Accounting for redundant referring expressions: continuous semantics and/versus incrementality

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CONTENT SELECTION

Which features of an object should/do speakers mention?

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

color sufficient

the green lightbulb

75-80% ***the big green lightbulb*** **8-10%**

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

Deutsch 1976; Pechmann 1989; Sedivy 2003; Gatt et al. 2011; Koolen et al 2013; Rubio-Fernández 2016; Westerbeek et al 2015; Davies & Katsos 2013; van Gompel et al 2019

Redundant referring expressions — color/size asymmetry

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the big lightbulb

75-80%

color sufficient

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8-10%

1. speakers produce **redundant** referring expressions
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Outline

I. Redundant modification in English
   I. continuous semantics model
II. Redundant modification cross-linguistically
   I. Spanish
   II. incremental model
   III. CTSL

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

models

experiments

Caroline Graf

Robert Hawkins

Leyla Kursat

Noah Goodman

Elisa Kreiss

PART I

—

Redundant modification in English

Graf et al 2016; Degen et al 2020; Kursat & Degen 2021

Computational models of REs

- Greedy Algorithm
  Dale 1989

Informativeness

- Incremental Algorithm
  Dale & Reiter 1995

Preferences

- PRO
  Gatt et al 2013; van Gompel et al 2019

Probabilities

- Rational Speech Act (RSA)
  Frank & Goodman 2012

Probabilistic pragmatics

Franke & Jäger, 2016; Goodman & Frank, 2016; Scontras, Tessler, & Franke 2018

Reference

Frank & Goodman 2012; Qing & Franke 2015; Degen & Franke 2012; Stiller et al 2015; Franke & Degen 2015; Degen et al 2020

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 2016; Bergen et al 2016; Franke & Bergen 2020

Free choice

Champollion et al 2019

Figurative meaning

Kao et al 2013; 2014; 2015; Cohn-Gordon & Bergen, under review

Exhaustivity inferences

Wilcox & Spector 2019; Javangula & Degen in prep

Gradable adjectives

Lassiter & Goodman 2013; 2015; Qing & Franke 2014; Xiang et al under review

Adjective ordering

Hahn et al 2018; Scontras et al 2019

Other

plural predication Scontras & Goodman 2017
I-implicatures Poppels & Levy, 2016
generics Tessler & Goodman, 2019
modals Herbstritt & Franke, 2017
vague quantifiers Schöller & Franke, 2017
convention formation Hawkins et al 2018; 2019
questions Hawkins et al 2015
pragmatic adaptation Schuster & Degen, 2020
exhaustivity inferences
atypicality inferences Kratvchenko & Demberg
social meaning Burnett 2017; Yoon et al 2020

The RSA framework

Frank & Goodman 2012

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

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

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

obvious problem:
no complex utterances

Literal listener

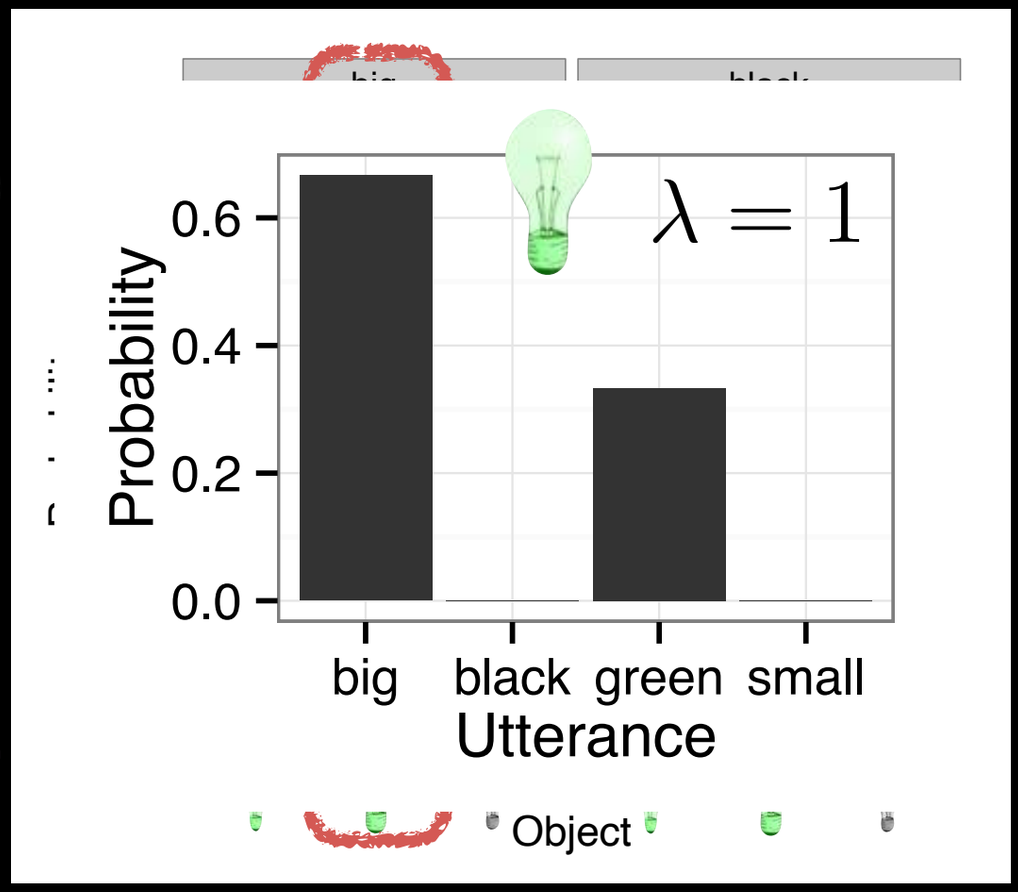
$$P_{L_0}(o|u) = \mathcal{U}(o|\{u \text{ is true of } o\})$$

$$[[u]] : O \rightarrow \{\text{true}, \text{false}\}$$

Pragmatic speaker

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

Quantity Manner



Utterance semantics & cost

Intersective semantics

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

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

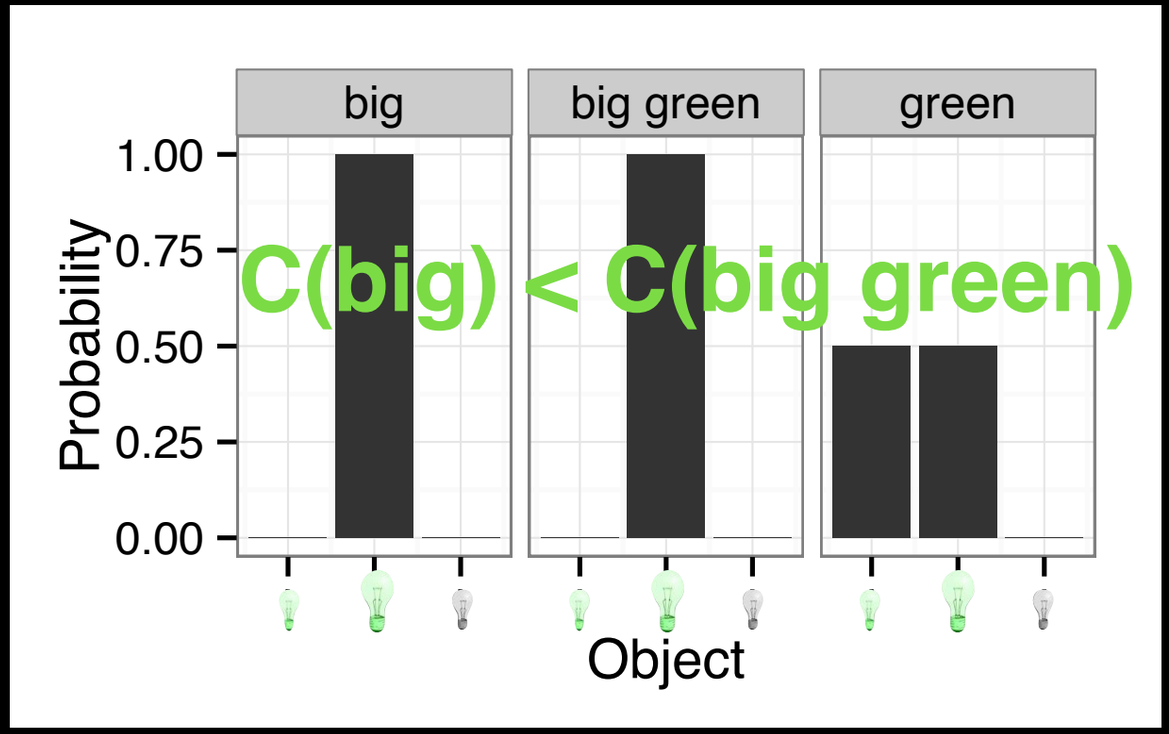
Cost

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

RSA does not produce redundant REs…

Gatt et al 2013; Westerbeek et al 2015

…with deterministic Boolean semantics



Motivation for relaxed semantics?

Modifiers differ:

size adjectives are more vague and context-dependent than color adjectives

color is more salient than size

Arts et al 2011; Gatt et al 2013

size adjectives are judged to be more subjective than color adjectives

Scontras, Degen, & Goodman 2017; Shi & Scontras 2020; Kachakeche & Scontras 2020; Scontras et al 2020

Continuous semantics

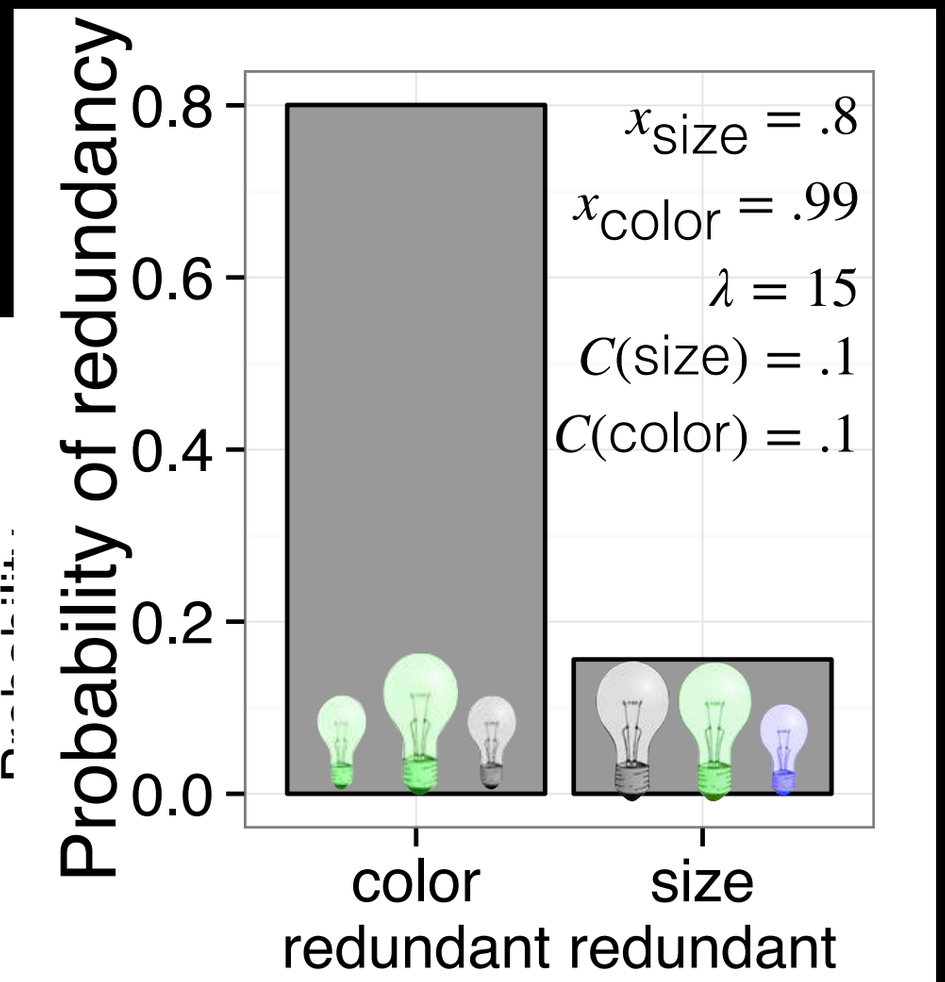
semantic value

Literal listener

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

Pragmatic speaker

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

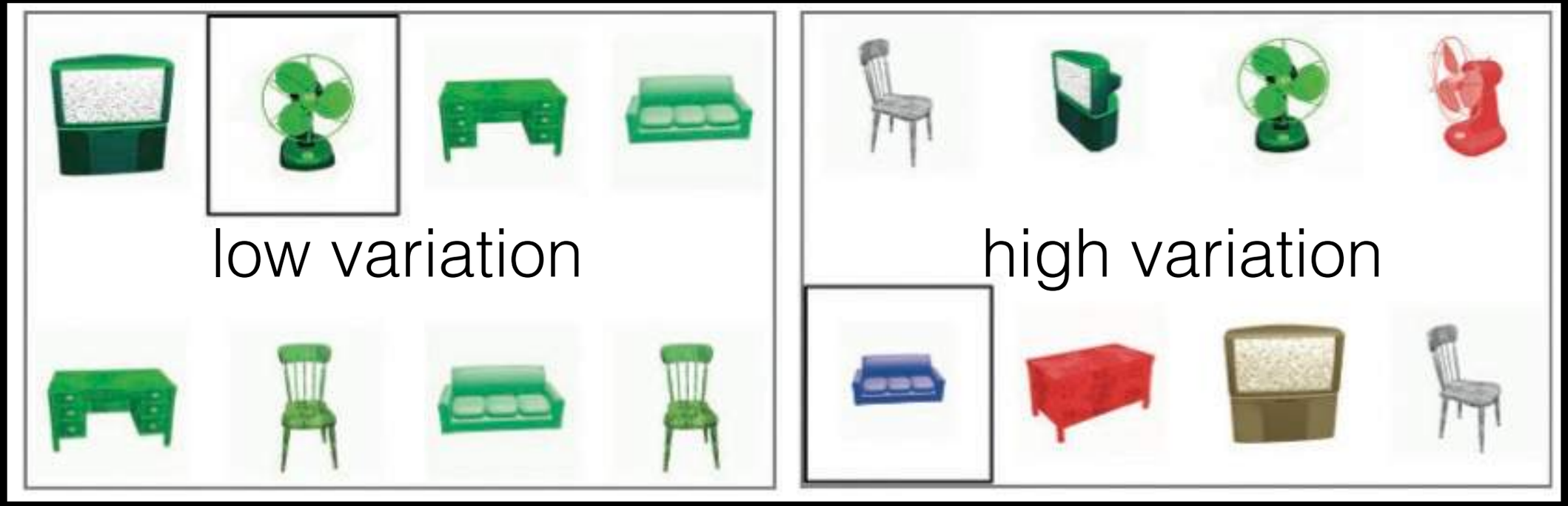


color-size asymmetry

If modifiers don't "work perfectly",
adding modifiers adds information

Independent empirical evidence for cs-RSA?

Scene variation



more redundant color use in high-variation scenes

Koolen et al 2013, Davies & Katsos 2013

cs-RSA predicts this result

Independent **quantitative** evidence for cs-RSA?

Scene variation

scene variation increases probability of redundancy

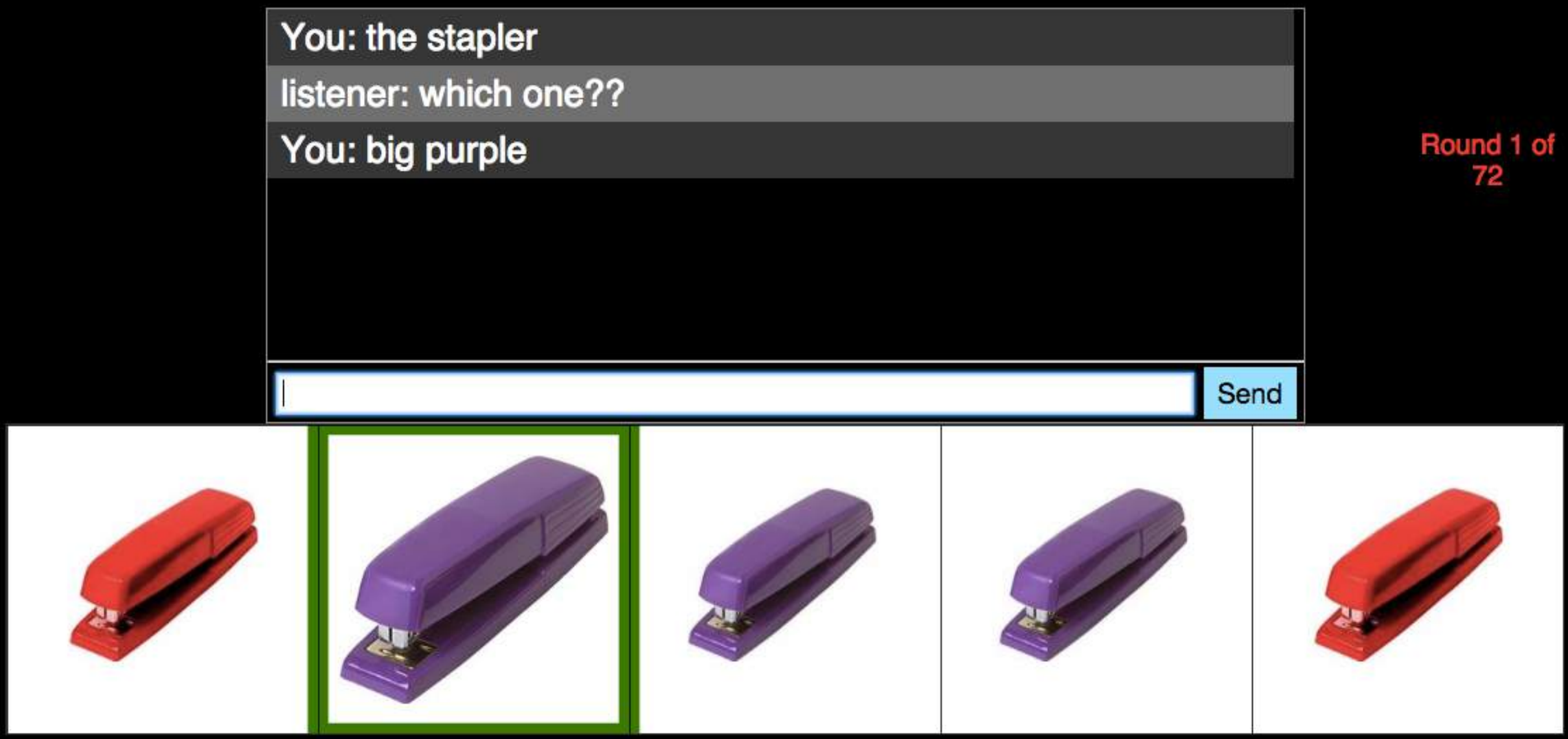
$\frac{n_{\text{diff}}}{n_{\text{total}}}$ proportion of total distractors that don't share target value on insufficient dimension

sufficient dimension: size

insufficient dimension: color → $\frac{n_{\text{red}}}{n_{\text{total}}} = \frac{2}{4} = .5$

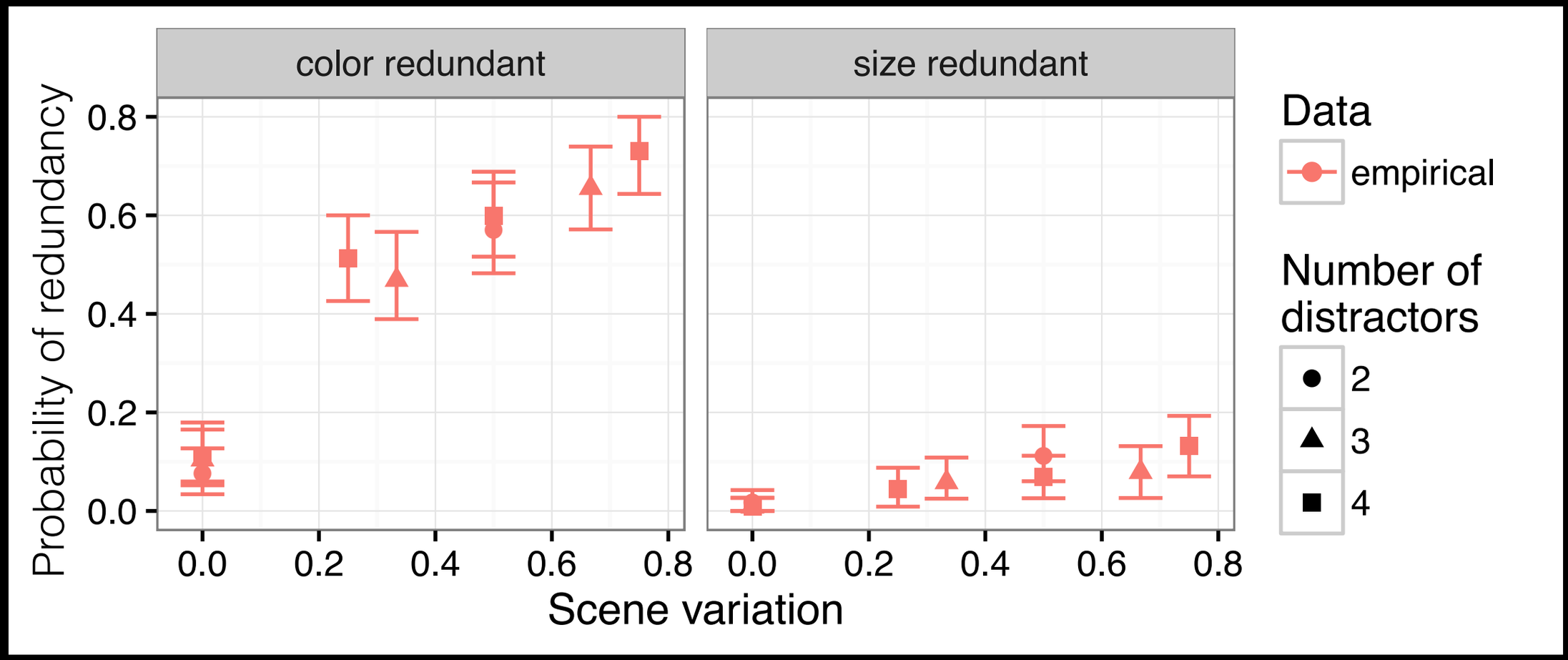
greater proportion = more variation

Web-based interactive reference game experiment



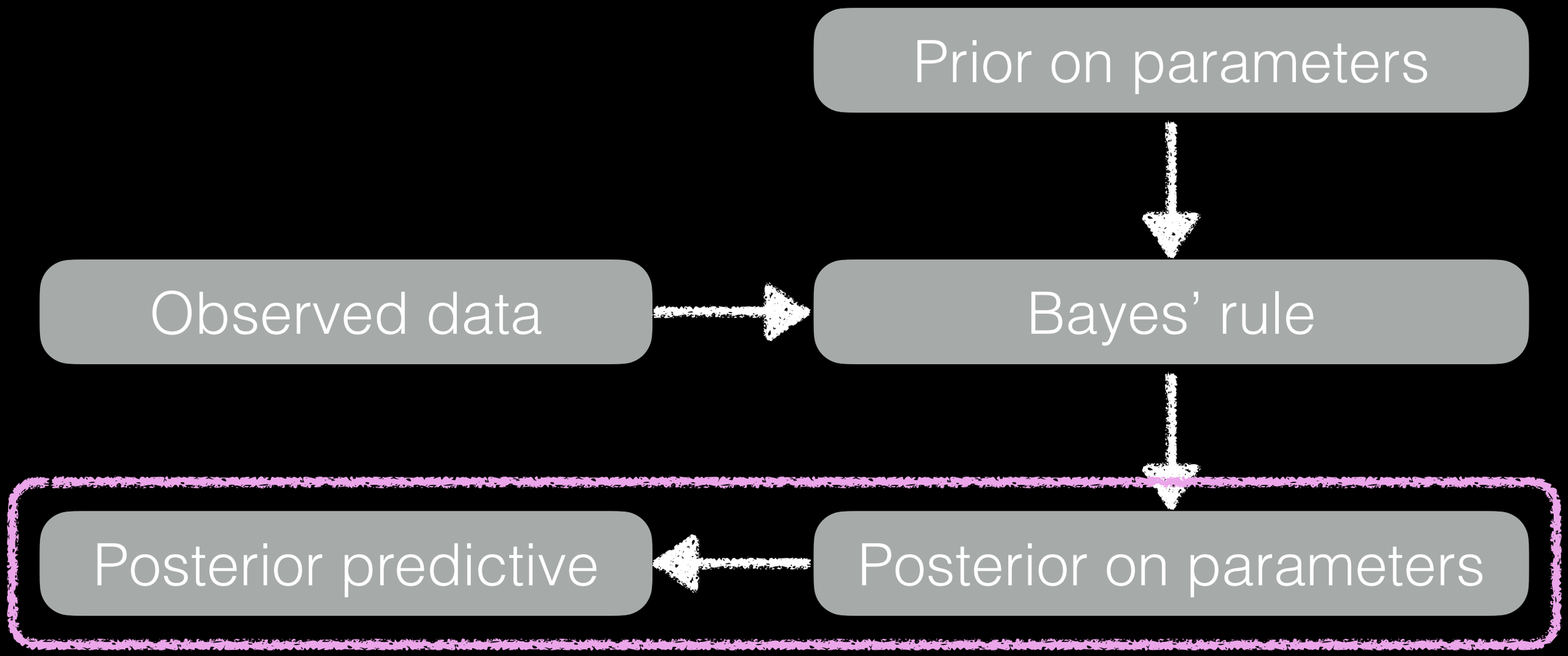
58 participant pairs, 72 trials
36 target trials: half color-sufficient, half size-sufficient

Results

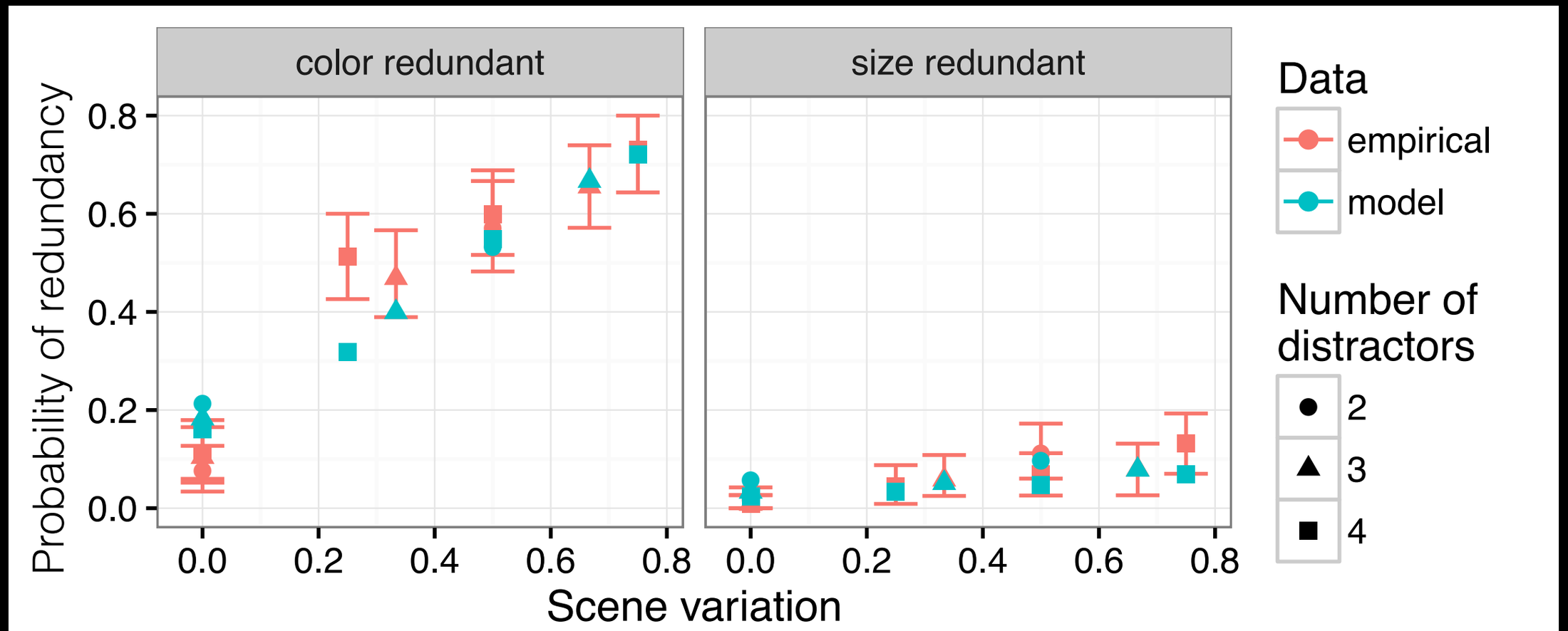


1. more redundant adjective use with greater scene variation
2. greater effect of scene variation for color than size

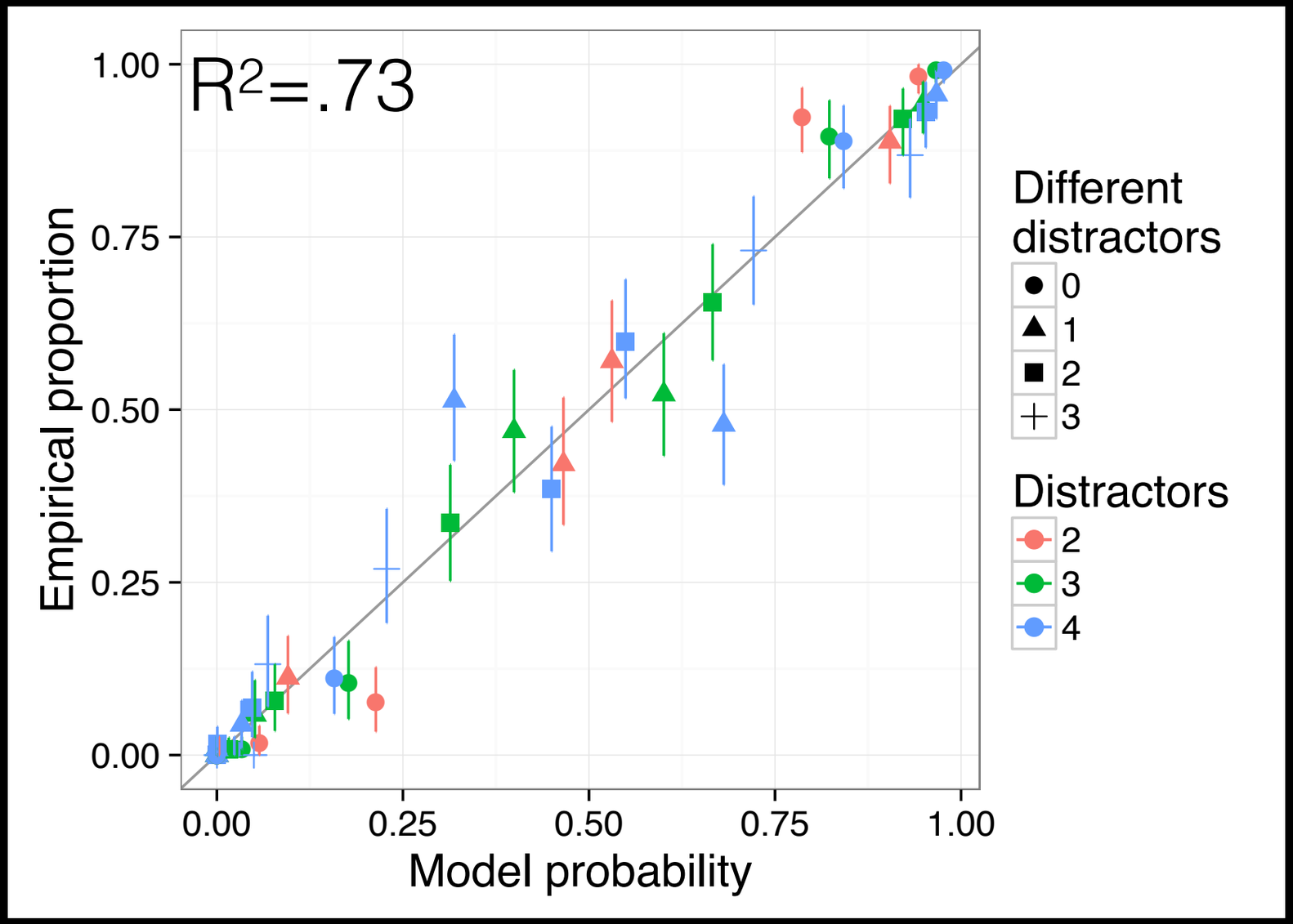
Bayesian data analysis



Results

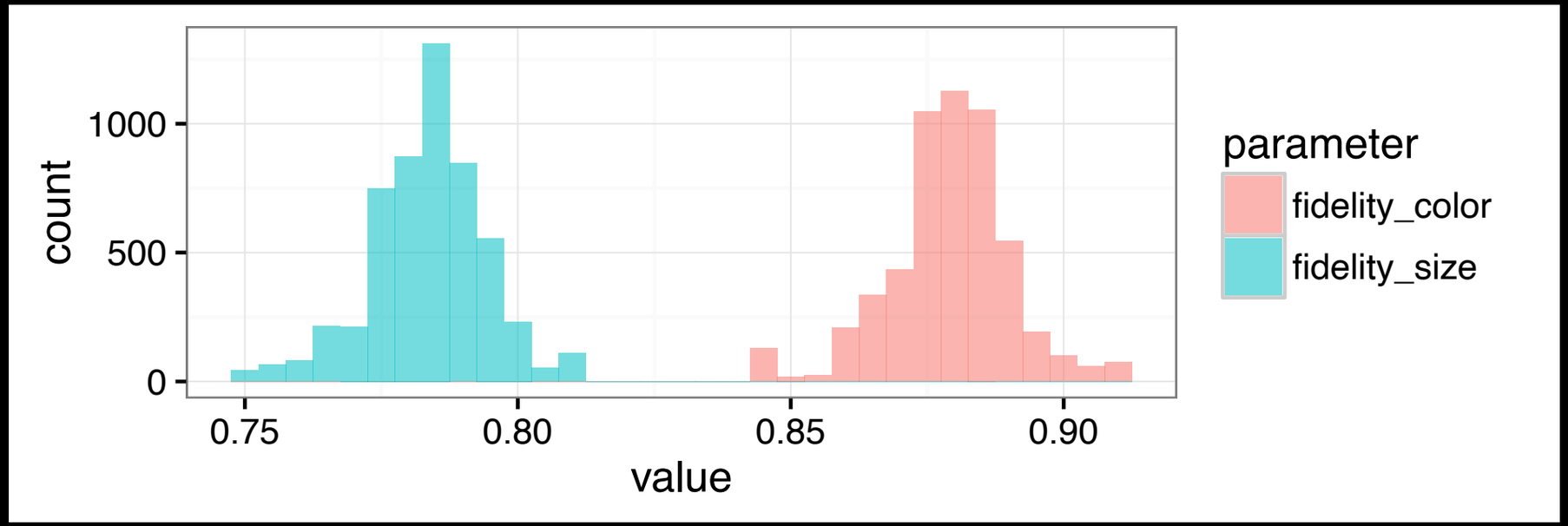

color redundant
size redundant
Probability of redundancy
0.0
0.2
0.4
0.6
0.8
Scene variation
Data
empirical
model
Number of distractors
2
3
4

Model fit

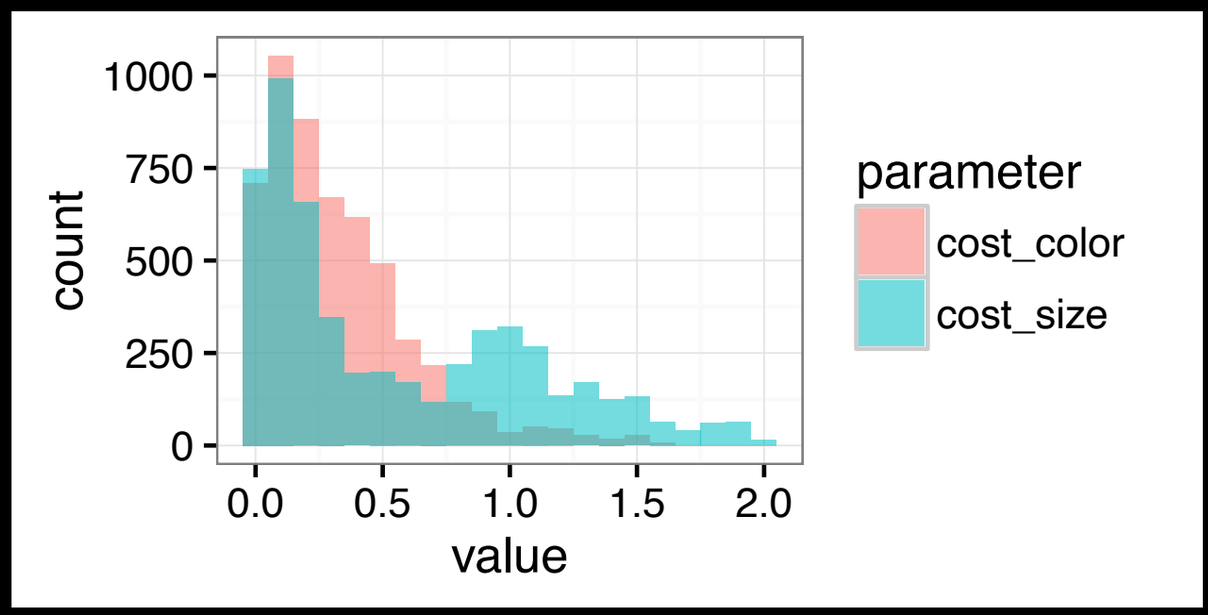

R²=.73
1.00
0.75
0.50
0.25
0.00
Empirical proportion
0.00
0.25
0.50
0.75
1.00
Model probability
Different distractors
0
1
2
3
Distractors
2
3
4

Posteriors over parameters

Semantic values:
inferred value lower for size than color



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



Interim summary

if modifiers are noisy, adding modifiers adds utility

RSA with continuous semantic values captures this:

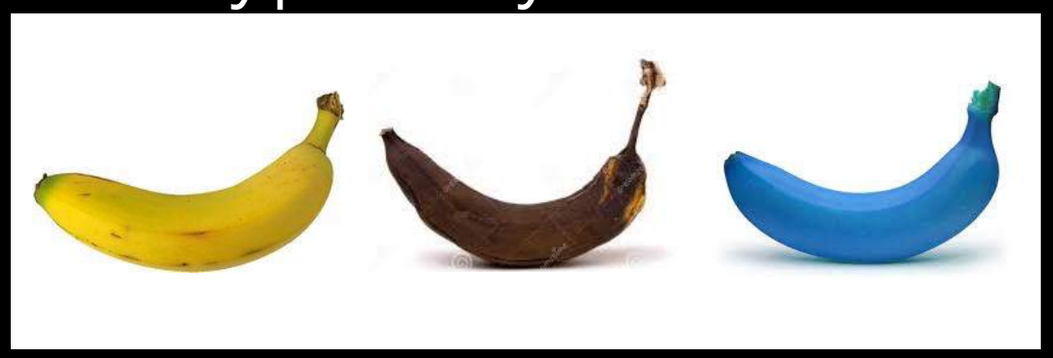
~~overinformative referring expressions~~

usefully redundant referring expressions

level of reference

Graf et al 2016; Degen et al 2020

typicality effects



Degen et al 2020

What does semantic noise reflect?

- past probability of communicative success in using the adjective

- semantic features (eg, uncertainty introduced by reasoning about comparison class)

- perceptual difficulty of verifying whether an object exhibits the property denoted by the adjective
  Kursat & Degen, 2021; Jara-Ettinger & Rubio-Fernandez to appear

Leyla Kursat

Brandon Waldon

Stefan Pophristic

Rabia Ergin

PART II

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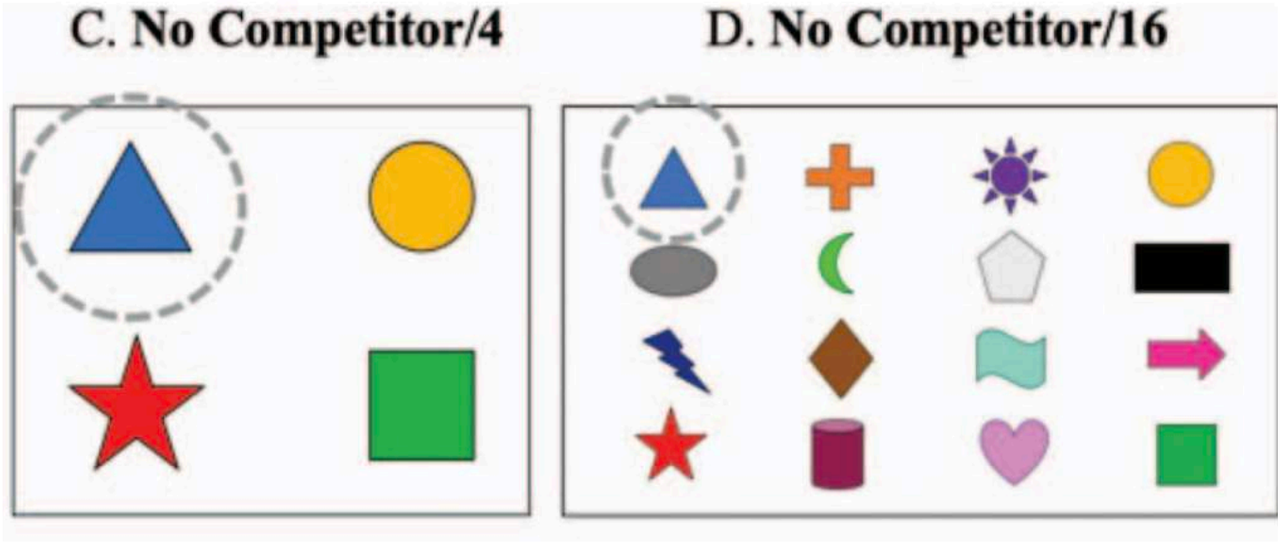
Redundant modification cross-linguistically

Waldon & Degen 2021; Kursat, Ergin, & Degen in prep

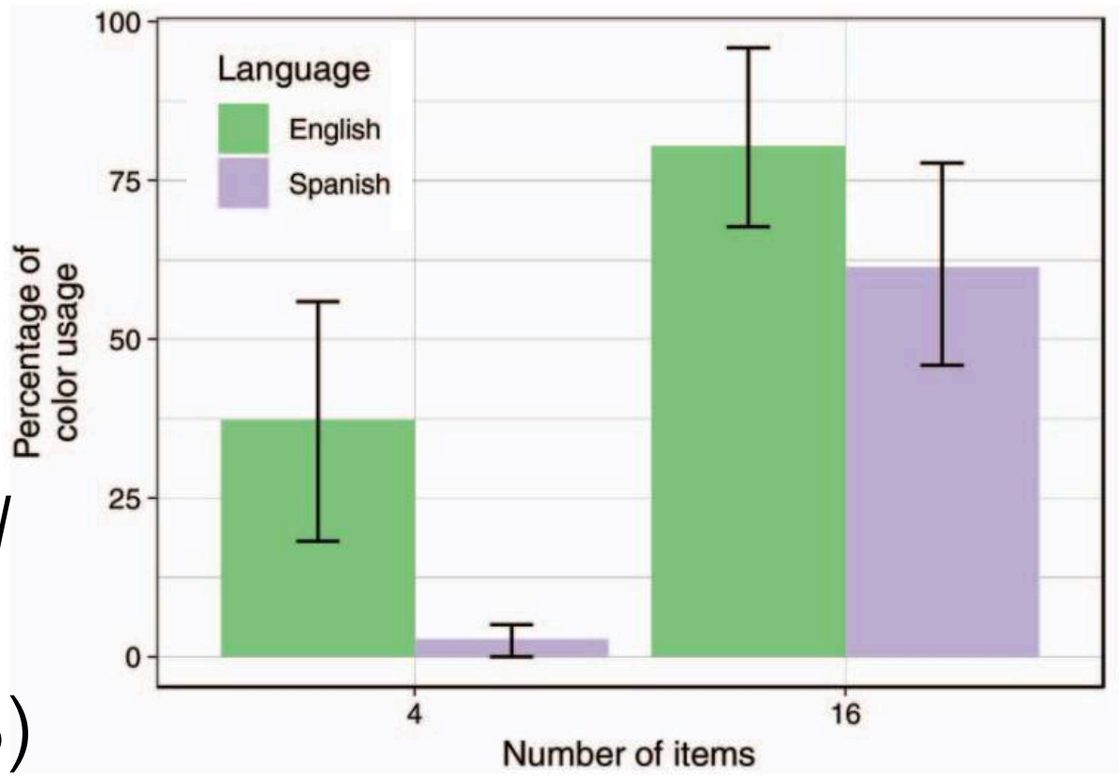
Cross-linguistic variability in redundant modification



English:
the triangle
the blue triangle
Spanish:
el triángulo
el triángulo azul

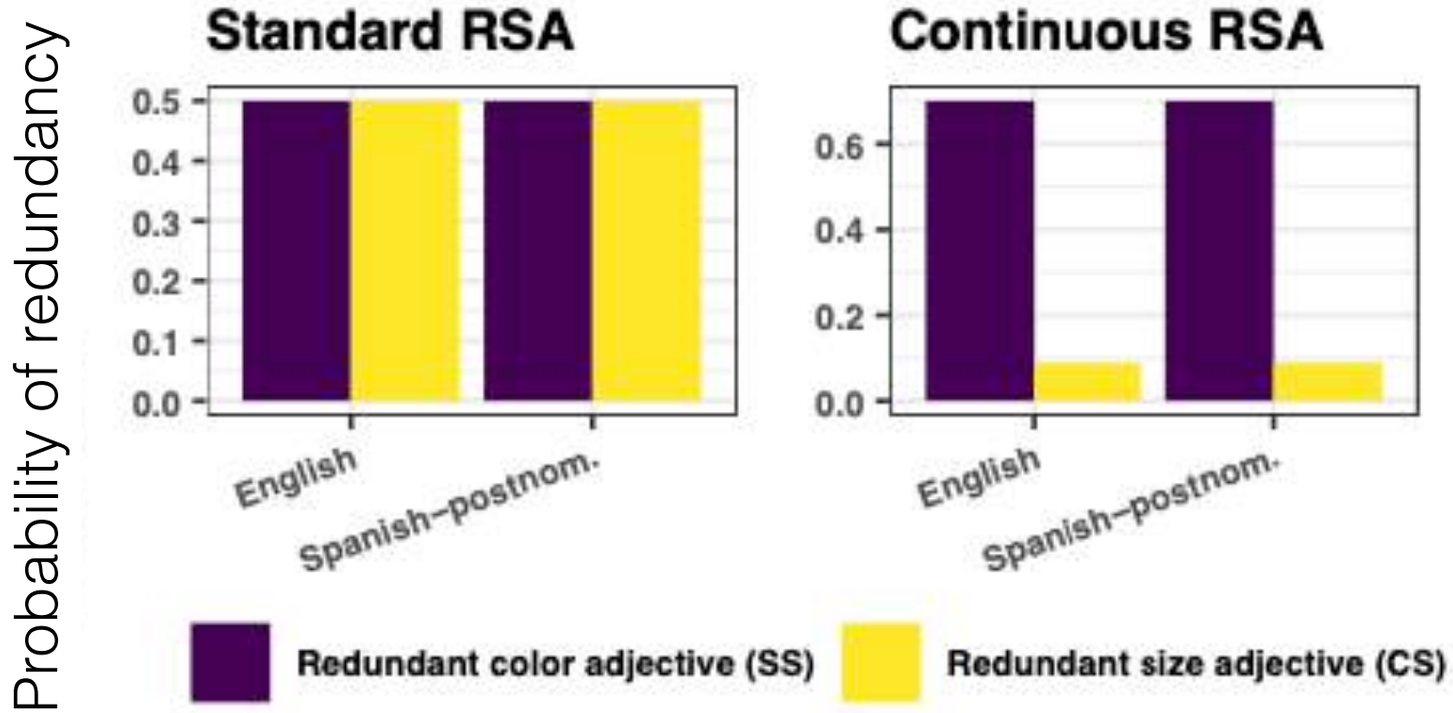
Less redundant color use in Spanish than in English.

Rubio-Fernández 2016; Rubio-Fernández et al 2020; Wu & Gibson 2020



Incremental Efficiency Hypothesis:
"*speakers aim to produce referential expressions that are* ***incrementally efficient*** *for listeners*" (RF et al., p. 3)

RSA model predictions



$x_{\text{size}} = .8$

$x_{\text{color}} = .99$

$\lambda = 15$

$C(\text{size}) = .1$

$C(\text{color}) = .1$

Utterances	$O_{\text{big\_blue}}$	$O_{\text{big\_red}}$	$O_{\text{small\_blue}}$
English	*blue pin, red pin, big pin, small pin, big blue pin, big red pin,* ***small blue pin***		
Spanish -postnom.	*pin blue, pin red, pin big, pin small, pin blue big, pin red big,* ***pin blue small***		

Problem for model: no difference in redundancy by language

Incremental RSA

Cohn-Gordon, Goodman, & Potts 2018, Waldon & Degen 2021

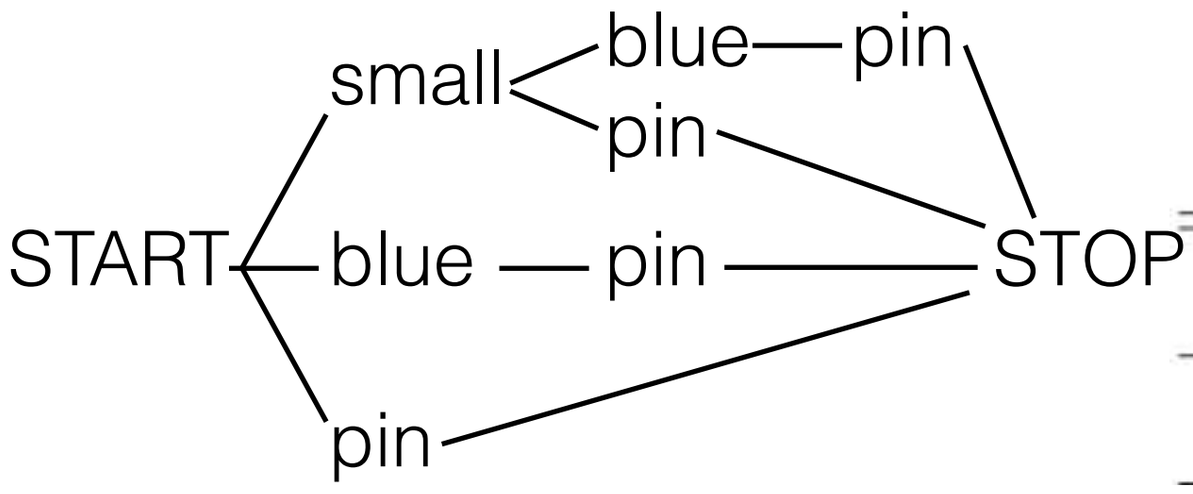
$$L_0^{INCR}(r|c,i) \propto \mathcal{X}^D(c,i,r) \cdot P(r)$$

$$\mathcal{X}^D(c,i,r) = \frac{|u{:}[[u]]^D(r){=}1 \wedge u \text{ is a continuation of } c{+}i|}{|u{:}u \text{ is a continuation of } c{+}i|}$$

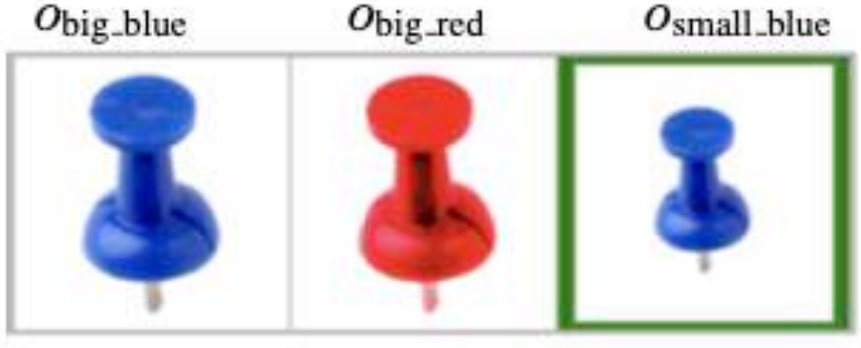
proportion of applicable continuations

$$S_1^{INCR}(i|c,r) \propto e^{\alpha(L_0^{INCR}(r|c,i)-C(i))}$$

$$S_1(u|r) = \prod_{j=1}^{n} S_1^{INCR}(i_j|c=[i_1 \ldots i_{j-1}],r)$$



Size-sufficient (SS) scene



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Incremental RSA

Cohn-Gordon, Goodman, & Potts 2018, Waldon & Degen 2021

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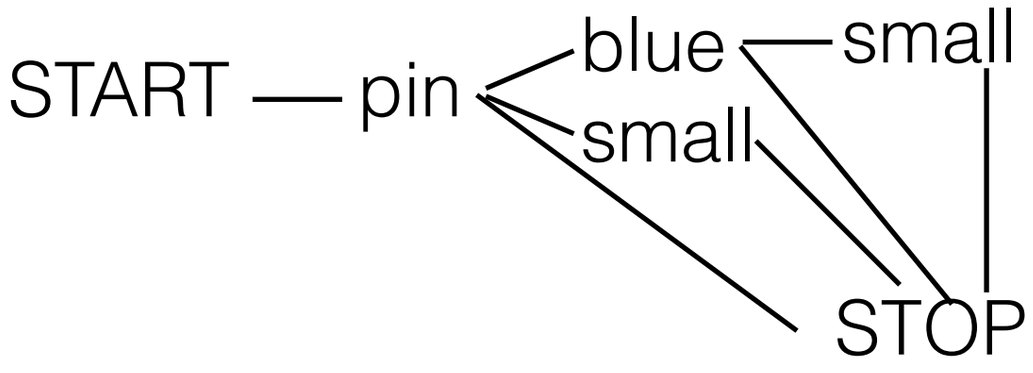

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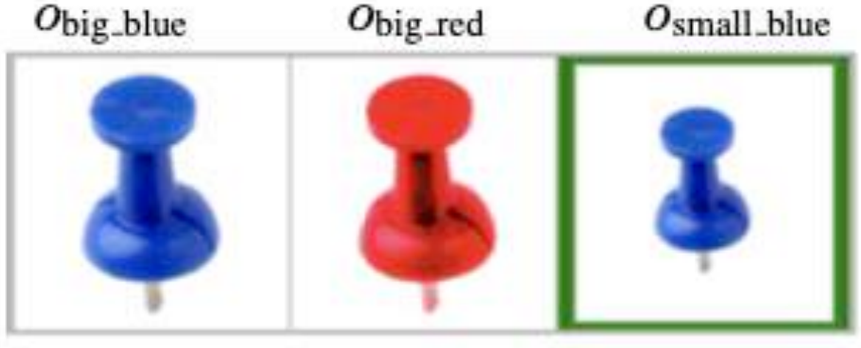

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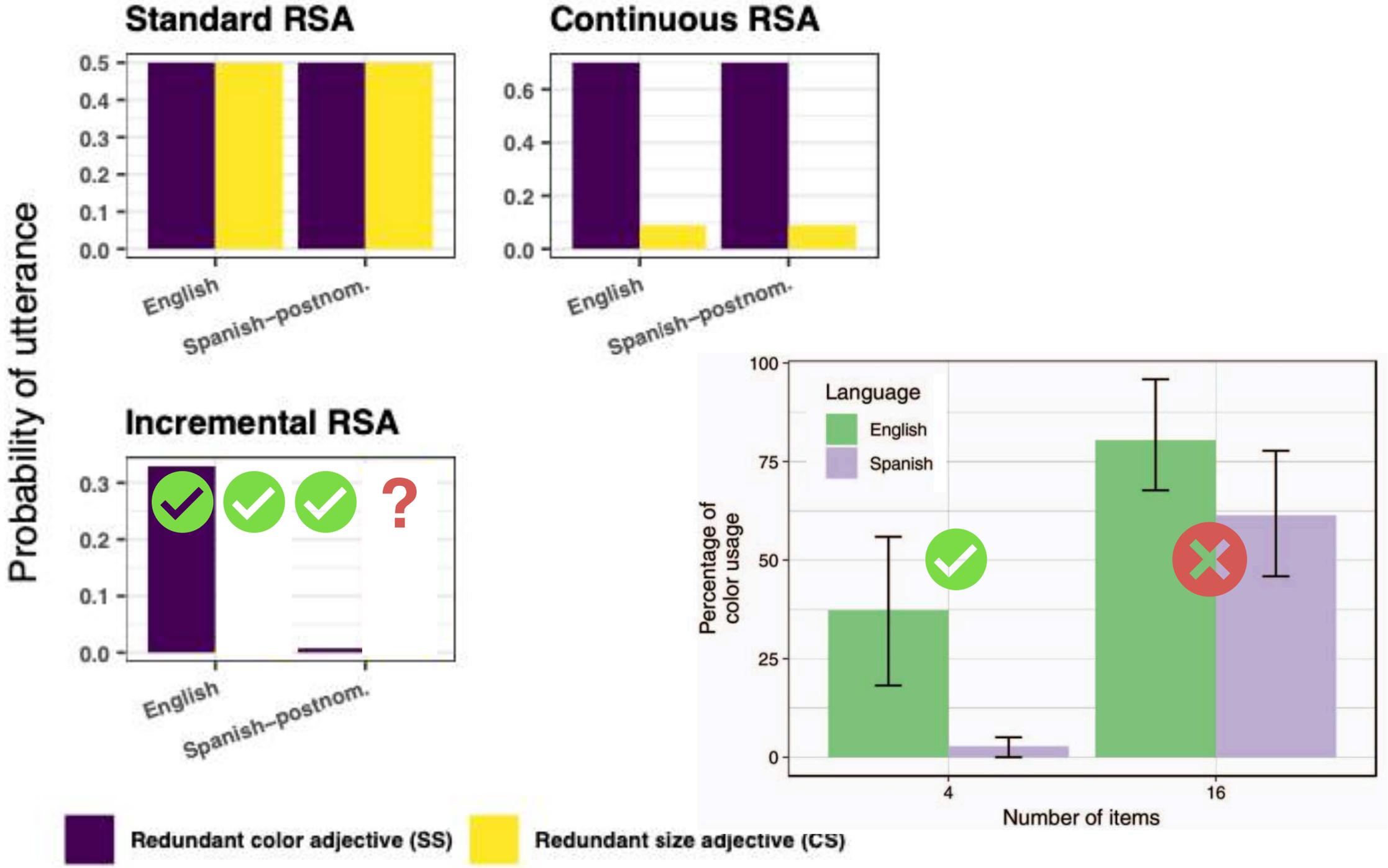
RSA model predictions

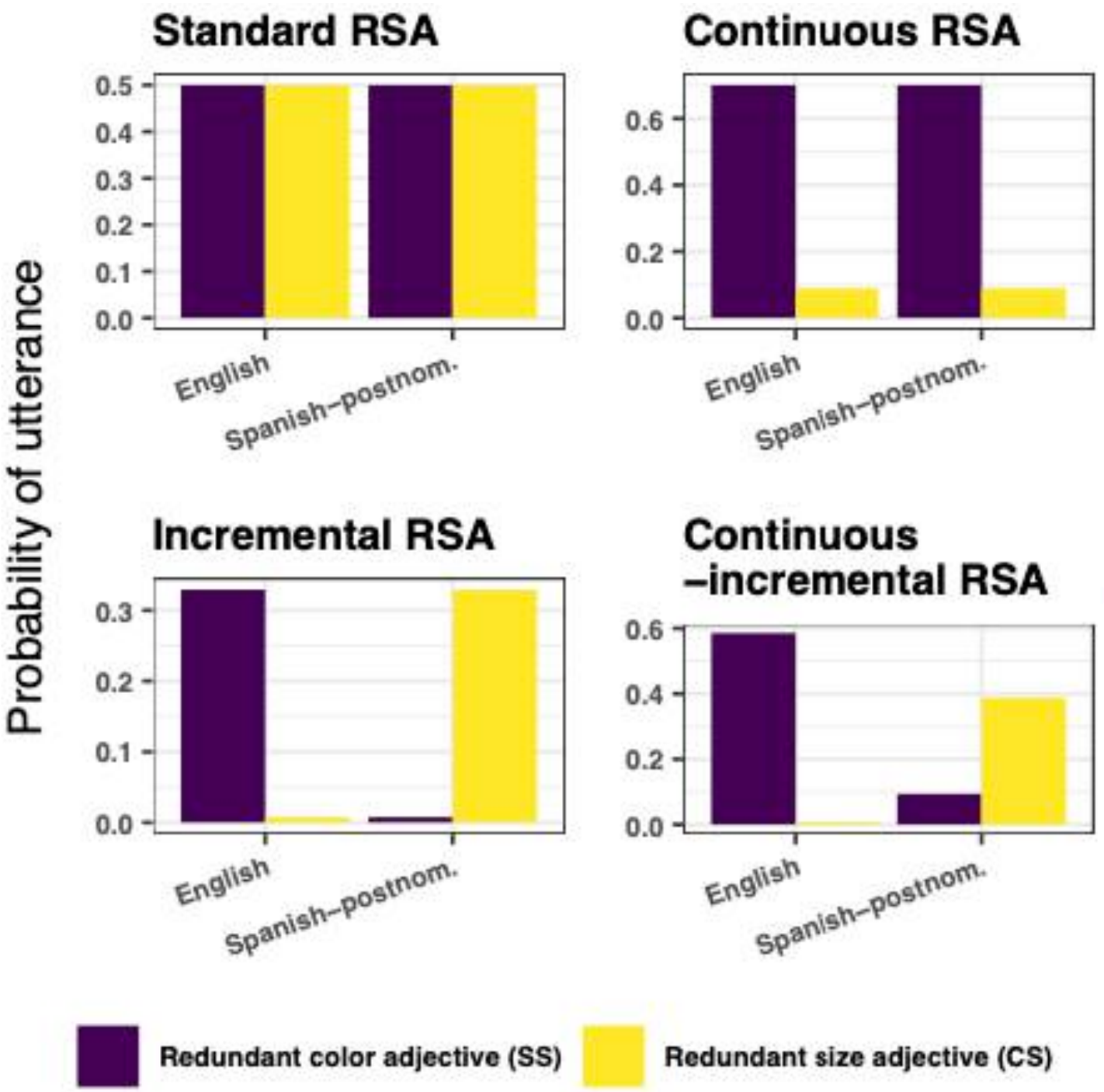


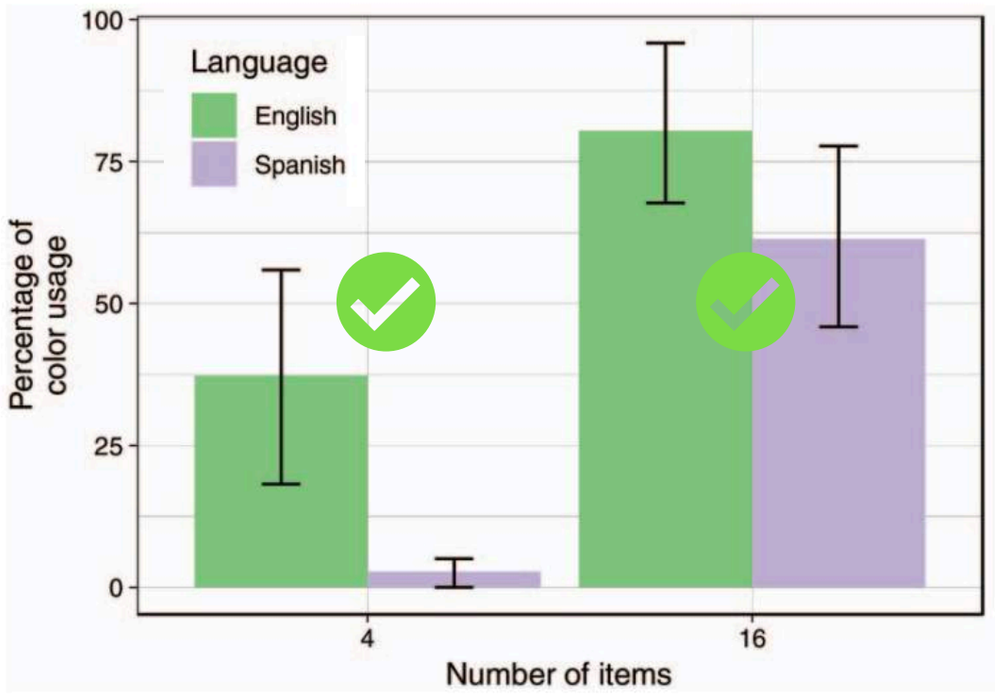
Continuous-Incremental RSA

Waldon & Degen 2021

$$\mathcal{X}^C(c,i,r) = \frac{\sum[[u]]^C(r) : u \text{ is a continuation of } c+i}{|u : u \text{ is a continuation of } c+i|}$$

sum of semantic values over number of continuations





Continuous-Incremental RSA

Combining incremental and continuous RSA

- provides some support for Rubio-Fernández's claim that modification is generally less useful post-nominally

- makes interesting novel prediction for flipped color/size overmodification asymmetry in post-nominal adjective languages

Much more empirical work needed!

Central Taurus Sign Language

36 deaf signers
~100 hearing Turkish speakers with some degree of fluency in CTSL

hereditary deafness

geographical isolation

no access to the official sign language

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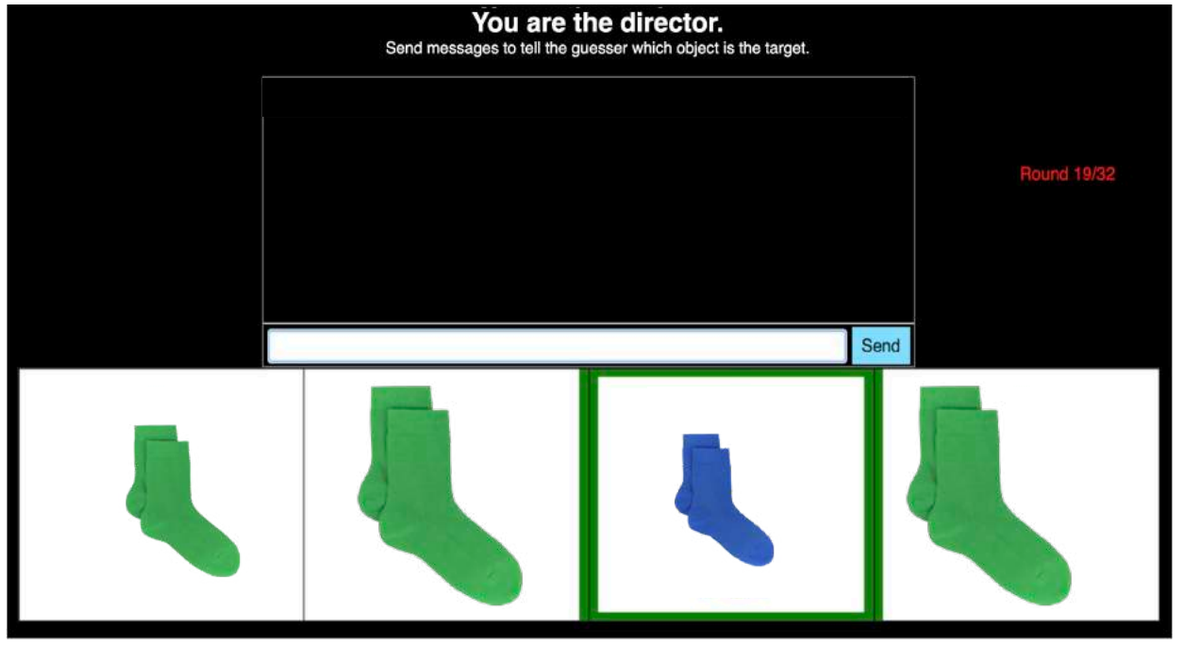
a new language: CTSL

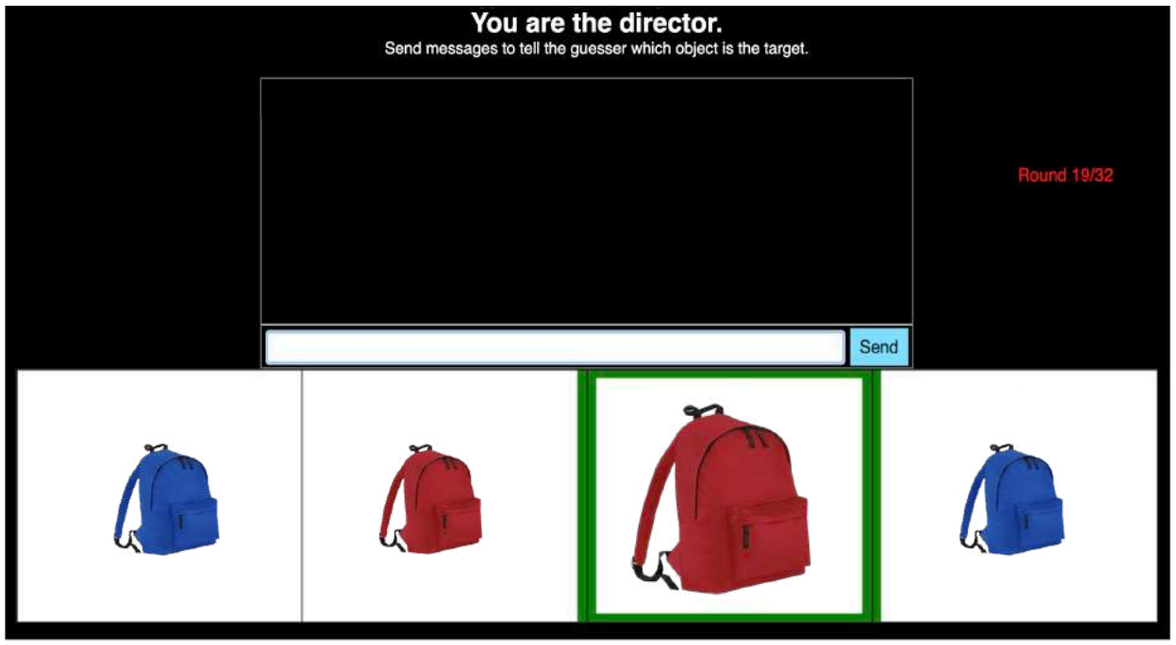
Ergin, 2017; Ergin & Brentari, 2017; Ergin, Meir, Ilkbasaran, Padden, & Jackendoff, 2018; Ergin, Senghas, Jackendoff, & Gleitman, 2018

Data collection



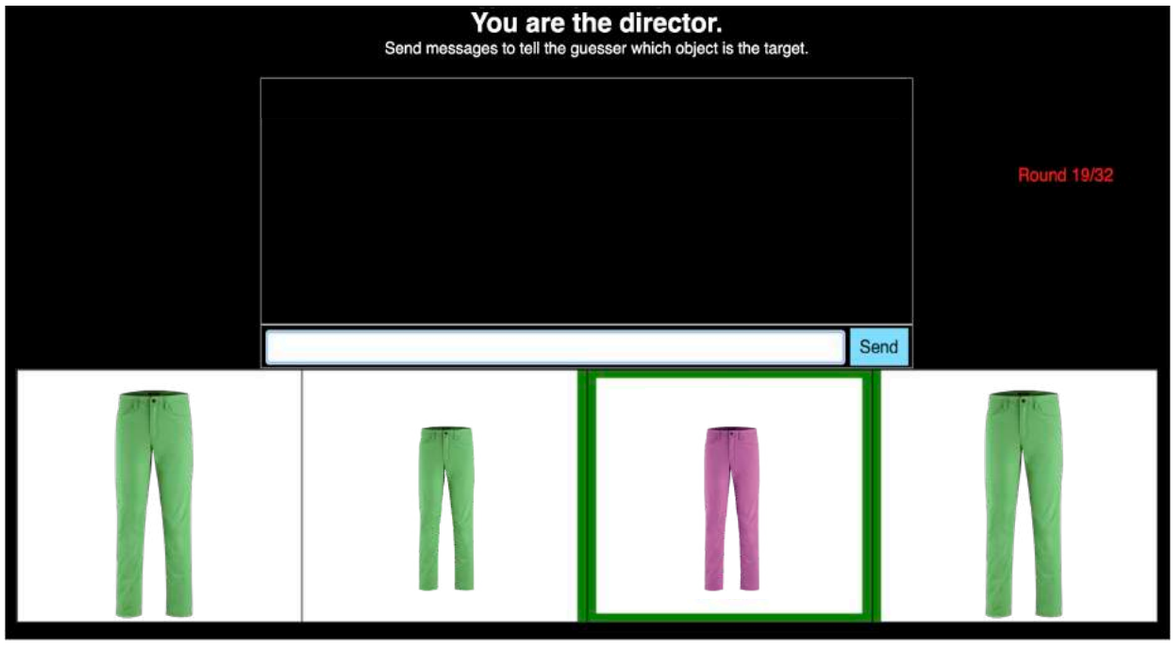
color sufficient

SOCKS + BLUE



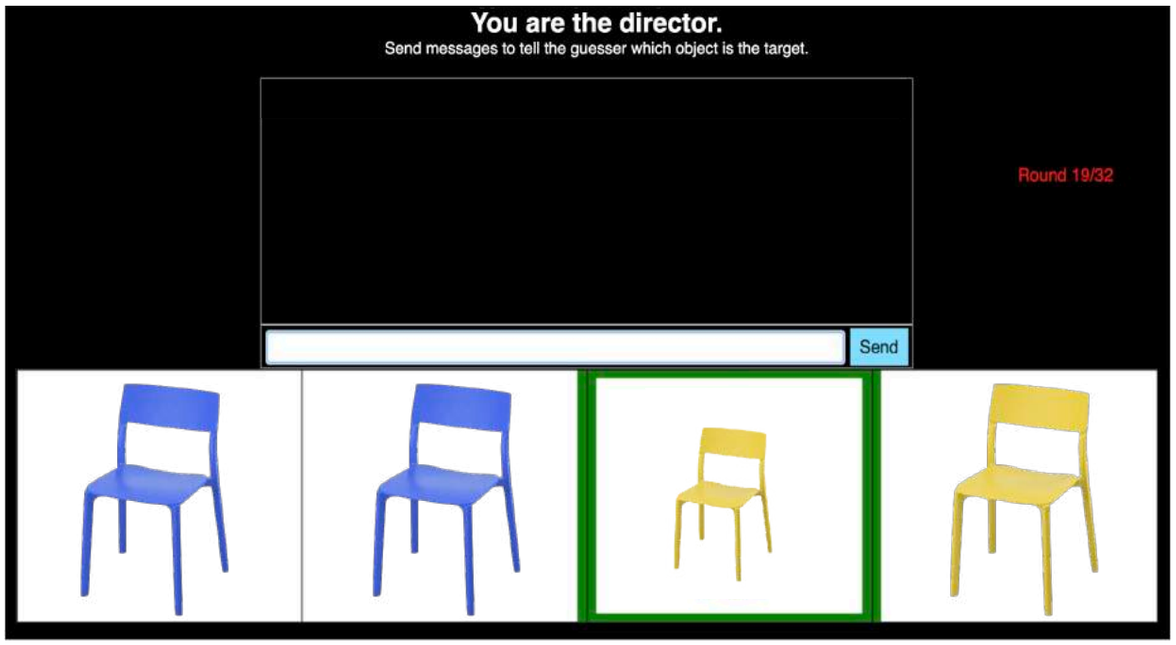
size sufficient

BAG + RED + BIG



color sufficient

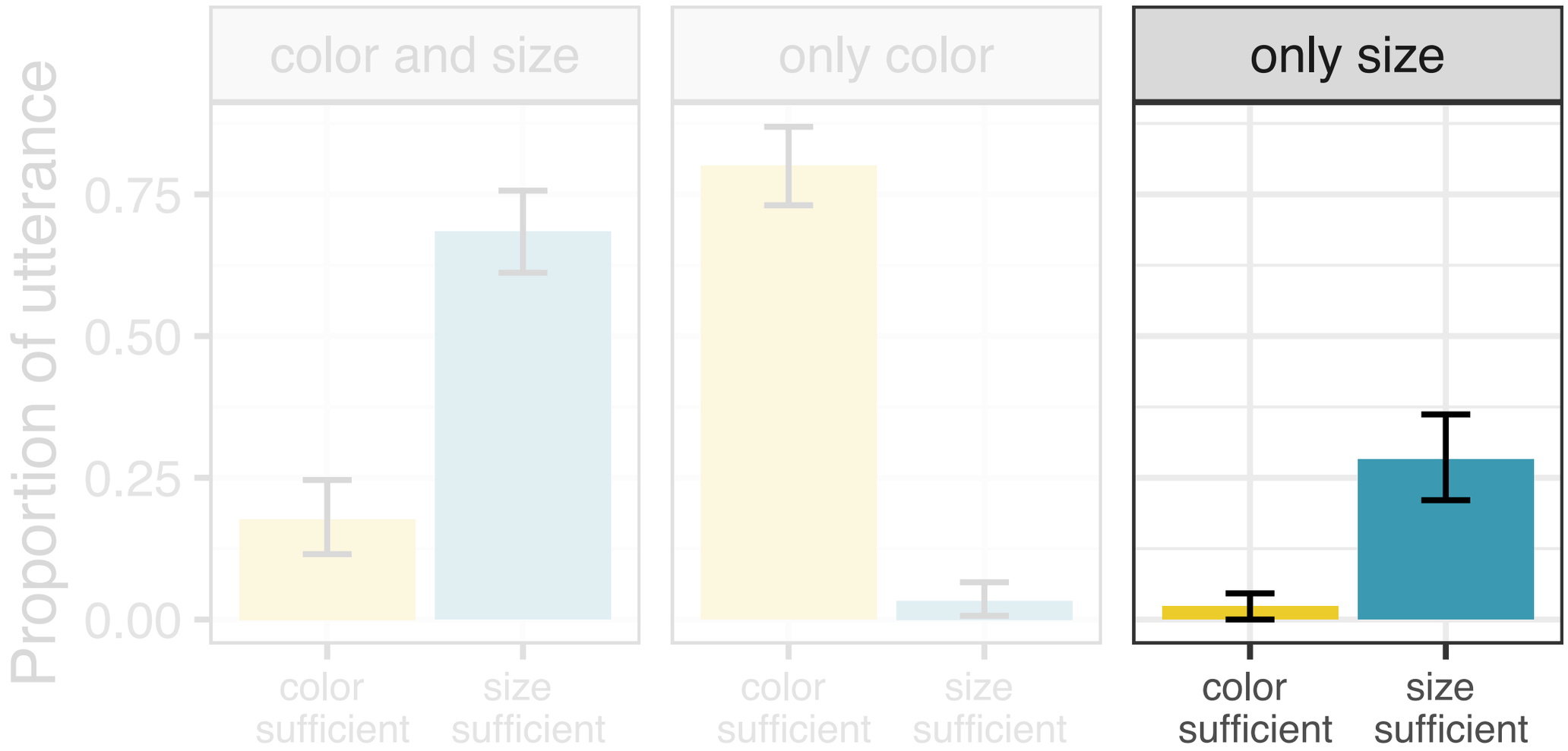
POINT(red) + PANTS



size sufficient

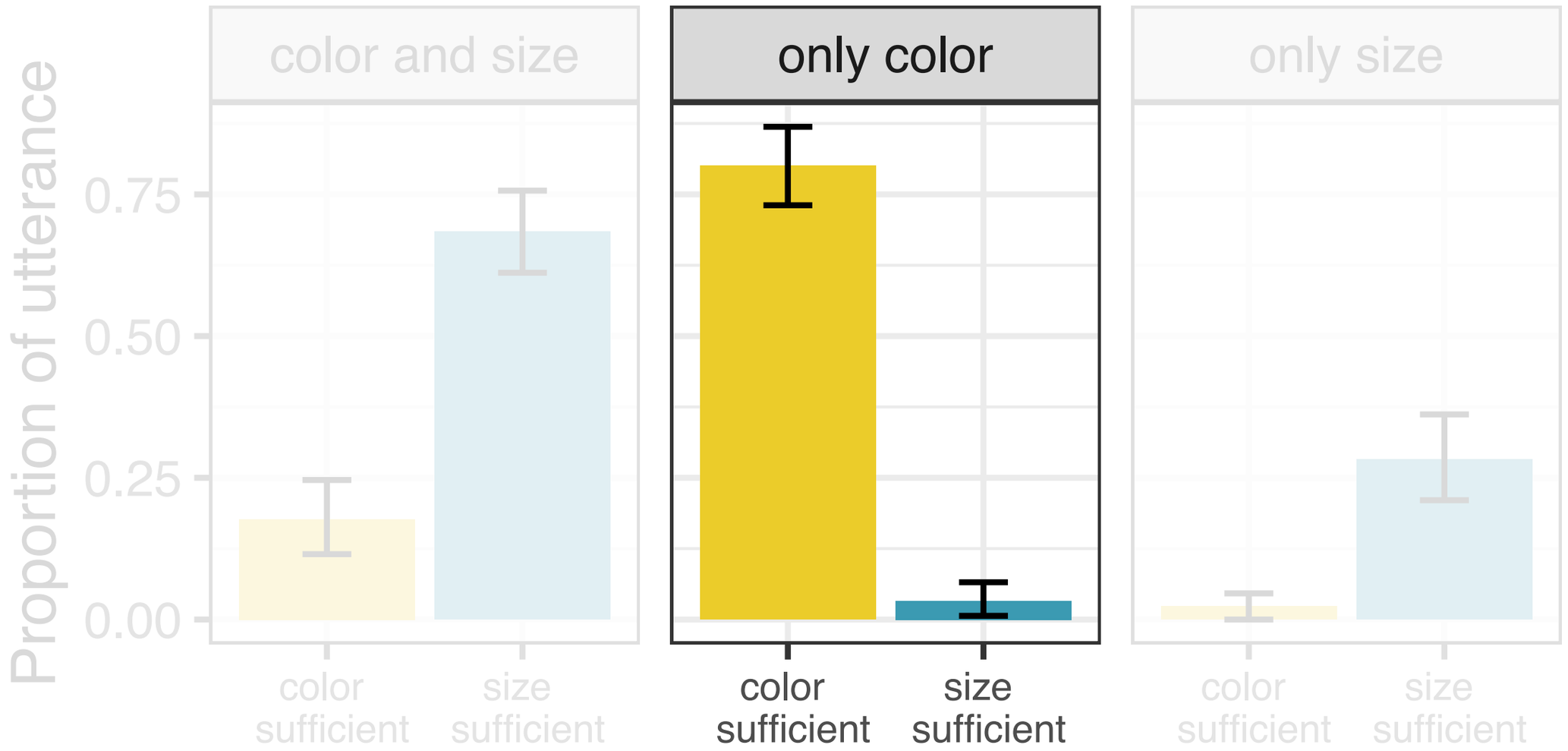
CHAIR + POINT(yellow) + CHAIR + SMALL

Redundant use of modifiers in CTSL



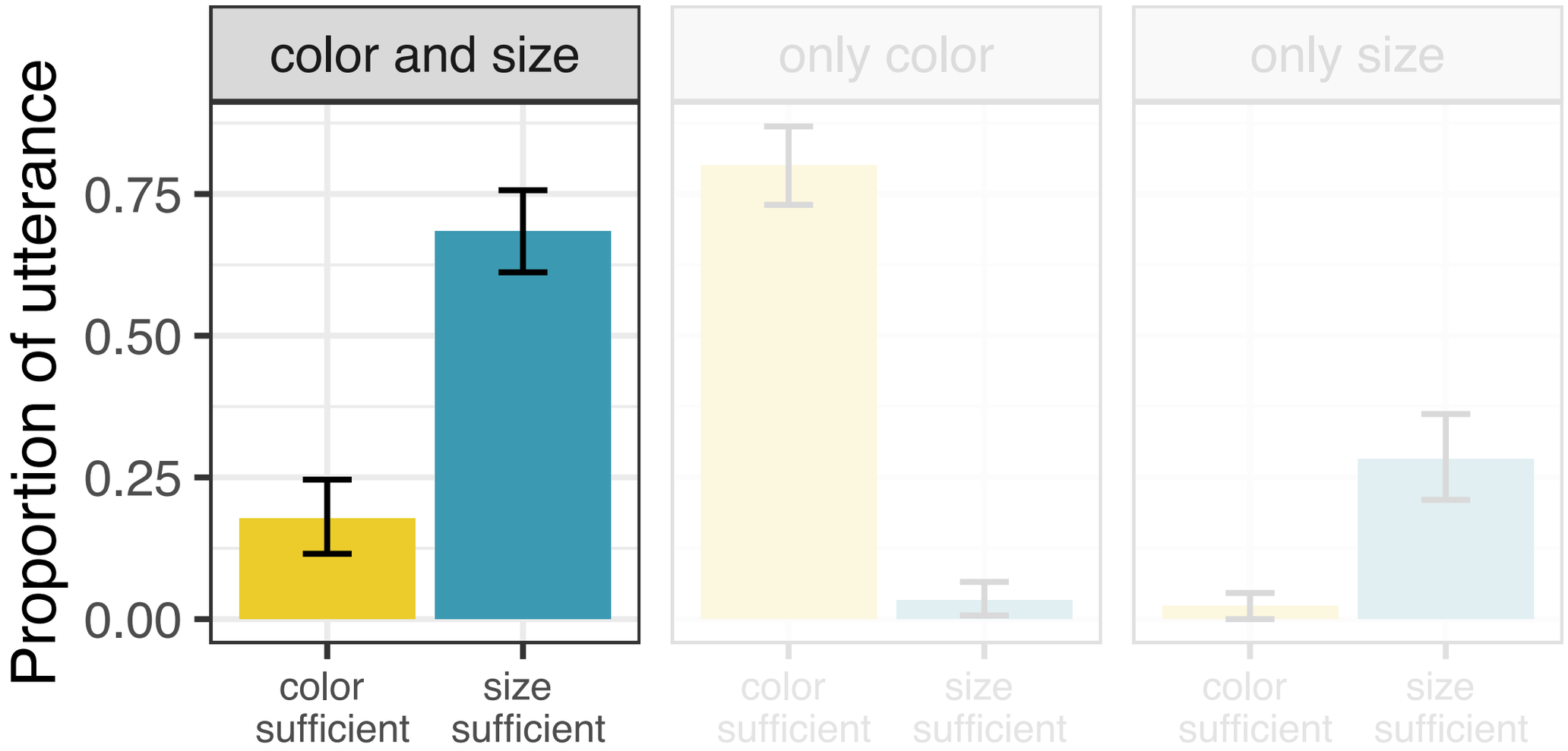
(n=11)

redundant use of modifiers in CTSL



(n=11)

Redundant use of modifiers in CTSL



(n=11)

Replication of English result:

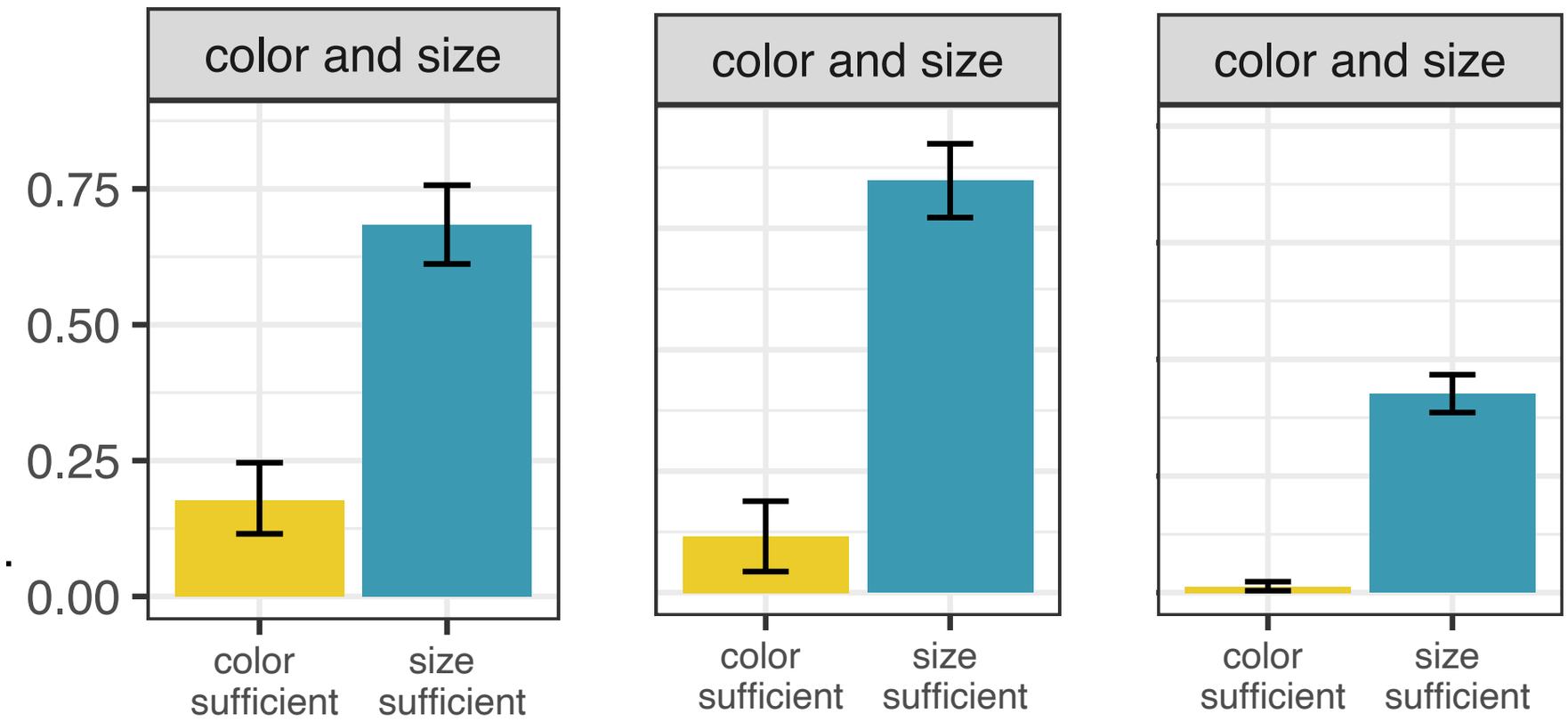
CTSL signers were more likely to redundantly mention color than size

Redundant use of modifiers in control groups

CTSL signers
(n=11)

Turkish speakers
in the village
(n=5)

English speakers
on MTurk
(n=50)

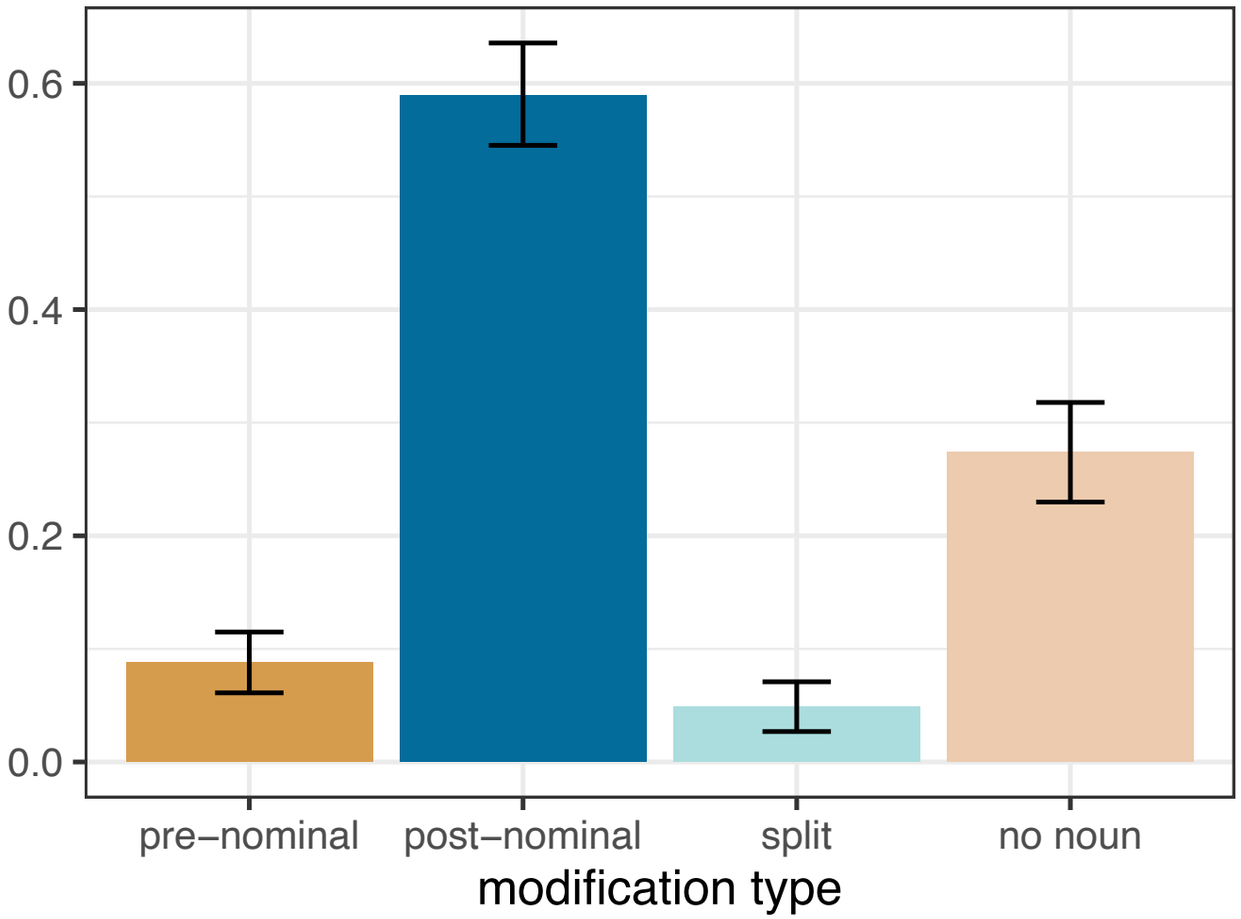


Coming soon..

Turkish
Arabic
Mandarin
Serbo-Croatian

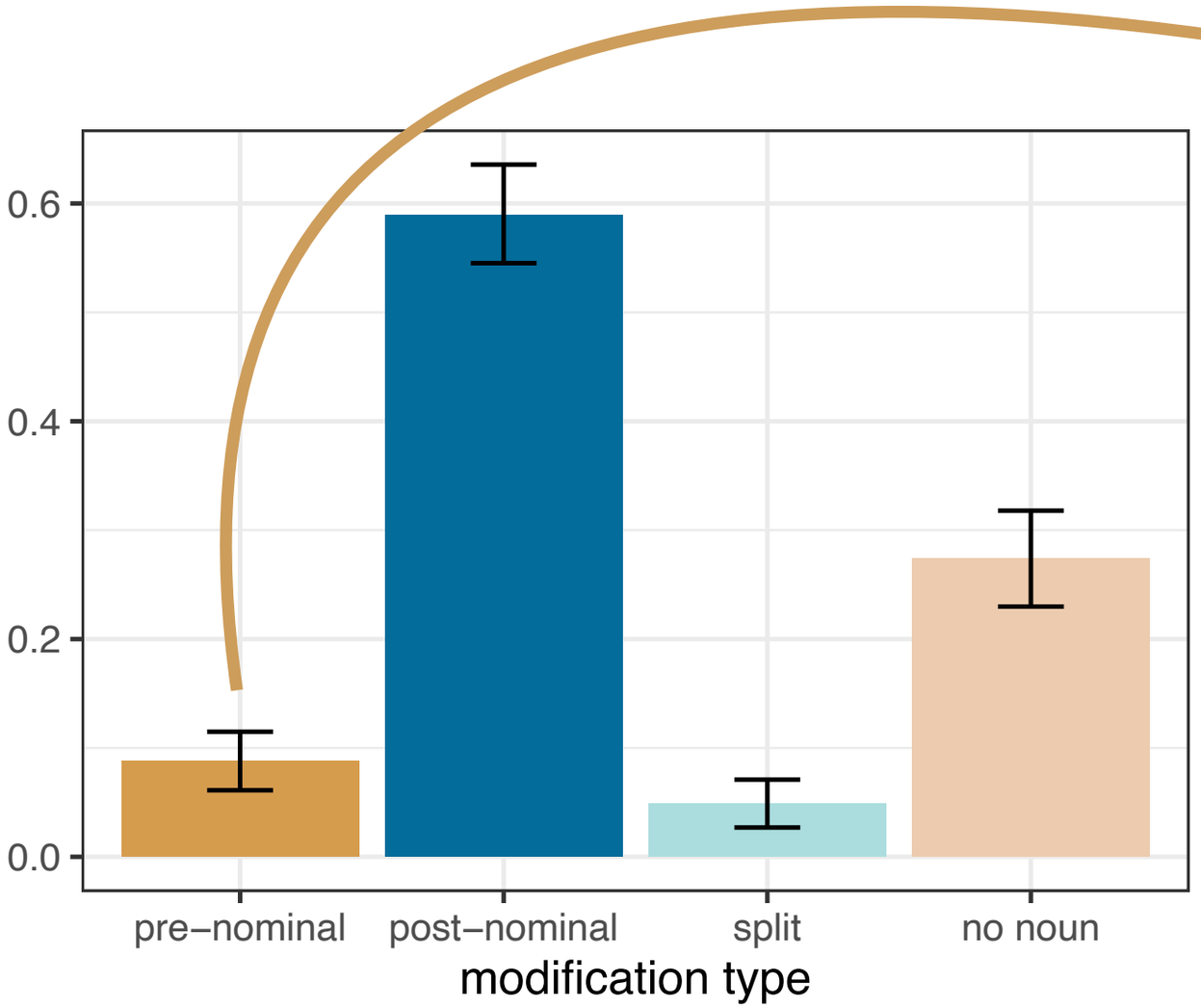
Redundant modification observed across all groups

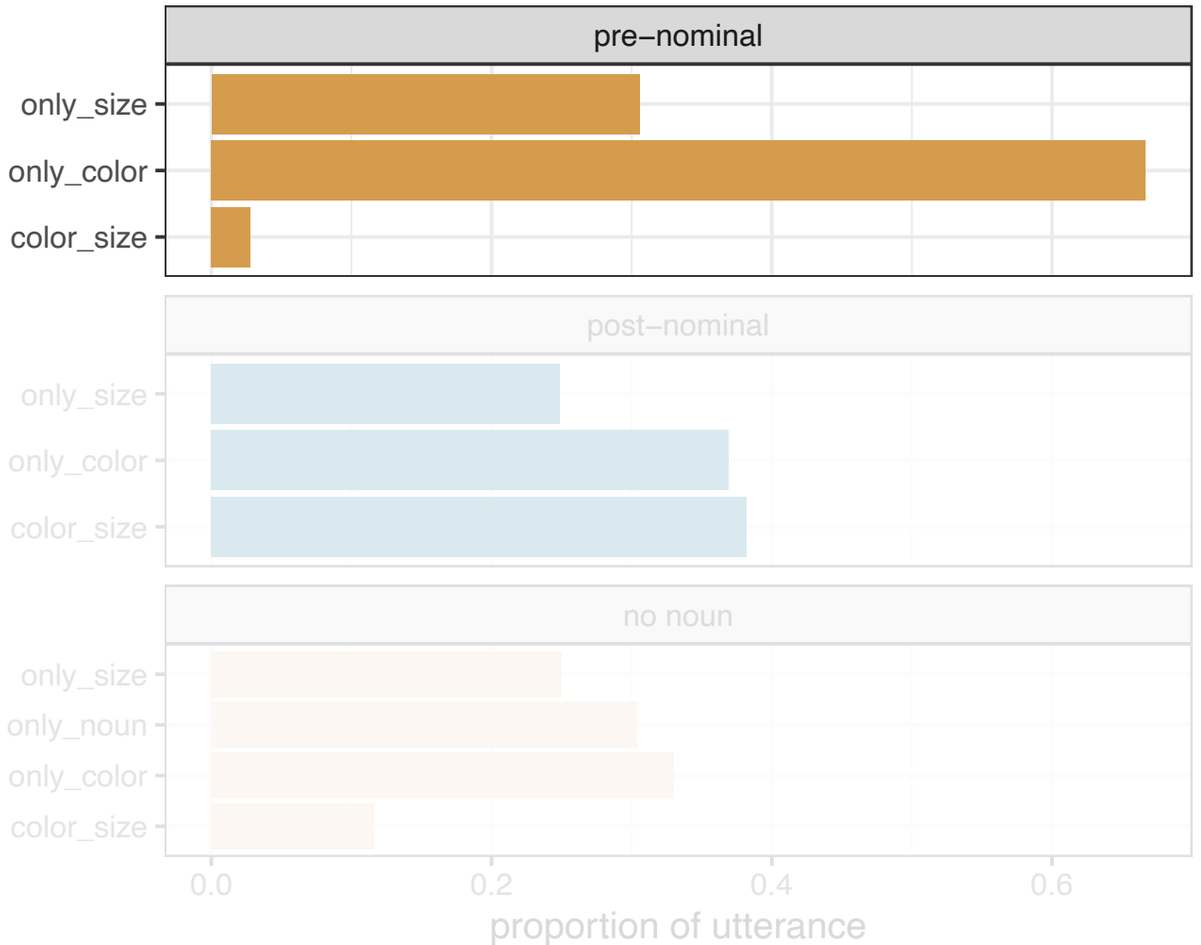
Modification order in CTSL



Modification was overwhelmingly post-nominal

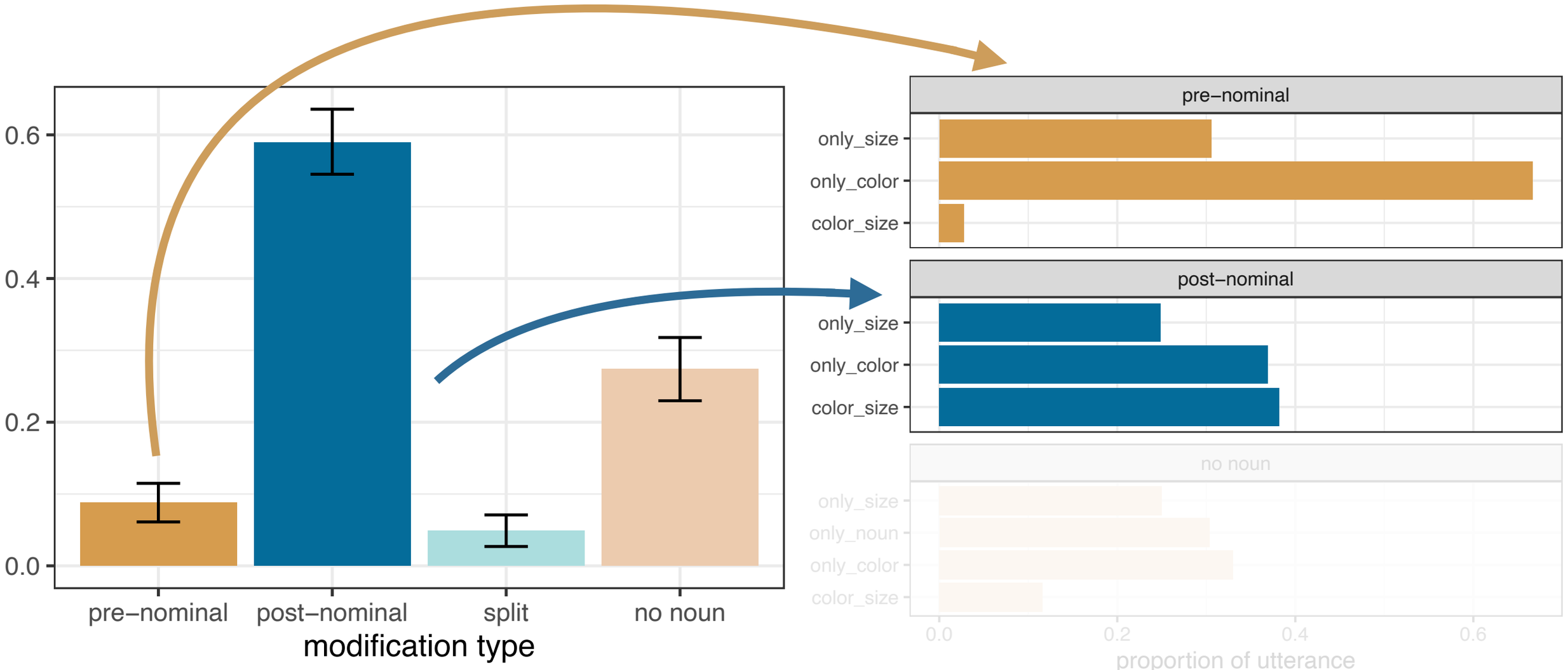
Modification order in CTSL





In pre-nominal position, redundant modifiers were rare

modification order in CTSL



In post-nominal position, redundant modifiers were common

Conclusion

Redundant modification…

…can be useful when modifiers are noisy, as captured by cs-RSA;

…is to some extent modulated by incremental pressures.

Much more cross-linguistic empirical work is required to inform a systematic model comparison.

Thank you!