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
75-80%

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

color sufficient

the big green lightbulb
8-10%

Redundant referring expressions — color/size asymmetry

- size sufficient
  - the big lightbulb
  - 75-80%
- color sufficient
  - the big green lightbulb
  - 8-10%

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

Outline

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

- **Incremental Algorithm**
  Dale & Reiter 1995

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

- **Rational Speech Act (RSA)**
  Frank & Goodman 2012

Informativeness
Preferences
Probabilities
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

\[ O = \{ \text{big, small, green, black} \} \]
\[ U = \{ \text{big green, small green, small black} \} \]

**Literal listener**

\[ P_{L_0}(o|u) = U(o|\{u \text{ is true of } o\}) \]
\[ [[u]] : O \rightarrow \{ \text{true, false} \} \]

**Pragmatic speaker**

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

obvious problem: no complex utterances
Utterance semantics & cost

**Intersective semantics**

\[ [[u]] = [[u_1]] \land [[u_2]] \]
\[ [[\text{big green}]] = [[\text{big}]] \land [[\text{green}]] \]

**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

![Graph showing probability distribution for big, big green, and green objects, with \( C(\text{big}) < C(\text{big green}) \).]
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

**Literal listener**

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

**Pragmatic speaker**

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

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

greater proportion = more variation

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

- Prior on parameters
- Observed data → Bayes’ rule → Posterior on parameters → Posterior predictive
Results

The figure shows the probability of redundancy as a function of scene variation for color and size redundant conditions. The data points are color-coded by number of distractors (2, 3, 4) and are compared to empirical and model predictions. The graphs illustrate how the probability of redundancy changes with scene variation, highlighting the impact of distractors on perceived redundancy.
Model fit

\[ R^2 = .73 \]
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 (e.g., 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
PART II

Redundant modification cross-linguistically

Waldon & Degen 2021; Kursat, Ergin, & Degen in prep
Cross-linguistic variability in redundant modification

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

Problem for model: no difference in redundancy by language

\[ x_{\text{size}} = .8 \]
\[ x_{\text{color}} = .99 \]
\[ \lambda = 15 \]
\[ C(\text{size}) = .1 \]
\[ C(\text{color}) = .1 \]
Incremental RSA
Cohn-Gordon, Goodman, & Potts 2018, Waldon & Degen 2021

\[ L_{0}^{\text{INCR}}(r|c,i) \propto \mathcal{X}^{D}(c,i,r) \cdot P(r) \]

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

\[ S_{1}^{\text{INCR}}(i|c,r) \propto e^{\alpha(L_{0}^{\text{INCR}}(r|c,i)-C(i))} \]

\[ S_{1}(u|r) = \prod_{j=1}^{n} S_{1}^{\text{INCR}}(i_{j}|c = [i_{1}...i_{j-1}], r) \]

**Size-sufficient (SS) scene**

<table>
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<tr>
<th>Obig_blue</th>
<th>Obig_red</th>
<th>Os_small_blue</th>
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**Utterances**

- English
- Spanish postnom.
Incremental RSA
Cohn-Gordon, Goodman, & Potts 2018, Waldon & Degen 2021

\[ L^{INCR}_0(r|c,i) \propto \mathcal{X}^D(c,i,r) \cdot P(r) \]

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**Utterances**

- **English**
  - blue pin, red pin, big pin, small pin, big blue pin, big red pin, small blue pin
- **Spanish**
  - pin blue, pin red, pin big, pin small, pin blue big, pin red big, pin blue small
RSA model predictions

- **Standard RSA**
  - English
  - Spanish-postnom.

- **Continuous RSA**
  - English
  - Spanish-postnom.

- **Incremental RSA**
  - English
  - Spanish-postnom.

- **Percentage of color usage**
  - Language: English, Spanish
  - Number of items: 4, 16
Continuous-Incremental RSA

Waldon & Degen 2021

\[
\chi^C(c, i, r) = \sum_{u \mid u \text{ is a continuation of } c+i} \frac{[u]^C(r)}{[u : u \text{ is a continuation of } c+i]}
\]

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
gеographical isolation
no access to the official sign language

a new language: CTSL

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

- experimenter 1
- experimenter 2
- director
- guesser
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

Proportion of utterance

<table>
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<th>Size sufficient</th>
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<tr>
<td><strong>Color and Size</strong></td>
<td><img src="chart1" alt="Chart" /></td>
<td><img src="chart2" alt="Chart" /></td>
<td><img src="chart3" alt="Chart" /></td>
<td><img src="chart4" alt="Chart" /></td>
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<tr>
<td><strong>Only Color</strong></td>
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(n=11)
redundant use of modifiers in CTSL

Proportion of utterance

color and size

only color

only size

(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)
- Color and size
  - Color sufficient
  - Size sufficient

Turkish speakers in the village (n=5)
- Color and size
  - Color sufficient
  - Size sufficient

English speakers on MTurk (n=50)
- Color and size
  - Color sufficient
  - Size sufficient

Coming soon..
- Turkish
- Arabic
- Mandarin
- Serbo-Croatian

Redundant modification observed across all groups
Modification was overwhelmingly post-nominal
In pre-nominal position, redundant modifiers were rare.
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!