

Ling 151/Psych 156A:
Acquisition of Language II

Lecture 17
Pragmatics (Sentence-Level)

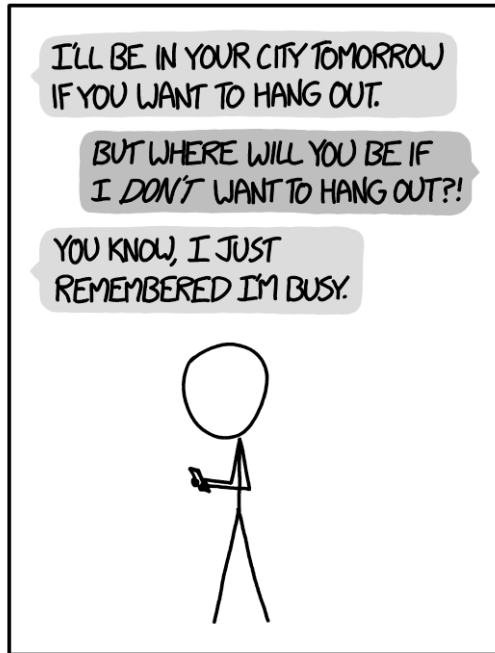
Announcements

Be working on syntax & sentences review questions

Be working on HW6 (due 2/26/18)

Pragmatics: How people use language

CONDITIONALS



WHY I TRY NOT TO BE
PEDANTIC ABOUT CONDITIONALS.

<https://xkcd.com/1652/>

“I’ll be in your city tomorrow if you want to hang out.”

pragmatic interpretation

= If you want to hang out, I can hang out with you tomorrow because I’ll be in your city.

literal interpretation

≠ If you want to hang out, I’ll be in your city. (If not, who knows where I’ll be?)

Pragmatics: How people use language



<http://languagelog.ldc.upenn.edu/nll/?p=3259>

Figuring out how people use language

Acquisition task:

Identify what a speaker means by an ambiguous utterance.

“Every kitty didn’t jump on the bed.”



*But there are some kitties on the bed — so this can’t mean
“No kitties jumped the bed”. It must mean “Not all kitties jumped the bed.”*

Pragmatics: How to use language

[Reminder]

<http://www.thelingspace.com/episode-2>

<https://www.youtube.com/watch?v=rzxyjFHH-y8>

intro through 1:01



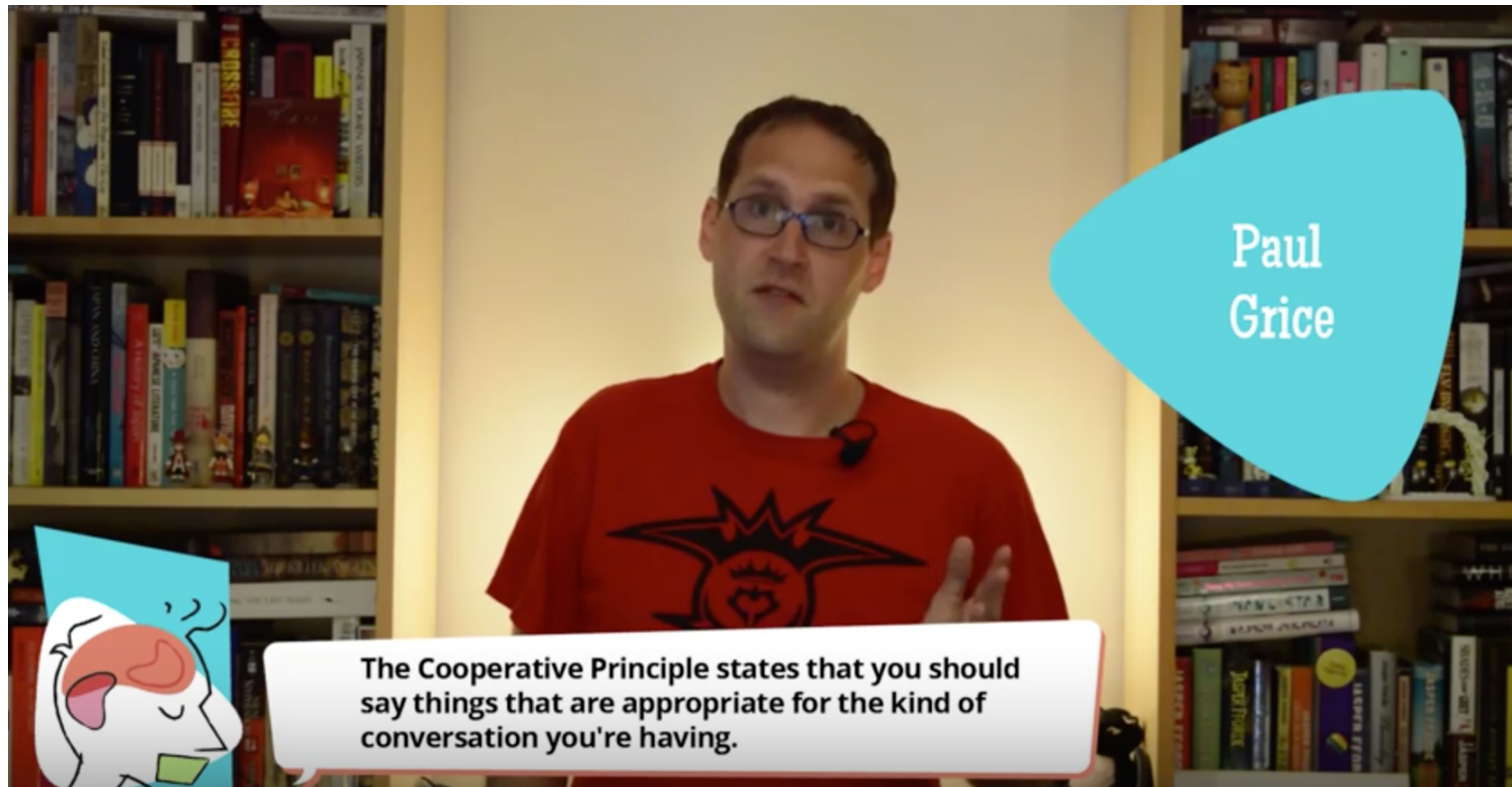
Cooperative Principle

[Reminder]

<http://www.thelingspace.com/episode-2>

<https://www.youtube.com/watch?v=rzxyjFHH-y8>

intro through 1:01-1:52



Paul
Grice

The Cooperative Principle states that you should say things that are appropriate for the kind of conversation you're having.

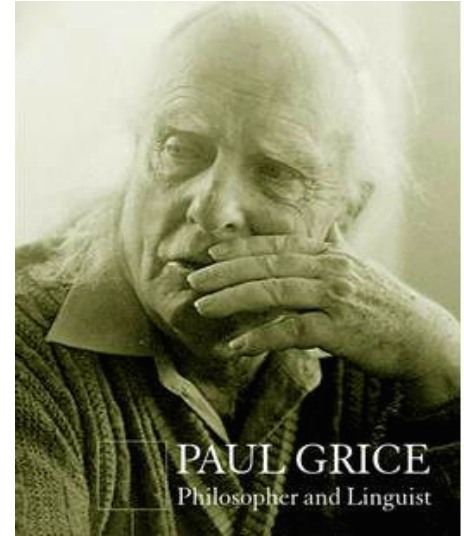
Cooperative Principle

Paul Grice:

Core assumption listeners have is that communication is a **purposeful** and **cooperative** activity.

(1) The speaker is trying to get the hearer **to understand a particular message**.

(2) The **hearer is trying to understand the speaker's message**, assuming it's cooperative and purposeful.



Maxims of cooperative conversation

[Reminder]

<http://www.thelingspace.com/episode-2>

<https://www.youtube.com/watch?v=rzxyjFHH-y8>

intro through 1:53-2:08



Maxim of Quality

<http://www.thelingspace.com/episode-2>

<https://www.youtube.com/watch?v=rzxyjFHH-y8>

intro through 2:08-2:34



Maxim of Quality

Quality: Speakers will be **truthful** (given their own current knowledge).

Note: When a speaker says something blatantly false, hearers assume non-literal meaning (ex: sarcasm, metaphor, hyperbole)

Sarcasm:

“It’s just delightful out, isn’t it?” when said during awful weather. Interpreted as meaning the weather is the opposite of delightful and the speaker is communicating chagrine/irony.



Maxim of Quality

Quality: Speakers will be **truthful** (given their own current knowledge).

Note: When a speaker says something blatantly false, hearers assume non-literal meaning (ex: sarcasm, metaphor, hyperbole)

Metaphor:

“She’s a beast at problem solving.”
interpreted as she’s really excellent at problem solving (because she’s not actually a beast).



Maxim of Quality

Quality: Speakers will be **truthful** (given their own current knowledge).

Note: When a speaker says something blatantly false, hearers assume non-literal meaning (ex: sarcasm, metaphor, hyperbole)

Hyperbole:

“That soda costs a million dollars!”
interpreted as the soda is more expensive than normal. Emerges when speakers realize one communicative intention is speaker attitude (Kao et al. 2014)



“Every kitty didn’t jump on the bed”



**Pragmatics in sentences:
Ambiguity resolution in context**

Pragmatics in sentences: Ambiguity resolution in context

“Every kitty didn’t jump on the bed”

✗ No kitties jumped on the bed.

✓ Not all kitties jumped on the bed.



Why are two interpretations available?

Quantifier scope

Pragmatics in sentences: Ambiguity resolution in context

Quantifier scope

“**Every** kitty didn’t jump on the bed”



X No kitties jumped on the bed.

✓ Not all kitties jumped on the bed.



Pragmatics in sentences: Ambiguity resolution in context

Quantifier scope

“Every kitty didn’t jump on the bed”

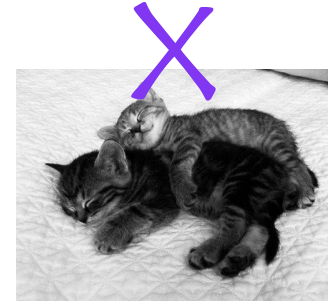


surface \forall kitties k \neg k jumped on the bed

“For all kitties k , it’s not true that k jumped on the bed”

No kitties jumped on the bed.

✓ Not all kitties jumped on the bed.



Pragmatics in sentences:

Ambiguity resolution in context

Quantifier scope

“**Every** kitty didn’t jump on the bed”



surface ∇ kitties k \neg k jumped on the bed

“For all kitties k , it’s not true that k jumped on the bed”

~~X~~ No kitties jumped on the bed.

inverse \neg ∇ kitties k , k jumped on the bed

“It’s not true that for all kitties k , k jumped on the bed”

Not all kitties jumped on the bed.



Quantifiers & Scope

[Reference]

<http://www.thelingspace.com/episode-8>

<https://www.youtube.com/watch?v=XC-MGuj75zQ>

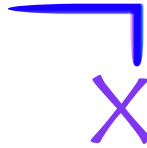
0:39 - 5:24



Pragmatics in sentences: Ambiguity resolution in context

Quantifier scope

✓ “Every kitty didn’t jump on the bed”



surface



No kitties jumped on the bed.

inverse



Not all kitties jumped on the bed.



Adults



Pragmatics in sentences: Ambiguity resolution in context

Quantifier scope

“Every kitty didn’t jump on the bed”



surface



No kitties jumped on the bed.

inverse



Not all kitties jumped on the bed.



What about kids?



Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006

Oh look! Three kitties. They tried to jump on the table, but couldn't. (It was too tall.)



early failure



Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006

Then, they tried to jump on the bed. Look —
two of them made it!

early failure



Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006

early failure

“**Every** kitty didn’t jump on the bed”



Do you think this is an okay thing to say?



4- and 5-year-olds

“Yes”: 15%

“No”: 85%

Baseline preference: Don’t endorse utterance

Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006

✗ Baseline: 15% endorsement early failure

“Every kitty didn’t jump on the bed”



Do you think this is an okay thing to say?



Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006

Oh look! Three kitties. They tried to jump on the table, and they all made it!

✗ Baseline: 15% endorsement

“Every kitty didn’t jump on the bed”



Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006

Oh look! Three kitties. They tried to jump on the table, and they all made it!



early success

✗ Baseline: 15% endorsement

“Every kitty didn’t jump on the bed”



Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006

Then, they tried to jump on the bed. Look —
two of them made it!

early success

✗ **Baseline: 15% endorsement**

“**Every** kitty didn’t jump on the bed”



Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006

✗ **Baseline: 15% endorsement**

“Every kitty jumped on the table,
but **every** kitty didn’t jump on the bed.”



early success



Do you think this is an okay thing to say?



4- and 5-year-olds

“Yes”: 60%

“No”: 40%

With early success: Endorse more

Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006

✓? Early success: 60% endorsement

✗ Baseline: 15% endorsement

“Every kitty didn’t jump on the bed.”



early success



Do you think this is an okay thing to say?



4- and 5-year-olds

“Yes”: 60%

“No”: 40%

Viau et al. 2010: Also the case
even if the explicit linguistic
contrast isn’t present

Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006, Viau et al. 2010

✓? Early success: 60% endorsement

✗ Baseline: 15% endorsement

“Every kitty didn’t jump on the bed.”



Why does this increase
children’s endorsement rate?

early success

Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006, Viau et al. 2010

✓? Early success: 60% endorsement

✗ Baseline: 15% endorsement

“Every kitty didn’t jump on the bed.”



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early success

One idea: It changes children’s expectations about **the world** of the experiment.

Kitties are really good at jumping, so it’s **informative** to mention that not all of them succeeded at jumping on the bed.

Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006, Viau et al. 2010

✓? Early success: 60% endorsement

✗ Baseline: 15% endorsement

“Every kitty didn’t jump on the bed.”



Savinelli, Scontras, & Pearl 2017

early success

One idea: It changes children’s expectations about **the world** of the experiment.

If kitties were bad at jumping (early failure), it’s not **informative** to mention that not all of them succeeded at jumping on the bed. You wouldn’t expect them to.

Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006, Viau et al. 2010

✓? Early success: 60% endorsement

✗ Baseline: 15% endorsement

“Every kitty didn’t jump on the bed.”



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early success

Another idea: It also changes children’s expectations about **the implicit topic of conversation**, known as the “Question Under Discussion” (QUD).

Kitties are really good at jumping, so the conversation is about whether all the kitties succeeded. This makes the interpretation that not all of them succeeded **informative**.

Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006, Viau et al. 2010

✓? Early success: 60% endorsement

✗ Baseline: 15% endorsement

“Every kitty didn’t jump on the bed.”



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early success

Another idea: It also changes children’s expectations about **the implicit topic of conversation**, known as the “Question Under Discussion” (QUD).

If kitties were bad at jumping (early failure), the conversation is more likely to be about whether none of the kitties succeeded. This makes the interpretation that not all of them succeeded **not informative**.

Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006, Viau et al. 2010

✓? Early success: 60% endorsement

✗ Baseline: 15% endorsement

“Every kitty didn’t jump on the bed.”



Viau et al. 2010

A third idea: The problem is more about children’s access to the inverse scope interpretation (not all).

Because the inverse scope interpretation is **harder to grammatically derive**, kids have trouble accessing it no matter what else is going on.



Kids have trouble fixing wrong interpretations

https://www.youtube.com/watch?v=E5Pp_wE14HU&feature=youtu.be

7:53-8:50



Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006, Viau et al. 2010

✓? **Early success: 60% endorsement**

✗ **Baseline: 15% endorsement**

“**Every** kitty didn’t jump on the bed.”



Viau et al. 2010

A third idea: The problem is more about children’s access to the inverse scope interpretation (not all).

3 trials

early success

50% endorsement

then 3 trials

early failure

80% endorsement!

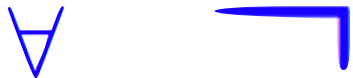
Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006, Viau et al. 2010

✓? **Early success: 60% endorsement**

✗ **Baseline: 15% endorsement**

“**Every** kitty didn’t jump on the bed.”



Viau et al. 2010

One explanation: Children could more easily access the inverse (not all) interpretation.

3 trials

early success

50% endorsement

then 3 trials

early failure

80% endorsement!

Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006, Viau et al. 2010

✓? Early success: 60% endorsement

✗ Baseline: 15% endorsement

“Every kitty didn’t jump on the bed.”



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Another explanation: Early success changes children’s expectations about the world and/or the QUD, which makes the inverse interpretation more **informative**.

3 trials

early success

50% endorsement

then 3 trials

early failure

80% endorsement!

Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006, Viau et al. 2010

- ✓ Early failure
(after early success): 80% endorsement
- ✓? Early success: 60% endorsement
- ✗ Baseline: 15% endorsement

“**Every** kitty didn’t jump on the bed.”



Viau et al. 2010

Another experimental manipulation

early failure + Unambiguous utterance

3 trials “**Not every** kitty jumped on the bed.”



Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006, Viau et al. 2010

- ✓ **Early failure**
(after early success): **80% endorsement**
- ✓? **Early success: 60% endorsement**
- ✗ **Baseline: 15% endorsement**



Viau et al. 2010

Another experimental manipulation

early failure + Unambiguous utterance

3 trials “**Not every** kitty jumped on the bed.”



80% endorsement

then 3 trials “**Every** kitty didn’t jump on the bed.”



80% endorsement



Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006, Viau et al. 2010

- ✓ Early failure
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“**Every** kitty didn’t jump on the bed.”



Viau et al. 2010



3 trials “**Not every** kitty jumped on the bed.”

then 3 trials “**Every** kitty didn’t jump on the bed.”

One explanation: Children could more easily access the inverse (not all) interpretation.

Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006, Viau et al. 2010

✓ Early failure

(after unambiguous): 80% endorsement

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“**Every** kitty didn’t jump on the bed.”



Viau et al. 2010

3 trials “**Not every** kitty jumped on the bed.”

then 3 trials “**Every** kitty didn’t jump on the bed.”

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Another explanation: The unambiguous utterance changes children’s expectations about the world and/or the QUD, which makes the inverse interpretation more informative.

Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006, Viau et al. 2010

✓ Early failure

(after unambiguous): 80% endorsement

✓ Early failure

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✓? Early success: 60% endorsement

✗ Baseline: 15% endorsement

“Every kitty didn’t jump on the bed.”



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The basic issue: Is children’s endorsement behavior due to **grammatical factors** (like the ability to access the inverse scope interpretation), or due to **pragmatic factors** (like expectations about the world or QUD) that change the informativity of the inverse scope interpretation?

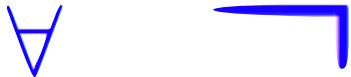
Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006, Viau et al. 2010

- ✓ Early failure
(after unambiguous): 80% endorsement
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(after early success): 80% endorsement
- ✓? Early success: 60% endorsement
- ✗ Baseline: 15% endorsement



“**Every** kitty didn’t jump on the bed.”



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grammatical factors

pragmatic factors

It’s hard to manipulate only one of these factors in experimental research investigating children’s responses.

Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006, Viau et al. 2010

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(after unambiguous): 80% endorsement
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“Every kitty didn’t jump on the bed.”



grammatical factors

pragmatic factors



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Using a **computational-level** model that formalizes the separate contribution of each factor, we can determine which ones have the largest impact on **children’s observed behavior**.

Input

Behavior

EXTERNAL

INTERNAL

Pragmatics in sentences: Ambiguity resolution in context

Musolino & Lidz 2006, Viau et al. 2010

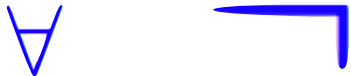
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“**Every** kitty didn’t jump on the bed.”



grammatical factors

pragmatic factors



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Rational Speech Act Framework

Input

Behavior

EXTERNAL

INTERNAL

Pragmatics in sentences: Ambiguity resolution in context

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grammatical factors pragmatic factors

“**Every** kitty didn’t jump on the bed.”



✓ Early failure

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Rational Speech Act Framework

“This framework views language understanding as a social reasoning process. A *pragmatic listener* L1...”

Pragmatics in sentences: Ambiguity resolution in context

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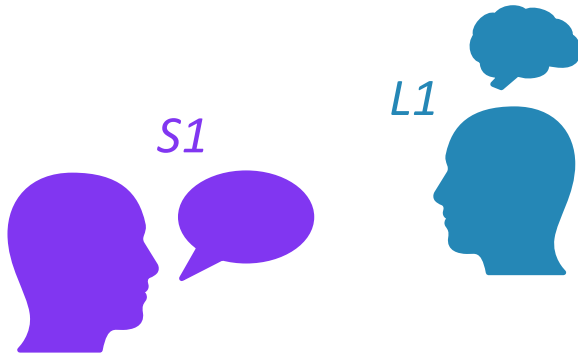


grammatical factors pragmatic factors

“**Every** kitty didn’t jump on the bed.”



- ✓ Early failure
(after unambiguous): 80% endorsement
- ✓ Early failure
(after early success): 80% endorsement
- ✓? Early success: 60% endorsement
- ✗ Baseline: 15% endorsement



Rational Speech Act Framework

“This framework views language understanding as a social reasoning process. A *pragmatic listener L1* interprets an utterance by reasoning about a *cooperative speaker S1...*”

Pragmatics in sentences: Ambiguity resolution in context

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grammatical factors pragmatic factors

“**Every** kitty didn’t jump on the bed.”



✓ Early failure

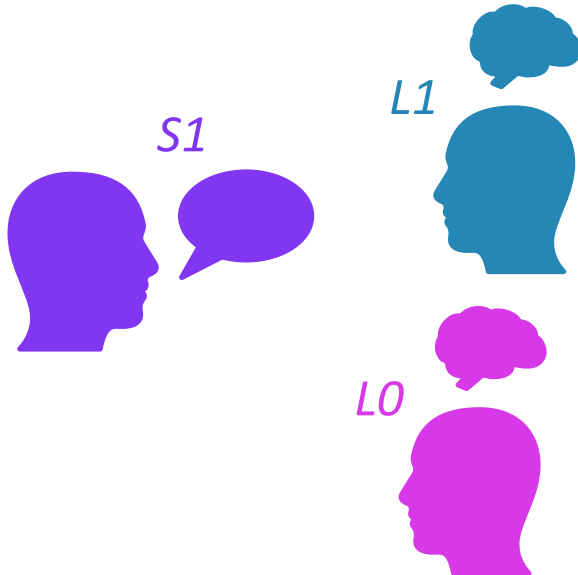
(after unambiguous): 80% endorsement

✓ Early failure

(after early success): 80% endorsement

✓? Early success: 60% endorsement

✗ Baseline: 15% endorsement



Rational Speech Act Framework

“This framework views language understanding as a social reasoning process. A *pragmatic listener L1* interprets an utterance by reasoning about a cooperative *speaker S1* who is trying to inform a *literal listener L0* about the world.”

Pragmatics in sentences: Ambiguity resolution in context

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grammatical factors pragmatic factors

“**Every** kitty didn’t jump on the bed.”



✓ Early failure

(after unambiguous): 80% endorsement

✓ Early failure

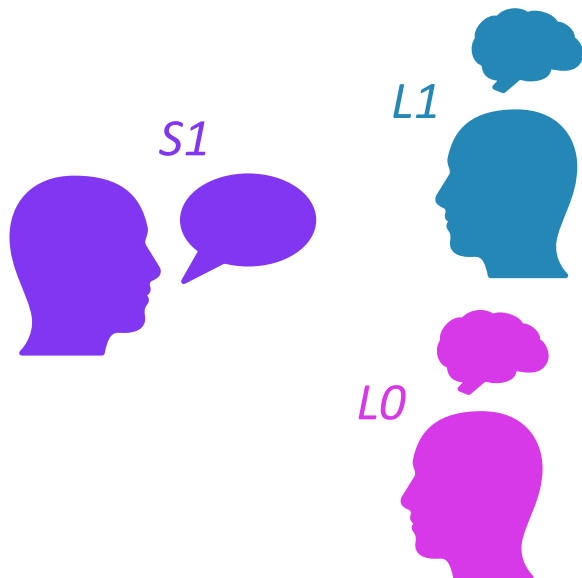
(after early success): 80% endorsement

✓? Early success: 60% endorsement

✗ Baseline: 15% endorsement

Rational Speech Act Framework

Hearing an ambiguous utterance, a **pragmatic listener** reasons jointly about the **true state of the world** (e.g., how many kitties jumped on the bed), the **scope interpretation** that the speaker had in mind (i.e., surface vs. inverse), as well as the likely **QUD** that the utterance addresses.



Pragmatics in sentences: Ambiguity resolution in context

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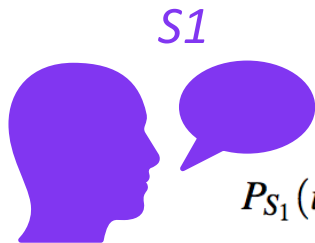
grammatical factors pragmatic factors

“**Every** kitty didn’t jump on the bed.”



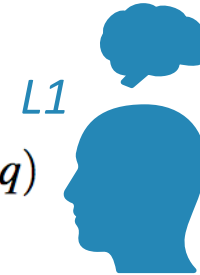
- ✓ Early failure
(after unambiguous): 80% endorsement
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- ✓? Early success: 60% endorsement
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Rational Speech Act Framework
= Bayesian inference



S1

$$P_{S_1}(u|w, i, q) \propto \exp(\alpha \cdot \log(L_0(x|u, i, q)))$$



L1

$$P_{L_1}(w, i, q|u) \propto P_{S_1}(u|w, i, q) \cdot P(w) \cdot P(i) \cdot P(q)$$

$$P_{L_0}(x|u, i, q) \propto \sum_w \delta_{x=[[q]](w)} \cdot P_{L_0}(w|u, i)$$

$$P_{L_0}(w|u, i) \propto \delta_{[[u]]^i(w)} \cdot P(w)$$



L0

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grammatical factors pragmatic factors

“**Every** kitty didn’t jump on the bed.”



✓ Early failure

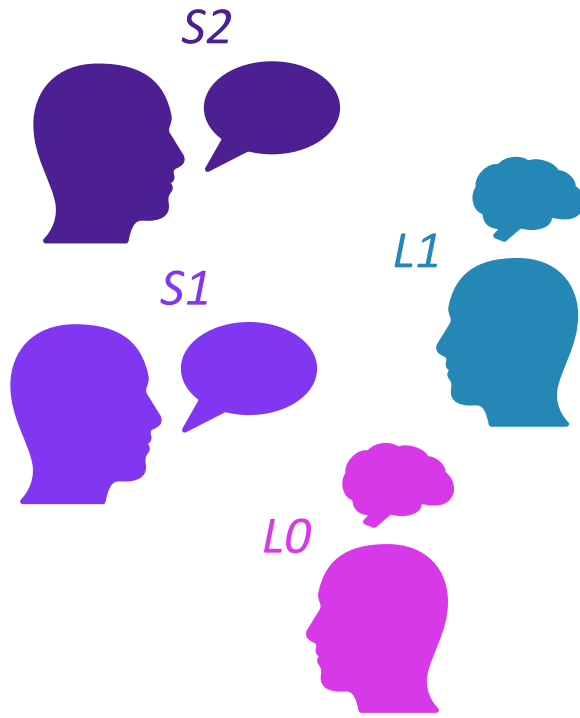
(after unambiguous): 80% endorsement

✓ Early failure

(after early success): 80% endorsement

✓? Early success: 60% endorsement

✗ Baseline: 15% endorsement



Rational Speech Act Framework

“...we model whether a speaker **would endorse** the scopally-ambiguous utterance as a description of the observed state, or whether the speaker would prefer to say nothing at all. **The pragmatic speaker S2** makes this decision by reasoning about the probability that a pragmatic listener L1 (who is reasoning about a speaker S1 reasoning about a literal listener L0) would arrive at the correct world state after hearing the utterance.”

Pragmatics in sentences: Ambiguity resolution in context

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grammatical factors pragmatic factors

“**Every** kitty didn’t jump on the bed.”



endorsement



Rational Speech Act Framework

= Bayesian inference

S_2



L_1



S_1



L_0



$$P_{S_2}(u|w) \propto \exp(\log \sum_{i,q} P_{L_1}(w,i,q|u))$$

Probability of endorsing utterance u
given the observed world state w

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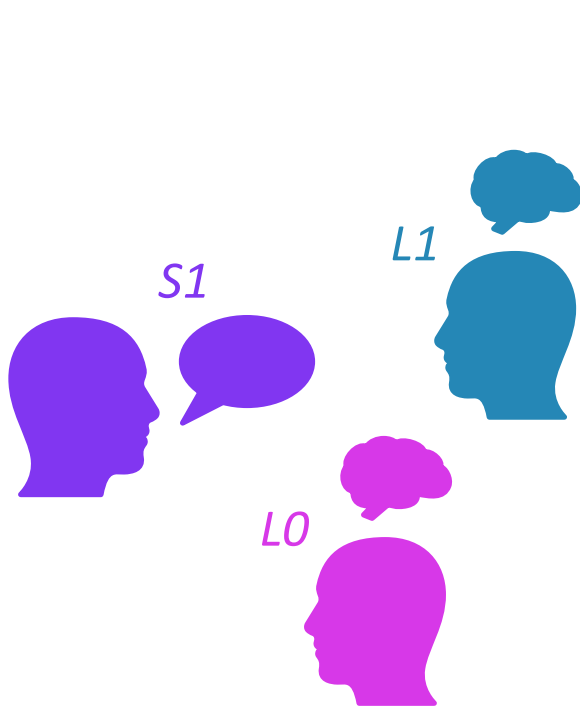
grammatical factors pragmatic factors

“**Every** kitty didn’t jump on the bed.”



Rational Speech Act Framework

= Bayesian inference



$$P_{S_2}(u|w) \propto \exp(\log \sum_{i,q} P_{L_1}(w, i, q|u))$$



Depends on L1’s probability of inferring that world and whatever interpretations i and QUDs q go with it, given the utterance u .

Pragmatics in sentences: Ambiguity resolution in context

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grammatical factors

“**Every** kitty didn’t jump on the bed.”



endorsement



S2



probability of endorsing
ambiguous utterance

1.0
0.8
0.6
0.4
0.2

world state prior
manipulation

pragmatic factors

What if we fiddle with expectations about the world,
but keep everything else constant?

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grammatical factors

“**Every** kitty didn’t jump on the bed.”



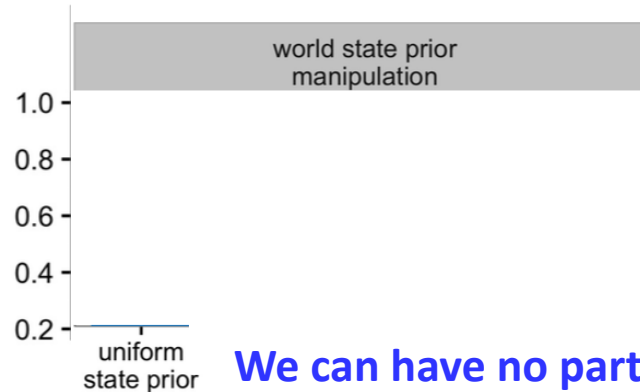
endorsement



S2



probability of endorsing
ambiguous utterance



pragmatic factors

We can have no particular expectation
about how good at jumping kitties are.
Maybe 0 or 1 or 2 or all 3 will be successful.

Pragmatics in sentences: Ambiguity resolution in context

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grammatical factors

“**Every** kitty didn’t jump on the bed.”



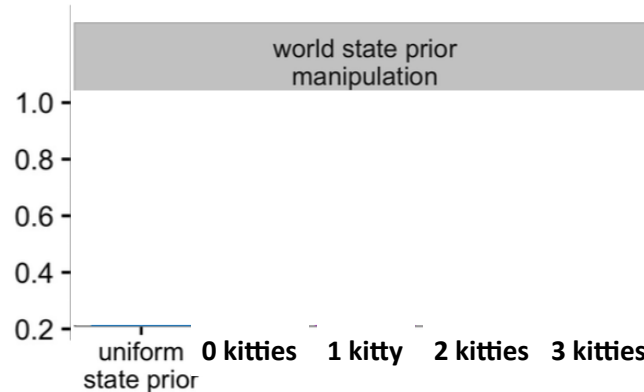
endorsement



S2



probability of endorsing
ambiguous utterance



pragmatic factors

Or maybe we have strong beliefs about how good at jumping kitties are, which leads us to believe a certain number of them will make it over even before we see what happens.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017



grammatical factors

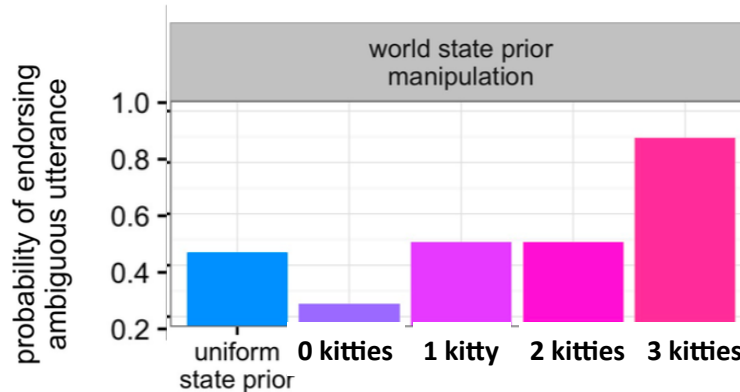
“**Every** kitty didn’t jump on the bed.”



endorsement



S2



Our prior expectations about the world of kitties make a big difference in our endorsement rate.

pragmatic factors

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017



grammatical factors

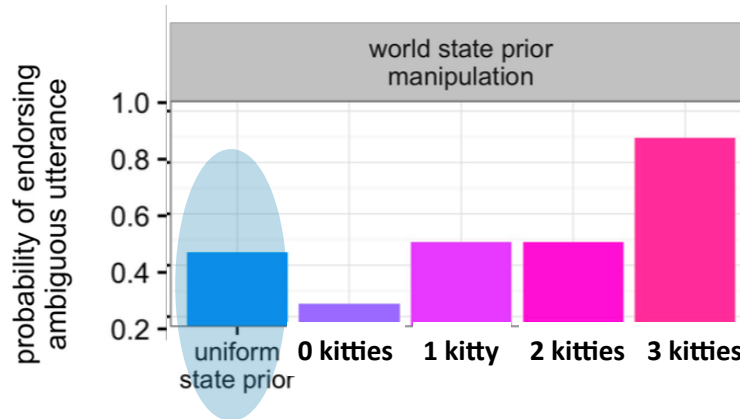
“**Every** kitty didn’t jump on the bed.”



endorsement



S2



pragmatic factors

If we have no particular expectation, we’ll endorse it a little less than half the time.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017



grammatical factors

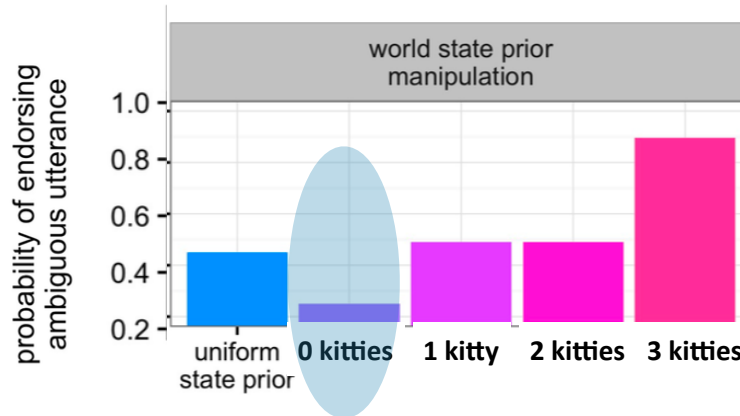
“**Every** kitty didn’t jump on the bed.”



endorsement



S2



pragmatic factors

If we think 0 kitties are likely to make it on the bed, we don’t like to endorse this utterance at all.

Why? Finding out “not all” of them made it isn’t very informative— we didn’t think any were going to make it in the first place.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017



grammatical factors

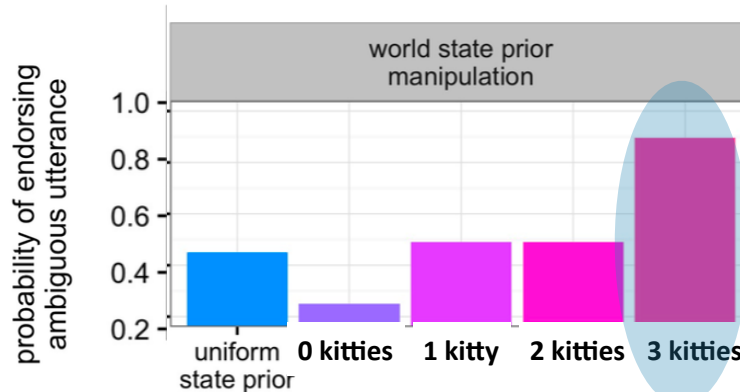
“**Every** kitty didn’t jump on the bed.”



endorsement



S2



pragmatic factors

If we think all 3 kitties are likely to jump on the bed, we’re very likely to endorse the utterance.

Why? Finding out “not all” of them made it *is* very informative— we thought all of them were going to make it.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017



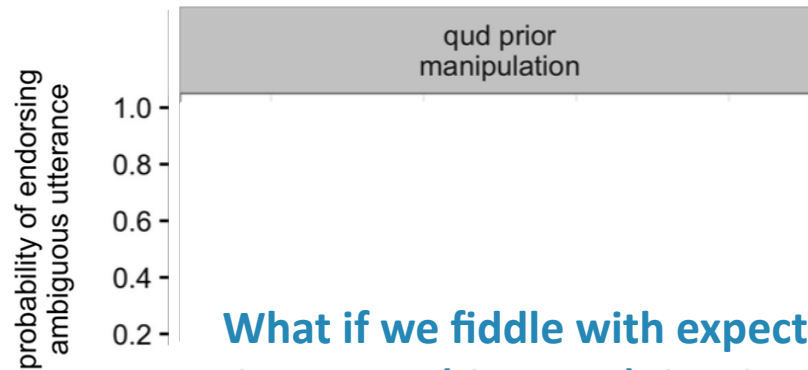
grammatical factors

“**Every** kitty didn’t jump on the bed.”



the world

pragmatic factors



What if we fiddle with expectations about the question under discussion (the QUD), but keep everything else constant?

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017



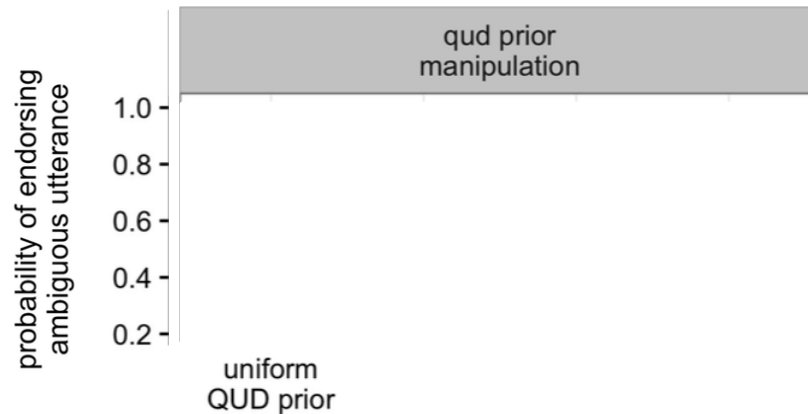
grammatical factors

“**Every** kitty didn’t jump on the bed.”



the world

pragmatic factors



We can have no particular expectation about the implicit QUD. Maybe we’re interested in how many kitties made it, or if all made it, or if none made it.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017



grammatical factors

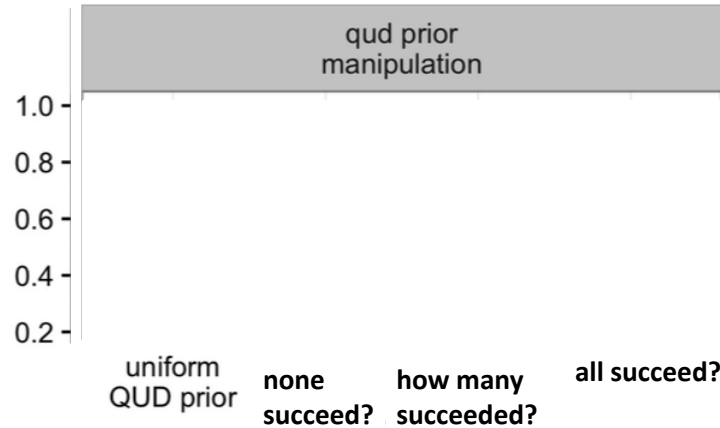
endorsement



“**Every** kitty didn’t jump on the bed.”



probability of endorsing
ambiguous utterance



the world

pragmatic factors

Or maybe we have strong beliefs about what the conversation is about.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017



grammatical factors

“**Every** kitty didn’t jump on the bed.”



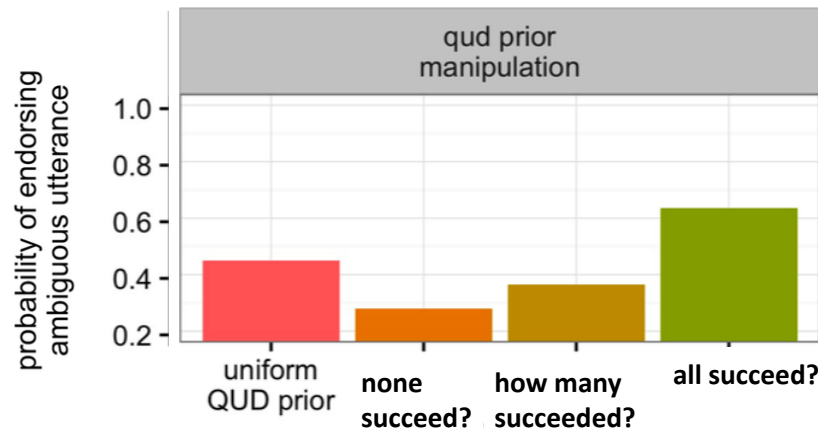
the world

pragmatic factors

endorsement



S2



Our prior expectations about the implicit topic of conversation make a good difference in our endorsement rate.

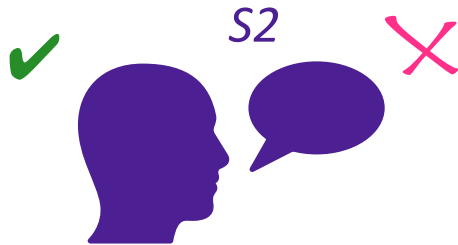
Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017



grammatical factors

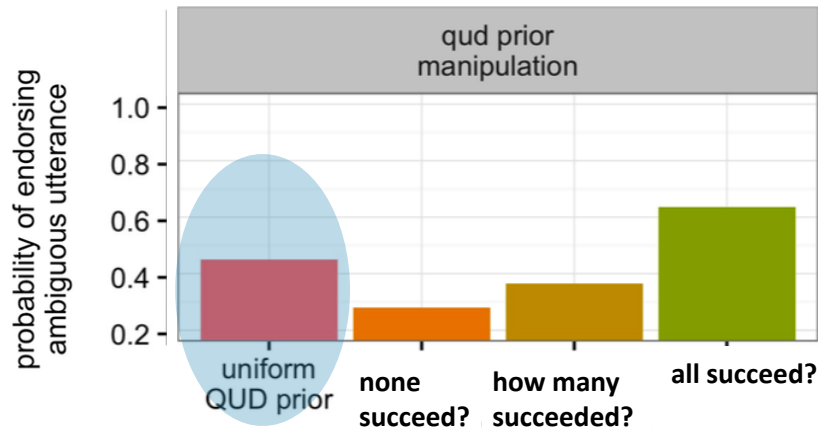
endorsement



“**Every** kitty didn’t jump on the bed.”



the world



pragmatic factors

If we have no particular expectation, we’ll endorse it a little less than half the time.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017



grammatical factors

endorsement



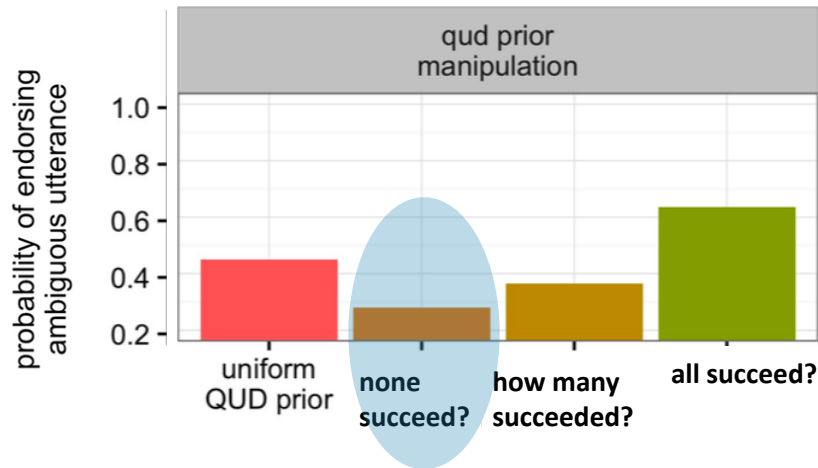
S2



“**Every** kitty didn’t jump on the bed.”



the world



pragmatic factors

If we think the QUD is about whether none succeeded, we don’t like to endorse this utterance at all.

Why? Finding out “not all” of them made it isn’t very informative— we want to know whether none did or not.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017



grammatical factors

endorsement



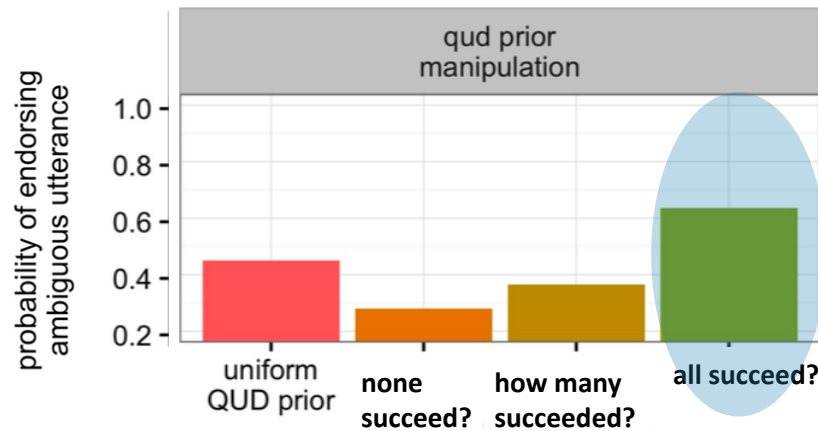
S2



“**Every** kitty didn’t jump on the bed.”



the world



pragmatic factors

If we think the QUD is about whether all kitties succeeded, we’re likely to endorse the utterance.

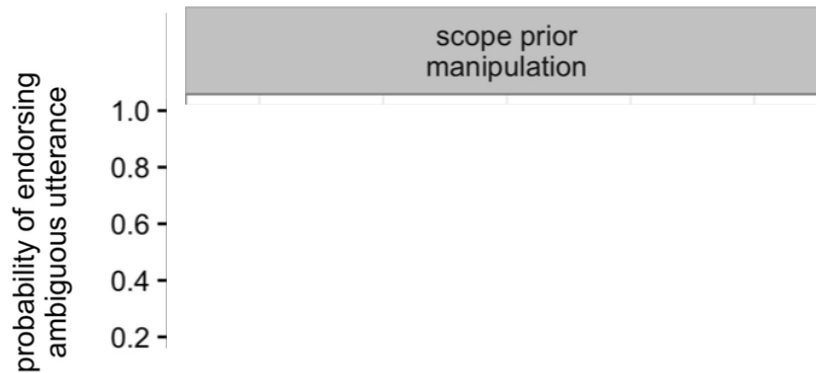
Why? Finding out “not all” of them made it *is* very informative— we want to know whether all made it or not.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017



“**Every** kitty didn’t jump on the bed.”



QUD



the world

pragmatic factors

grammatical factors

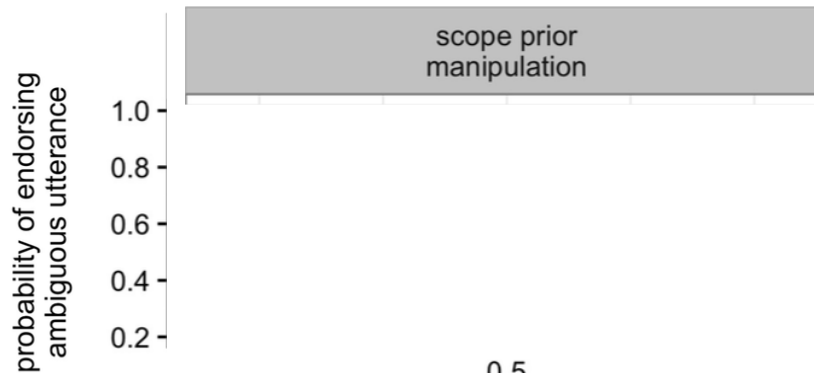
What if we fiddle with expectations about how easy it is to access the inverse scope (not all) interpretation?

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017



“**Every** kitty didn’t jump on the bed.”



QUD



the world

pragmatic factors

grammatical factors

We can have no bias to favor the inverse scope over the surface scope interpretation.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017



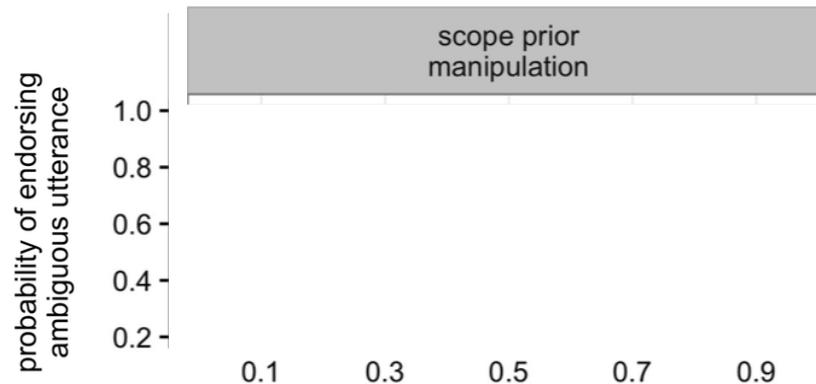
“**Every** kitty didn’t jump on the bed.”



QUD



the world



pragmatic factors

grammatical factors

Or maybe it's easier (<0.5) or harder (>0.5) to access the inverse scope.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017



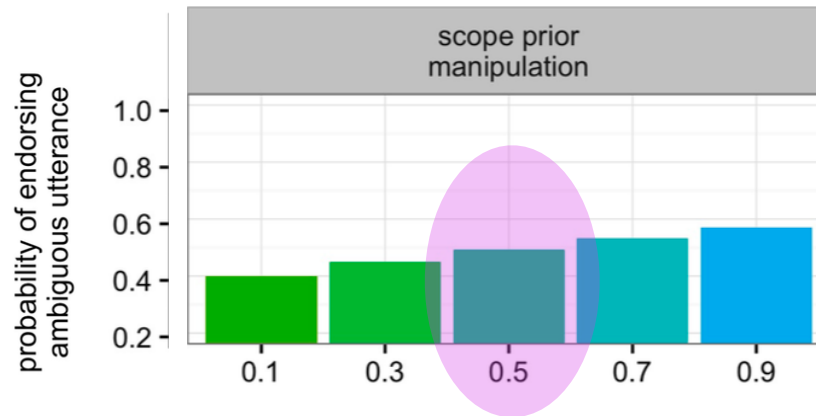
“**Every** kitty didn’t jump on the bed.”



QUD



the world



pragmatic factors

grammatical factors

If we have no particular bias, we’ll endorse it a little less than half the time.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017



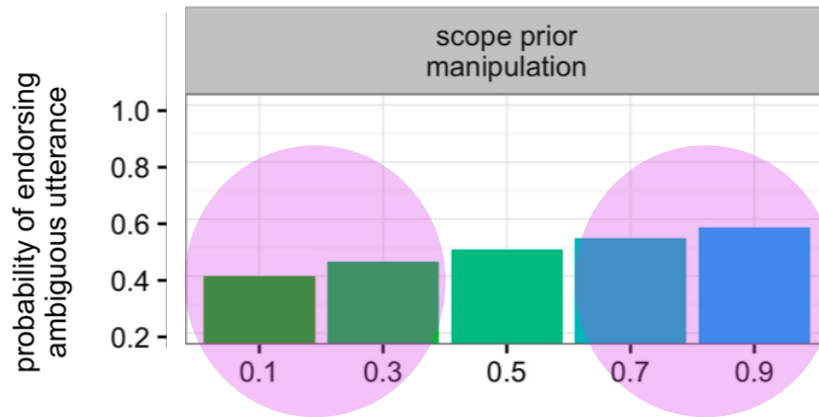
“**Every** kitty didn’t jump on the bed.”



QUD



the world



pragmatic factors

grammatical factors

But it doesn't seem to matter so much whether we favor the inverse scope or disfavor it...the endorsement rate doesn't change that much (doesn't go below 40% or above 60%).

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017

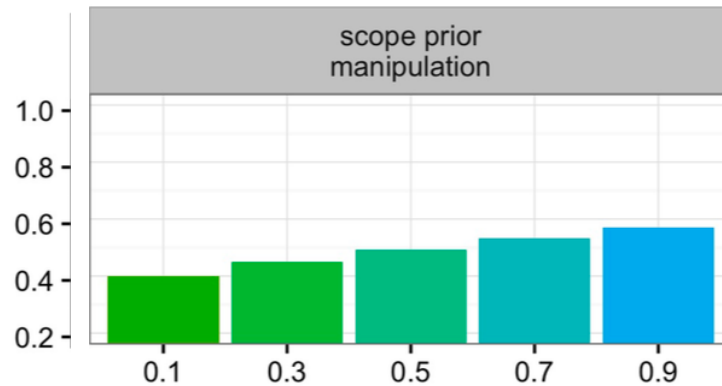


endorsement

S2



probability of endorsing
ambiguous utterance



“**Every** kitty didn’t jump on the bed.”



QUD



the world

pragmatic factors

grammatical factors



Implication: The grammatical factor of scope access doesn’t seem to matter as much for explaining utterance endorsement rate in these contexts. It’s likely less responsible for children’s shift in utterance endorsement behavior.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017

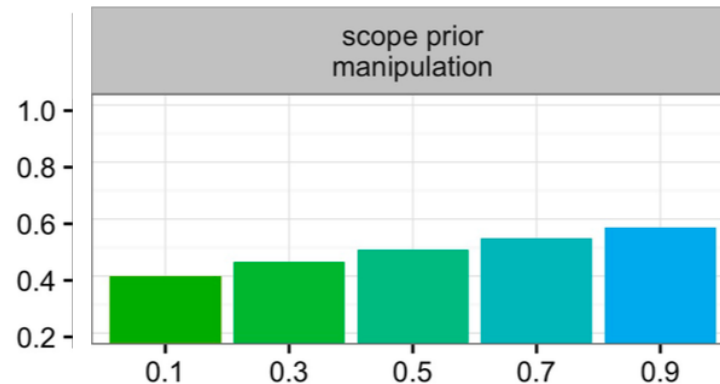


endorsement

S2



probability of endorsing
ambiguous utterance



“**Every** kitty didn’t jump on the bed.”



QUD



the world

pragmatic factors

grammatical factors



If this is true, then we would predict that **pragmatic factors** can overwhelm **grammatical factors**. For example, if pragmatic factors favor utterance endorsement, it shouldn’t matter what the scope access is.

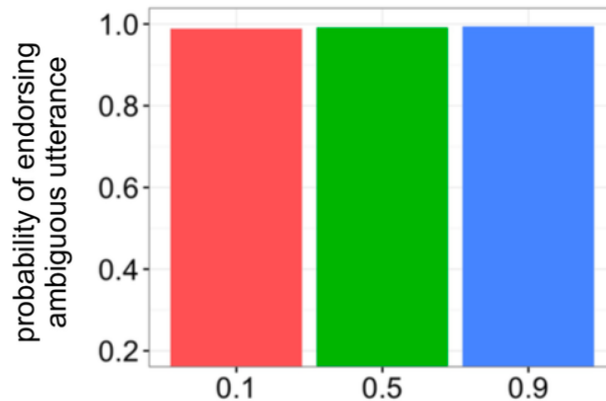
Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017



endorsement

S2



“**Every** kitty didn’t jump on the bed.”



QUD



the world

pragmatic factors

grammatical factors



This is exactly what we find — when the **prior expectations** are that **kitties are good at jumping** and the **QUD** is about whether **all the kitties succeeded**, it doesn’t matter what the scope access is — utterance endorsement is high!

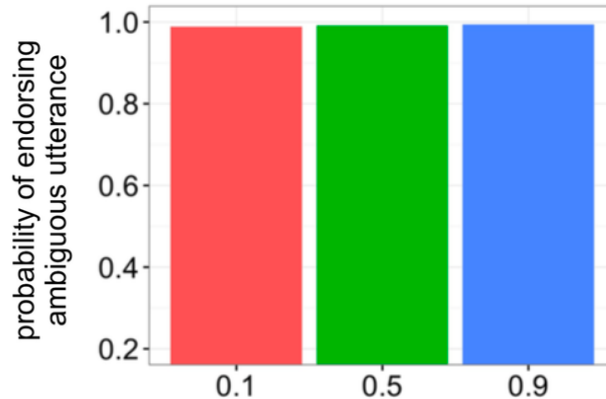
Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2017



endorsement

S2



“**Every** kitty didn’t jump on the bed.”



QUD



the world

pragmatic factors

grammatical factors



This is because these two **pragmatic** factors, when set this way, make the inverse scope interpretation (“Not all kitties jumped on the bed”) very **informative**.

Pragmatics in sentences: Ambiguity resolution in context



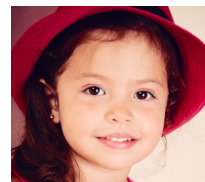
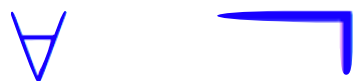
Musolino & Lidz 2006, Viau et al. 2010

- ✓ Early failure
(after unambiguous): 80% endorsement
- ✓ Early failure
(after early success): 80% endorsement
- ✓? Early success: 60% endorsement

✗ **Baseline: 15% endorsement**



“**Every** kitty didn’t jump on the bed.”



QUD



the world

pragmatic factors

grammatical factors



Savinelli, Scontras, & Pearl 2017: Explaining children’s behavior

“Children’s relative lack of experience **managing world and conversational knowledge** likely contributes to their sensitivity to the experimental context. In short, five-year-olds **may know the right interpretation**, but they’re still figuring out **whether it’s the best answer in the context of the experimental conversation.**”

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2018



Adults



QUD



the world



pragmatic factors

grammatical factors



“Two kitties didn’t jump on the bed.”

2



surface

There are *two* kitties *k*, and both *didn’t* jump on the bed.

2



inverse

It’s *not* the case that *two* kitties *k* jumped on the bed.



2

Pragmatics in sentences: Ambiguity resolution in context



Savinelli, Scontras, & Pearl 2018

“Two kitties didn’t jump on the bed.”



Adults

2



surface *There are two, and both didn’t*
inverse *It’s not that two did.*



QUD



the world



pragmatic factors

grammatical factors



Look! Two kitties.



Pragmatics in sentences: Ambiguity resolution in context



Savinelli, Scontras, & Pearl 2018

“Two kitties didn’t jump on the bed.”



Adults

2



surface *There are two, and both didn’t*
inverse *It’s not that two did.*



QUD



the world



pragmatic factors

grammatical factors



One of them jumped on the bed (the other didn’t make it).



Pragmatics in sentences: Ambiguity resolution in context



Savinelli, Scontras, & Pearl 2018

2

surface *There are **two**, and both didn't*
inverse *It's **not** that **two** did.*



QUD



the world



pragmatic factors

grammatical factors



One of them jumped on the bed (the other didn't make it).



Musolino & Lidz 2003

"**Two** kitties didn't jump on the bed."



Adults



27.5% endorsement

Pragmatics in sentences: Ambiguity resolution in context



Savinelli, Scontras, & Pearl 2018

2

surface *There are two, and both didn't*

inverse *It's not that two did. only 1 did!*



QUD



the world

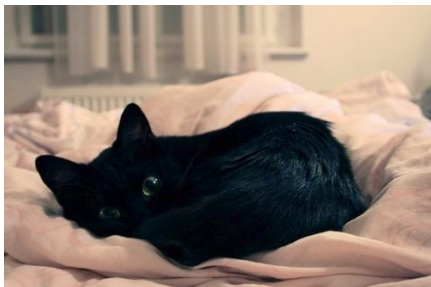


pragmatic factors

grammatical factors



One of them jumped on the bed (the other didn't make it).



Musolino & Lidz 2003

“Two kitties didn't jump on the bed.”



Adults



27.5% endorsement

Important: Surface interpretation is false, but inverse is true.

Pragmatics in sentences: Ambiguity resolution in context



Savinelli, Scontras, & Pearl 2018

1-of-2 context **27.5% endorsement**

2

surface *There are two, and both didn't*

inverse *It's not that two did. only 1 did!*



QUD



the world



pragmatic factors

grammatical factors



One of them jumped on the bed (the other didn't make it).



Musolino & Lidz 2003

“Two kitties didn't jump on the bed.”

Adults



Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2018

1-of-2 context **27.5% endorsement**

2 

surface *There are two, and both didn't*
inverse *It's not that two did.*

Adults



pragmatic factors

grammatical factors



Look! Four kitties.



Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2018

1-of-2 context **27.5% endorsement**

2 

surface *There are two, and both didn't*
inverse *It's not that two did.*

Adults



QUD



the world



pragmatic factors

grammatical factors



Two of them jumped on the bed (the others didn't make it).



Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2018

1-of-2 context **27.5% endorsement**

2 

surface *There are **two**, and both didn't*

inverse *It's **not** that **two** did.*



QUD



the world



pragmatic factors

grammatical factors



Two of them jumped on the bed (the others didn't make it).



Musolino & Lidz 2003

“**Two** kitties didn't jump on the bed.” 



Adults



100% endorsement

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2018

1-of-2 context **27.5% endorsement**

2 

surface *There are two, and both didn't* **kitties 1 and 2 didn't** ✓

inverse *It's not that two did.* ~~no~~ - **kitties 3 and 4 sure did!**



QUD



the world



pragmatic factors

grammatical factors



Two of them jumped on the bed (the others didn't make it).

kitties 3 and 4



kitty 2



kitty 1



Musolino & Lidz 2003

"**Two** kitties didn't jump on the bed." 

Adults



100% endorsement

Important: Surface interpretation is true, but inverse is false.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2018

“**Two** kitties didn’t jump on the bed.”
 surface *There are **two**, and both didn’t*
 inverse *It’s **not** that **two** did.*



Adults



QUD



the world



pragmatic factors

grammatical factors



It certainly looks like the
grammatical factor of scope access
 matters for adults in this context.

Musolino & Lidz 2003

1-of-2 context **27.5% endorsement**

Surface interpretation is false, but inverse is true.

2-of-4 context **100% endorsement**

Surface interpretation is true, but inverse is false.



Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2018



Adults

surface *There are two, and both didn't*
inverse *It's not that two did.*

grammatical factors



QUD



the world

pragmatic factors

Adults are also responsive to the **explicit contrast** that children were responsive to in the every-not context.

Musolino & Lidz 2003

1-of-2 context
+ explicit contrast

Surface interpretation is false, but inverse is true.

1-of-2 context 27.5% endorsement

2-of-4 context 100% endorsement

Surface interpretation is true, but inverse is false.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2018



Adults

surface *There are **two**, and both didn't*
inverse *It's **not** that **two** did.*

grammatical factors



QUD



the world

pragmatic factors

early success

“Two kitties jumped on the table,
but **two** kitties didn't jump on the bed.”

Musolino & Lidz 2003

1-of-2 context
+ explicit contrast **92.5% endorsement**

1-of-2 context **27.5% endorsement**

2-of-4 context **100% endorsement**

Surface interpretation is false, but inverse is true.

Surface interpretation is true, but inverse is false.



Pragmatics in sentences: Ambiguity resolution in context



Savinelli, Scontras, & Pearl 2018

“**Two** kitties didn’t jump on the bed.”



Adults

surface *There are **two**, and both didn’t*

inverse *It’s **not** that **two** did.*



grammatical factors

So how can we tell what might be going on to explain this **observable behavior**? Is it the same thing that was happening with kids?



QUD



the world

pragmatic factors

Musolino & Lidz 2003

1-of-2 context
+ explicit contrast **92.5% endorsement**

Surface interpretation is false, but inverse is true.

1-of-2 context **27.5% endorsement**

2-of-4 context **100% endorsement**

Surface interpretation is true, but inverse is false.

Pragmatics in sentences: Ambiguity resolution in context



Savinelli, Scontras, & Pearl 2018

Musolino & Lidz 2003

“**Two** kitties didn’t jump on the bed.”



1-of-2 context **92.5% endorsement**

+ explicit contrast

1-of-2 context **27.5% endorsement**

2-of-4 context **100% endorsement**

Adults



QUD

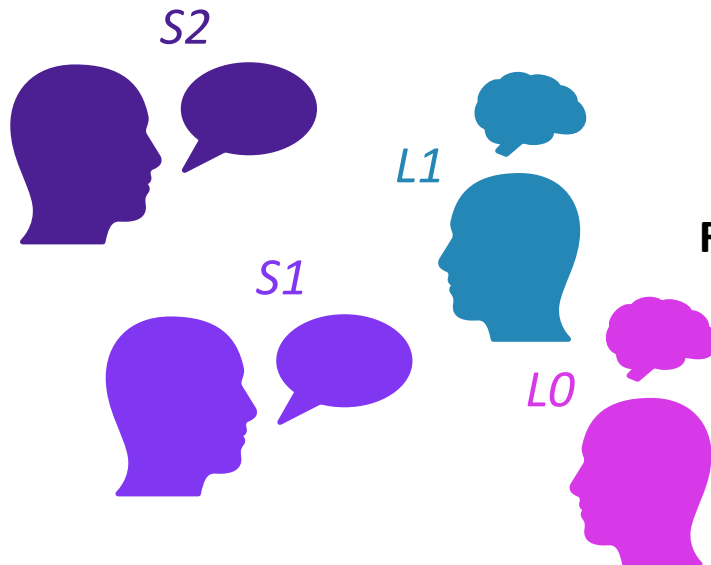


the world

pragmatic factors



grammatical factors



Let’s use the same
Rational Speech Act Framework
model

Pragmatics in sentences: Ambiguity resolution in context



Savinelli, Scontras, & Pearl 2018

Musolino & Lidz 2003

“**Two** kitties didn’t jump on the bed.”



Adults



1-of-2 context **92.5% endorsement**

+ explicit contrast

1-of-2 context **27.5% endorsement**

S2



We’ll focus on the explicit contrast effect first — in kids, this seemed driven primarily by pragmatic factors.



grammatical factors



QUD



the world

pragmatic factors

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2018

Musolino & Lidz 2003

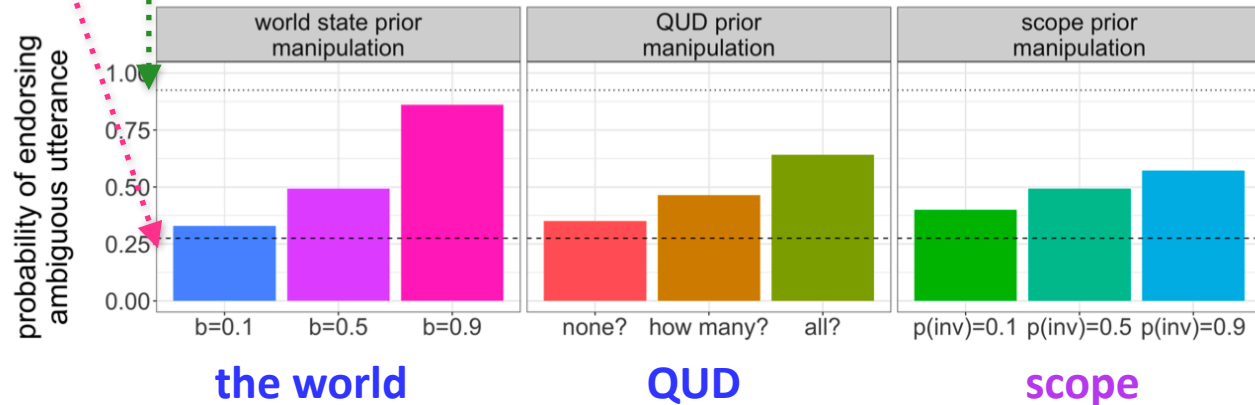
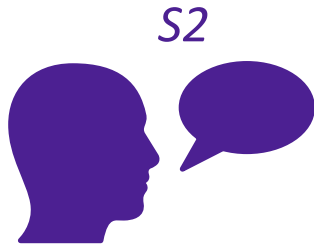
“**Two** kitties didn’t jump on the bed.”



Adults



- 1-of-2 context + explicit contrast **92.5% endorsement**
- 1-of-2 context **27.5% endorsement**



pragmatic factors

grammatical factors

Pragmatics in sentences: Ambiguity resolution in context



Savinelli, Scontras, & Pearl 2018

Musolino & Lidz 2003

“**Two** kitties didn’t jump on the bed.”



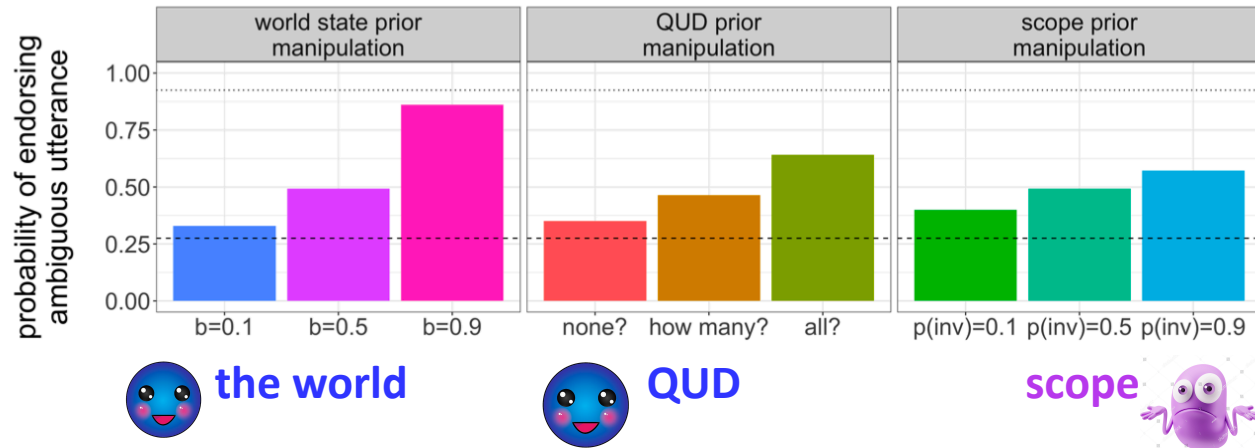
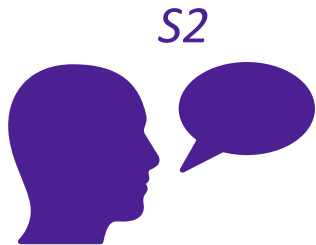
Adults



1-of-2 context **92.5% endorsement**

+ explicit contrast

1-of-2 context **27.5% endorsement**



As with children, the **pragmatic factors** of world knowledge and QUD have more impact than the **grammatical factor** of scope on shifting endorsement rate.

Pragmatics in sentences: Ambiguity resolution in context



Savinelli, Scontras, & Pearl 2018

Musolino & Lidz 2003

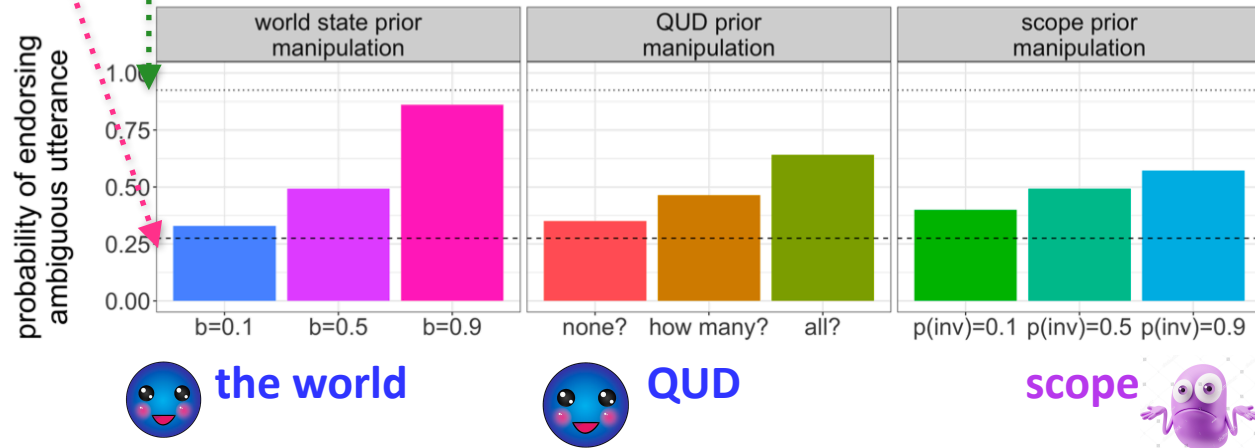
“**Two** kitties didn’t jump on the bed.”



Adults



1-of-2 context **92.5% endorsement**
+ explicit contrast
1-of-2 context **27.5% endorsement**



the world



QUD

scope



...but no single factor on its own is enough to quite get the observed shift

Pragmatics in sentences: Ambiguity resolution in context



Savinelli, Scontras, & Pearl 2018

Musolino & Lidz 2003

“**Two** kitties didn’t jump on the bed.”

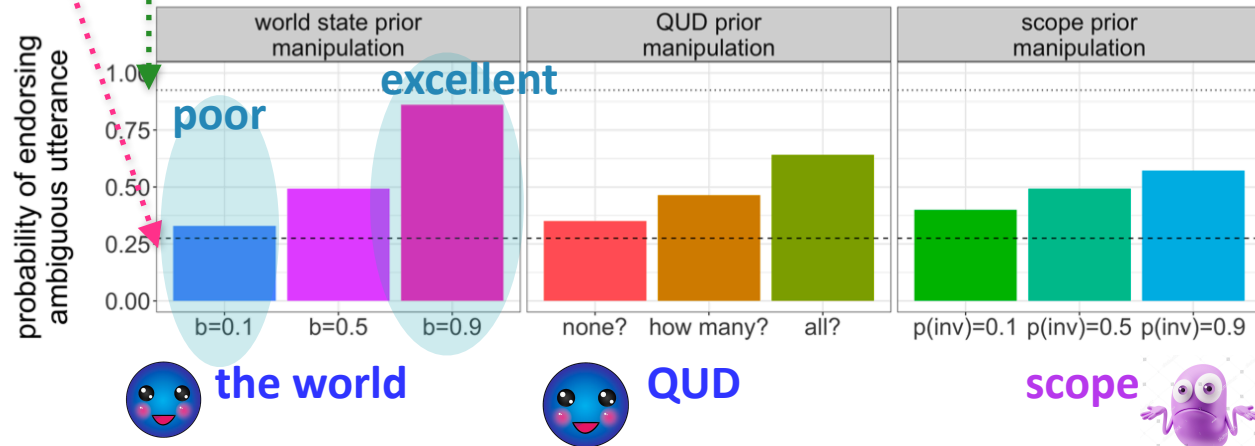
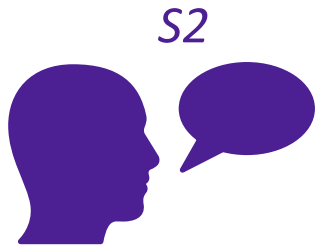
Adults



1-of-2 context **92.5% endorsement**

+ explicit contrast

1-of-2 context **27.5% endorsement**



...though world knowledge is closest. That is, whether kitties are poor or excellent jumpers matters the most.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2018

Adults



Musolino & Lidz 2003

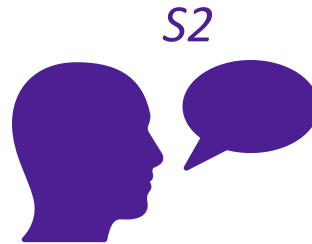
“**Two** kitties didn’t jump on the bed.”



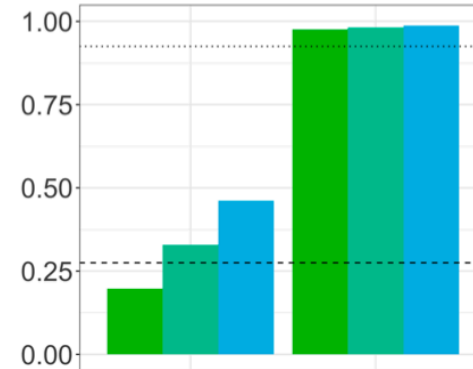
1-of-2 context **92.5% endorsement**

+ explicit contrast

1-of-2 context **27.5% endorsement**



probability of endorsing
ambiguous utterance



p(inv)
0.1
0.5
0.9



scope



the world



QUD



QUD: uniform

QUD: all?



the world



QUD

However, when the **two pragmatic factors are combined**, the observed behavior can be generated so long as adults have **no bias in favor of the inverse scope**.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2018

Adults



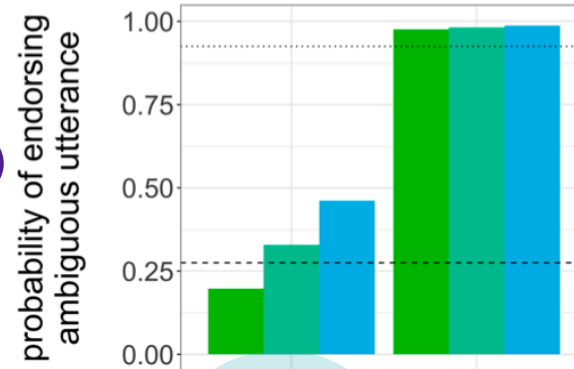
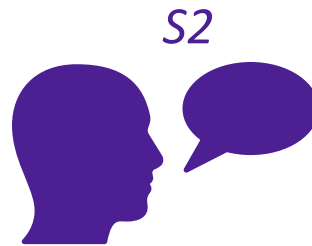
Musolino & Lidz 2003





“**Two** kitties didn’t jump on the bed.”



1-of-2 context **92.5% endorsement**
+ explicit contrast

1-of-2 context **27.5% endorsement**



the world QUD   **b=0.1 QUD: uniform** **b=0.9 QUD: all?**   the world QUD

If kitties are poor at jumping and we don’t know what the QUD is about...

Pragmatics in sentences: Ambiguity resolution in context



Savinelli, Scontras, & Pearl 2018

Adults



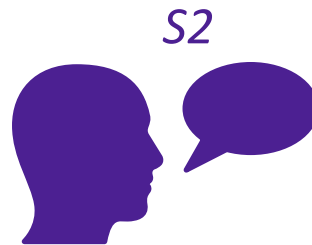
Musolino & Lidz 2003

“**Two** kitties didn’t jump on the bed.”

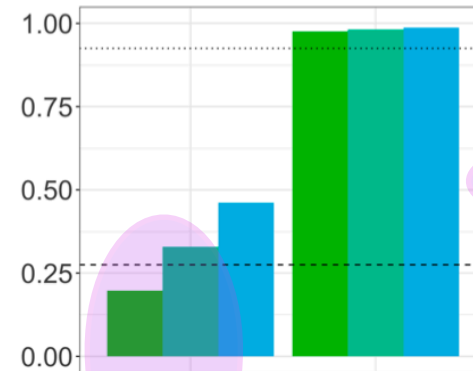


1-of-2 context **92.5% endorsement**
+ explicit contrast

1-of-2 context **27.5% endorsement**



probability of endorsing
ambiguous utterance



p(inv)
0.1
0.5
0.9



scope



the world



QUD



b=0.1
QUD: uniform

b=0.9
QUD: all?



the world



QUD

If kitties are poor at jumping and we don’t know what the QUD is about, we can get low enough endorsement so long as **inverse scope access is 50-50 or really low.**

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2018

Adults



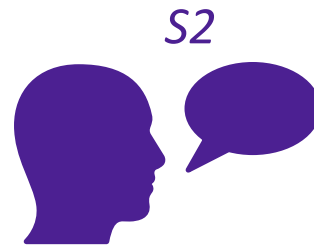
Musolino & Lidz 2003

“**Two** kitties didn’t jump on the bed.”

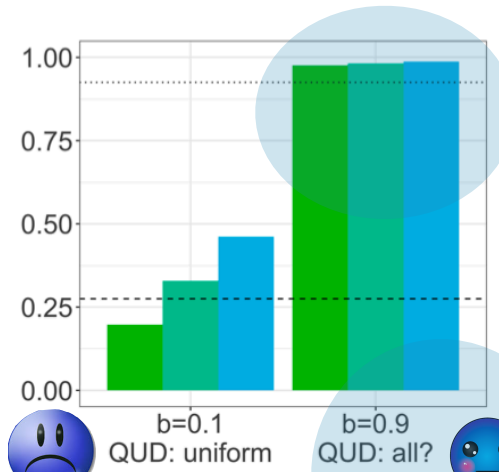


1-of-2 context **92.5% endorsement**
+ explicit contrast

1-of-2 context **27.5% endorsement**



probability of endorsing
ambiguous utterance



p(inv)
0.1
0.5
0.9



scope



the world



QUD



the world



the world



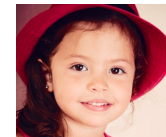
QUD

But if kitties are excellent at jumping and we think the QUD is about whether all of them made it, we can get really high endorsement no matter what the scope access is.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2018

Adults



Musolino & Lidz 2003

“Two kitties didn’t jump on the bed.”



QUD



the world

pragmatic factors

1-of-2 context **92.5% endorsement**

+ explicit contrast

1-of-2 context **27.5% endorsement**

This suggests the **same pragmatic factors** responsible for increasing children’s endorsement rates are active in adults as well.

There’s **continuity in development**. This means children don’t have to fundamentally change the way they’re doing things in order to develop into adults when it comes to resolving this kind of ambiguity in context.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2018

Musolino & Lidz 2003

“**Two** kitties didn’t jump on the bed.”

1-of-2 context **92.5% endorsement**

+ explicit contrast

1-of-2 context **27.5% endorsement**

Adults



QUD



the world



pragmatic factors

grammatical factors



However, for adults, **the grammatical factor of scope access does matter** in order to get the observed low endorsement rate.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2018

Musolino & Lidz 2003

“**Two** kitties didn’t jump on the bed.”

2-of-4 context **100% endorsement**

1-of-2 context **27.5% endorsement**

Let’s look at the other set of
behavioral findings for adults.

Adults



QUD



the world



pragmatic factors

grammatical factors

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2018

Musolino & Lidz 2003

“**Two** kitties didn’t jump on the bed.”

2-of-4 context **100% endorsement**

1-of-2 context **27.5% endorsement**

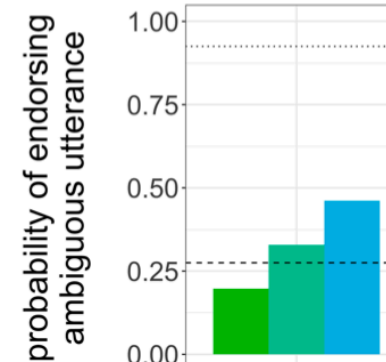
Adults



pragmatic factors

grammatical factors

Important: Because there’s no explicit contrast, whatever **pragmatic values** were in effect for the basic 1-of-2 context are still in effect for the 2-of-4 context.



the world

QUD



Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2018

Musolino & Lidz 2003

“**Two** kitties didn’t jump on the bed.”

2-of-4 context **100% endorsement**

1-of-2 context **27.5% endorsement**



Adults



QUD

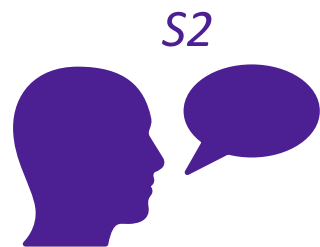


the world

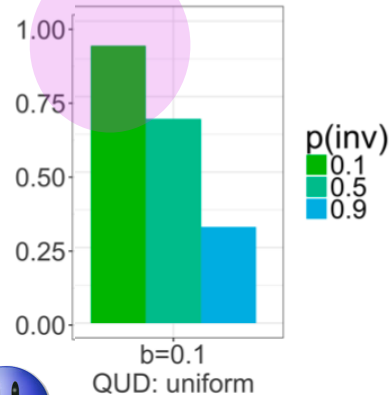


pragmatic factors

grammatical factors



probability of endorsing
ambiguous utterance



the world



QUD



But no problem! The same model can get high endorsement in the 2-of-4 context as long as adults are **biased against accessing the inverse scope**.

Pragmatics in sentences: Ambiguity resolution in context

Savinelli, Scontras, & Pearl 2018

Musolino & Lidz 2003

“**Two** kitties didn’t jump on the bed.”

2-of-4 context **100% endorsement**

1-of-2 context **27.5% endorsement**



Adults



QUD



the world

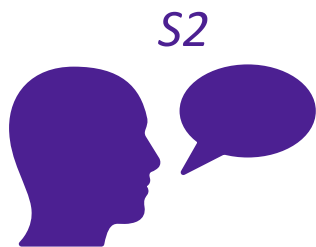


pragmatic factors

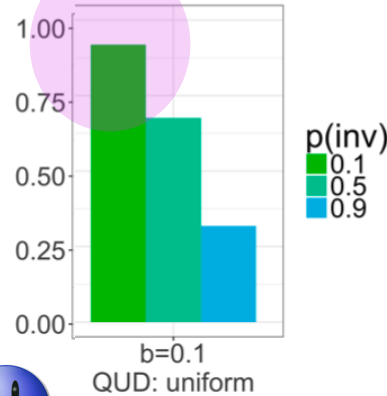
grammatical factors



This underscores the importance of **grammatical factors** for adult language understanding of these kind of ambiguous sentences.



probability of endorsing ambiguous utterance



the world



QUD



Pragmatics in sentences: Ambiguity resolution in context



Savinelli, Scontras, & Pearl 2018

“**Two** kitties didn’t jump on the bed.”



QUD



the world



pragmatic factors



grammatical factors



Maybe if we test kids in more carefully controlled experiments, we’ll be able to see the influence of grammatical factors on their language understanding, too.

Recap

Part of linguistic knowledge is how to resolve ambiguity in context.

The cooperative principle (implemented as the maxims of conversation) can be used to figure out how children and adults might do this, and can be implemented in computational frameworks like the Rational Speech Act framework.

Both children and adults are strongly influenced by pragmatic factors when resolving ambiguity for utterances involving multiple quantifiers.

Adults seem to also be influenced by grammatical factors such as the ability to access the inverse scope.

Questions?



You should be able to do all the questions on the syntax and sentences review questions and all the questions on HW6.

Extra material

Pragmatics: How to use language

Sometimes, there's a difference between the **literal meaning** and the **intended meaning** when something is used in conversation.

"Some of my friends like penguins"

Logical/literal/"technically": Compatible with all friends liking penguins

Intended: **Not all** friends like penguins



Conversational implicature

The “soft” part of the meaning that reflects the speaker’s intended meaning (over and above the linguistic code) is called a **conversational implicature**.

"Some of my friends like penguins"

Logical/literal/“technically”: Compatible with all friends liking penguins

Intended: **Not all** friends like penguins



Maxim of Manner

[Extra]

<http://www.thelingspace.com/episode-2>

<https://www.youtube.com/watch?v=rzxyjFHH-y8>

intro through 2:34-4:10



**Maxim of
Manner**

Maxim of Manner

[Extra]

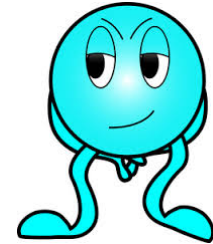
Manner: Speakers use reasonably straightforward, unambiguous, and orderly ways to communicate.

Ex: Describe events in the order they happen.

"Sam started hacking his boss's email."

"Sam got fired."

Implication: He got fired because of the hacking.



"Sam got fired."

"Sam started hacking his boss's email."

Implication: He started hacking because he was fired.



Maxim of Relevance/Relation

[Extra]

<http://www.thelingspace.com/episode-2>

<https://www.youtube.com/watch?v=rzxyjFHH-y8>

intro through 4:10-5:22



**Maxim of
Relevance**

Maxim of Relevance/Relation

[Extra]

Relevance/Relation: Speaker utterances organized around some specific communicative purpose.

Ex:

Attia felt very dizzy and fainted.

She was carried away unconscious to the hospital.

Second utterance is connected to the first: Attia was unconscious *because* she fainted, not because something else happened (like being hit over the head).



Maxim of Relevance/Relation

[Extra]

Relevance/Relation: Speaker utterances organized around some specific communicative purpose.

Connection to advertising:

"Why are you telling me this?"

Inference: This must be something special about your product.

Ex: "Our mangos contain no additives."

(But do any mangos have additives??)



Relevance Theory

[Reference]

<http://www.thelingspace.com/episode-61>

https://www.youtube.com/watch?time_continue=52&v=yRv1agt776c



Maxim of Quantity

[Extra]

<http://www.thelingspace.com/episode-2>

<https://www.youtube.com/watch?v=rzxyjFHH-y8>

intro through 5:22-6:46



Maxim of Quantity

[Extra]

Quantity: Speakers don't add unnecessary information.

Ex:

"Some of my friends like penguins."

Inference: The speaker used the vague expression *some* because she couldn't use a more precise expression like *many*, *most*, or *all*.



Maxim of Quantity

[Extra]

Quantity: Speakers don't add unnecessary information.

Note: This line of reasoning can be used any time expressions sit in a "scalar relation" to each other. The implicature is referred to as a **scalar implicature**.

I like some kinds of pies —> I don't like all kinds of pies.
(some < all)



Maxim of Quantity

[Extra]

Quantity: Speakers don't add unnecessary information.

Note: This line of reasoning can be used any time expressions sit in a "scalar relation" to each other. The implicature is referred to as a **scalar implicature**.

It's possible he'll win. —> It's not likely he'll win.
(possible < probable < certainly)



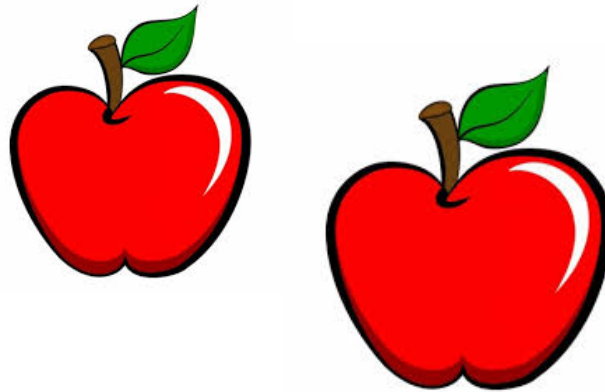
Maxim of Quantity

[Extra]

Quantity: Speakers don't add unnecessary information.

Note: This line of reasoning can be used any time expressions sit in a "scalar relation" to each other. The implicature is referred to as a **scalar implicature**.

I have two apples → I don't have three (or more) apples.
(two < three < four < ...)



Maxim of Quantity with numbers

[Extra]

<http://www.thelingspace.com/episode-34>

<https://www.youtube.com/watch?v=N9OdeDQKnR4>

intro through 0:36-1:46

