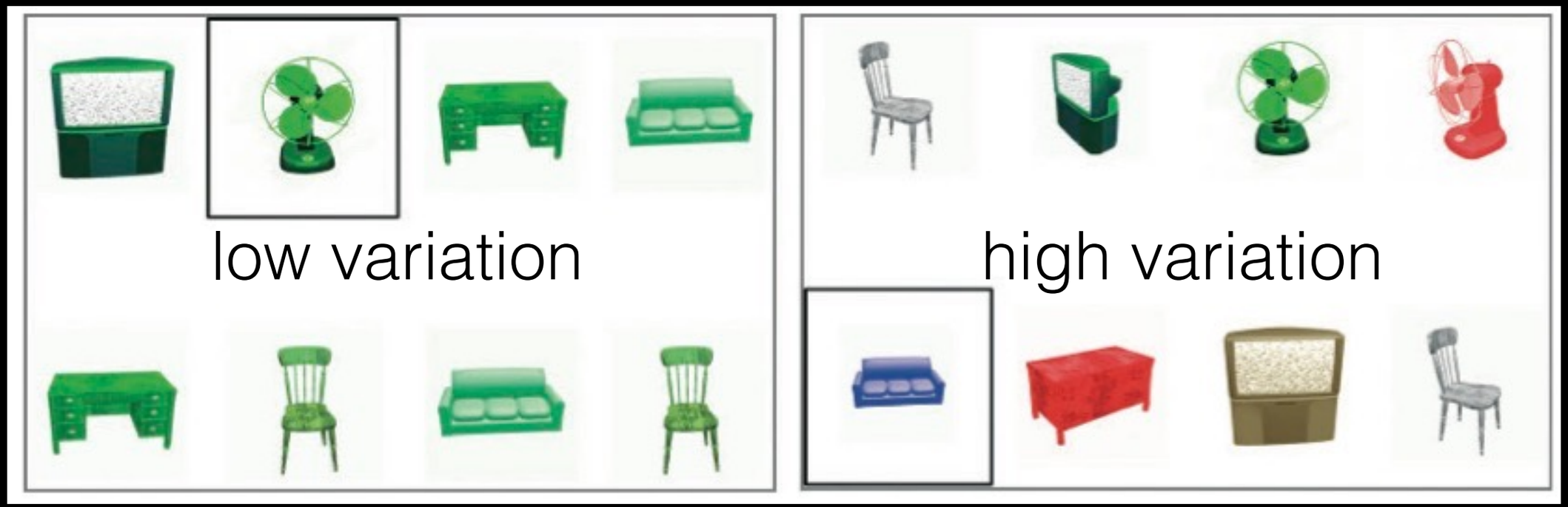
color-size asymmetry!

If modifiers don't "work perfectly",

adding modifiers adds information

Independent empirical evidence for RSA with non-deterministic semantics?

Scene variation



Koolen et al 2013, Davies & Katsos 2013

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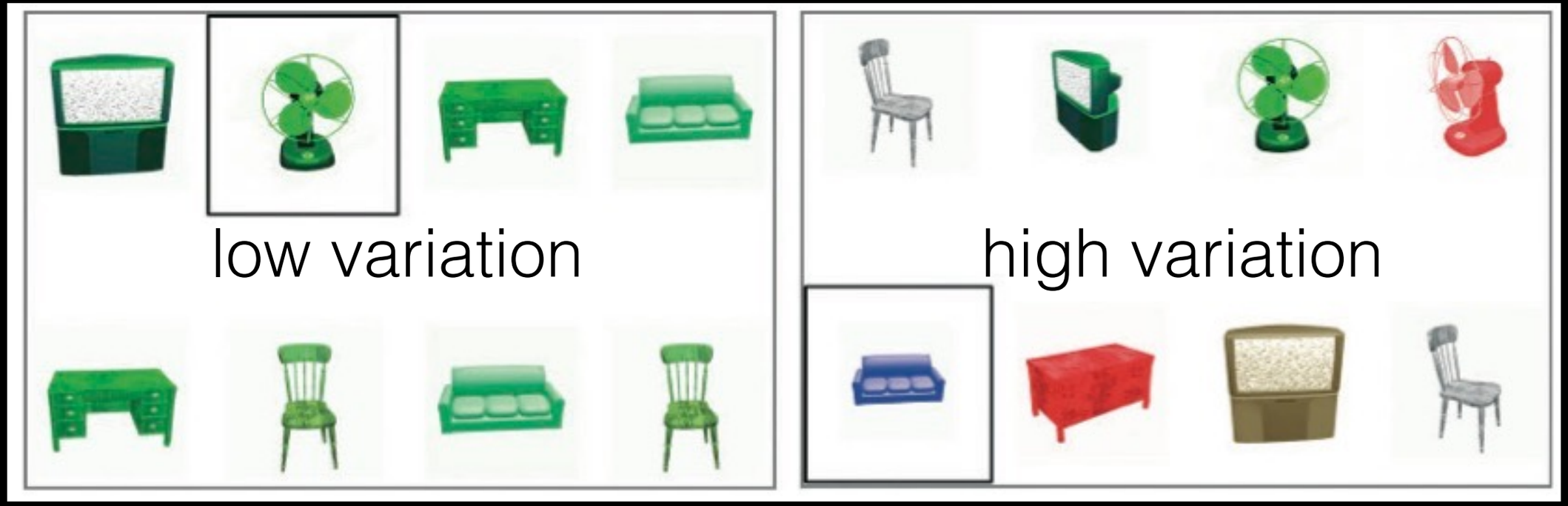

more redundant color use in high-variation scenes

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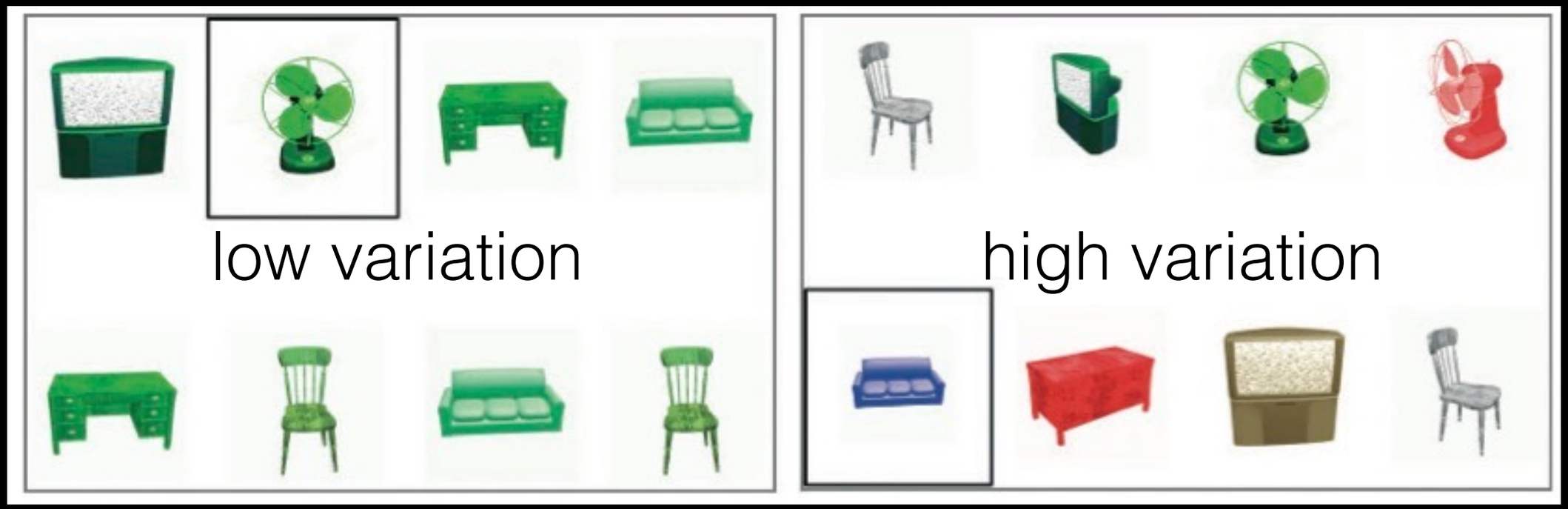

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non-deterministic RSA predicts this result

Independent
quantitative evidence
for non-deterministic
RSA?

Scene variation

scene variation increases probability of redundancy

Scene variation

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$\frac{n_{\text{diff}}}{n_{\text{total}}}$ proportion of total distractors that don't share target value on insufficient dimension

Scene variation

scene variation increases probability of redundancy

$\frac{n_{\text{diff}}}{n_{\text{total}}}$ proportion of total distractors that don't share target value on insufficient dimension

sufficient dimension: size

insufficient dimension: color

$$\frac{n_{\text{red}}}{n_{\text{total}}} = \frac{2}{4} = .5$$

Scene variation

scene variation increases probability of redundancy

$\frac{n_{\text{diff}}}{n_{\text{total}}}$ proportion of total distractors that don't share target value on insufficient dimension

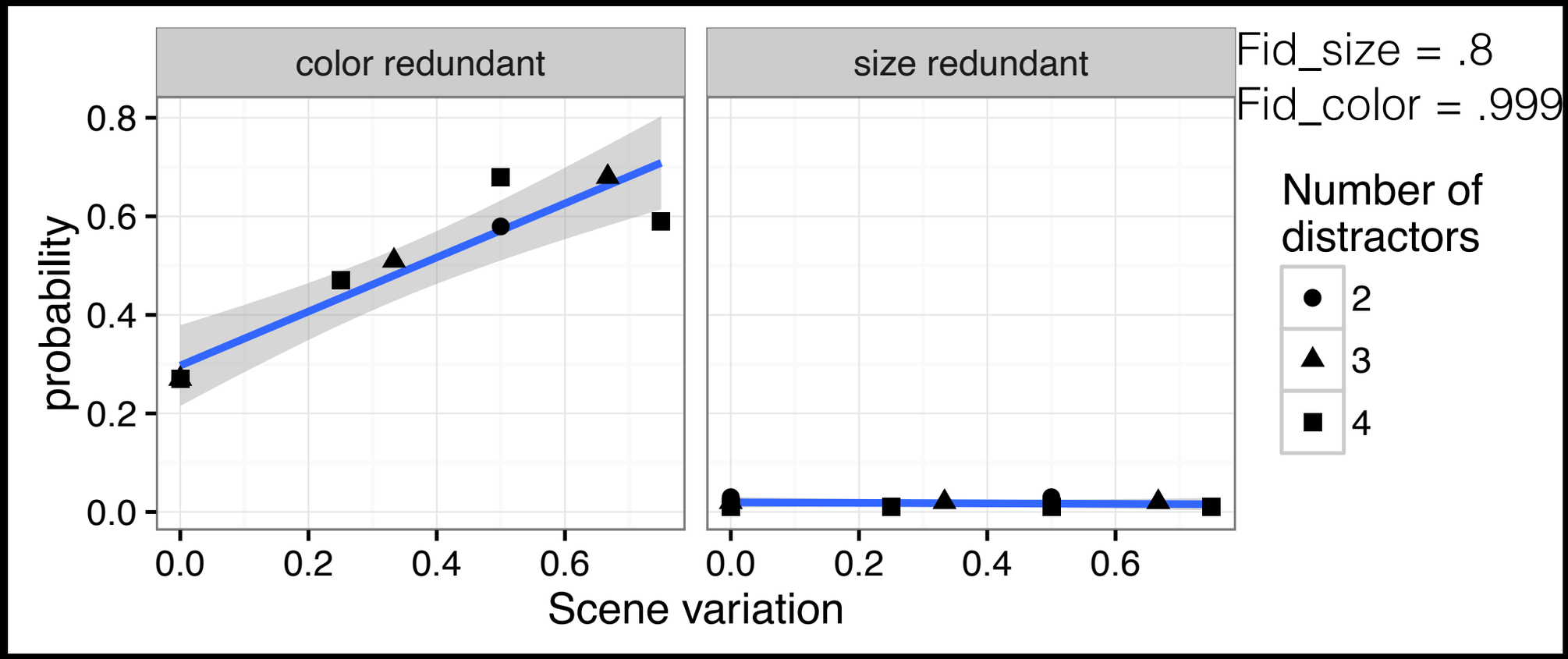
sufficient dimension: size

insufficient dimension: color

$$\frac{n_{\text{red}}}{n_{\text{total}}} = \frac{2}{4} = .5$$

greater proportion = more variation

Model predictions



Prediction: increase in redundant adjective use with increasing scene variation for color but not size

Interactive reference game experiment

- 58 pairs of participants on Mechanical Turk
- random assignment to speaker/listener role
- 72 trials (half targets, half fillers)
- 36 object types
- on all target trials, one of size or color was sufficient
- **scene variation manipulation**:
  - total number of distractors (2, 3, 4)
  - number of distractors that shared the insufficient feature value with target

Speaker's perspective

You: the stapler

listener: which one??

You: big purple

Round 1 of 72

Send

Listener's perspective

speaker: the stapler

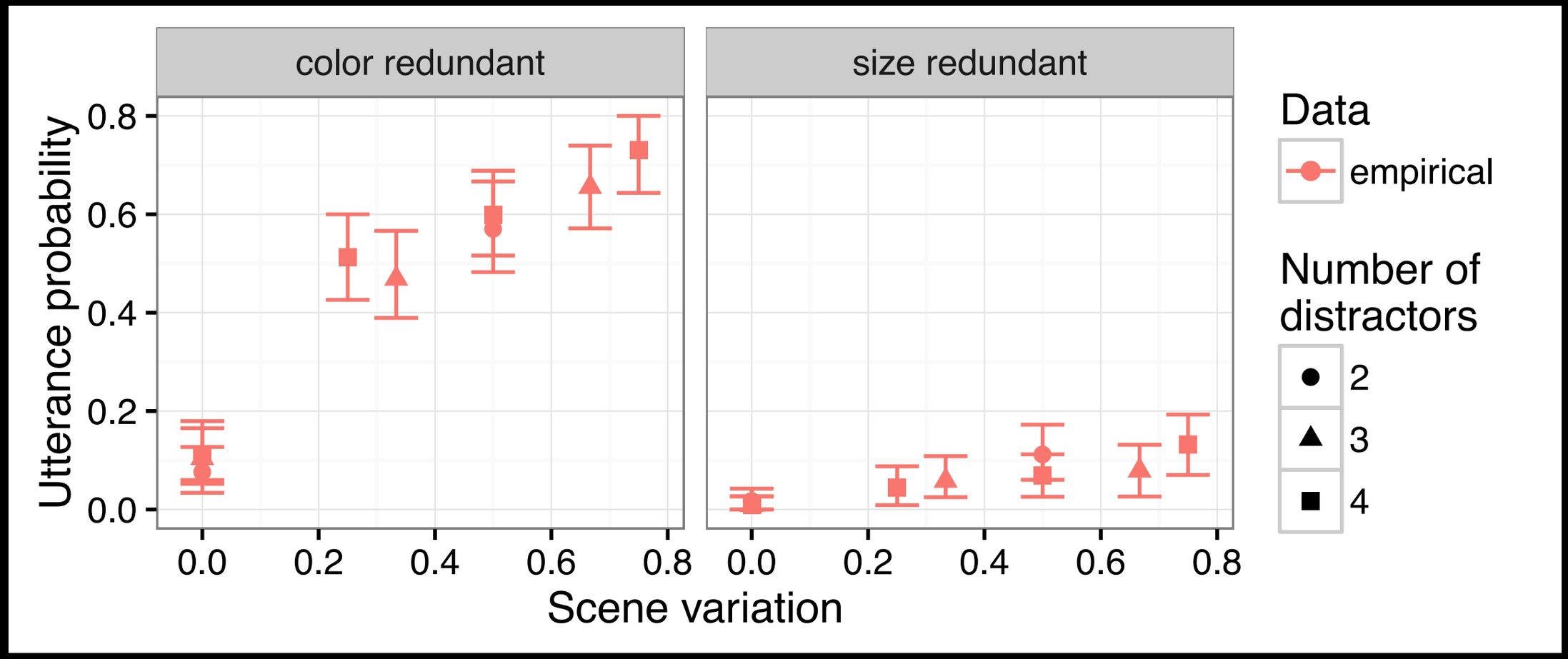
You: which one??

speaker: big purple

Round 1 of 72

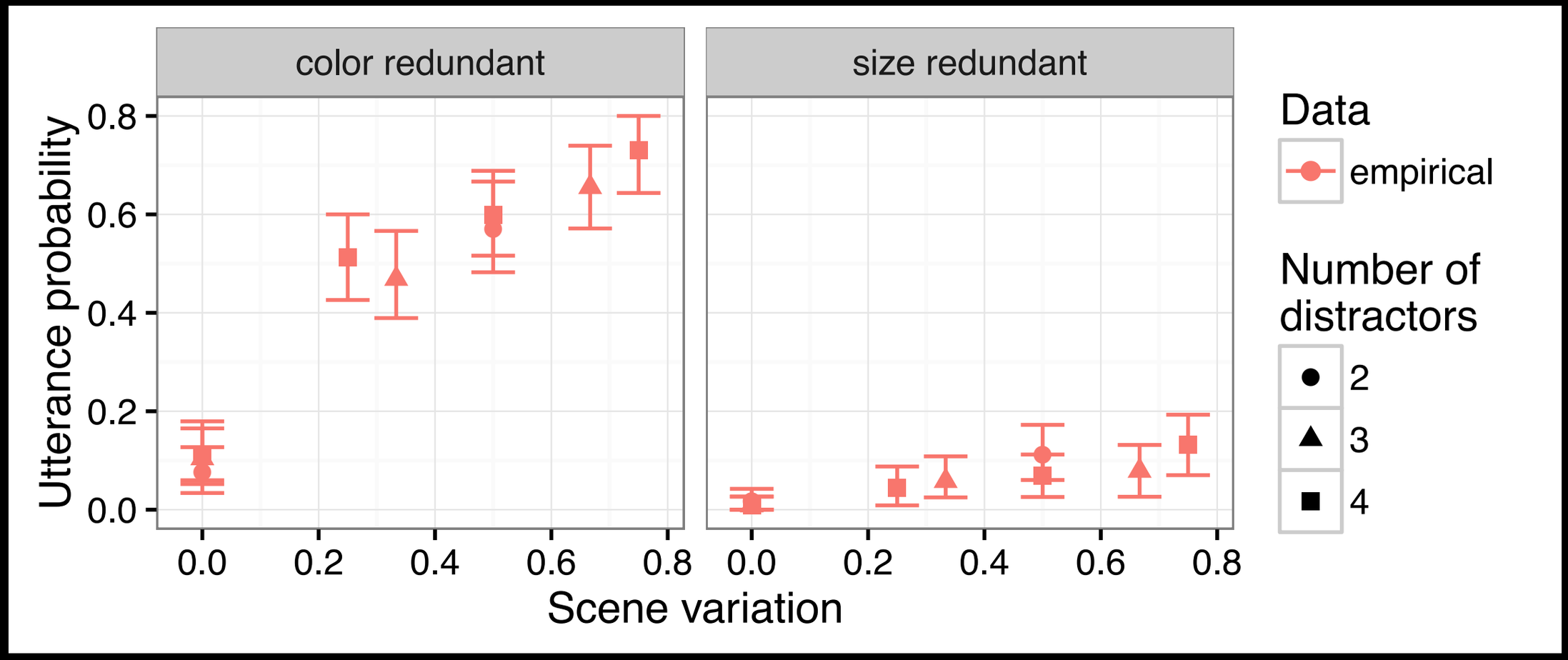
Send

Results



1. more redundant adjective use with greater scene variation
2. greater effect of scene variation for color than size

Results



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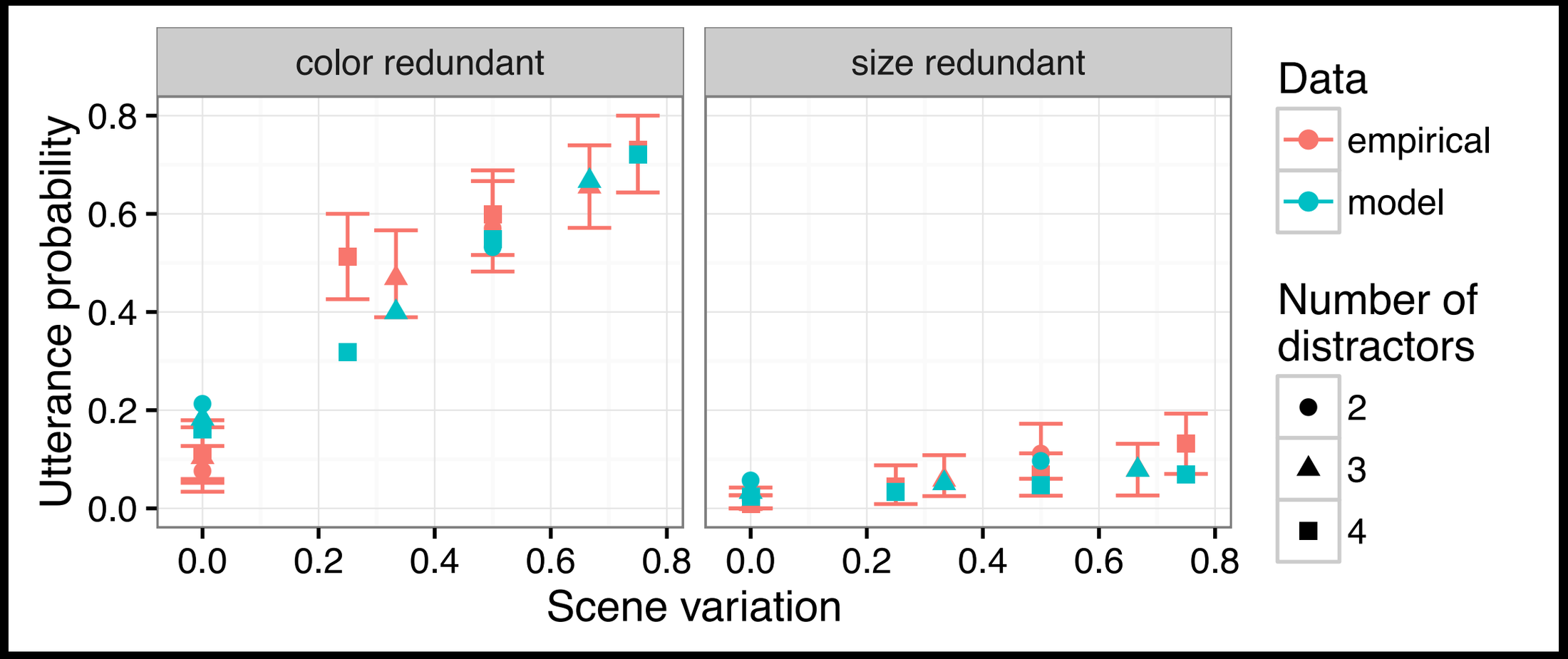
Bayesian Data Analysis

Results



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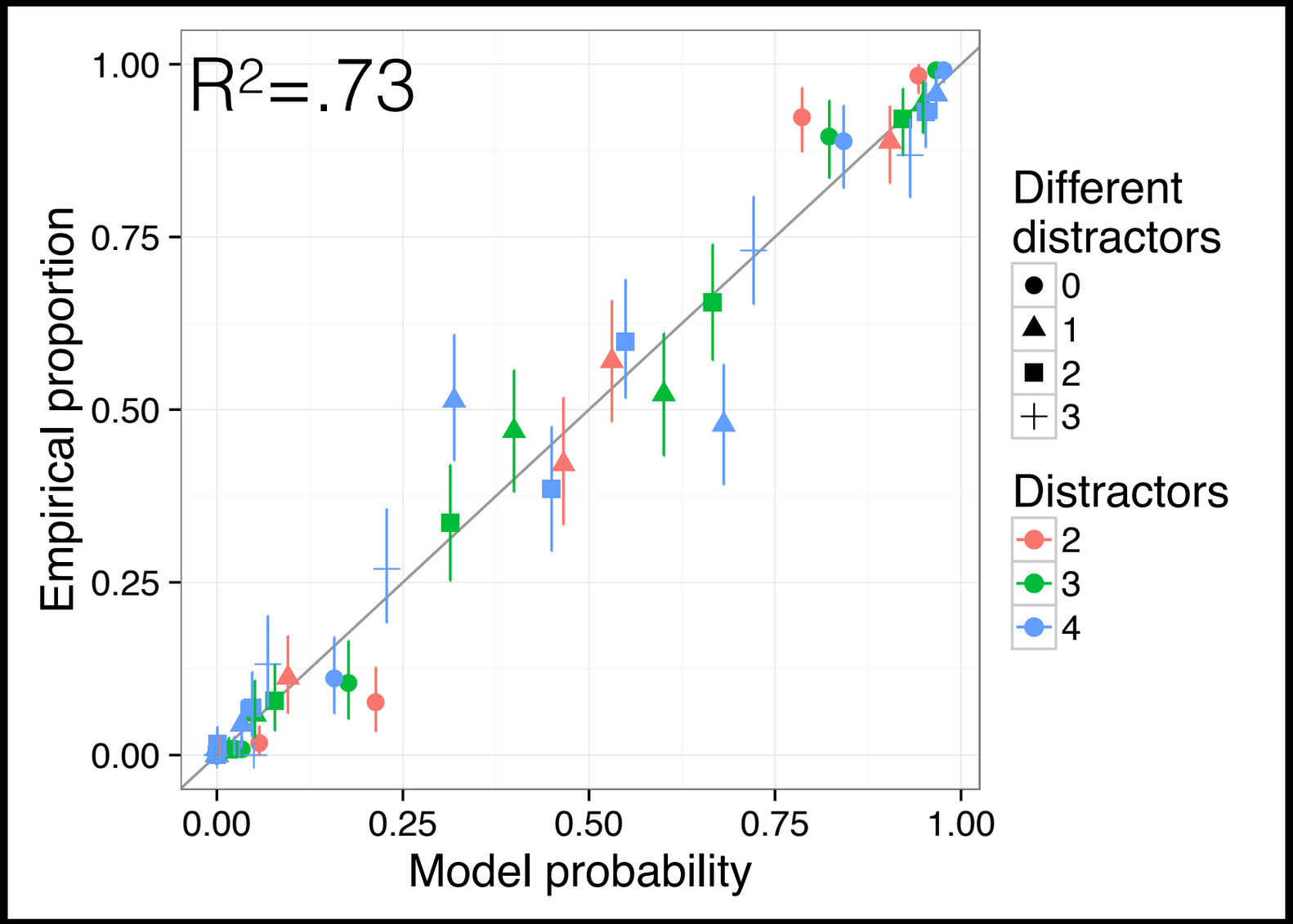
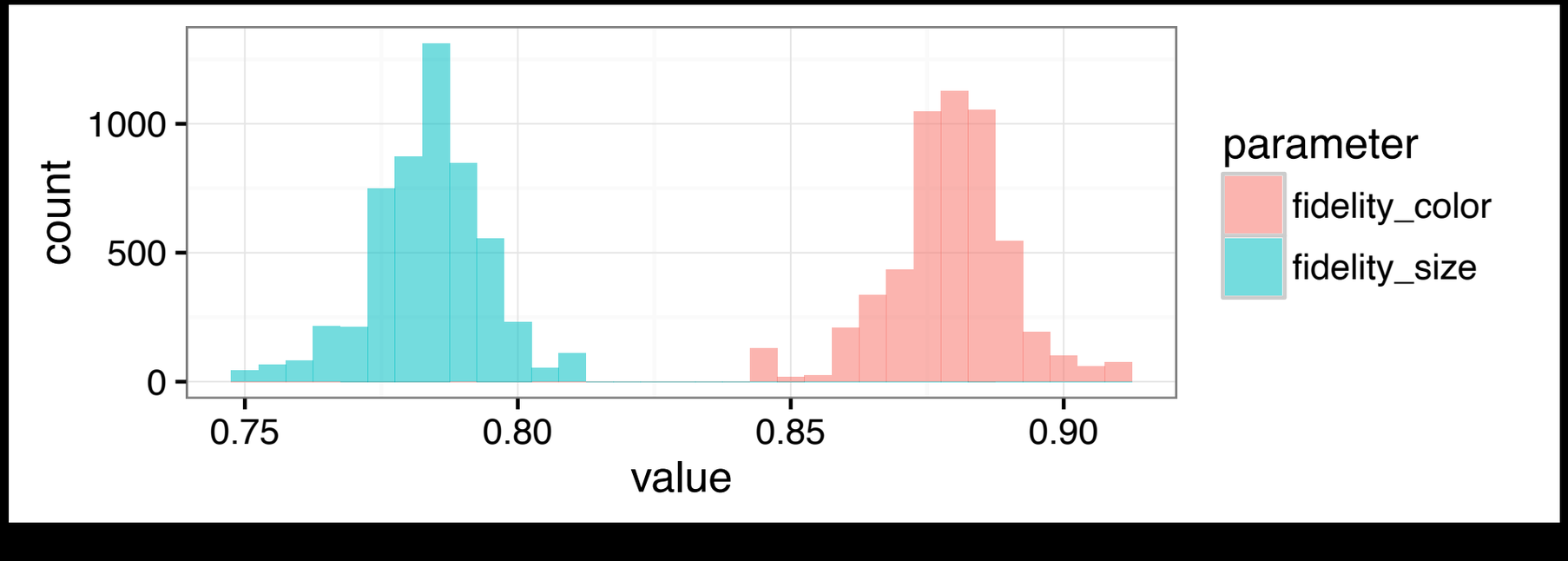
Bayesian Data Analysis

Posterior predictive

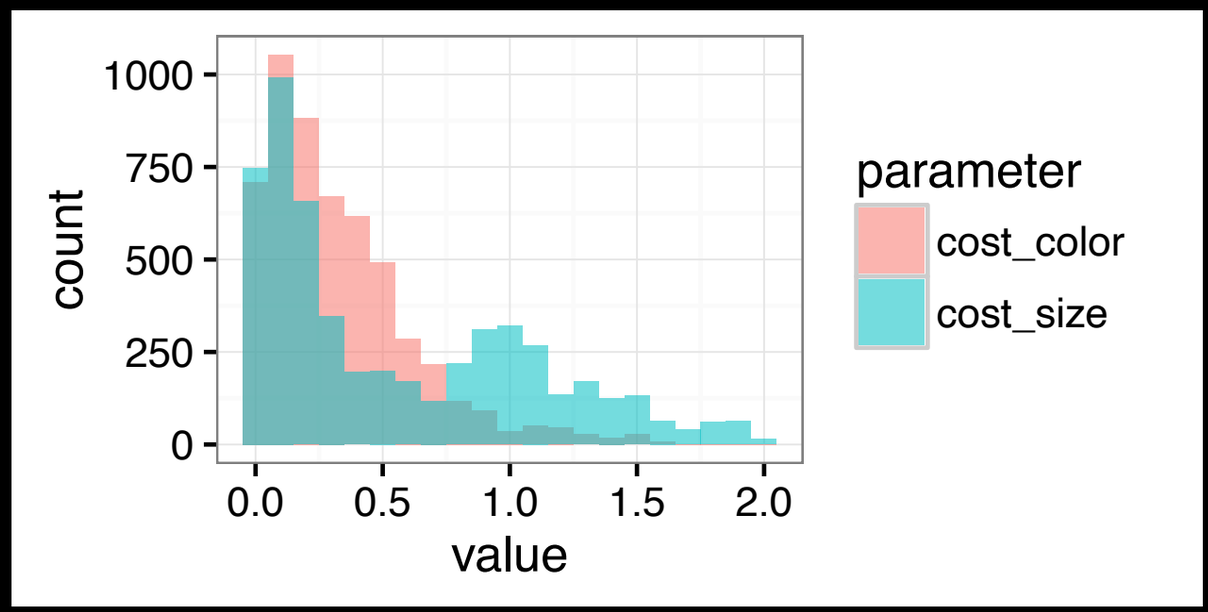


Posteriors over parameters

Fidelity:
inferred size fidelity lower than inferred color fidelity



Cost:
inferred size and color costs similar (with tendency towards costlier size)



Interim summary

if modifiers are noisy, adding modifiers adds utility

RSA with noisy truth functions captures this:

overinformative referring expressions

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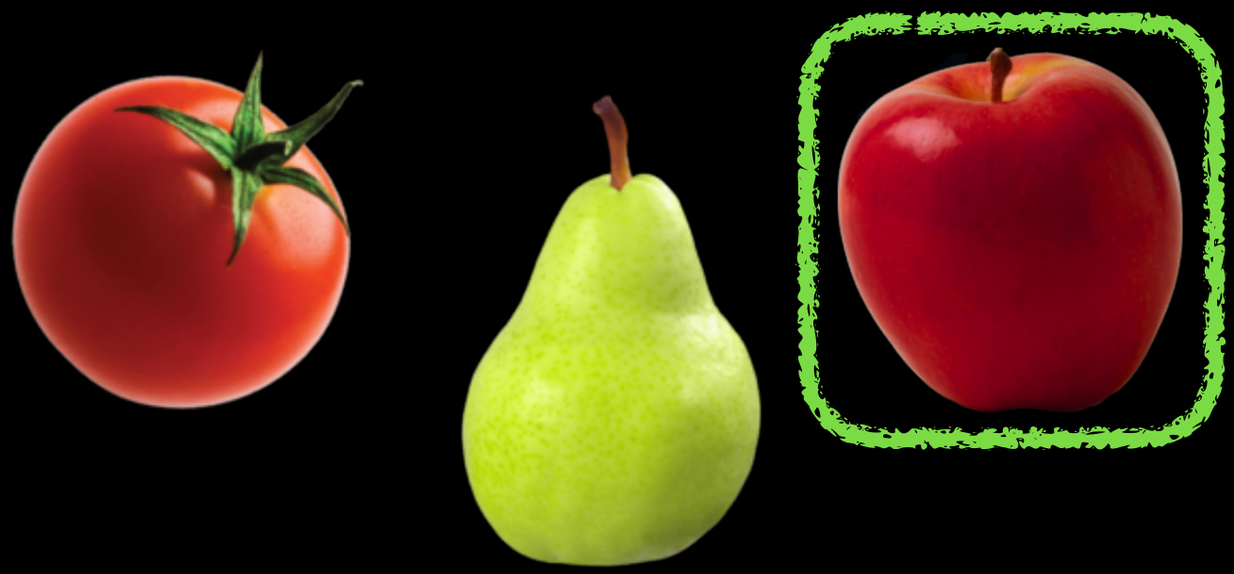
rational redundant referring expressions

Typicality effects in overinformative color mention

“Hand me the apple.”

Typicality effects in overinformative color mention

“Hand me the apple.”



Typicality effects in overinformative color mention

“Hand me the apple.”

Typicality effects in overinformative color mention

“Hand me the apple.”

“Hand me the blue apple.”

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Sedivy 2003; Westerbeek et al. 2015;
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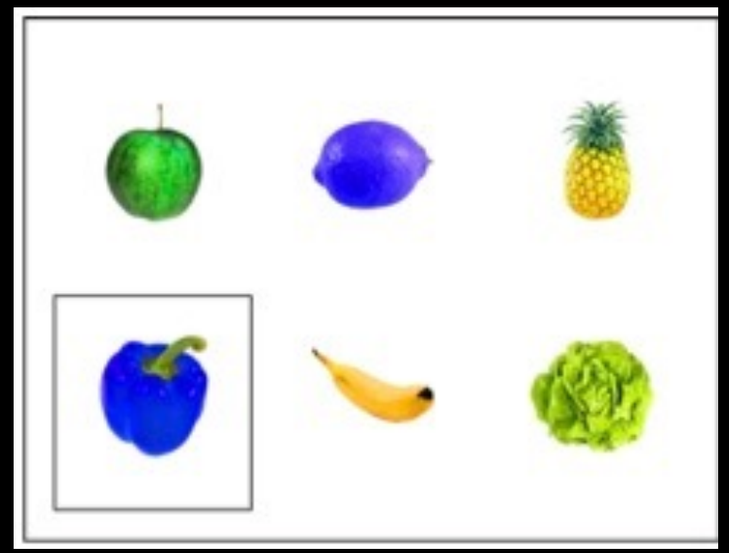

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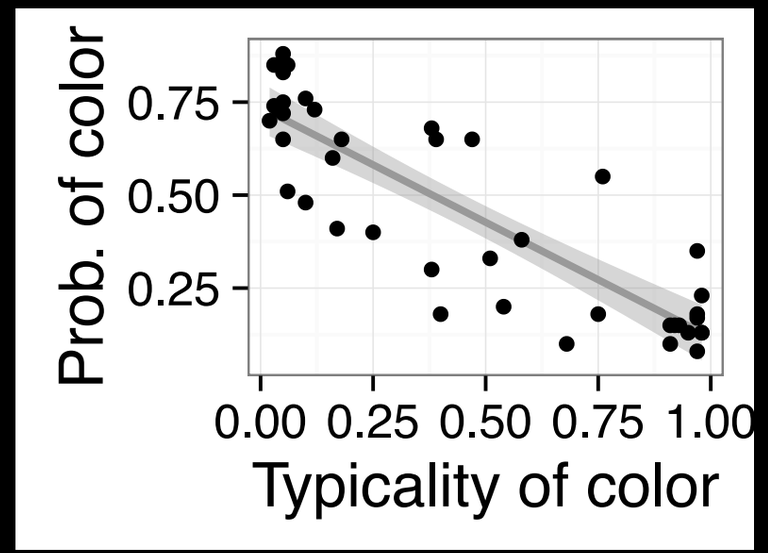

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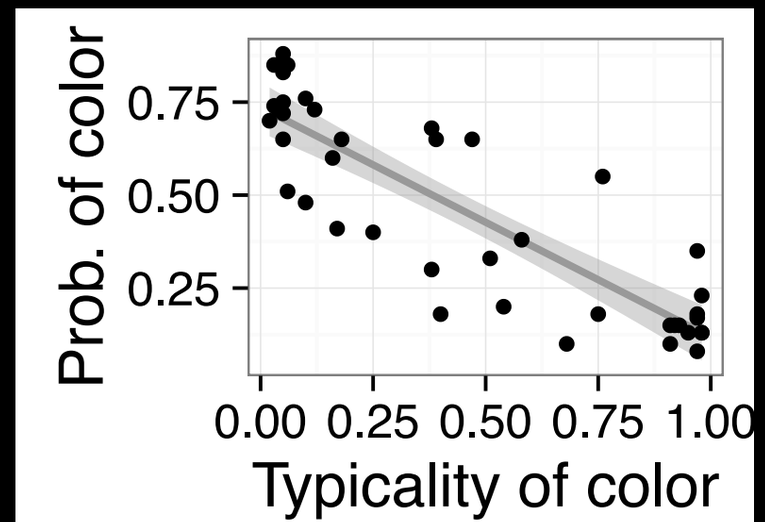

WHY?

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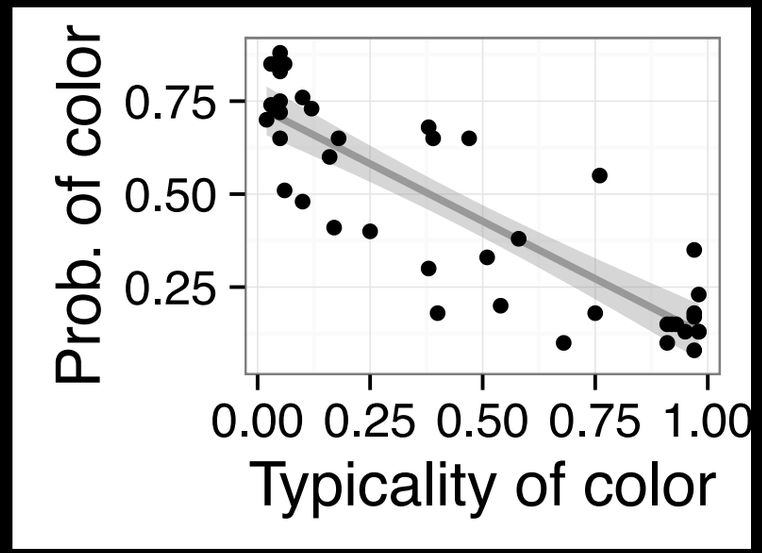

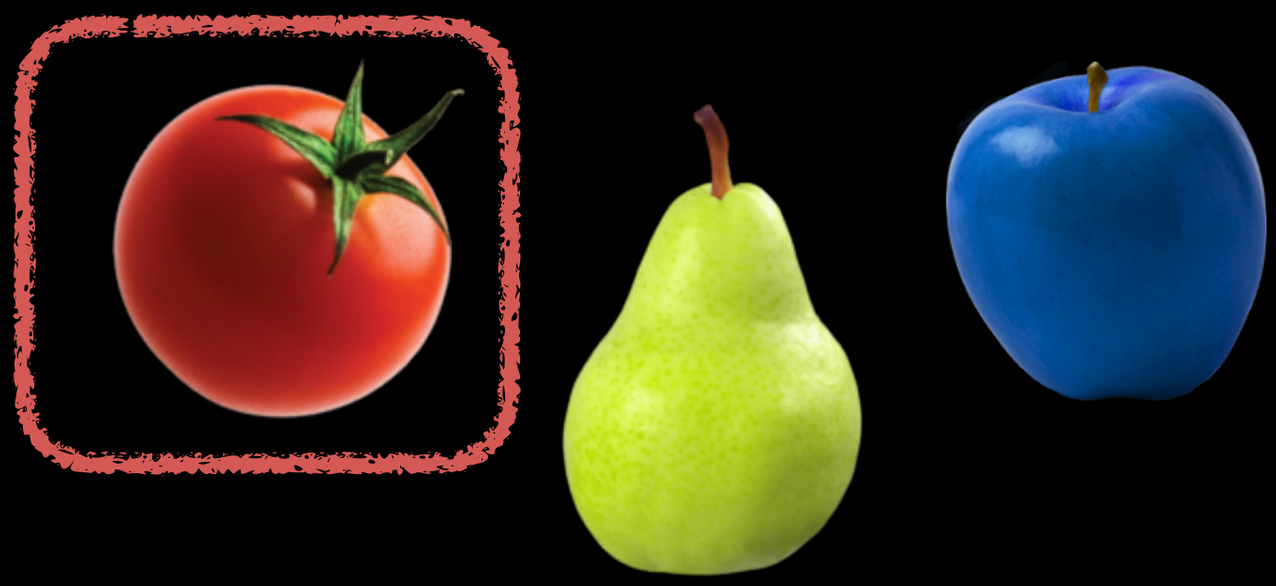

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Sonnenschein & Whitehurst 1982; Paarboni et al 2007; Arts et al 2011; Rubio-Fernandez 2016

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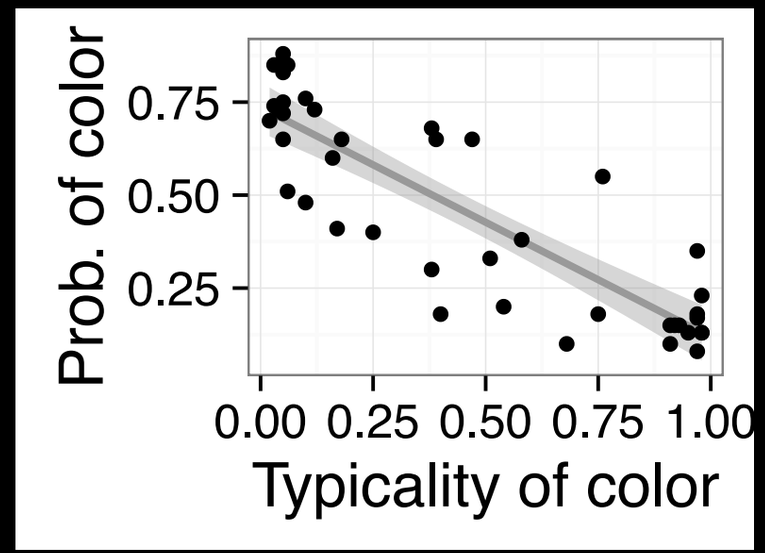

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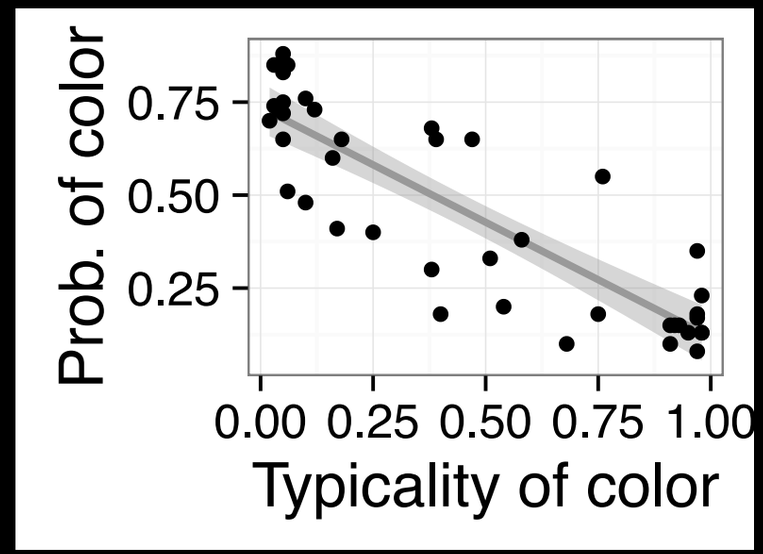

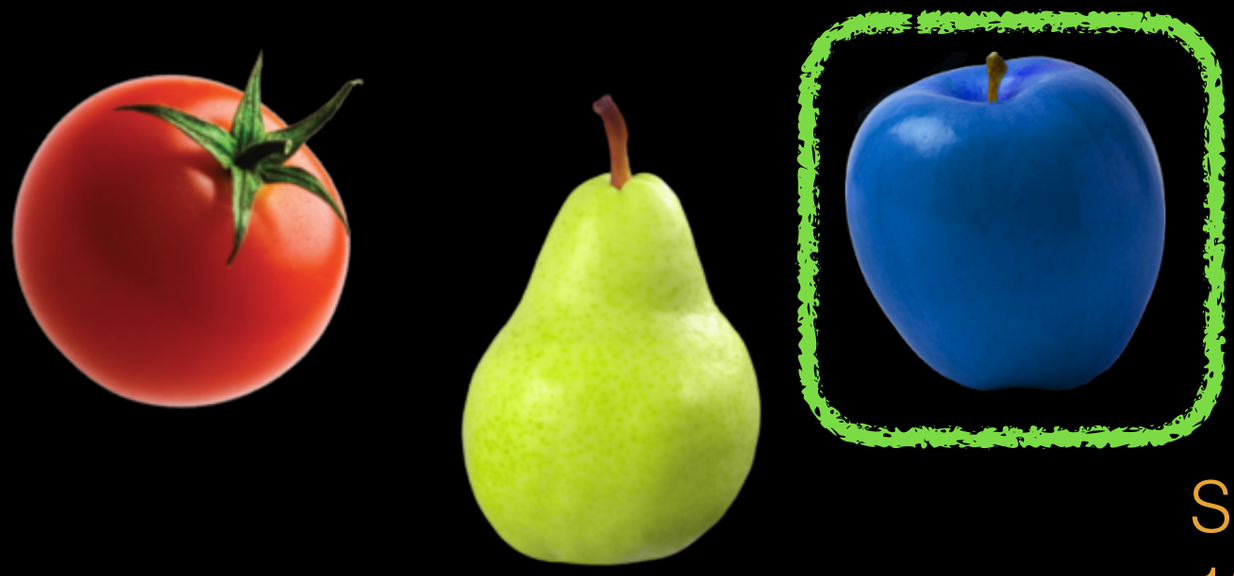

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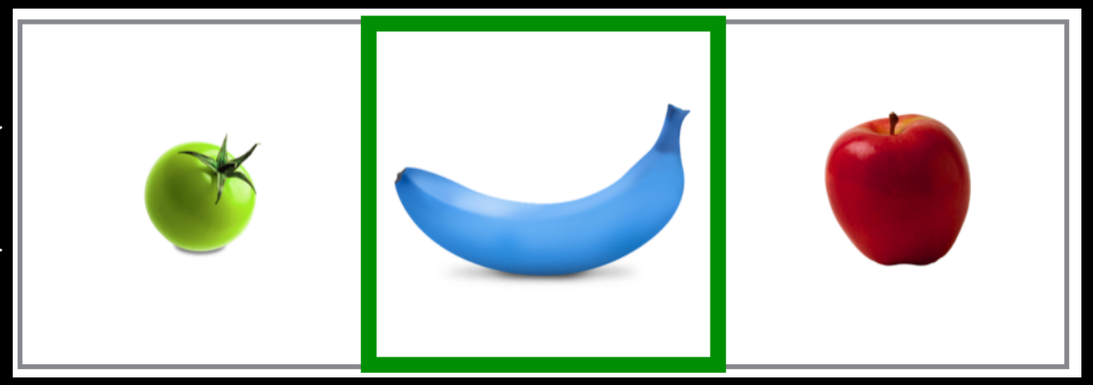
Typicality effects in RSA

$O = \{$  $\}$

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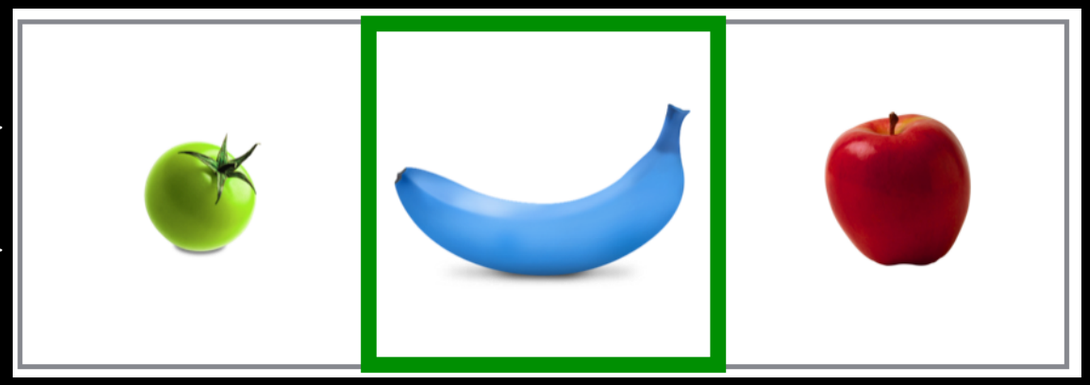
$O = \{$  $\}$

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Pragmatic speaker

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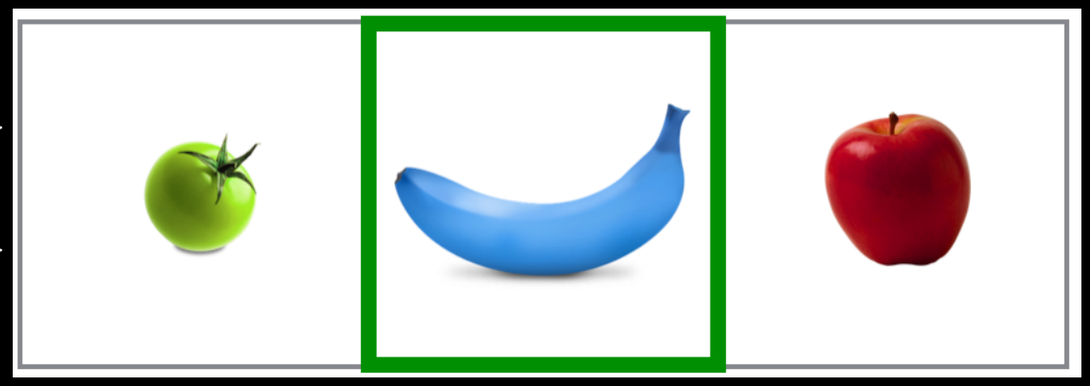
$O = \{$  $\}$

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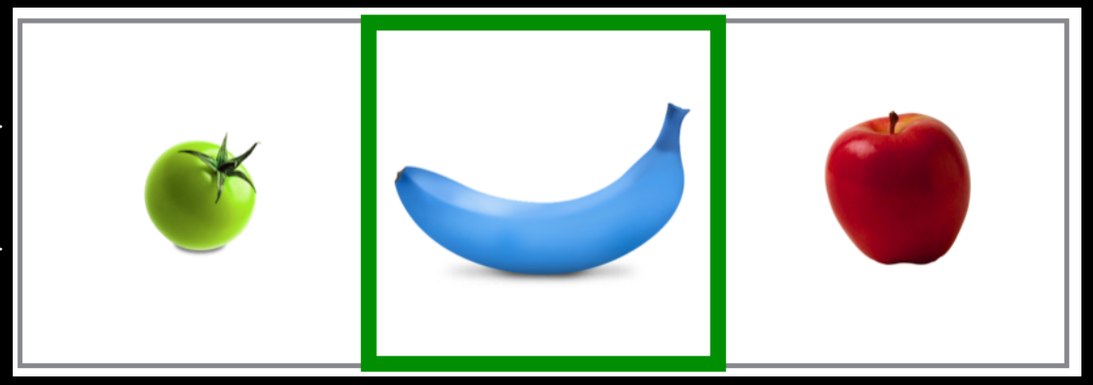
$O = \{$  $\}$

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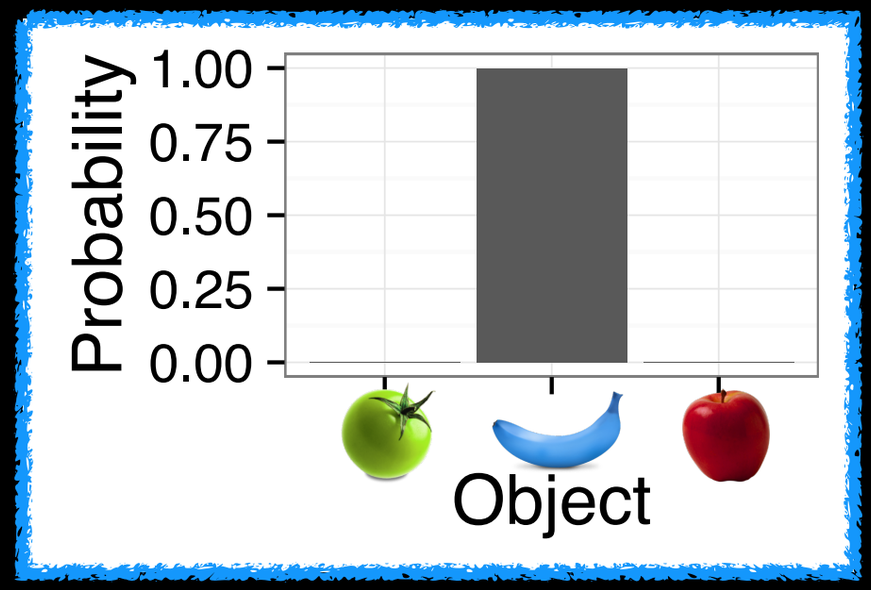
"banana"



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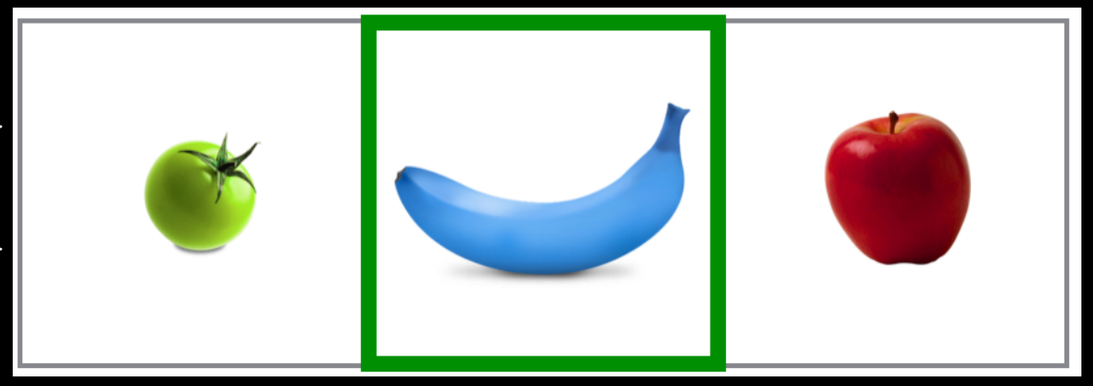
$O = \{$  $\}$

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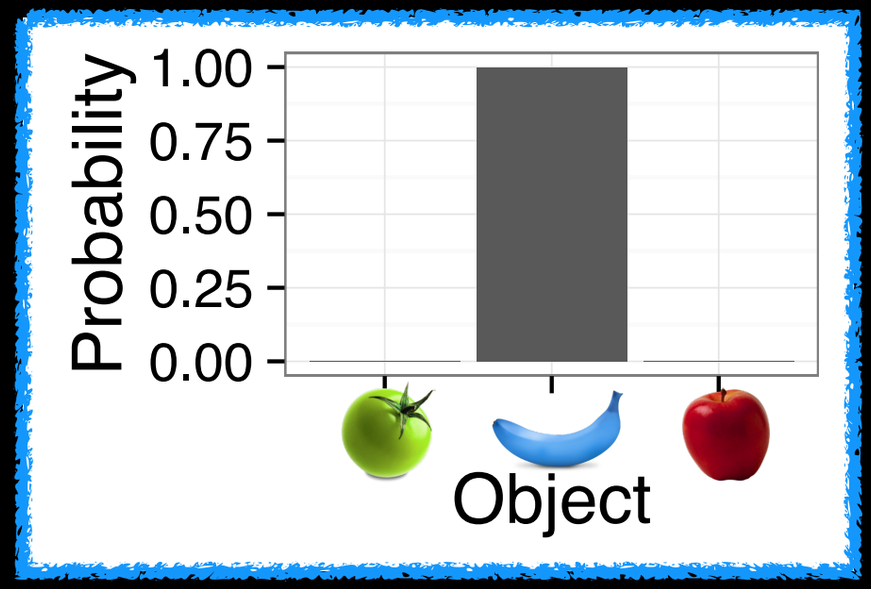
"blue"



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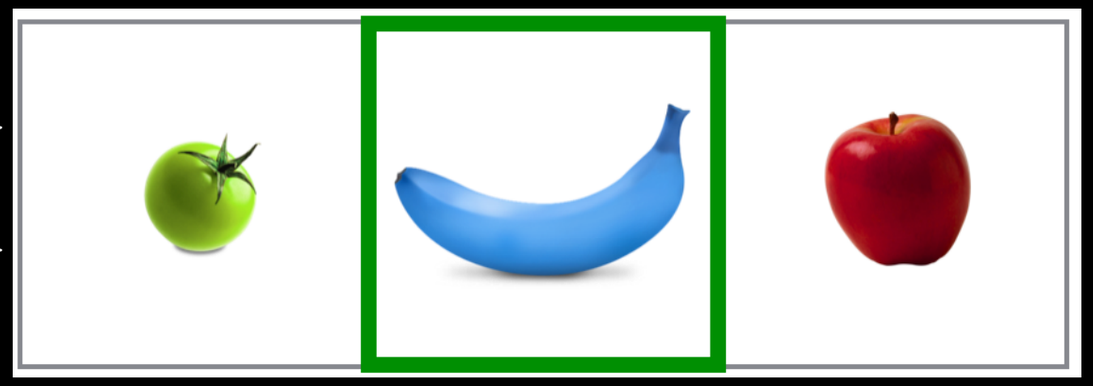
$O = \{$  $\}$

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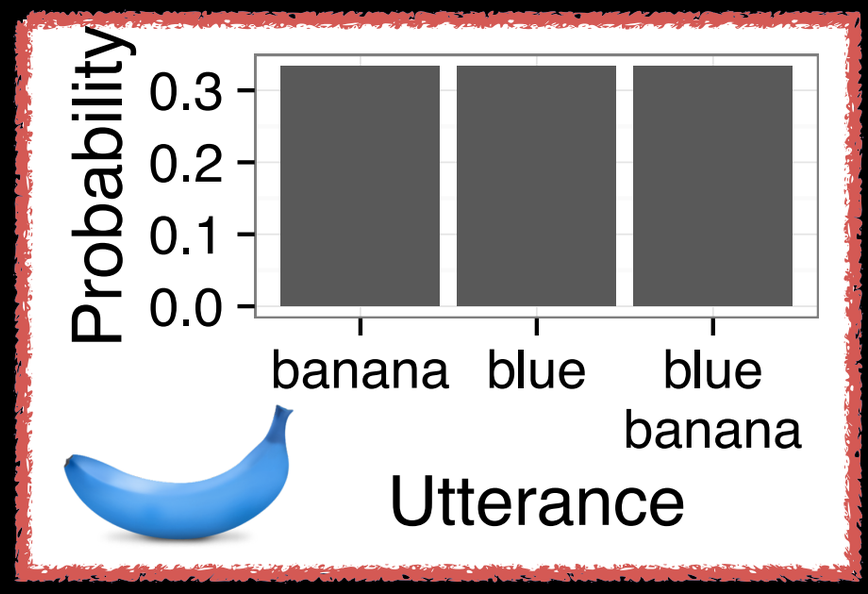

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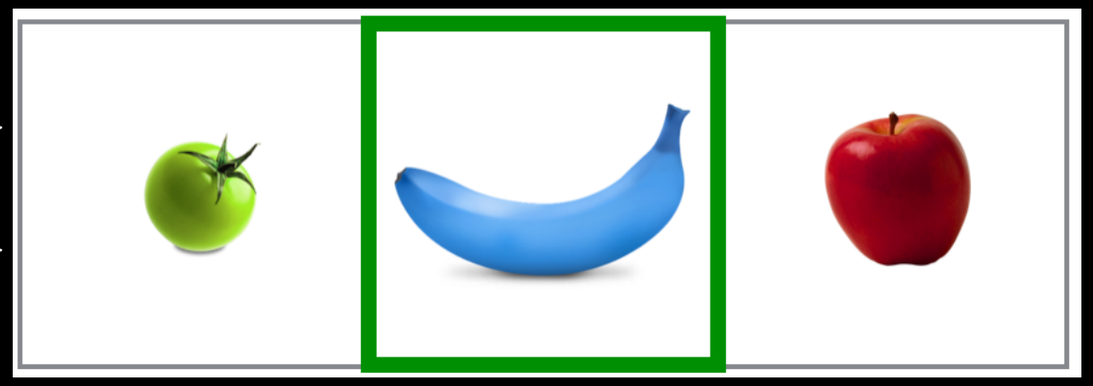
$O = \{$  $\}$

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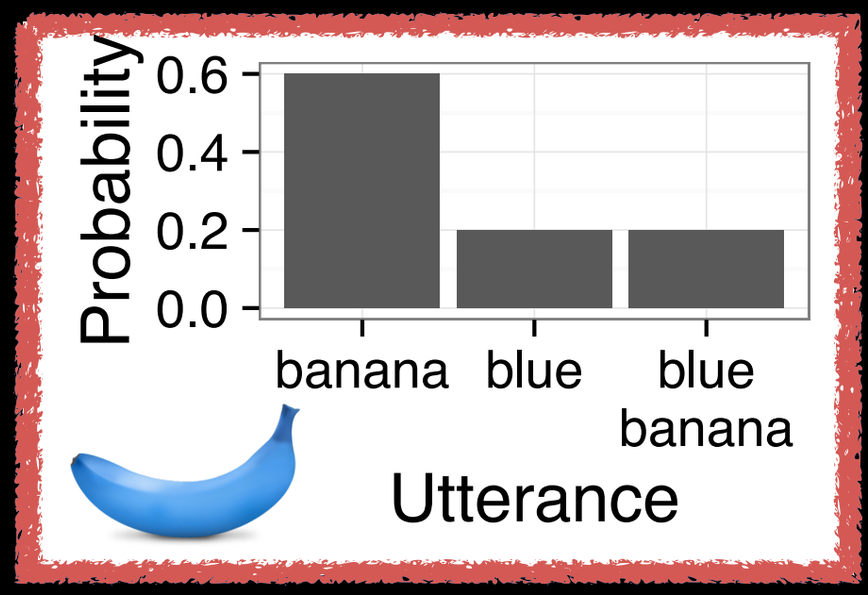

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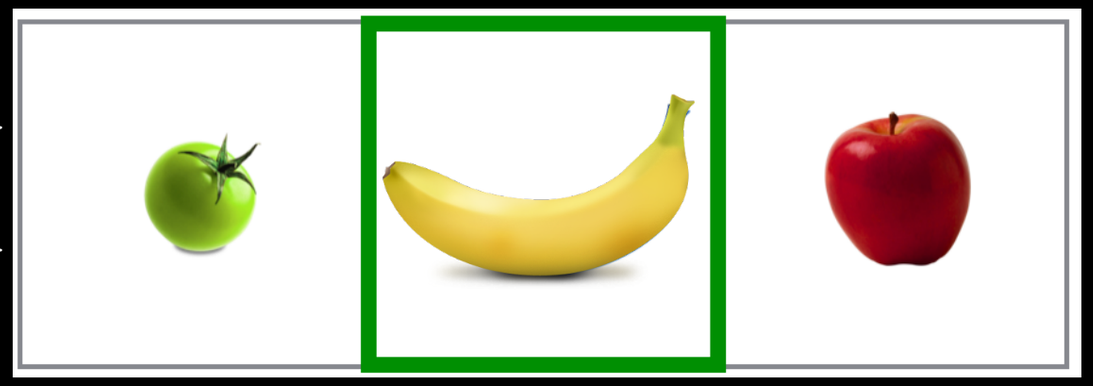
$O = \{$  $\}$

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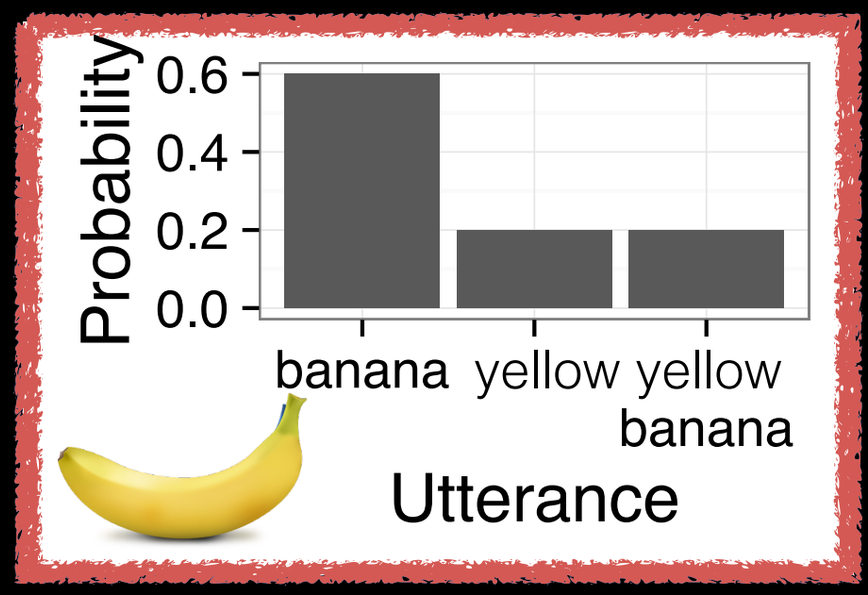

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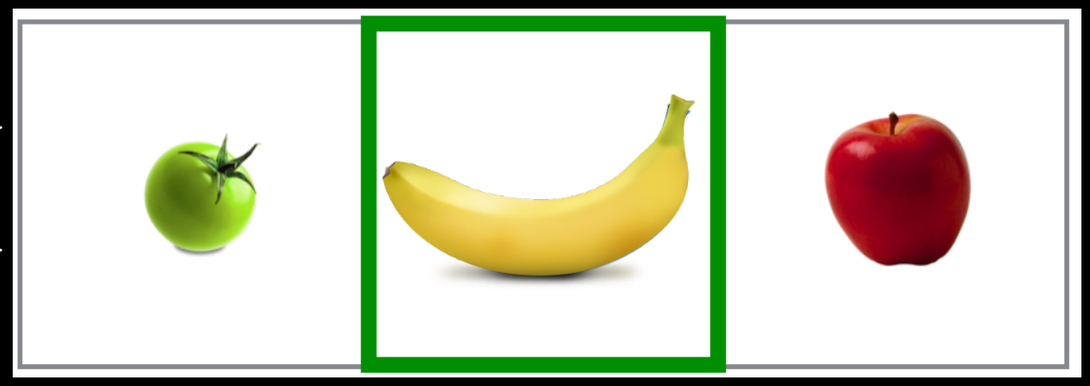
$O = \{$  $\}$

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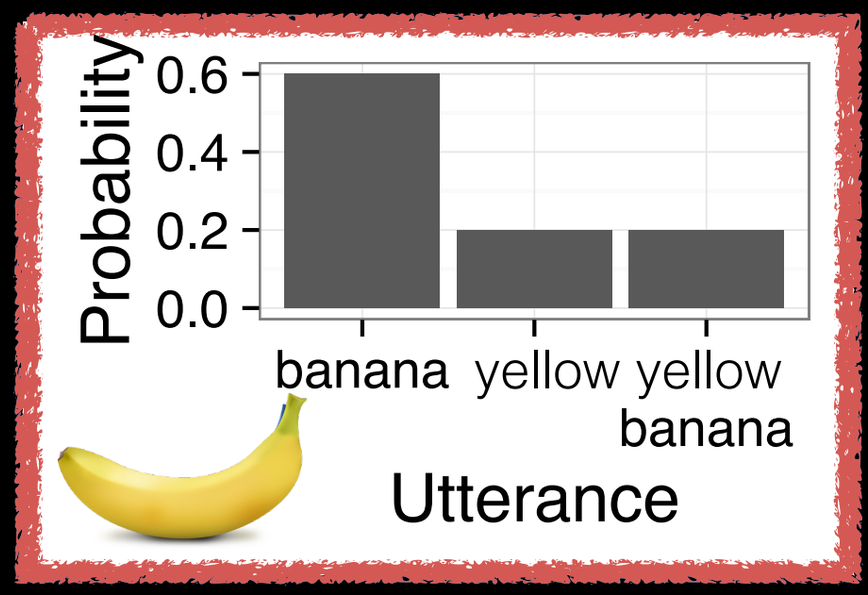

Basic RSA can't account for typicality effects

Extending the continuous semantics

Extending the continuous semantics

Pragmatic speaker

$$P_{S_1}(u|o) \propto e^{\lambda \ln P_{L_0}(o|u) - \text{cost}(u)}$$

Extending the continuous semantics

Pragmatic speaker

$$P_{S_1}(u|o) \propto e^{\lambda \ln P_{L_0}(o|u) - \mathrm{cost}(u)}$$

$$\mathrm{cost}(u) = \begin{cases} c_{\text{type}} & \text{“banana”} \\ c_{\text{type}} + c_{\text{color}} & \text{“yellow banana”} \\ c_{\text{color}} + c_{\text{color-only}} & \text{“yellow”} \end{cases}$$

Extending the continuous semantics

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$$P_{L_0}(o|u) \propto [[u]](o)$$

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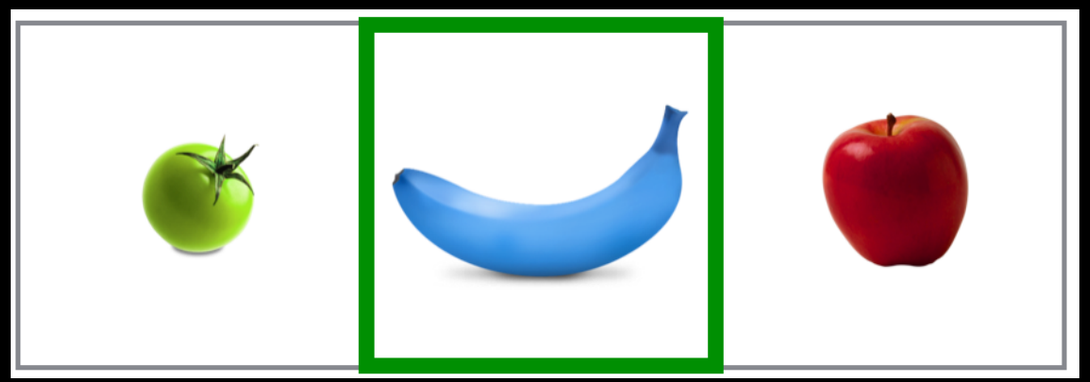
How typical is *o* for *u*?

x

“banana”
“yellow banana”
“yellow”
“brown banana”
“brown”
…

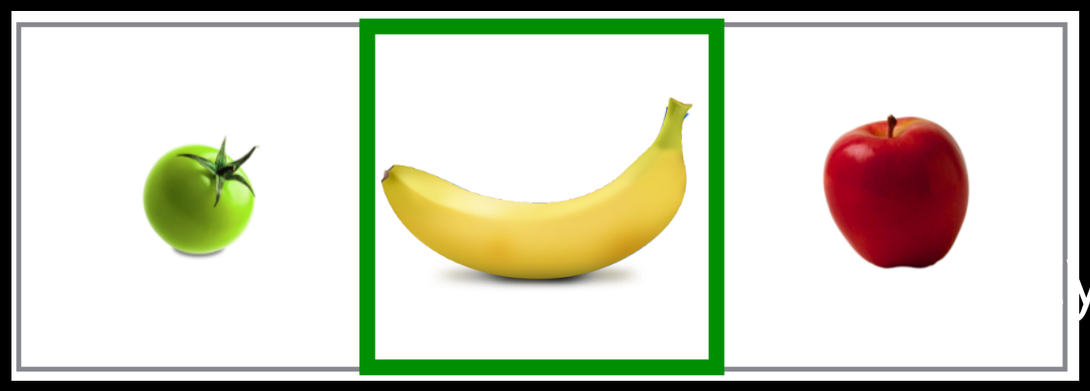
RSA predictions with continuous semantics



typicality(“banana”, 🍌) = .4

typicality(“blue banana”, 🍌) = .98

typicality(“banana”, 🍎) = .01



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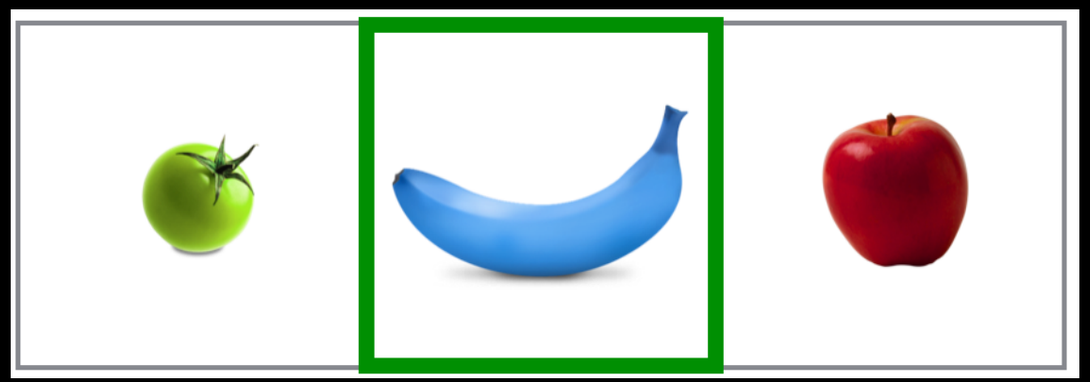
RSA predictions with continuous semantics



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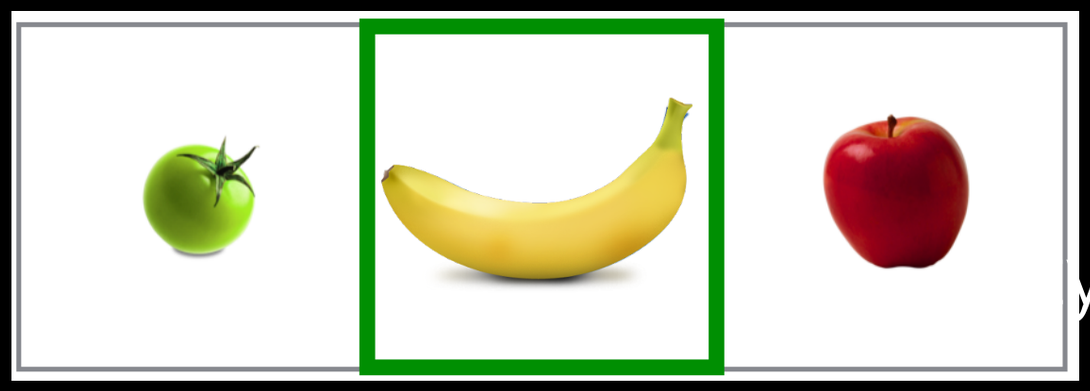

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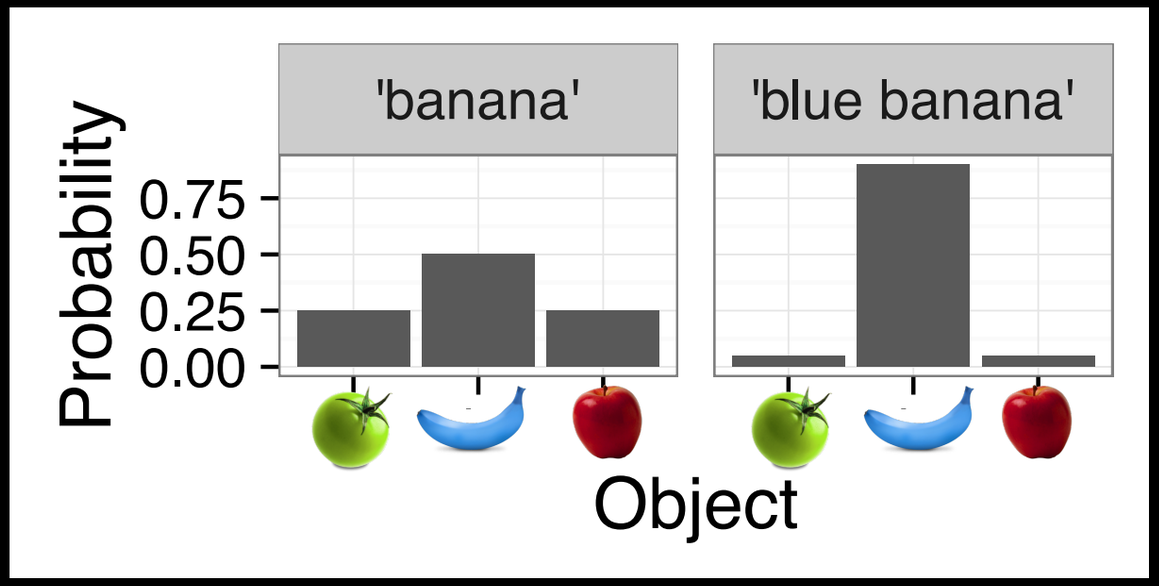
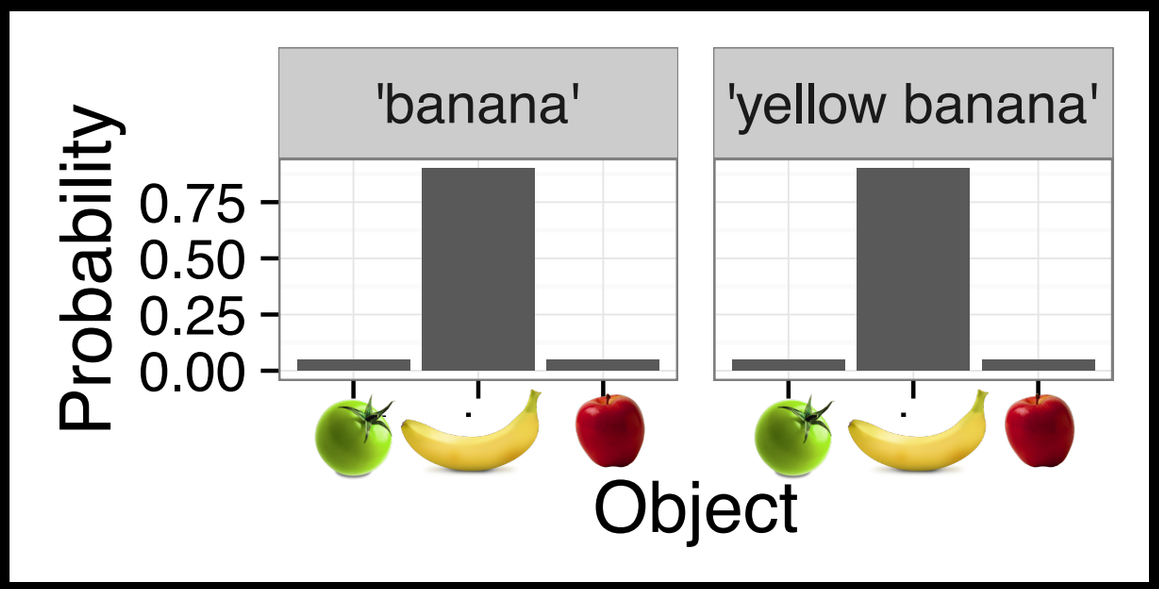
Predictions

Literal listener

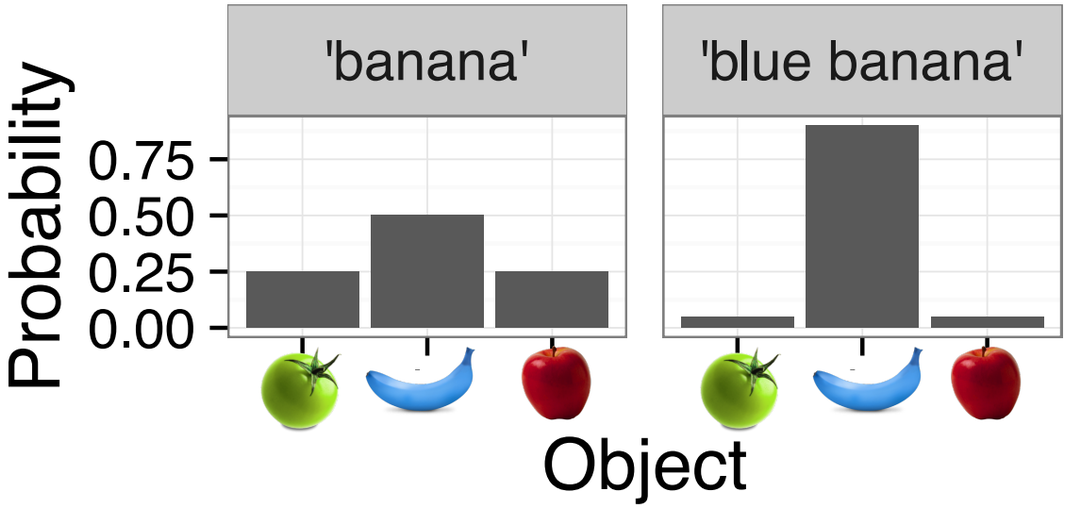




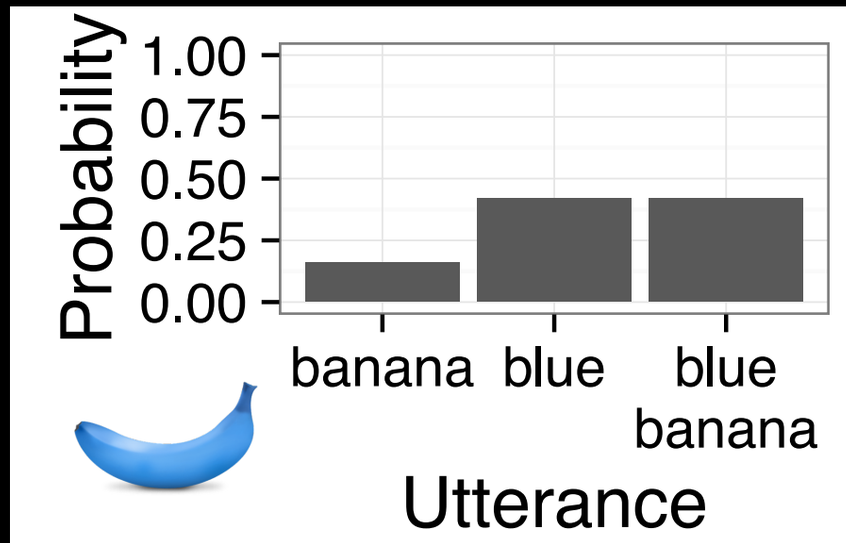
Pragmatic speaker

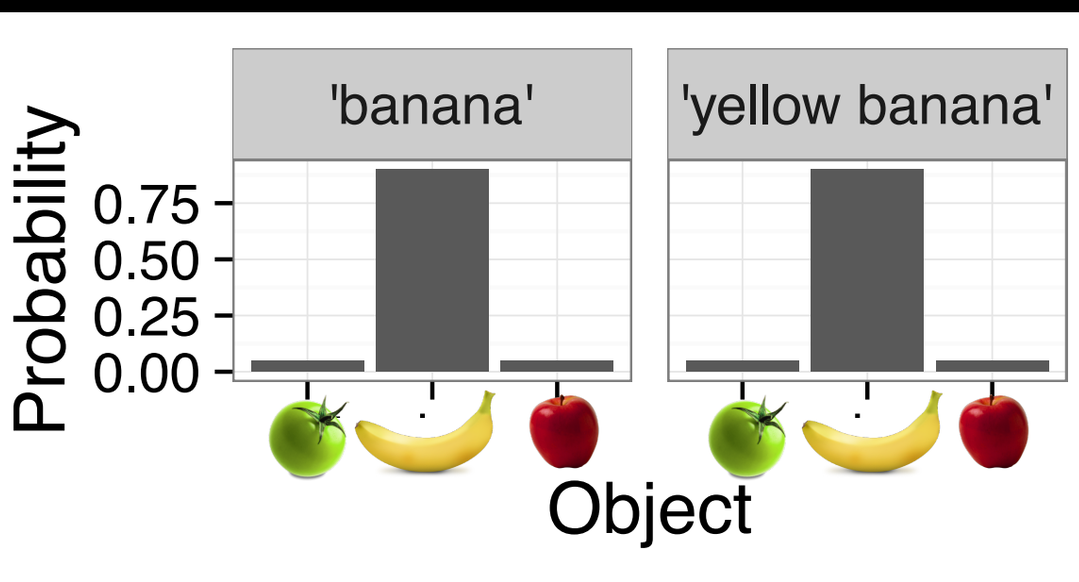
Predictions

Literal listener



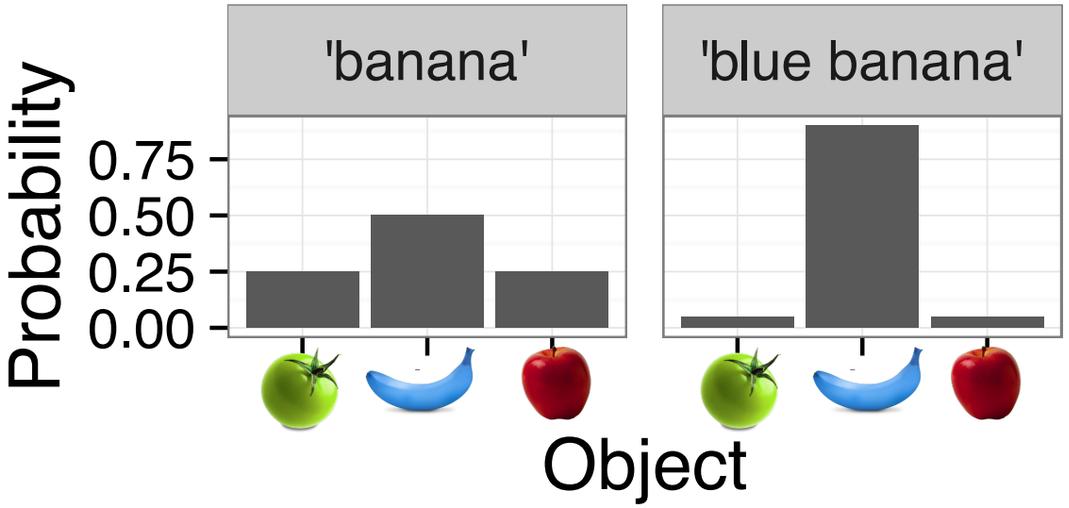
Pragmatic speaker



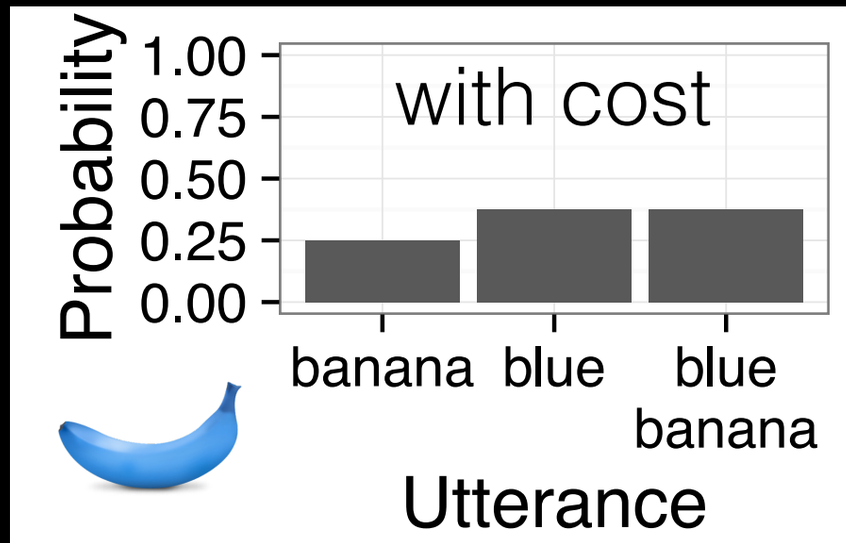


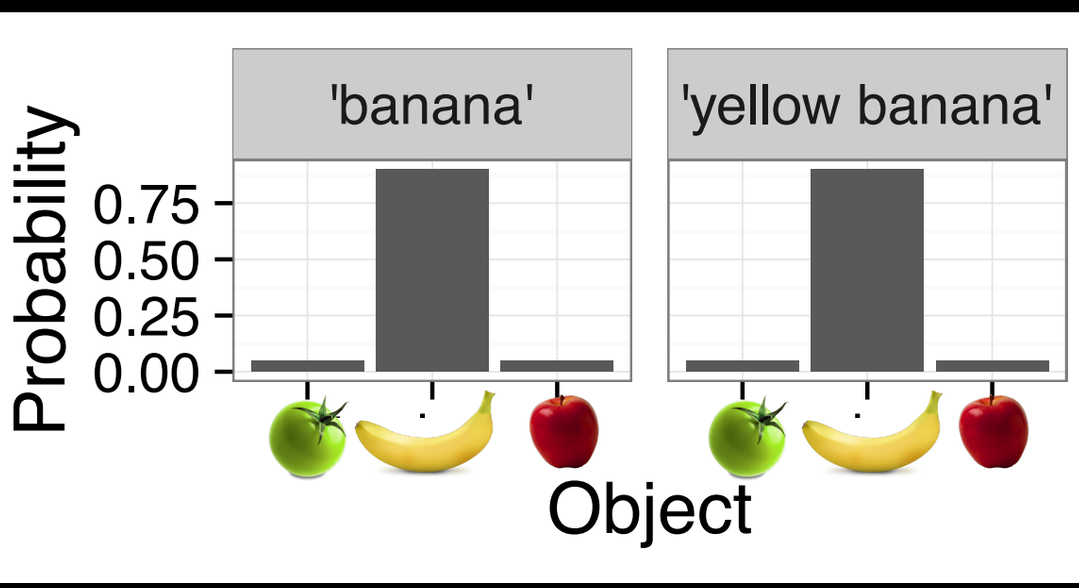
Predictions

Literal listener



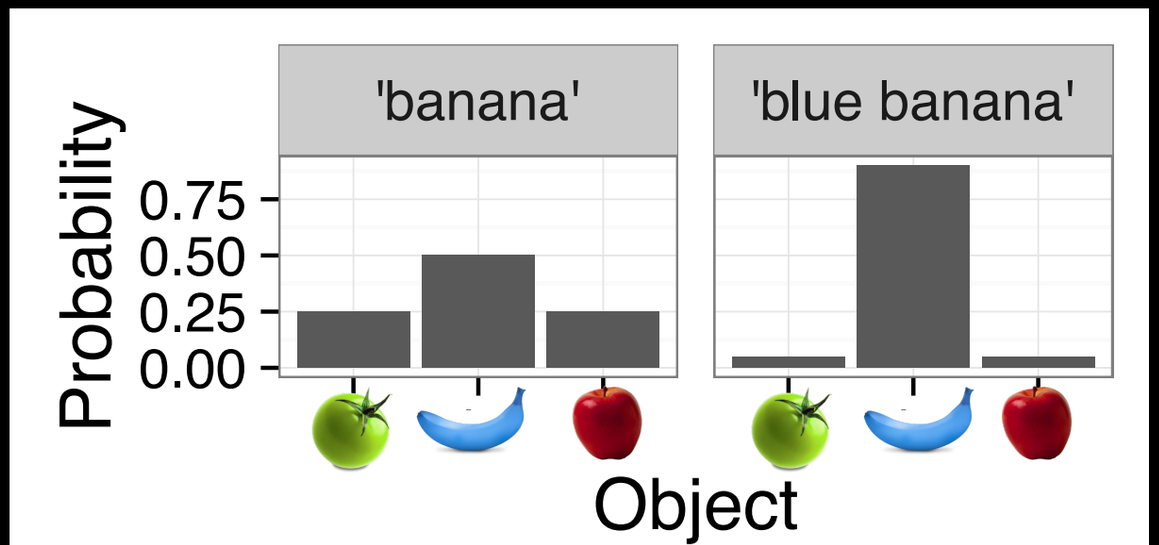
Pragmatic speaker



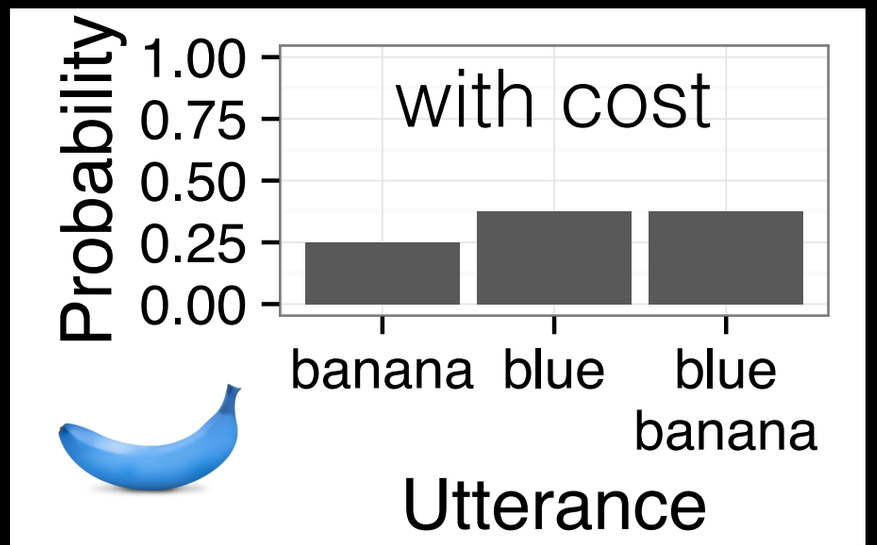


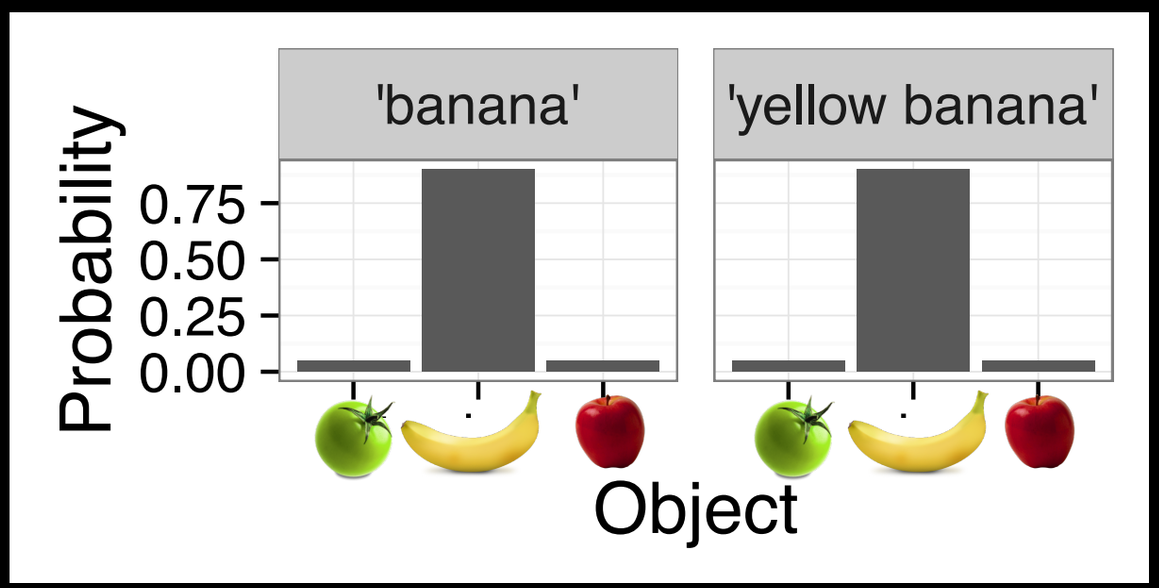
Predictions

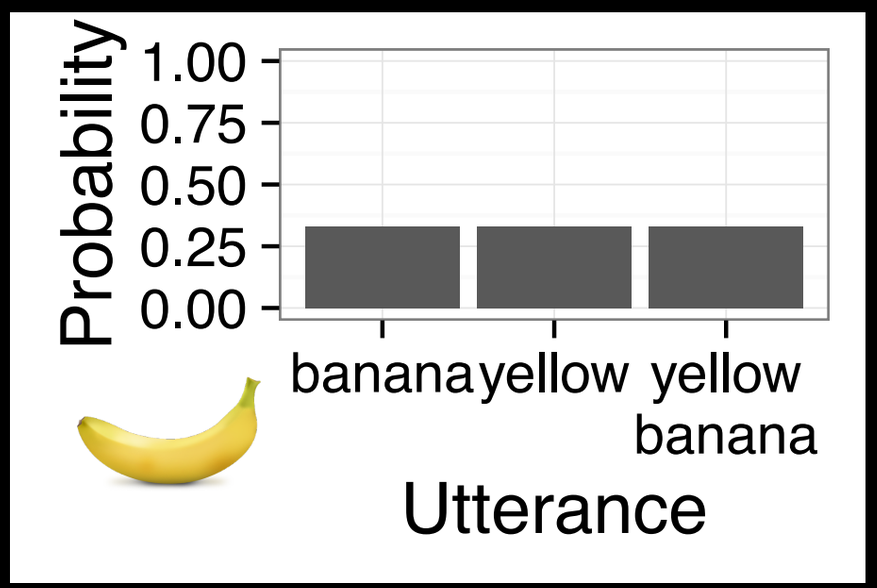
Literal listener



Pragmatic speaker

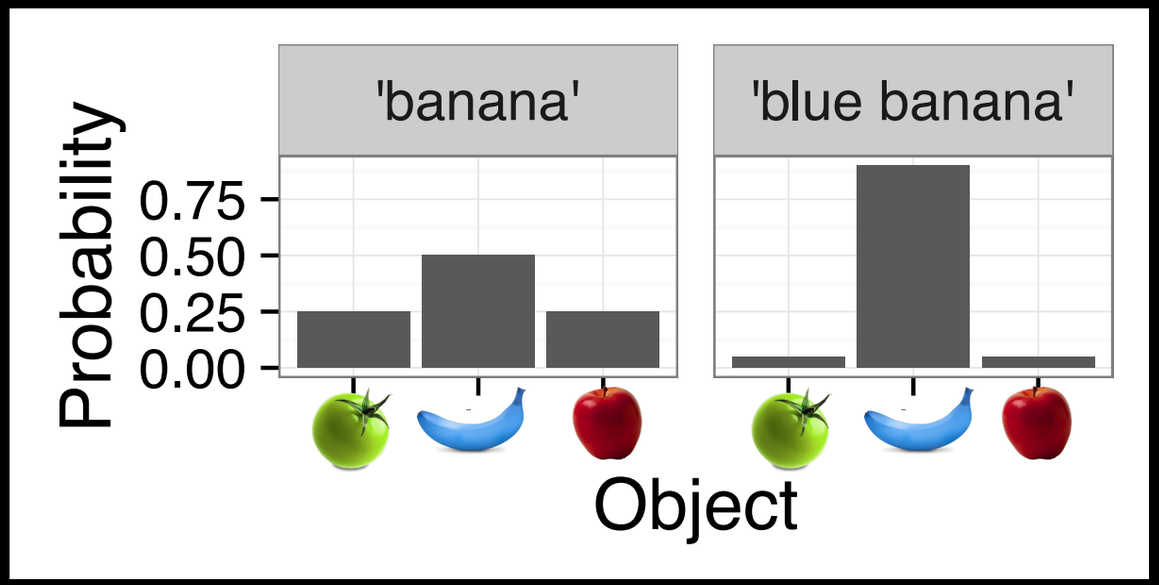




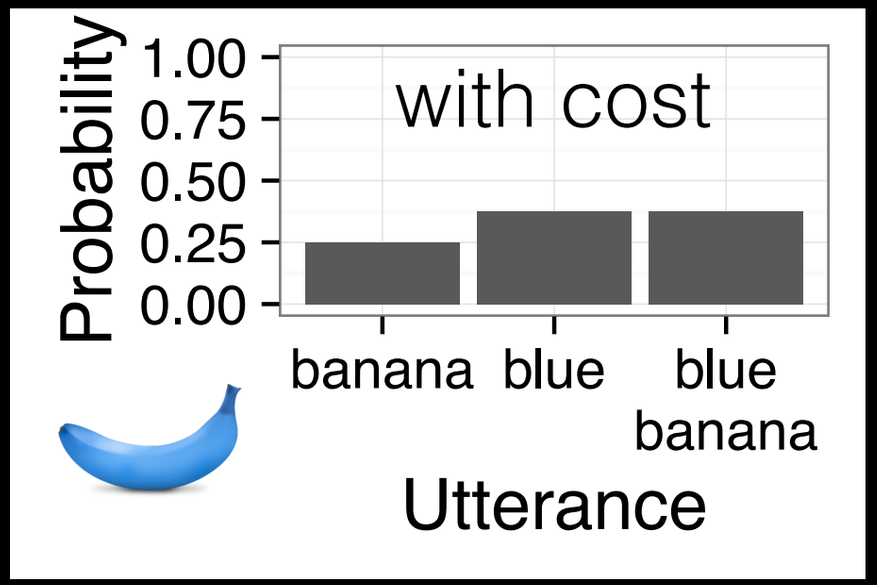


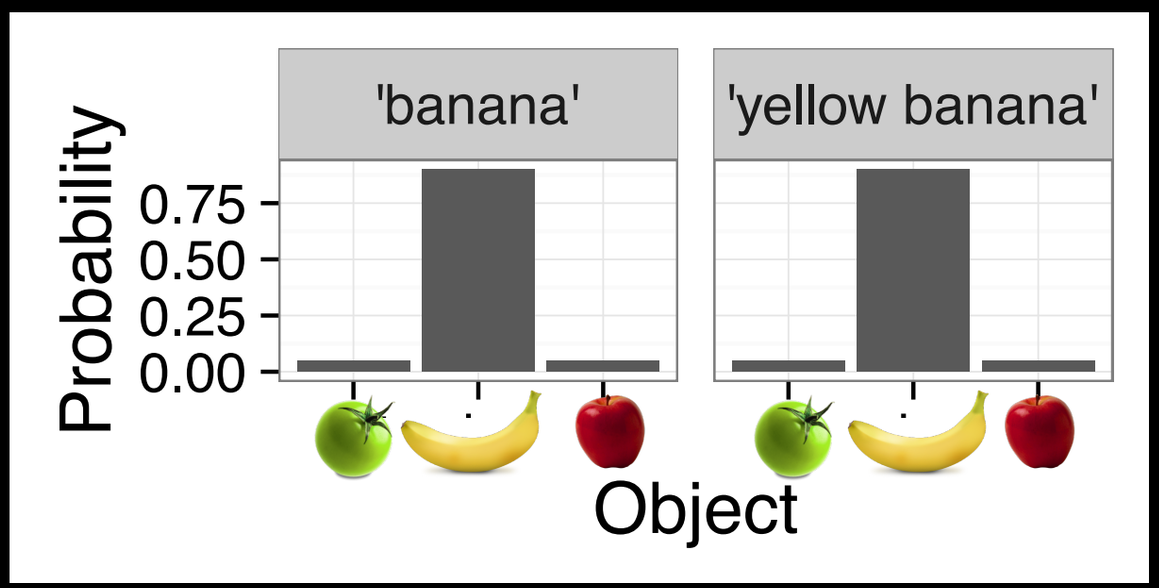
Predictions

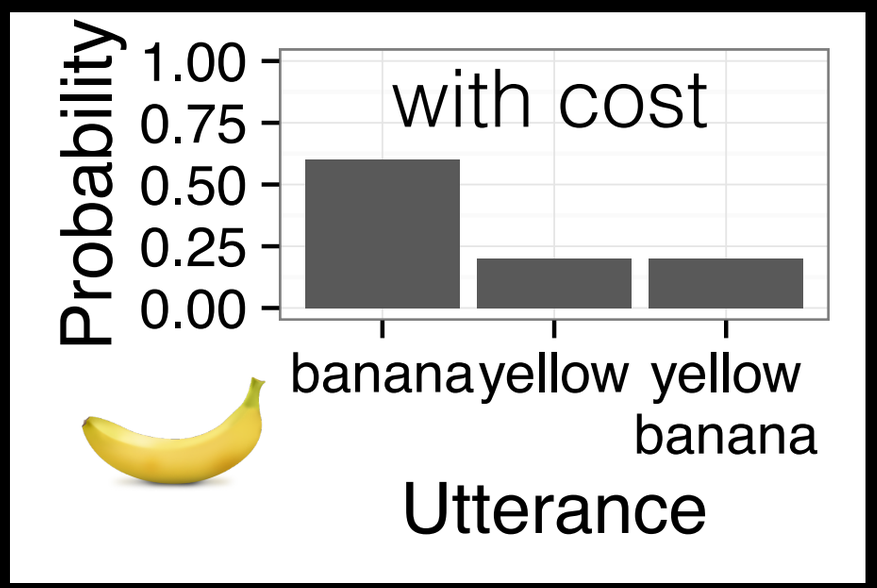
Literal listener



Pragmatic speaker

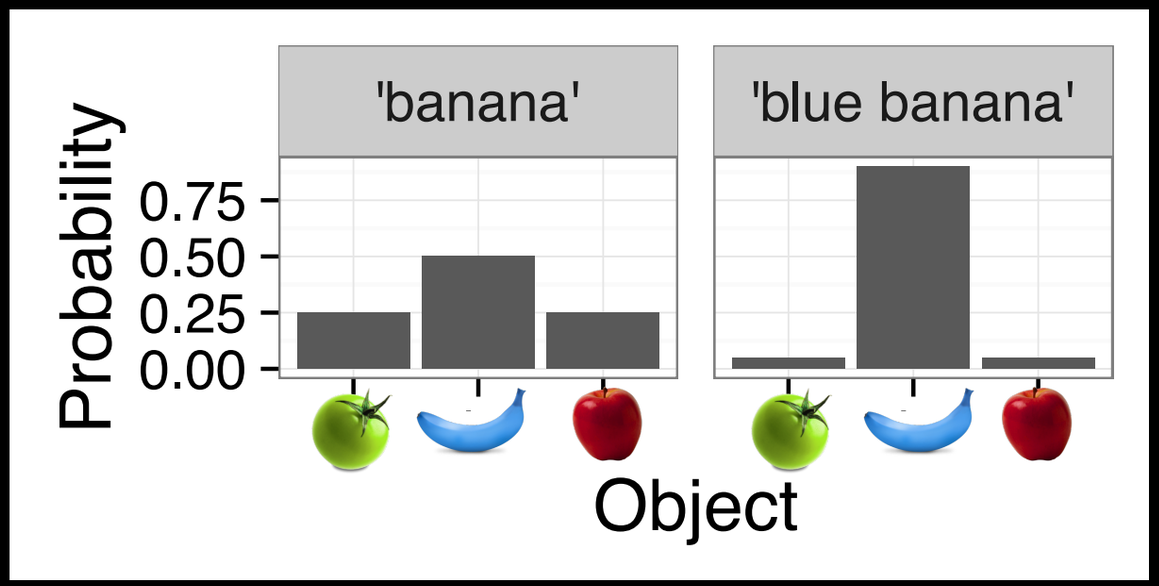


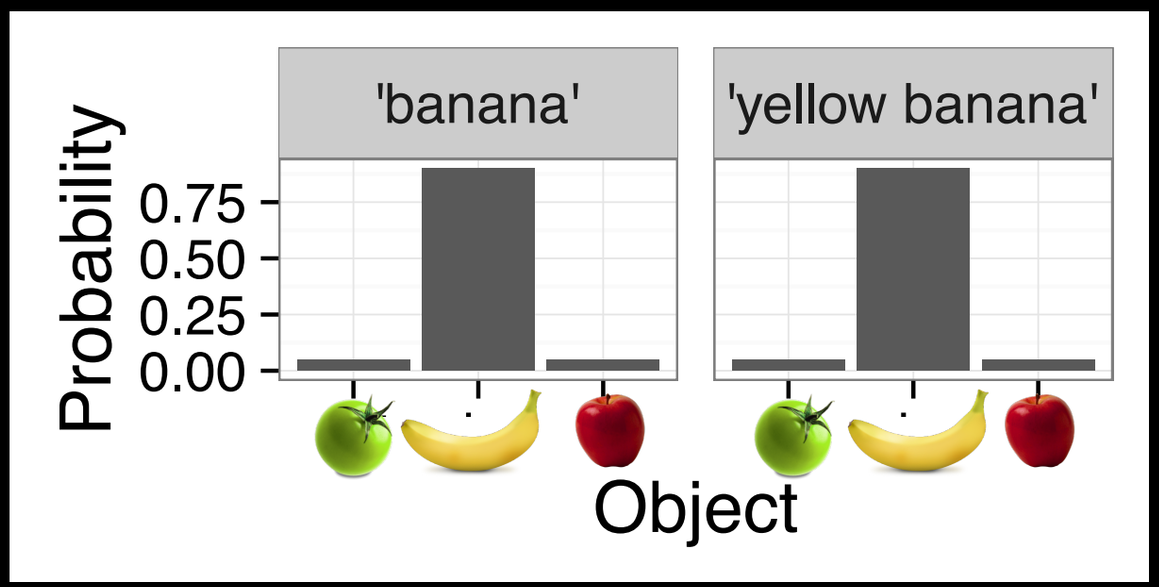




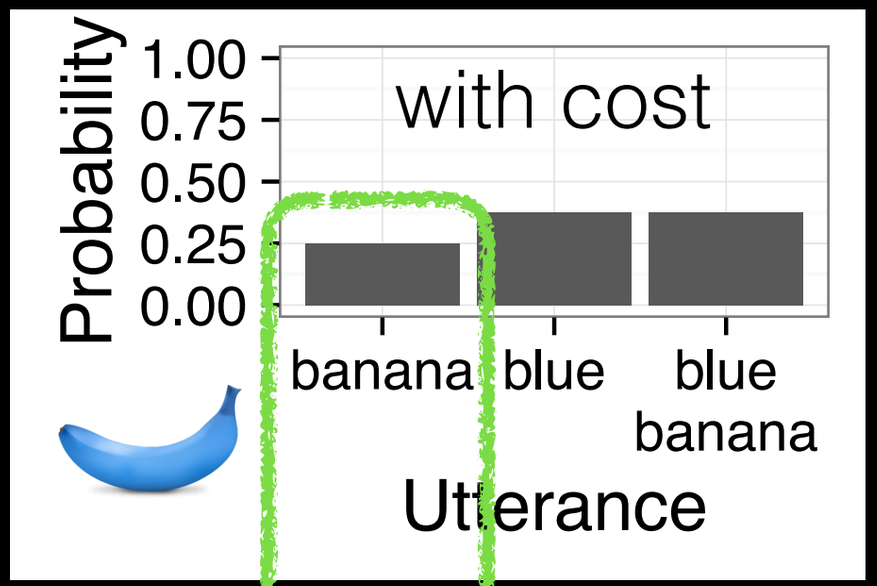
Predictions

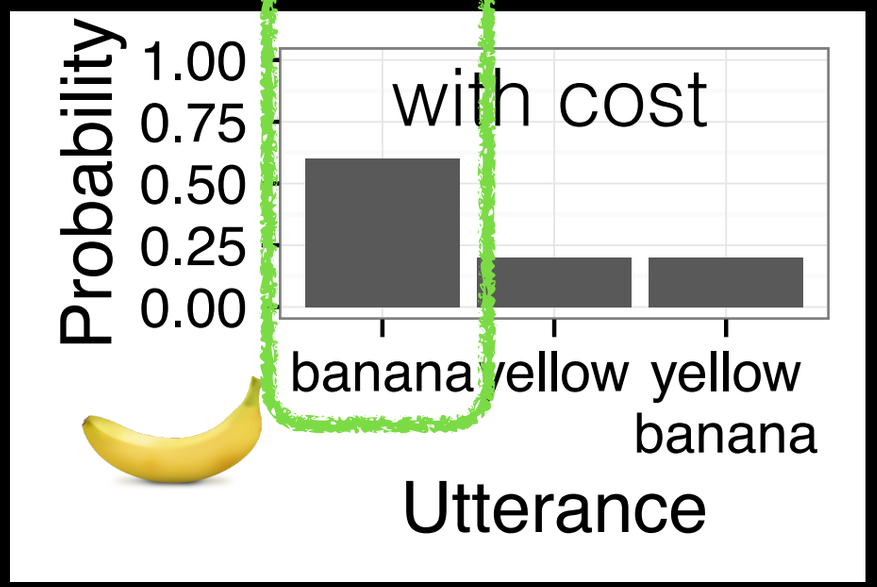
Literal listener





Pragmatic speaker





Non-redundant utterances more likely when probability of confusion is low

Independent empirical evidence for RSA with continuous semantics?

Literal listener

$$P_{L_0}(o|u) \propto [[u]](o)$$

$$[[u]](o) = \text{typicality}(u, o)$$

Pragmatic speaker

$$P_{S_1}(u|o) \propto e^{\lambda \ln P_{L_0}(o|u) - \text{cost}(u)}$$

Independent empirical evidence for RSA with continuous semantics?

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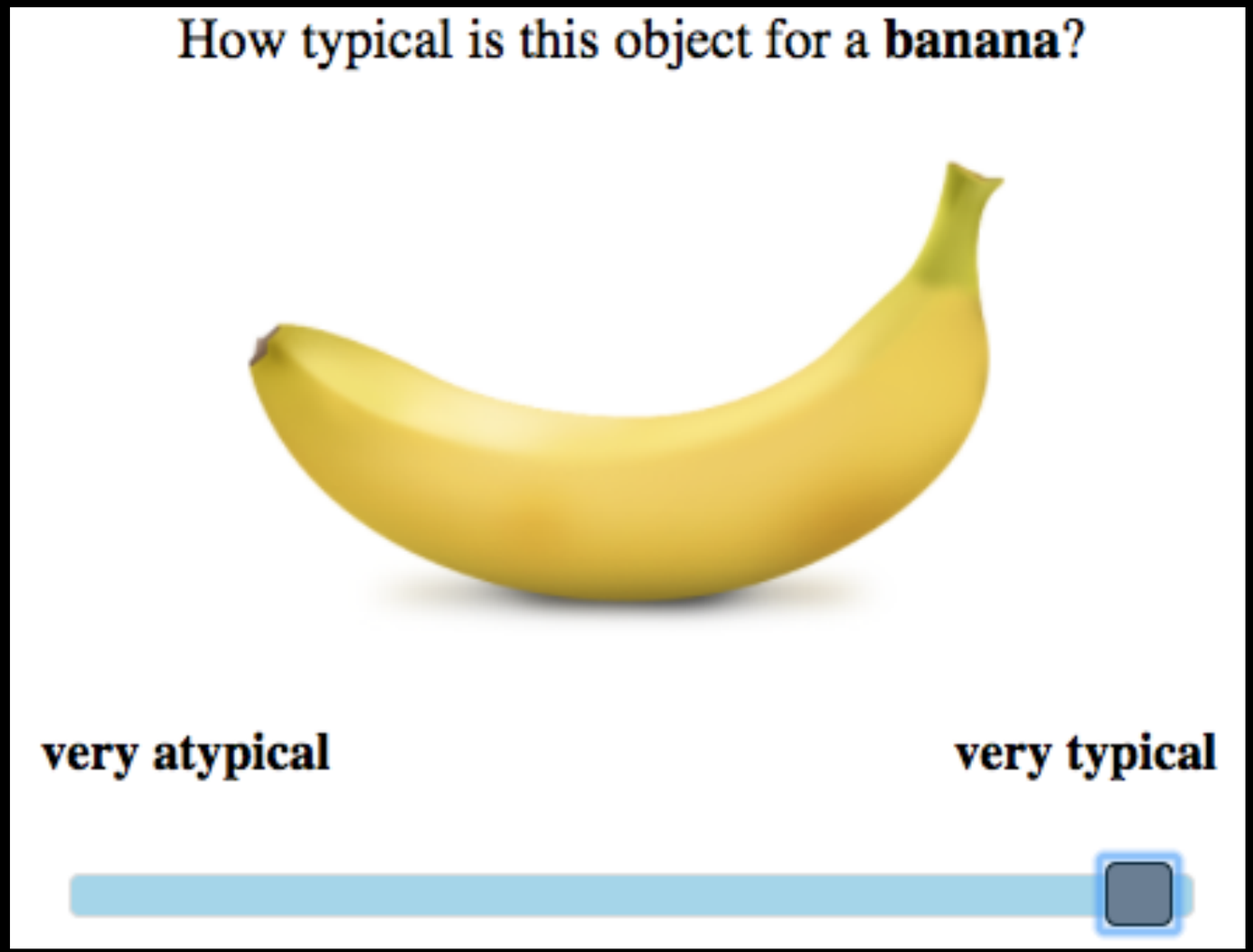
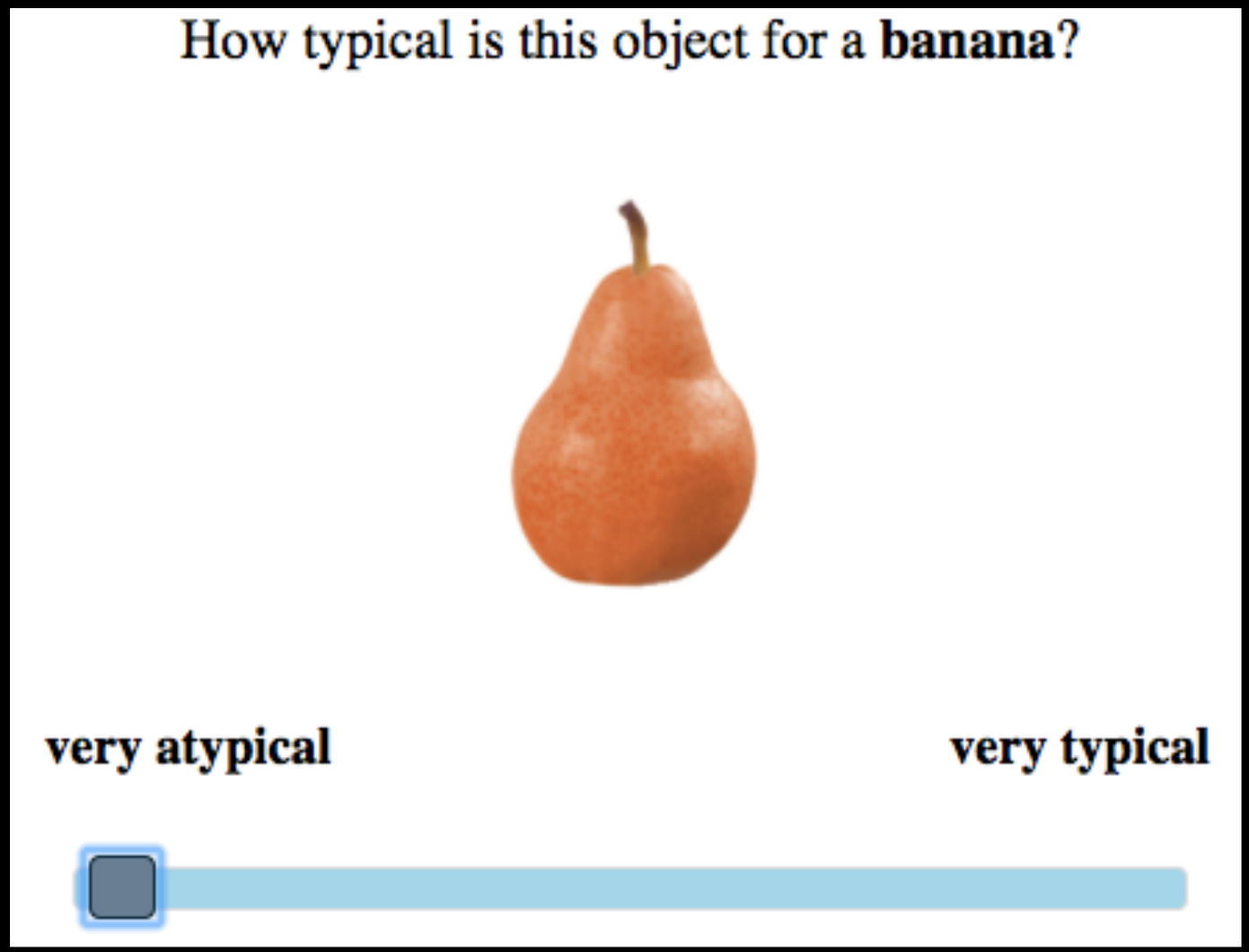
1. Typicality norming
2. Production study
3. Model evaluation

Typicality norming studies

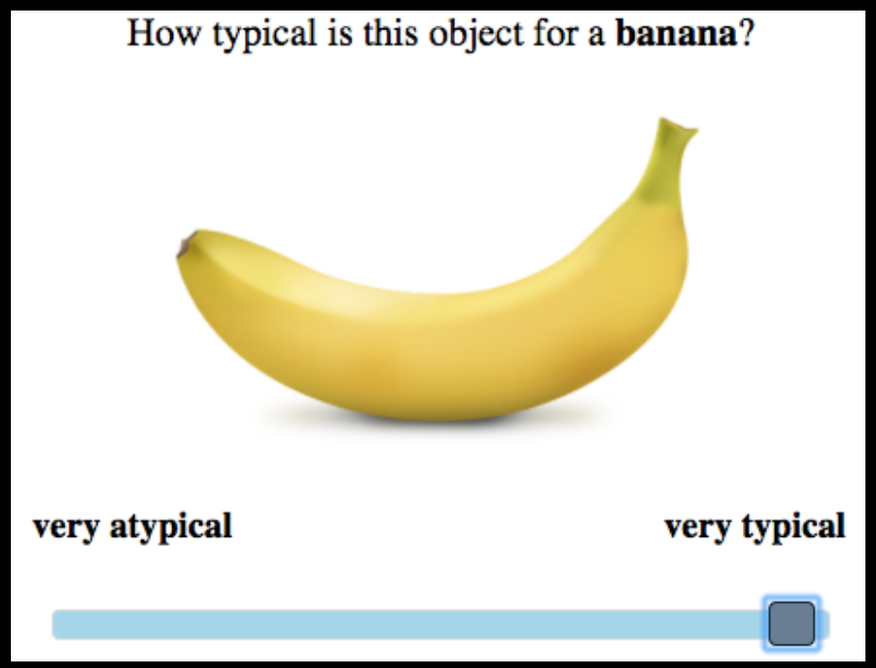


Typicality norming studies



Typicality norming studies

Exp. 1a: type nouns



Typicality norming studies

Exp. 1a: type nouns

How typical is this ob

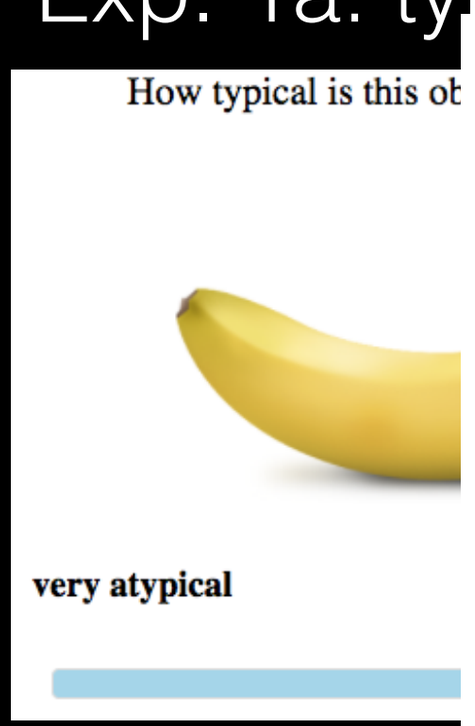
very atypical

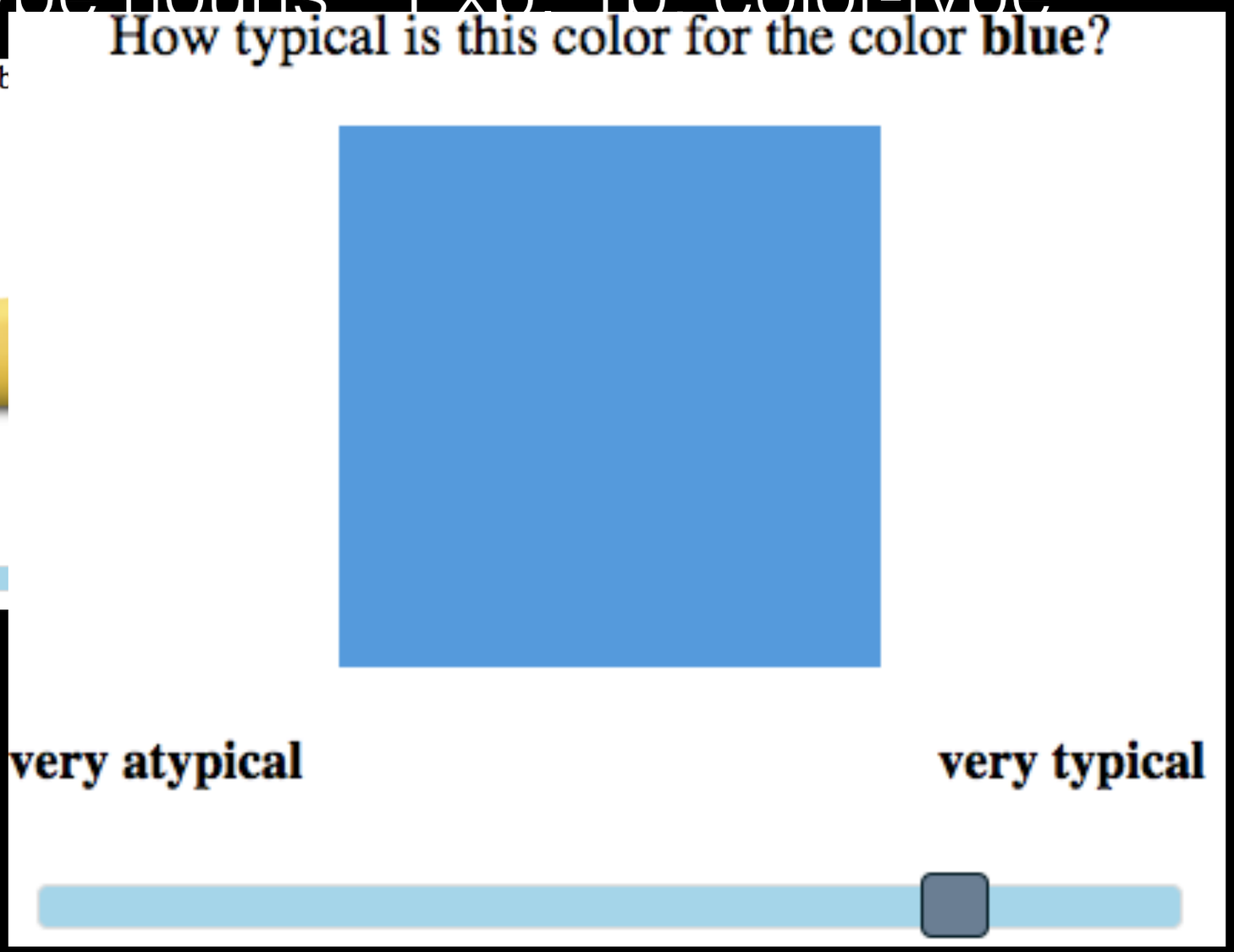
How typical is this object for a **brown banana**?

very atypical very typical

Typicality norming studies

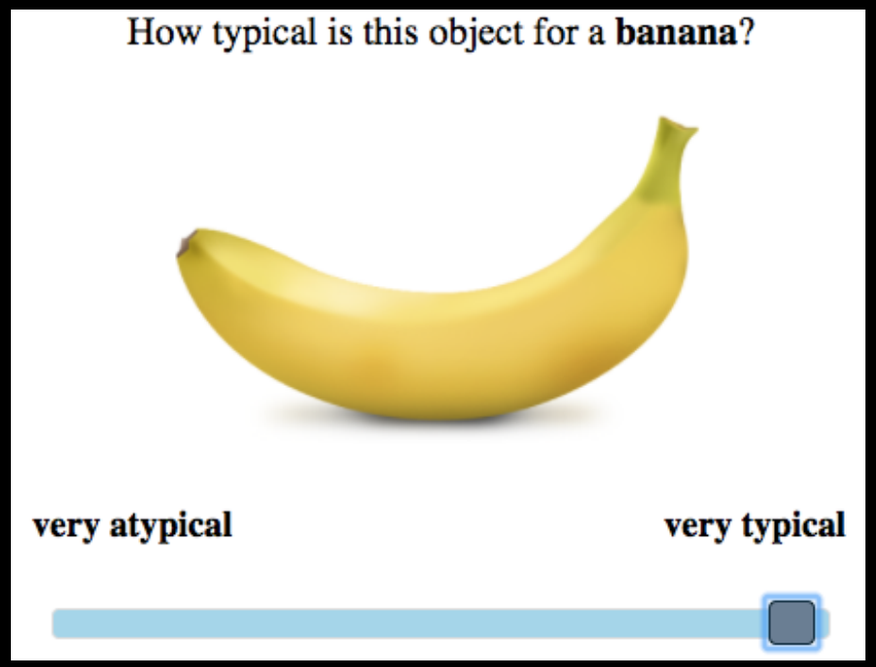
Exp. 1a: type nouns Exp. 1b: color-type





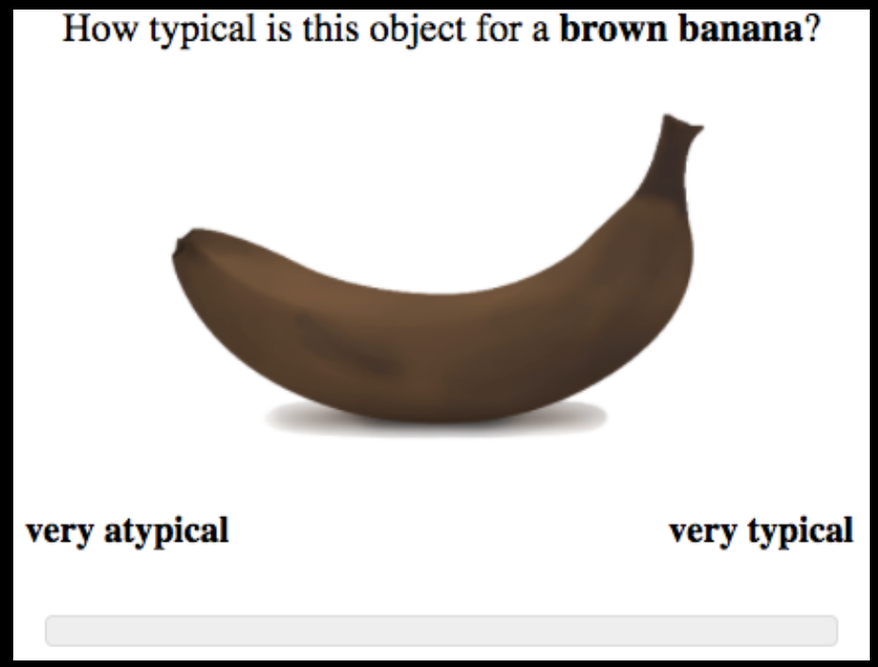
Typicality norming studies

Exp. 1a: type nouns



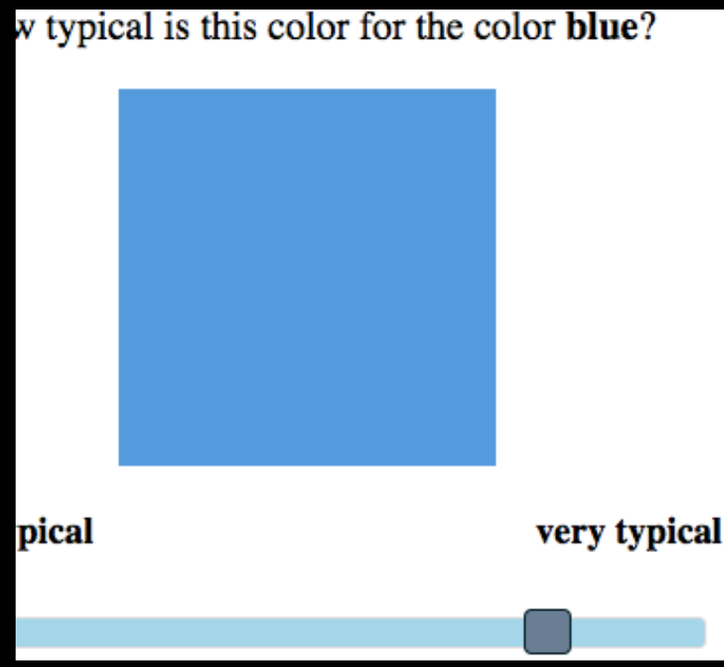
75 participants
90 trials

Exp. 1b: color-type



100 participants
110 trials

Exp. 1c: color



75 participants
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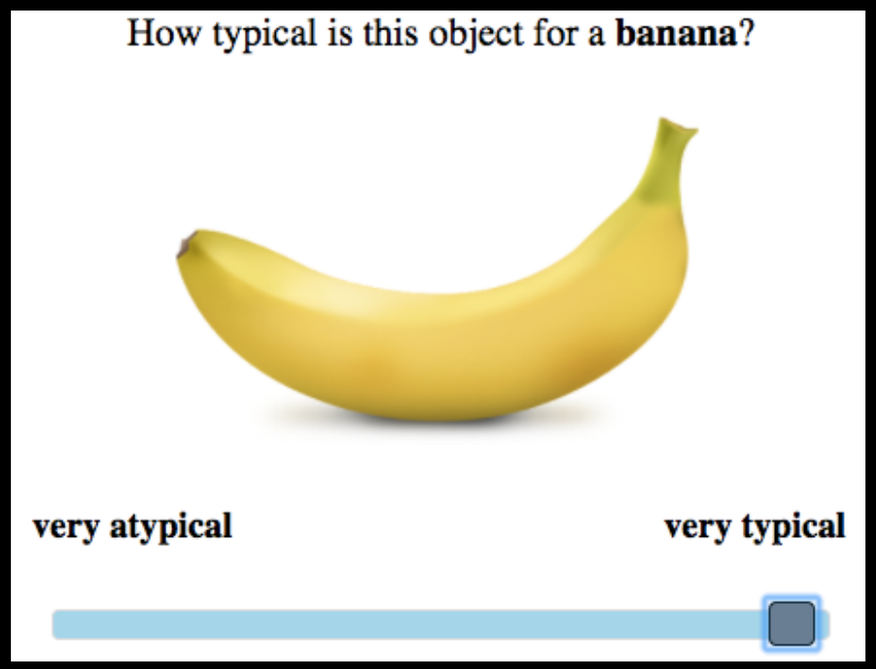
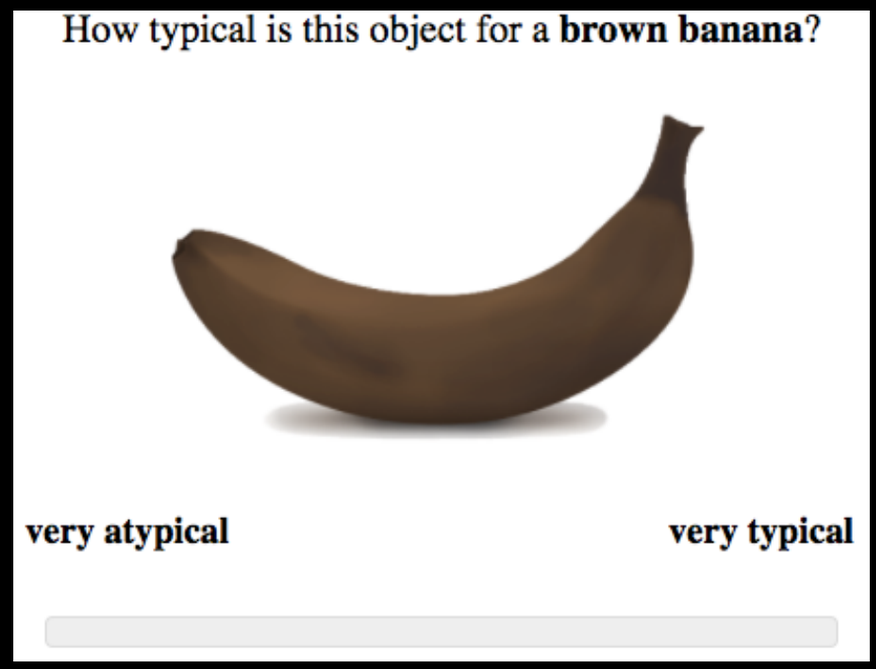
Typicality norming studies

Exp. 1a: type nouns



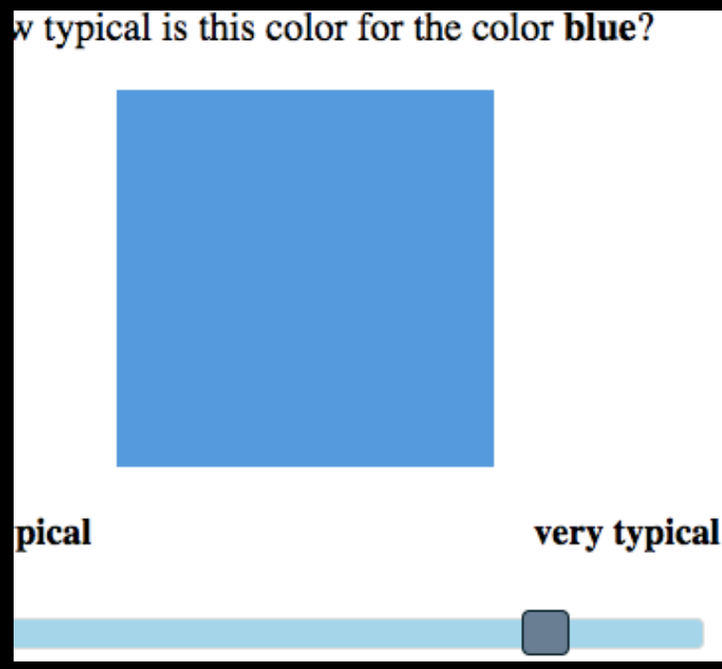
75 participants
90 trials

Exp. 1b: color-type



100 participants
110 trials

Exp. 1c: color



75 participants
90 trials

7 fruit/vegetable categories in 3 colors each

Typicality norming results

banana	**.98**	**.66**	**.42**	.05

Typicality norming results

banana	**.98**	**.66**	**.42**	.05
yellow banana	**.98**	.33	.17	.05
brown banana	.28	**.90**	.18	.04
blue banana	.20	.18	**.91**	.06

Typicality norming results

banana	**.98**	**.66**	**.42**	.05
yellow banana	**.98**	.33	.17	.05
brown banana	.28	**.90**	.18	.04
blue banana	.20	.18	**.91**	.06
yellow	**.77**	.05	.06	.09
brown	.11	**.87**	.01	.12
blue	.06	.06	**.92**	.07

Production study: interactive reference game experiment

You are the speaker.

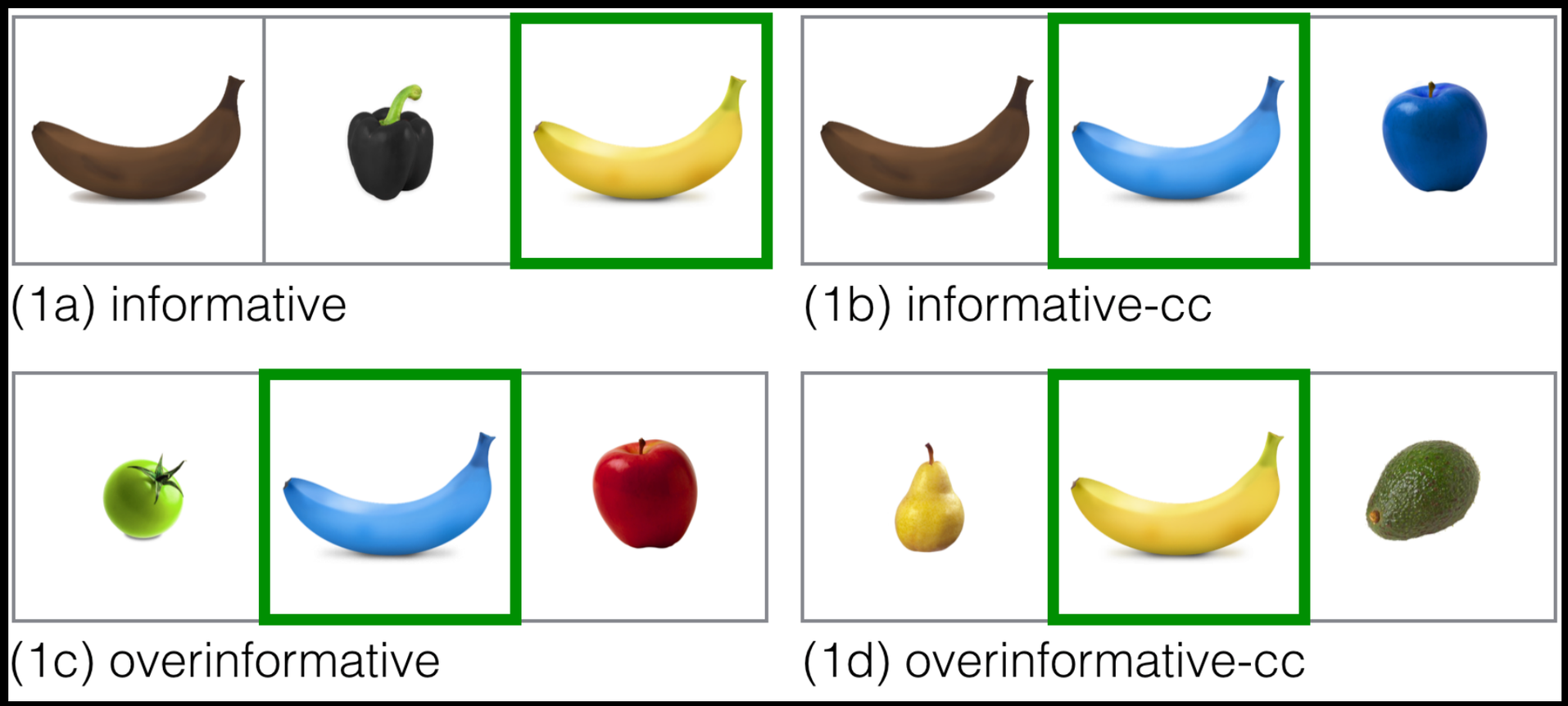
Send messages to tell the listener which object is the target.

blue banana

Send

Experimental details

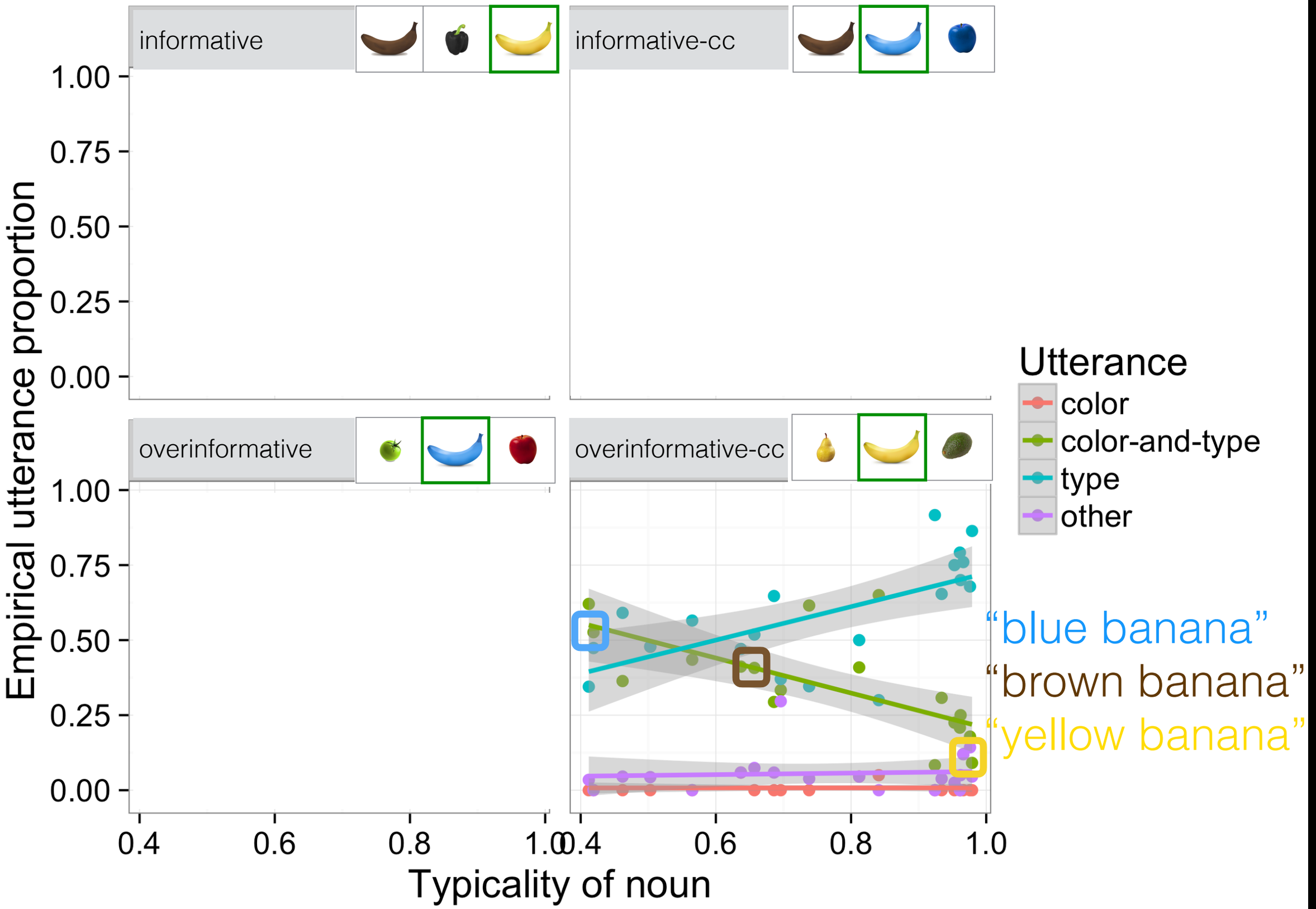
- 60 pairs of participants on Mechanical Turk
- random assignment to speaker/listener role
- 42 trials
- varied contextual informativeness of utterances:

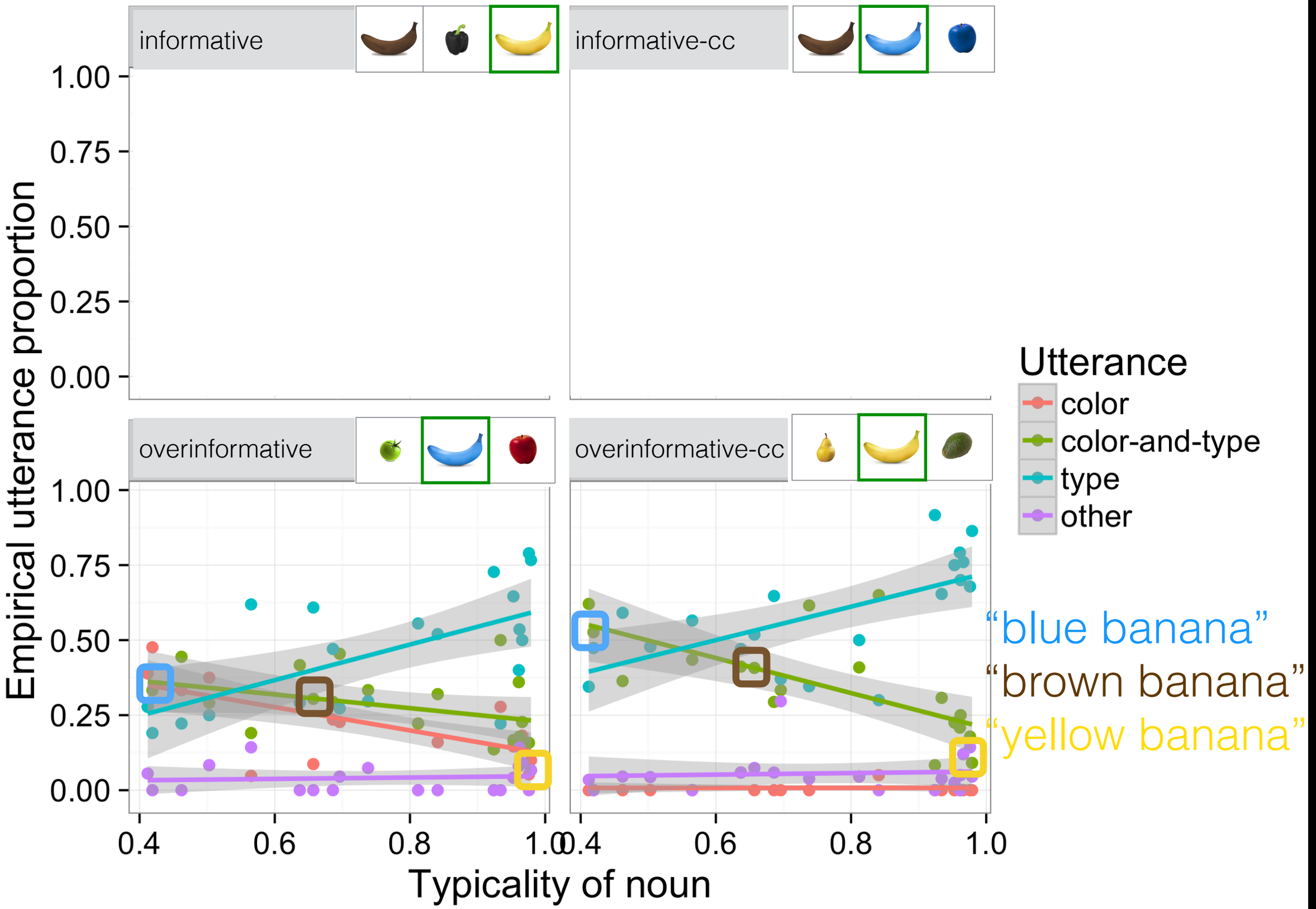


presence of same type x presence of color competitor

Data processing

“blue”	color
“yellow banana”	color-and-type
“the banana”	type
“banan”	
“funky carrot”	other


informative
informative-cc
overinformative
overinformative-cc
Empirical utterance proportion
1.00
0.75
0.50
0.25
0.00
0.4
0.6
0.8
1.0
Typicality of noun
Utterance
color
color-and-type
type
other
“blue banana”
“brown banana”
“yellow banana”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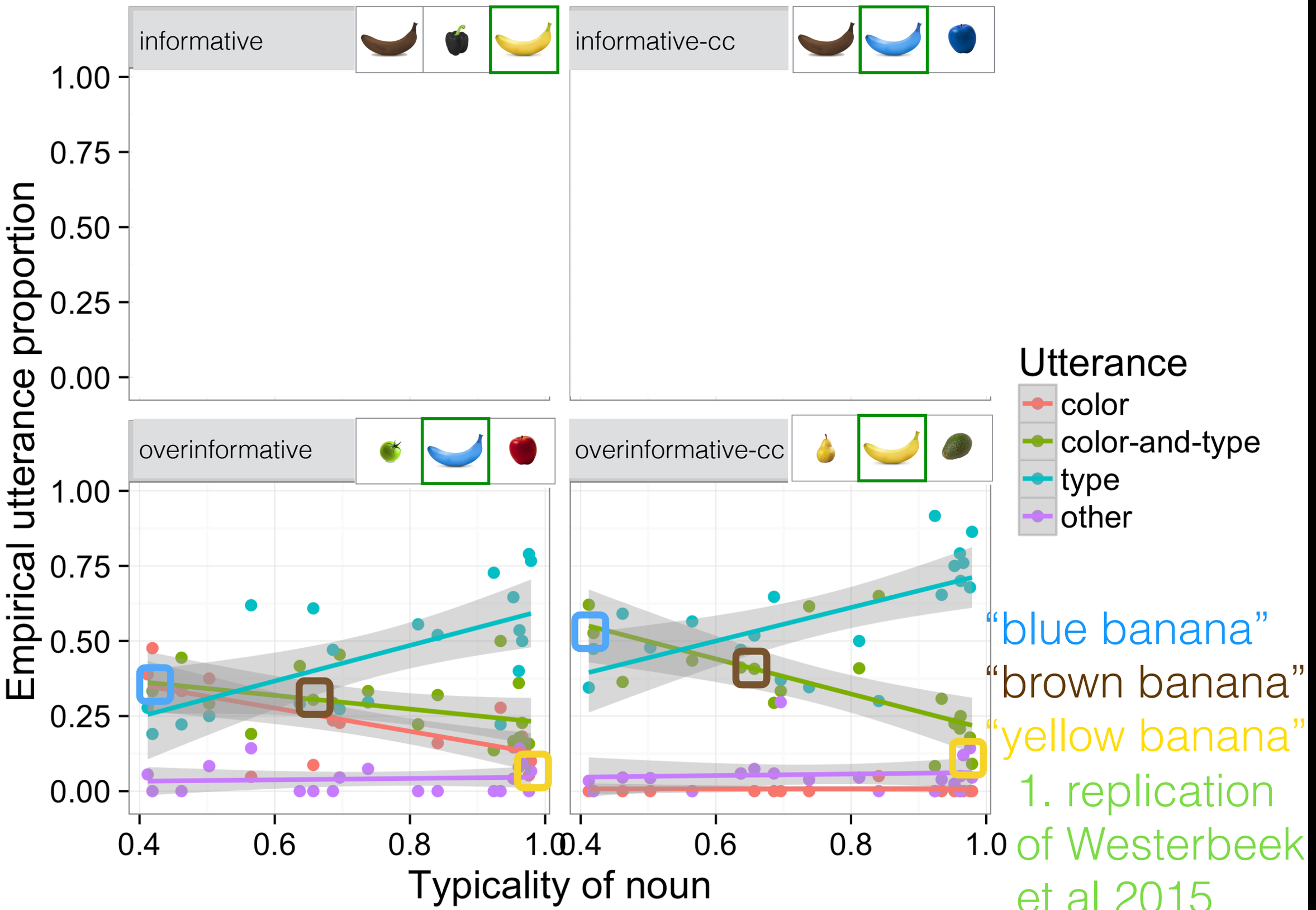
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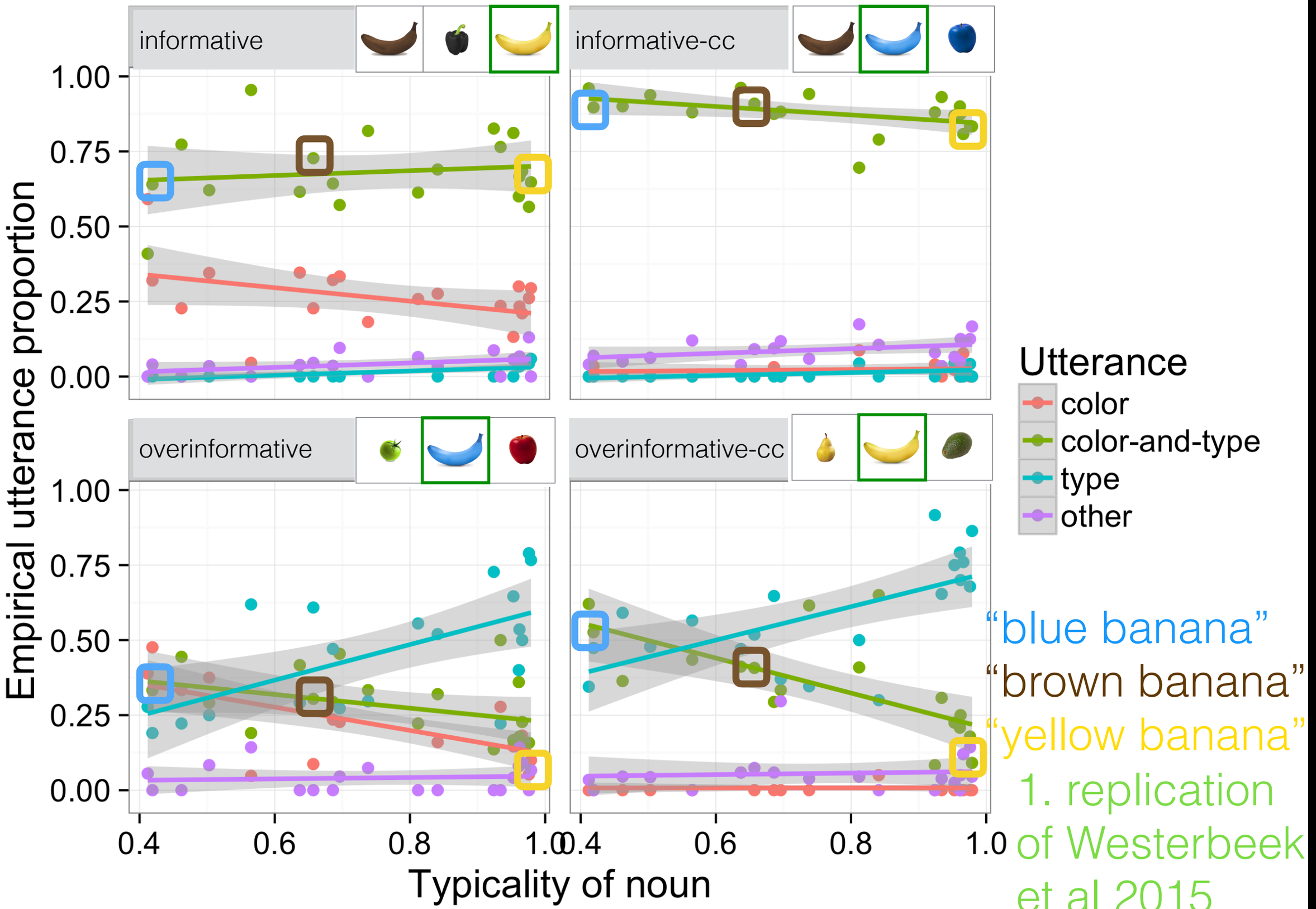
1. replication of Westerbeek et al 2015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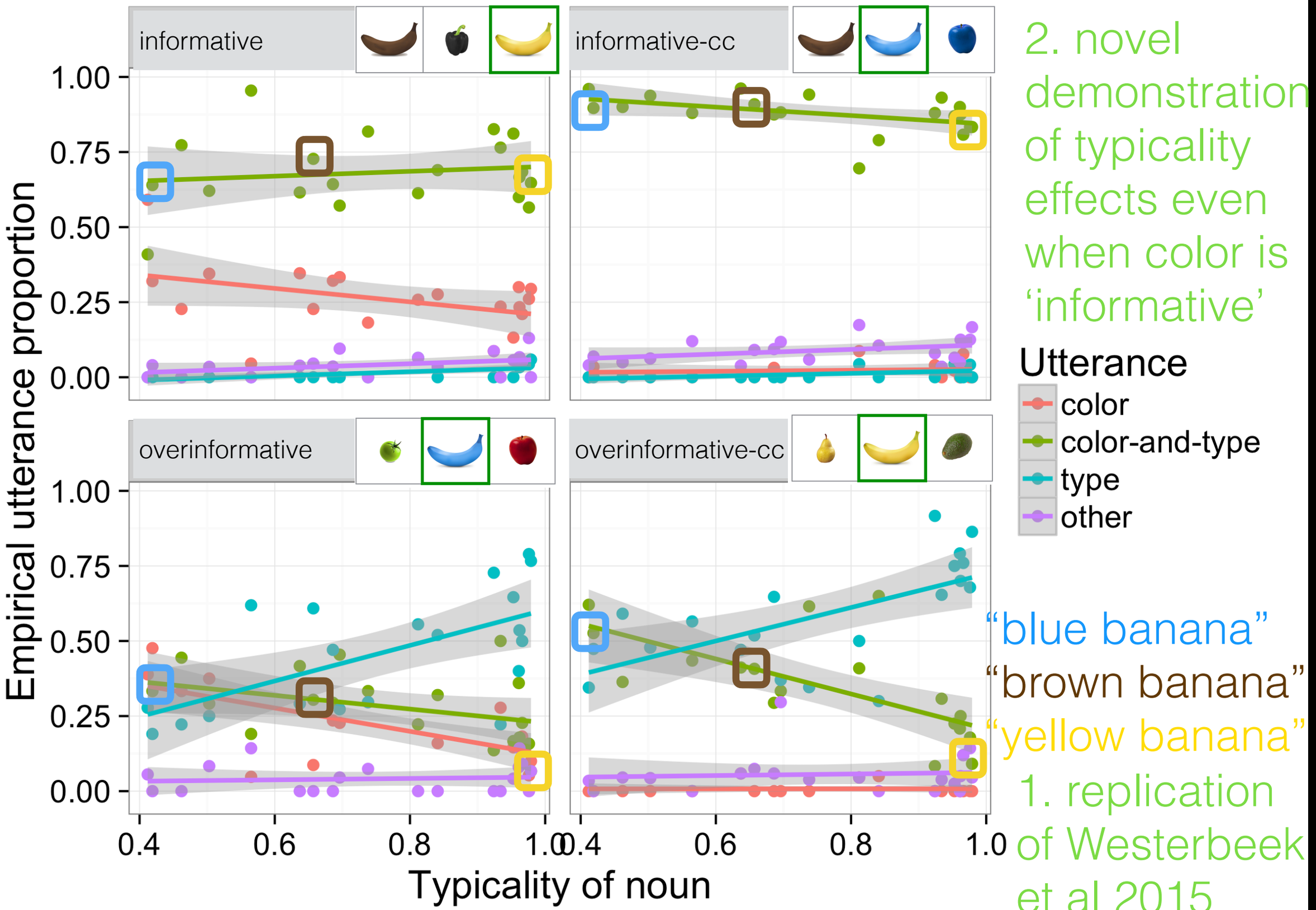


2. novel demonstration of typicality effects even when color is ‘informative’

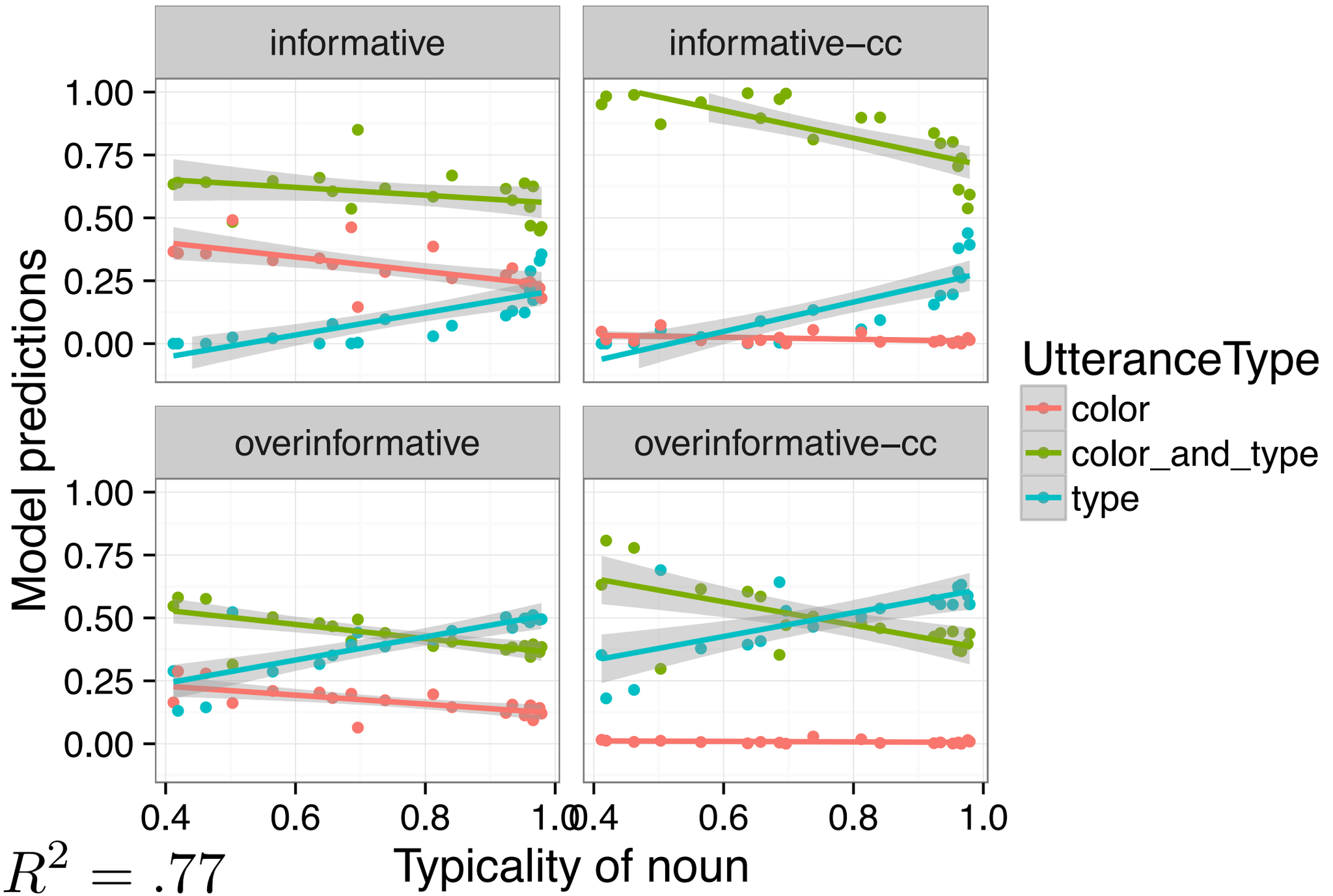
“blue banana”

“brown banana”

“yellow banana”

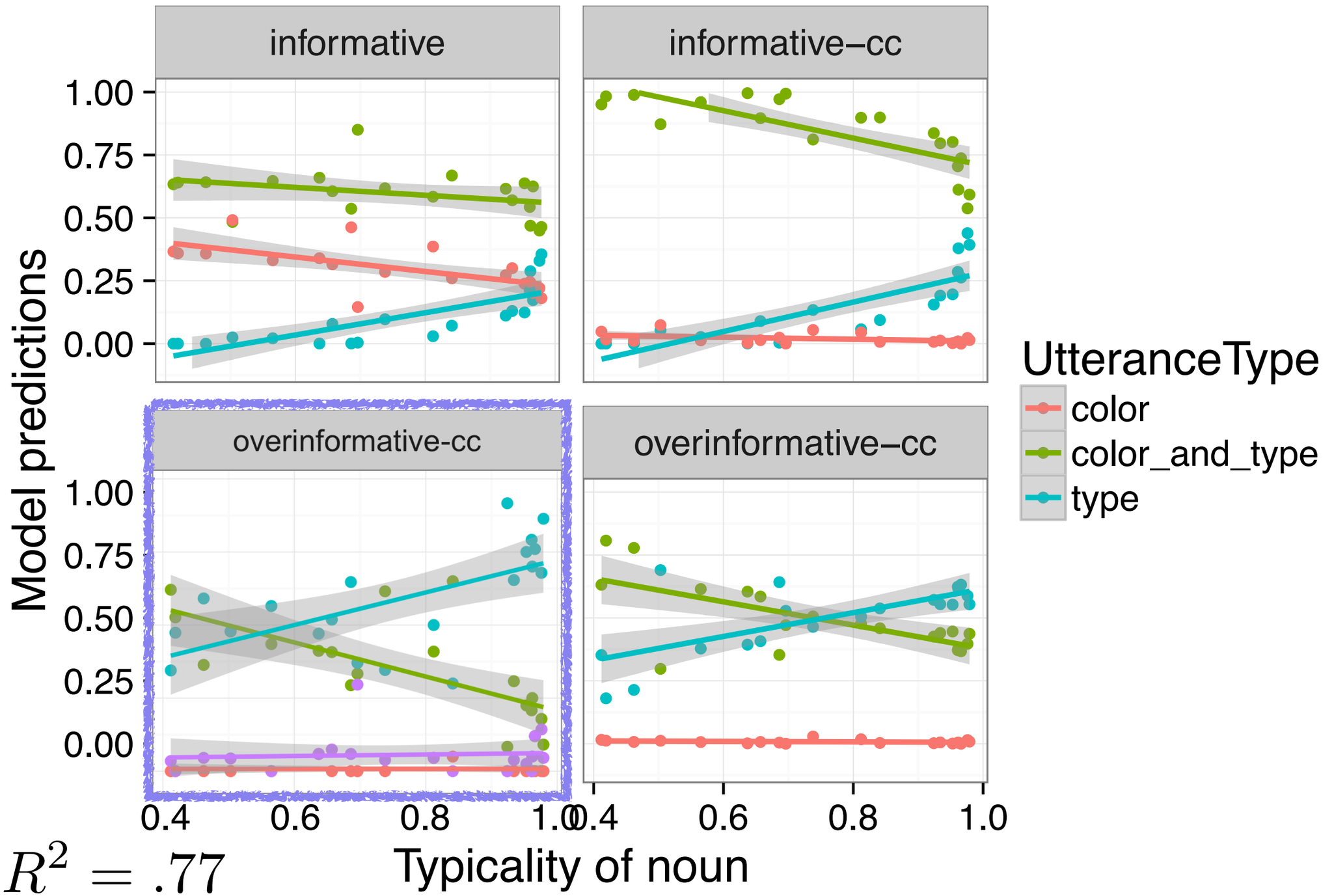
1. replication of Westerbeek et al 2015

Model evaluation



$R^2 = .77$

Model evaluation



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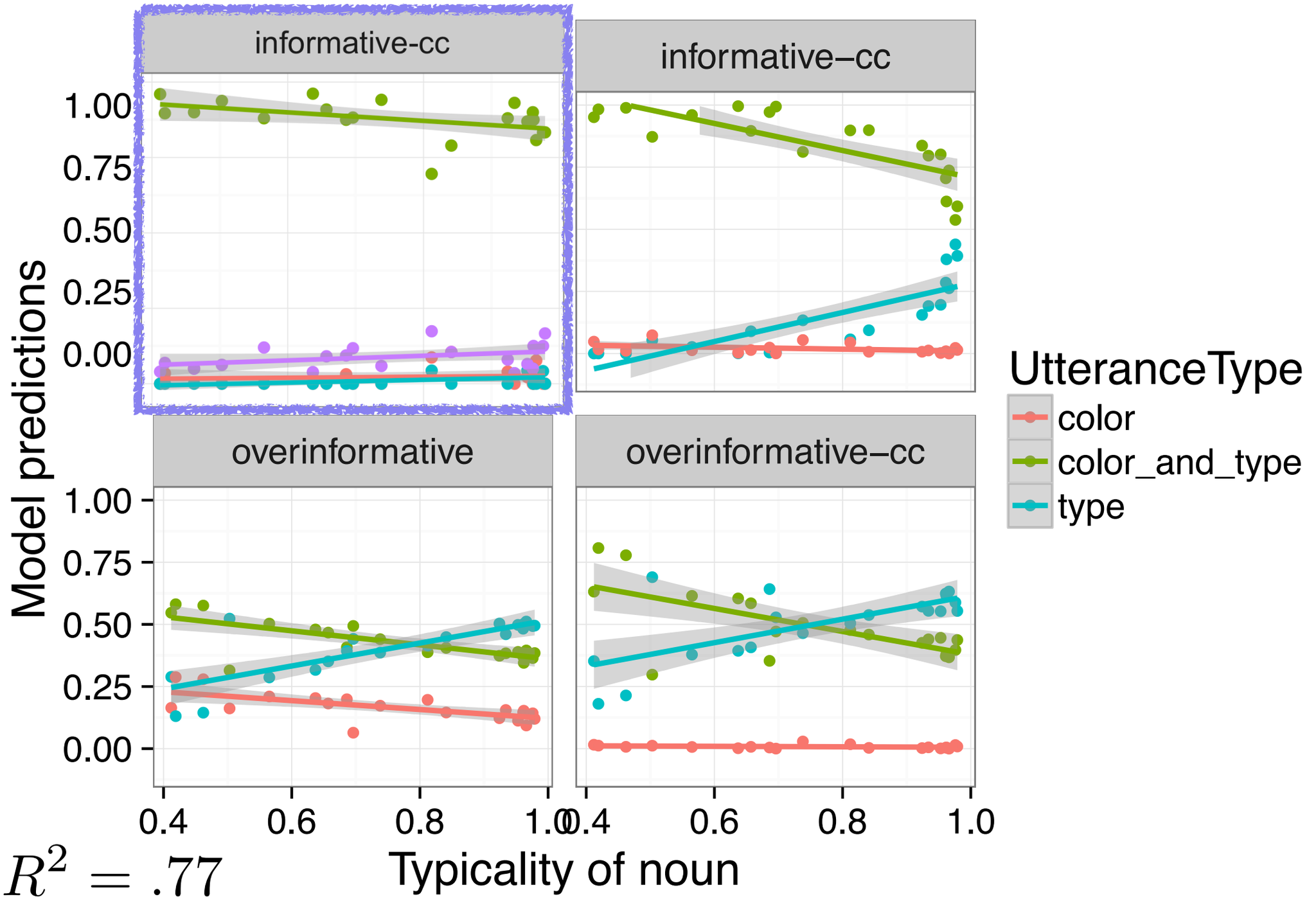
Model evaluation



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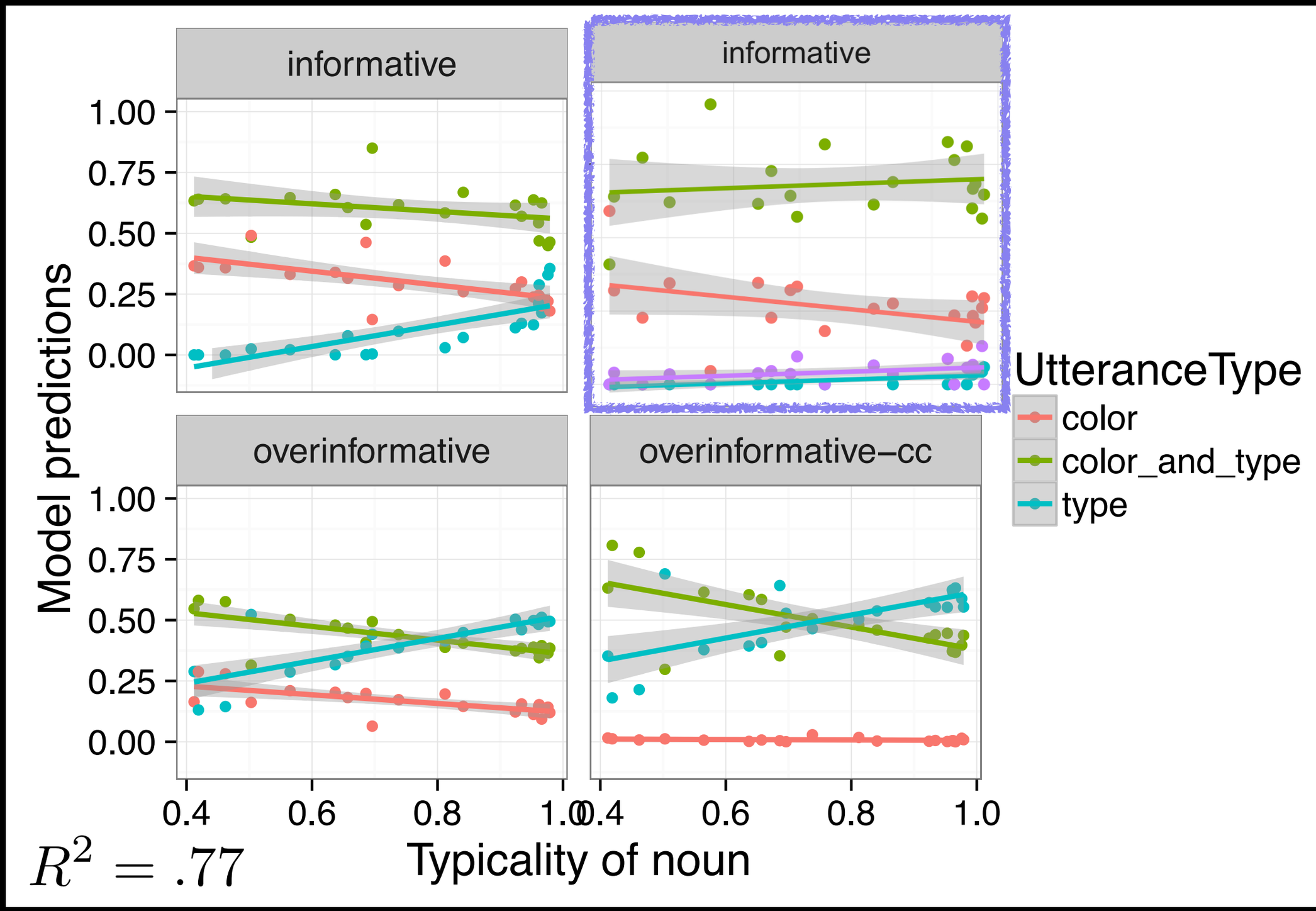
Model evaluation



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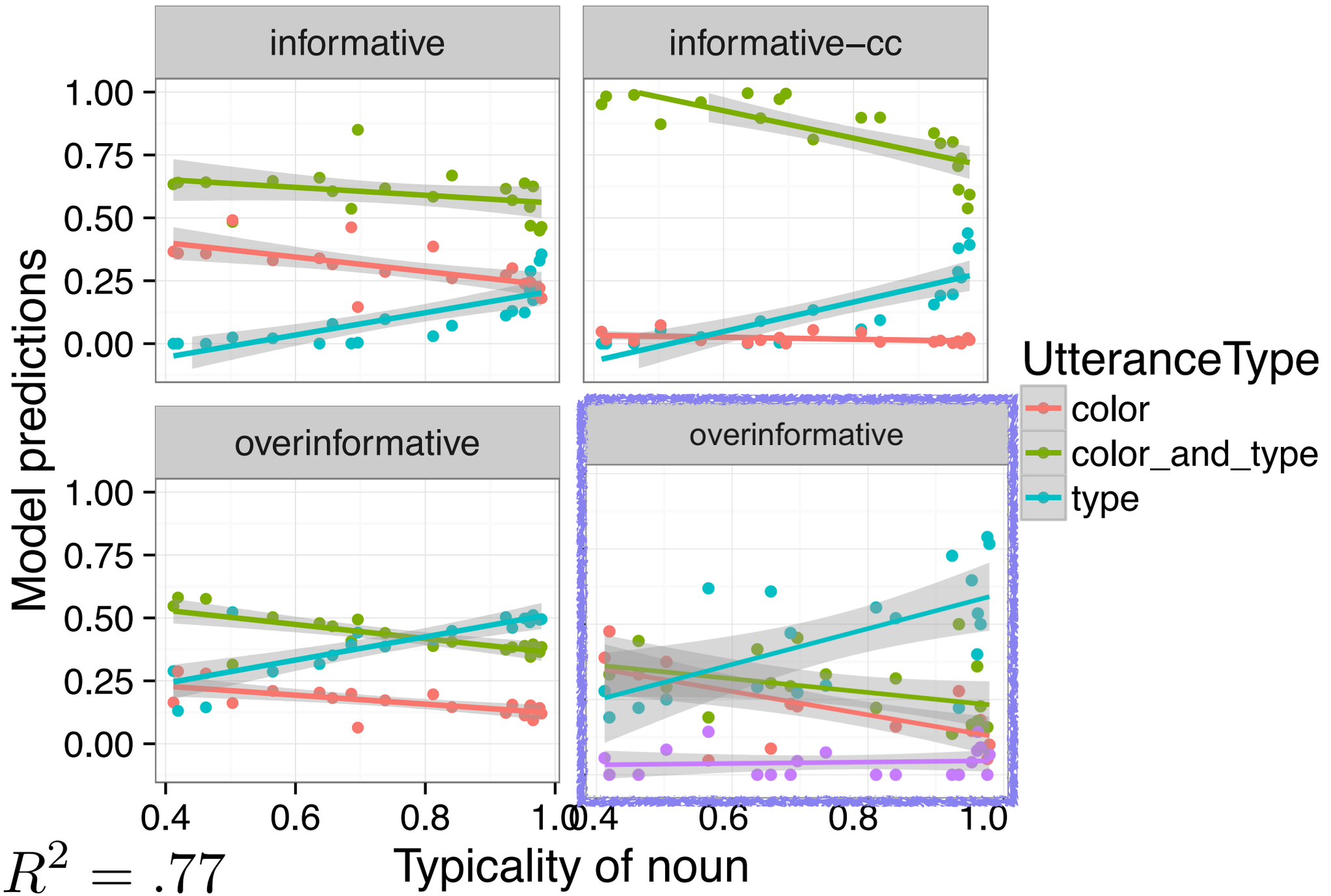

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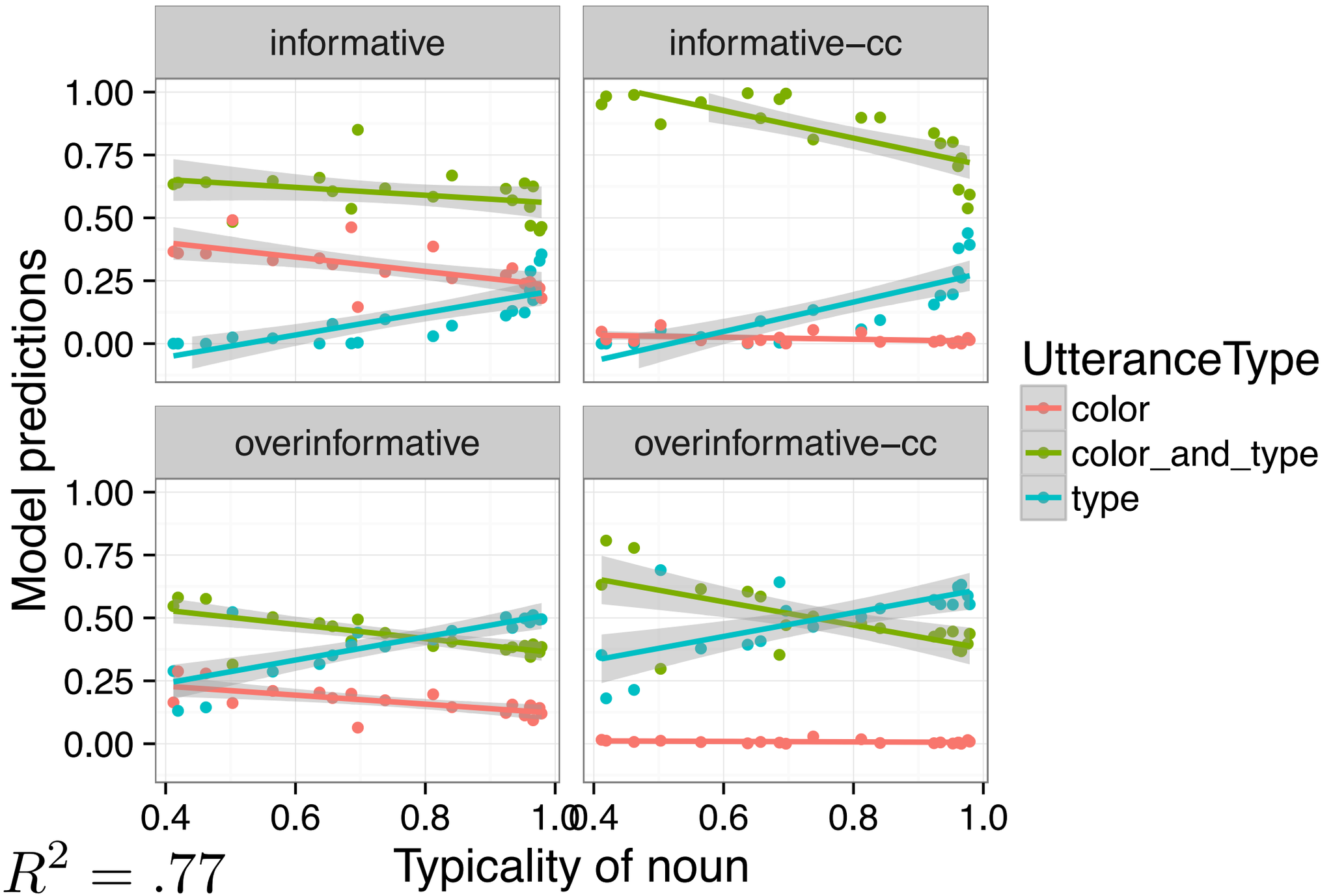
Model evaluation



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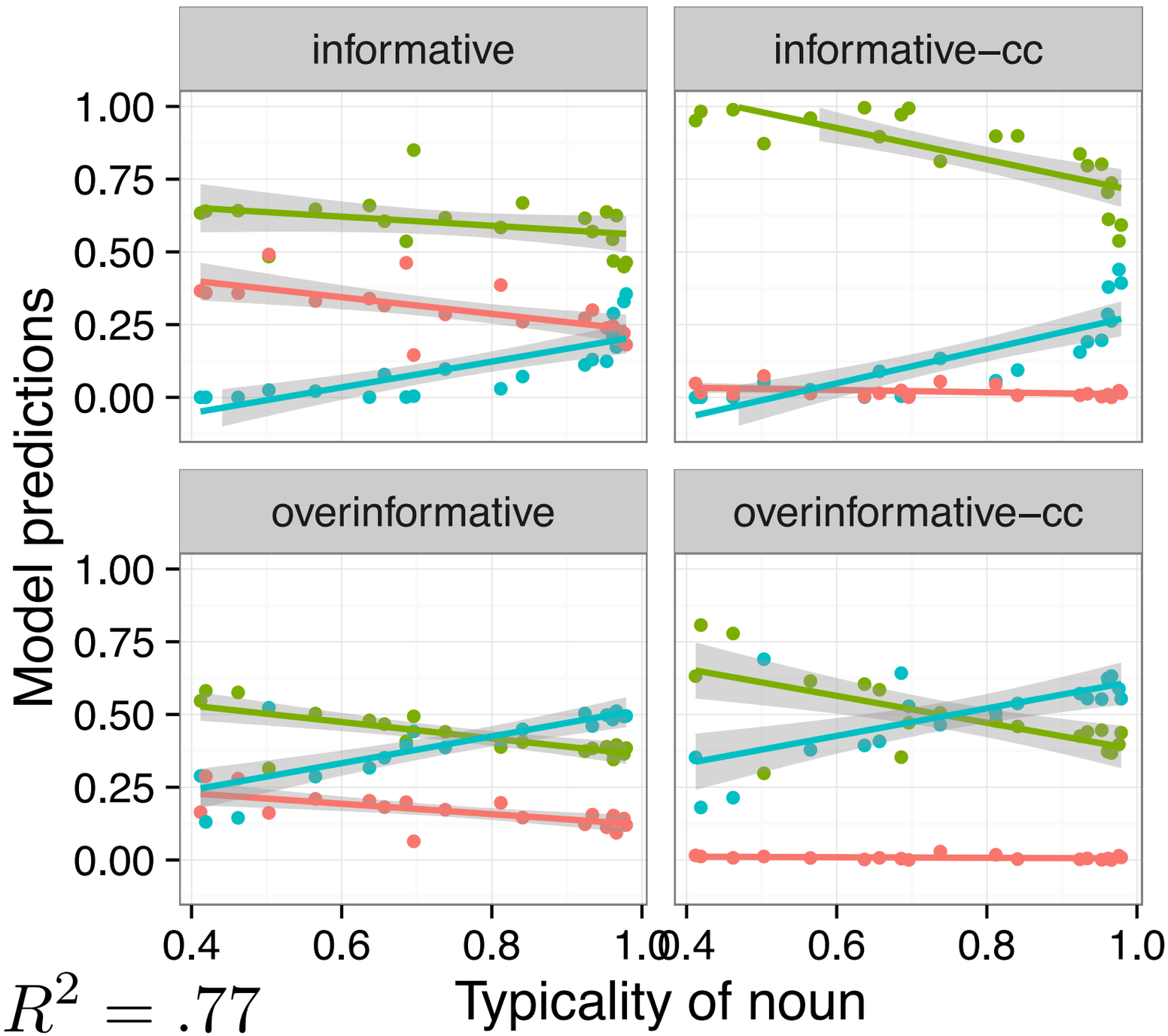
Model evaluation



$R^2 = .77$

1. model captures qualitative patterns

UtteranceType
color
color_and_type
type

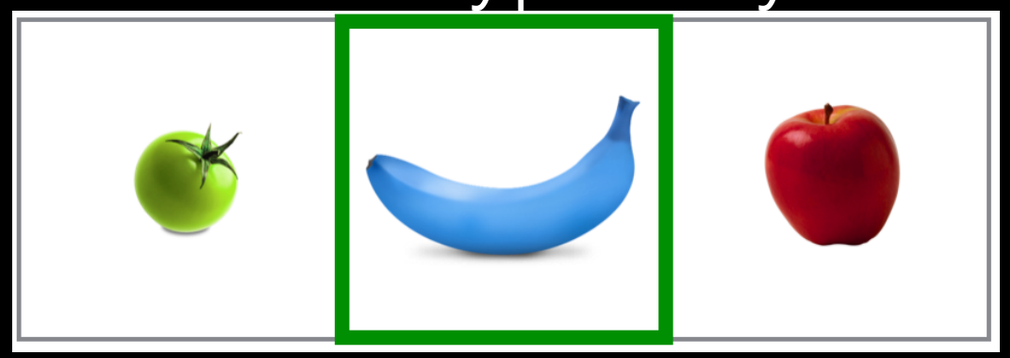
2. mostly captures quantitative patterns but overpredicts type mention

Summary & Conclusion

Speakers redundantly mention features when confusability of intention otherwise high

RSA with continuous semantics captures this

color typicality



Kreiss et al 2016

modifier choice

Degen et al in prep

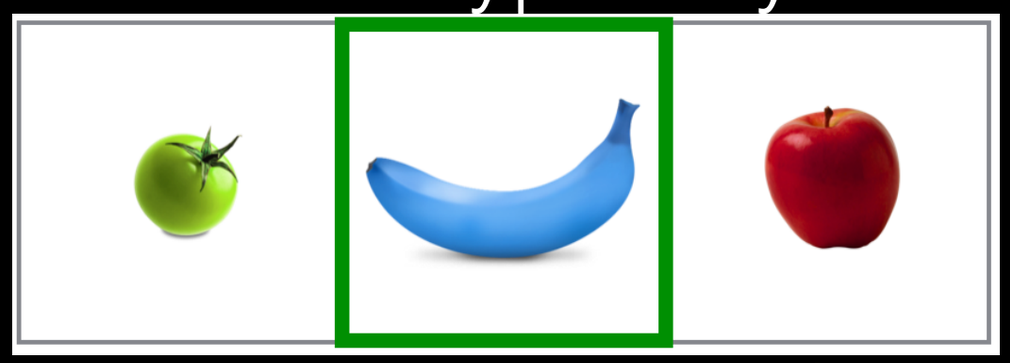
Summary & Conclusion

Speakers redundantly mention features when confusability of intention otherwise high

RSA with continuous semantics captures this

overinformative referring expressions

color typicality



Kreiss et al 2016

modifier choice

Degen et al in prep

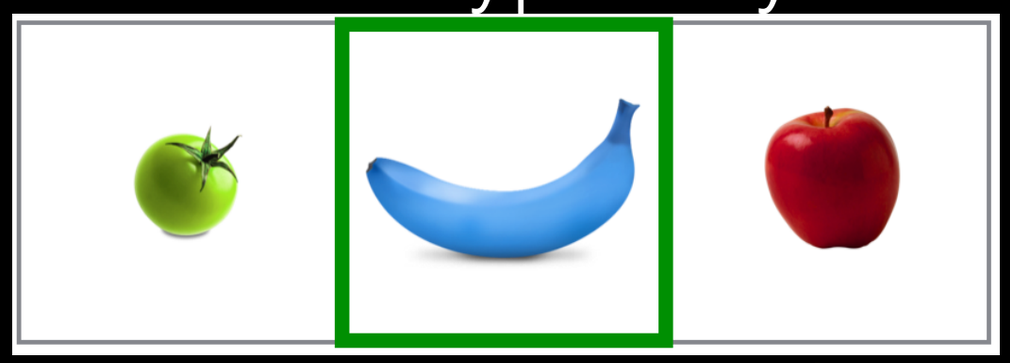
Summary & Conclusion

Speakers redundantly mention features when confusability of intention otherwise high

RSA with continuous semantics captures this

~~overinformative referring expressions~~

color typicality



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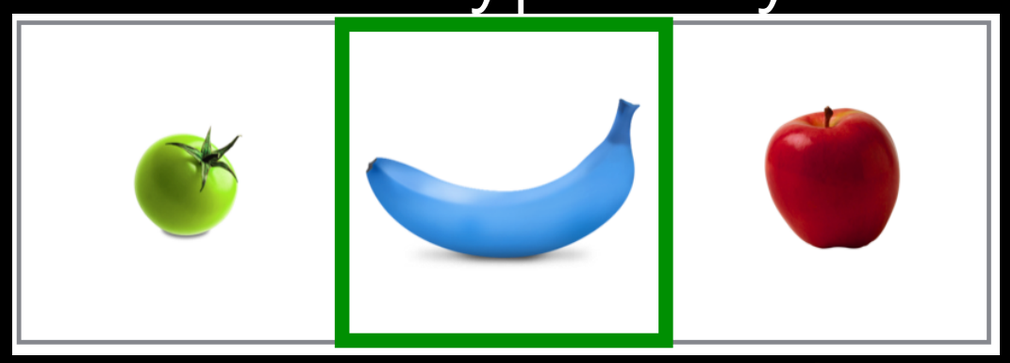

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Thank you

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