

Real-time licensing and interpretation of negation and negative polarity

Hanna Muller & Colin Phillips



NPI illusions

* Ein Mann, der keinen Bart hatte, war jemals glücklich.
a man who no beard had was ever happy

'A man who had no beard was ever happy.'

*The authors [that no critics recommended] have ever written a best-selling novel.

Overview

1. Two ways of thinking about online NPI licensing
2. Intro to NPI illusions
3. What do we know independently about incremental negation processing?
4. Selectivity of the NPI illusion
5. Interpretation of illusion sentences

(Cross-language variation - we can discuss!)

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Negative polarity items

NPIs' defining characteristic is their **limited distribution**:

- (1) We **haven't** left the house *in months*.
- (2) * We have left the house *in months*.

NPI processing

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- (1) We **haven't** left the house *in months*.
- (2) * We have left the house *in months*.

The unacceptability of sentences like 2 is detected quickly - how?

NPI processing

(1) We **haven't** left the house *in months*.

NPI processing

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NPI processing

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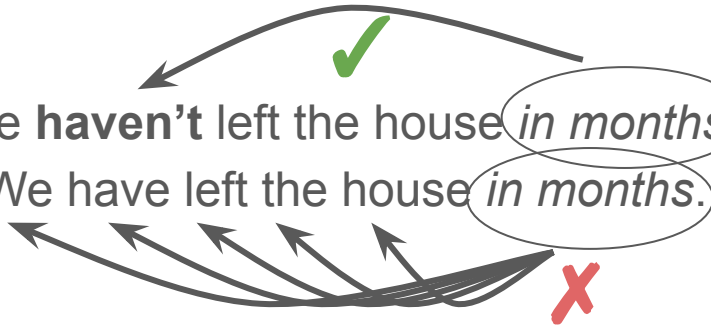
NPI processing

- (1) We **haven't** left the house *in months*.
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-

NPI processing

- (1) We **haven't** left the house *in months*.
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-
- The diagram illustrates the processing of Negative Polarity Items (NPIs). It shows two sentences: (1) "We haven't left the house in months." and (2) "* We have left the house in months." The phrase "in months" is circled in both sentences. A green checkmark is positioned above the circled phrase in sentence (1), indicating that the NPI is correctly licensed in this negative context. A red X is positioned below the circled phrase in sentence (2), indicating that the NPI is not licensed in this positive context. Two curved arrows connect the circled phrases: one points from the phrase in sentence (2) up to the phrase in sentence (1), and another points from the phrase in sentence (1) down to the phrase in sentence (2).

NPI processing

- (1) We **haven't** left the house *in months*.
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- 

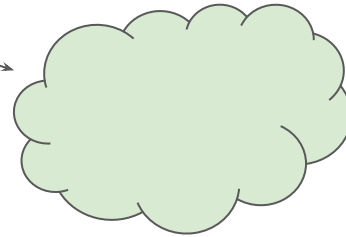
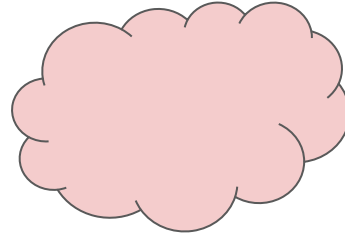
NPI processing

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NPI processing

(1) We **haven't** left the house

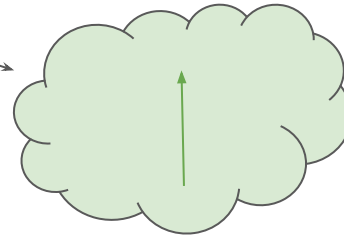
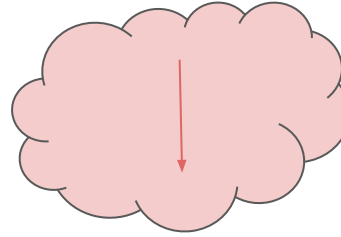
(2) * We **have** left the house



NPI processing

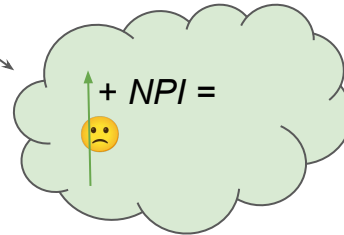
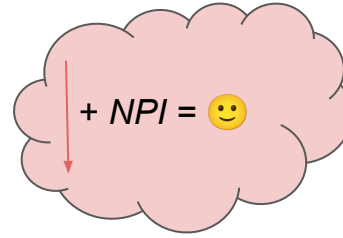
(1) We **haven't** left the house

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NPI processing

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NPI processing

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NPI illusions

Comprehenders occasionally make mistakes in their NPI processing

The pattern of errors can help identify the representations at stake

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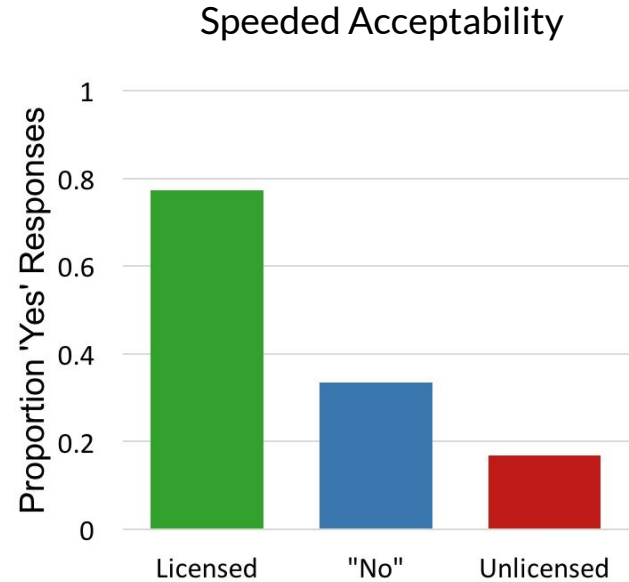
'A man who had no beard was ever happy.'

Basic Phenomenon

(3) **No** authors [that the critics recommended] have *ever* written a best-selling novel.

(4) *The authors [that **no** critics recommended] have *ever* written a best-selling novel.

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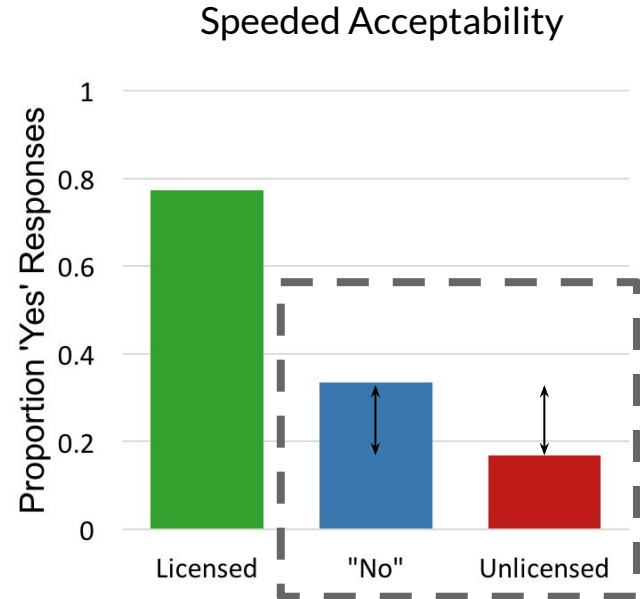


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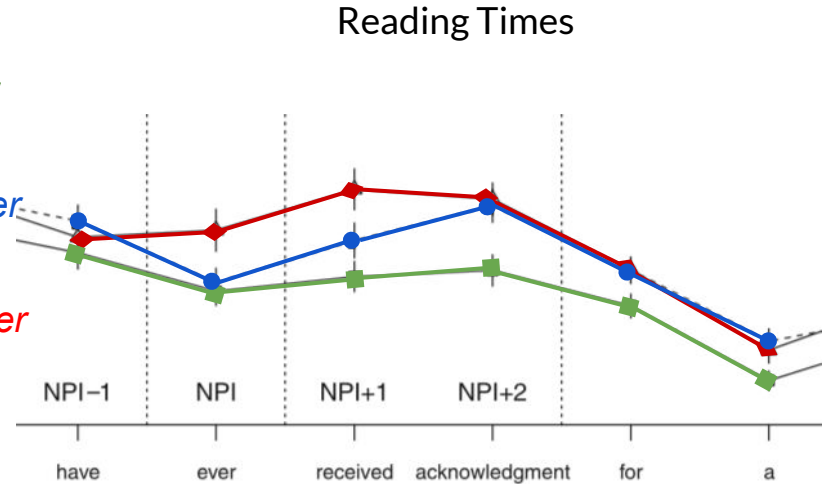
Basic Phenomenon

Online sentence comprehension does not perfectly align with these licensing facts.

(5) **No** authors [that the critics recommended] have *ever* written a best-selling novel.

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(7) *The authors [that the critics recommended] have *ever* written a best-selling novel.



Basic Phenomenon

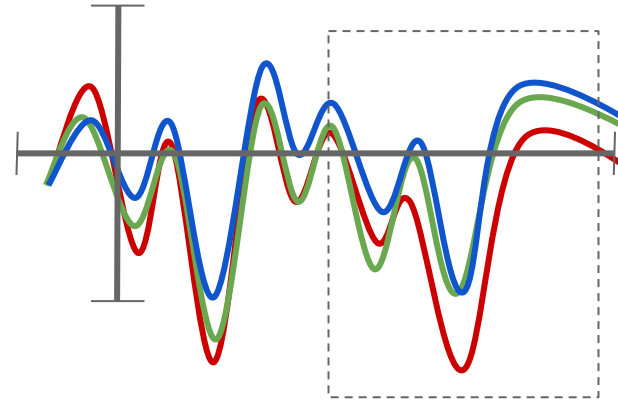
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ERPs



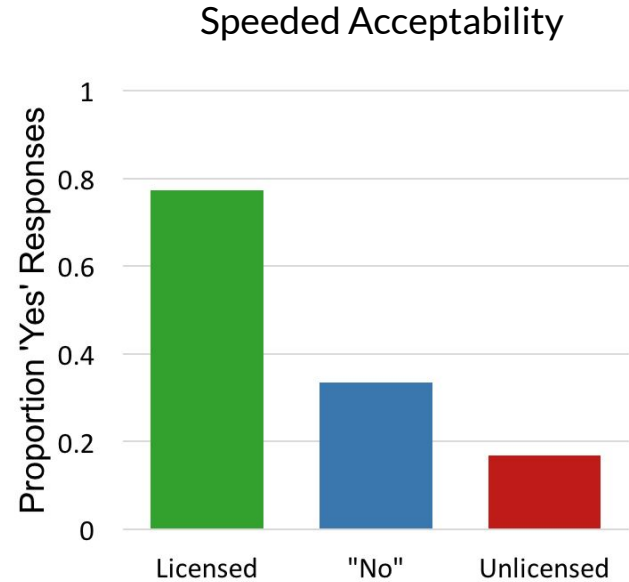
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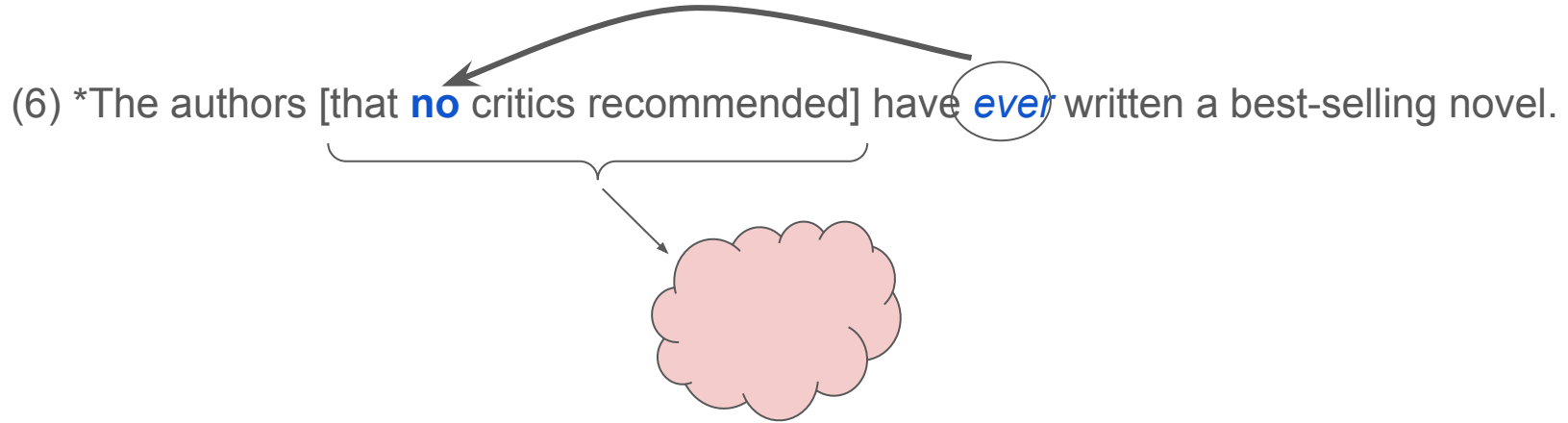
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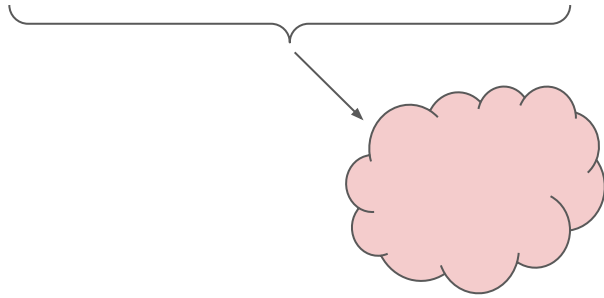
Basic Phenomenon



Pause for discussion

Basic Phenomenon

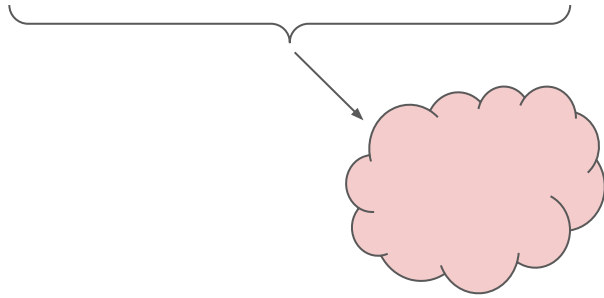
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Do we know that negative interpretations are built incrementally?

Basic Phenomenon

(6) *The authors [that **no** critics recommended] have *ever* written a best-selling novel.



Do we know that negative interpretations are built incrementally?

Not our question: do we interpret prejacent before adding NEG?

Our question: how do we interpret NEG before prejacent is known?

Negative interpretations

“The boy doesn’t have a pencil” → NOT(“the boy has a pencil”)

Negative interpretations

“The boy doesn’t have a pencil” → NOT(“the boy has a pencil”)

“The boy doesn’t have...”

Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Cognition

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A 'no' with a trace of 'yes': A mouse-tracking study of negative sentence processing



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ARTICLE INFO

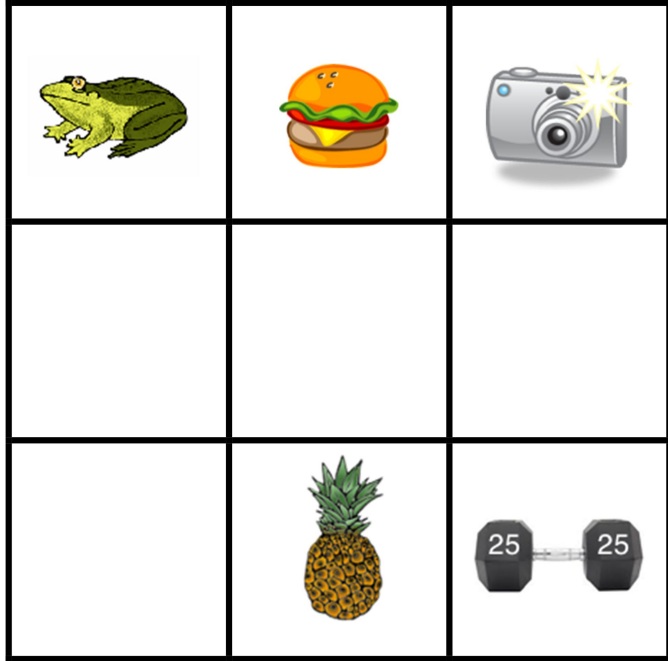
Keywords:

Negation
 Mouse-tracking
 Sentence processing
 Prediction

ABSTRACT

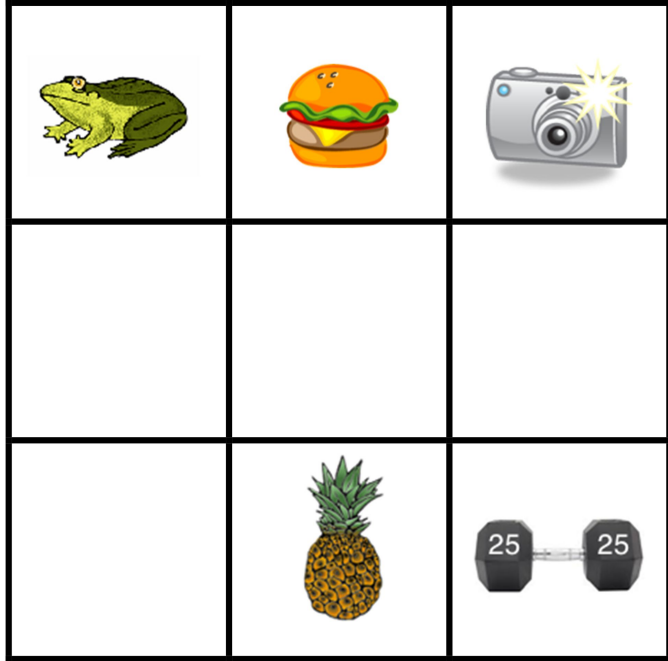
There is strong evidence that comprehenders can parse sentences in an incremental fashion. However, when the sentence contains a negation, the evidence is less clear. Previous work has shown that increasing the pragmatic felicity of a negative sentence reduces or eliminates any processing overhead relative to affirmative sentences. However, in previous work felicity has gone hand-in-hand with the predictability of critical material in a sentence. In three experiments reported here, we presented equally felicitous sentences with critical material of varying predictability (operationalised as the number of possible completions) to test whether this might be a critical factor determining the ease with which partial sentences containing a negation are interpreted. Participants completed a truth-value judgement task (Experiment 1) or a sentence completion task (Experiments 2 and 3) after viewing a visual environment that provided the context for a test sentence, which could differ in truth value (in Experiment 1 only), polarity (affirmative or negative), and number of possible completions (one, two, or three). In all three experiments, we recorded response times and accuracy, but also response dynamics via participants' computer mouse trajectories, allowing us to test specific hypotheses about the time course of comprehension. Across all experiments, in conditions with one or two possible targets, we observed consistent detrimental effects of negative polarity, suggesting that the difficulty in processing negation cannot be reduced to effects relating to predictability or pragmatic felicity. We discuss this finding in relation to incremental and two-stage models of processing and outline a new account of the processing difficulty arising from negation in terms of a conflict between what is locally activated on the basis of individual words and phrases and the global meaning of a negative sentence.

Experiment 1



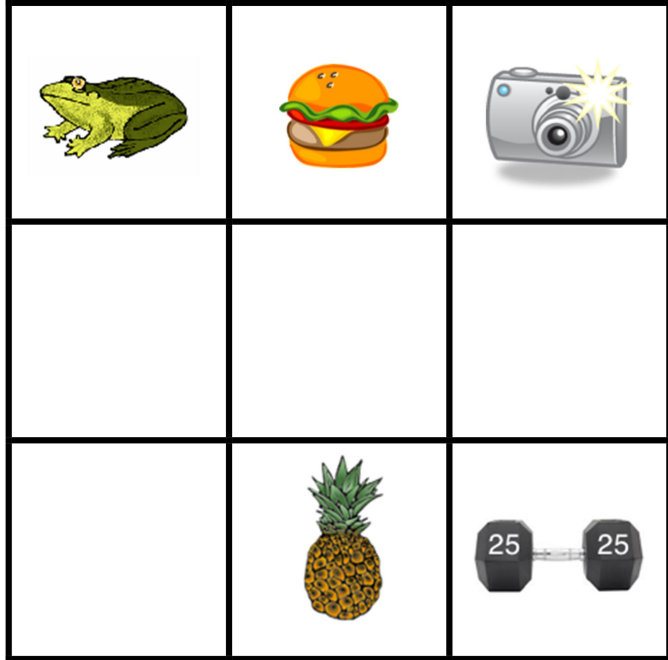
Task: Find the object mentioned in the second sentence, and answer a question querying some feature about it.

Experiment 1



Task: Find the **object mentioned in the second sentence**, and answer a question querying some feature about it.

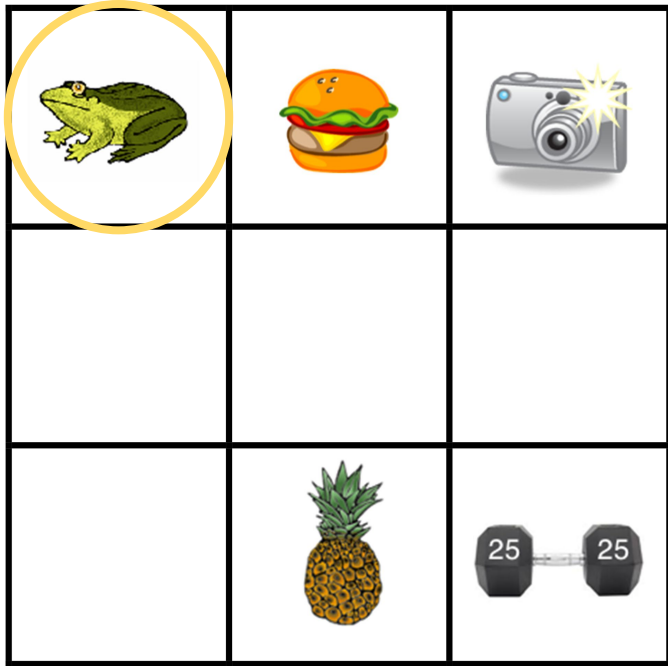
Experiment 1



Task: Find the object mentioned in the second sentence, and answer a question querying some feature about it.

“The top row contains the frog ...

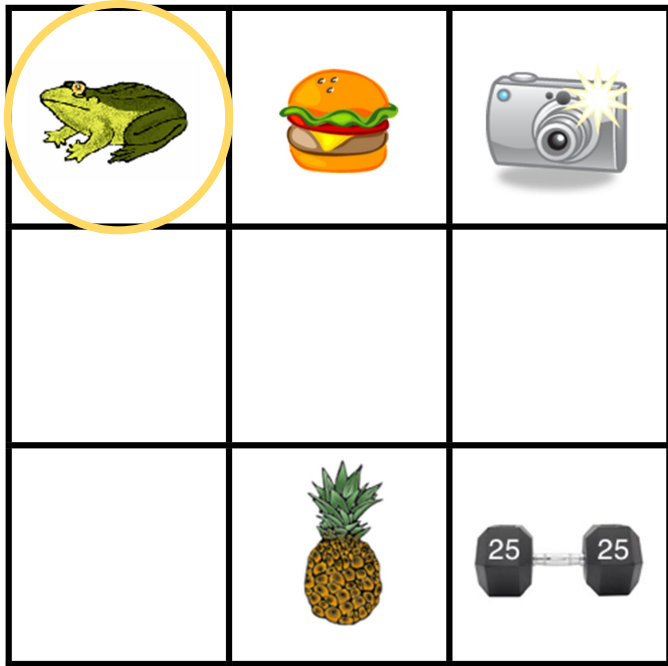
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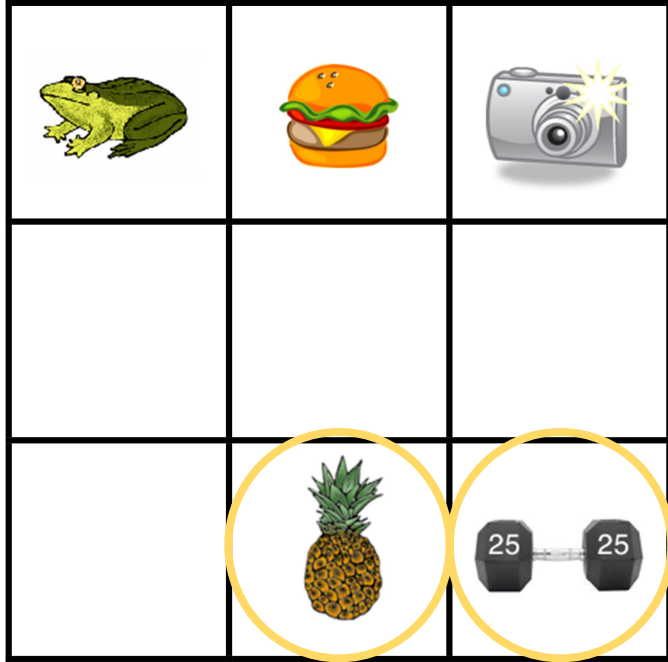


Task: Find the object mentioned in the second sentence, and answer a question querying some feature about it.

“The top row contains the frog ...

It doesn’t contain the ...

Experiment 1

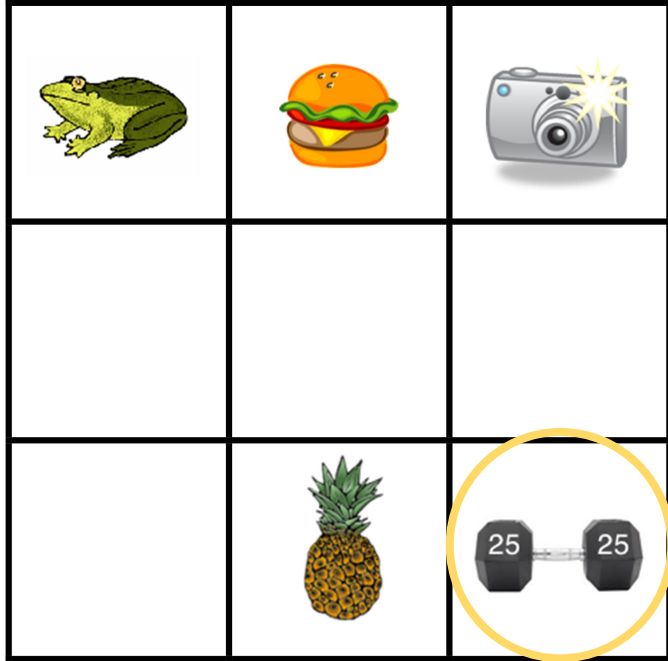


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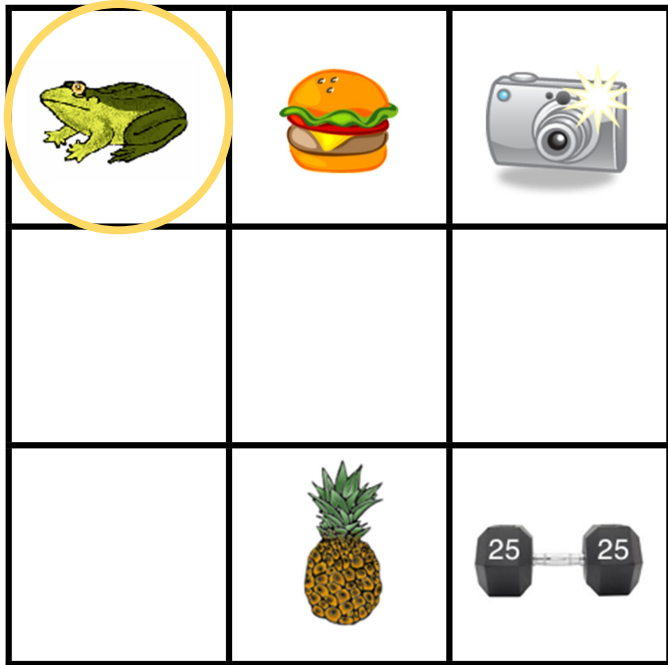
It doesn’t contain the dumbbell.

Experiment 1

Task: Find the object mentioned in the second sentence, and answer a question querying some feature about it.

“How much weight was on the dumbbell?”

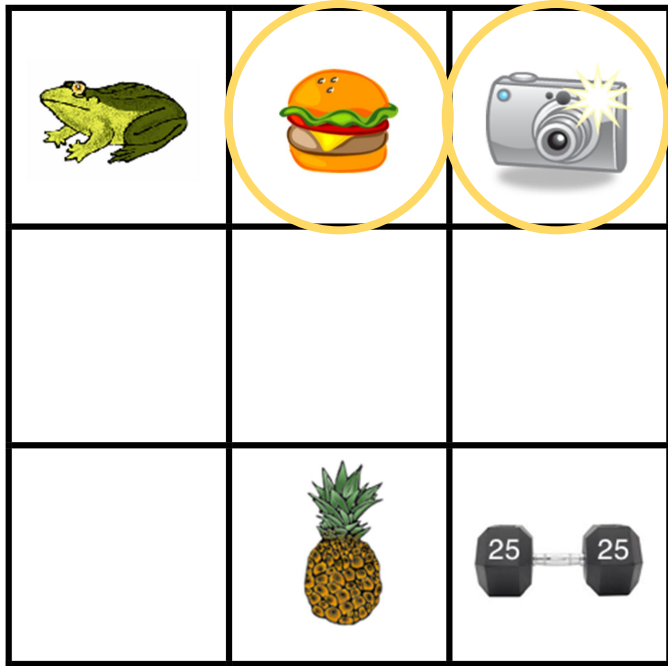
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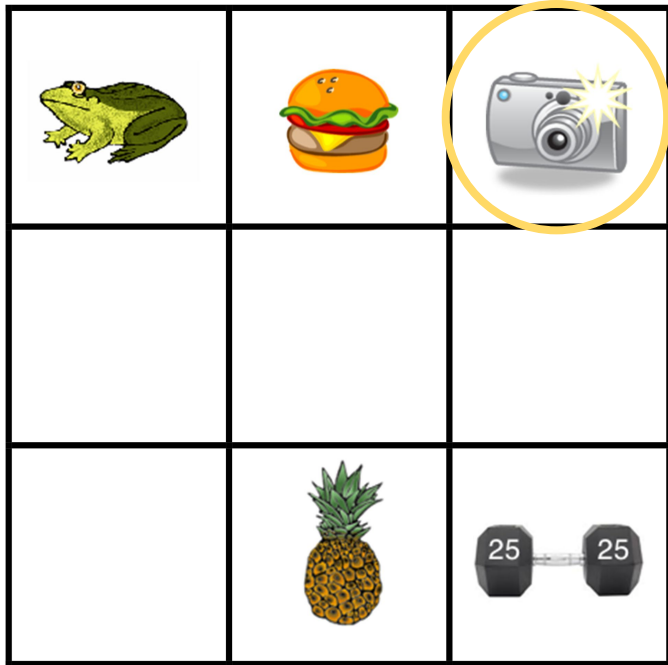


Task: Find the object mentioned in the second sentence, and answer a question querying some feature about it.

“The top row contains the frog ...

It also contains the ...

Experiment 1



Task: Find the object mentioned in the second sentence, and answer a question querying some feature about it.

“The top row contains the frog ...

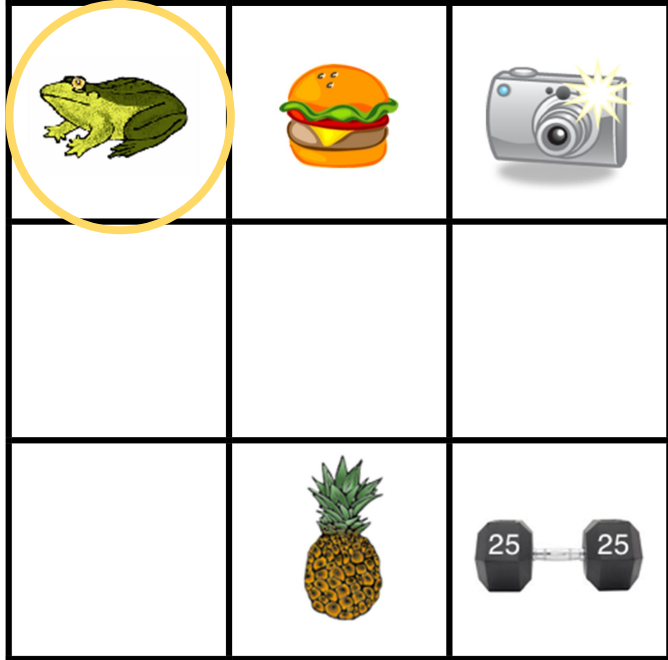
It also contains the camera.

Experiment 1

Task: Find the object mentioned in the second sentence, and answer a question querying some feature about it.

“Was the camera’s flash going off?”

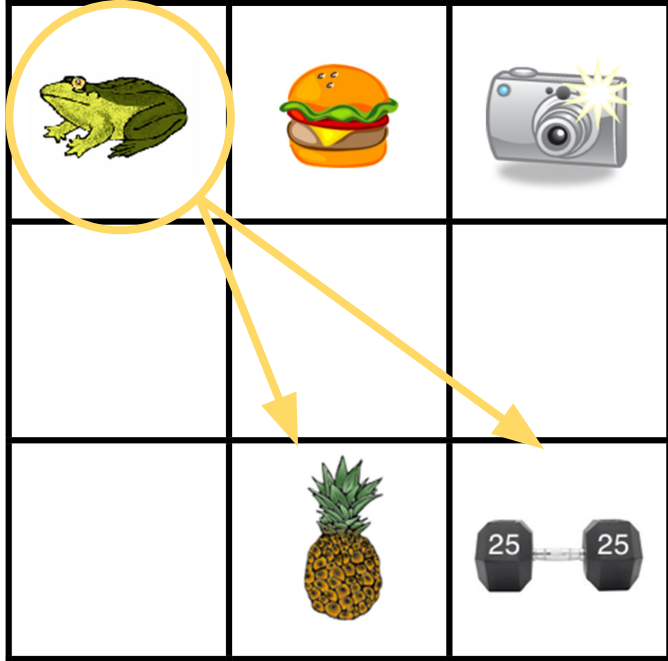
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“The top row contains the frog ...

Experiment 1



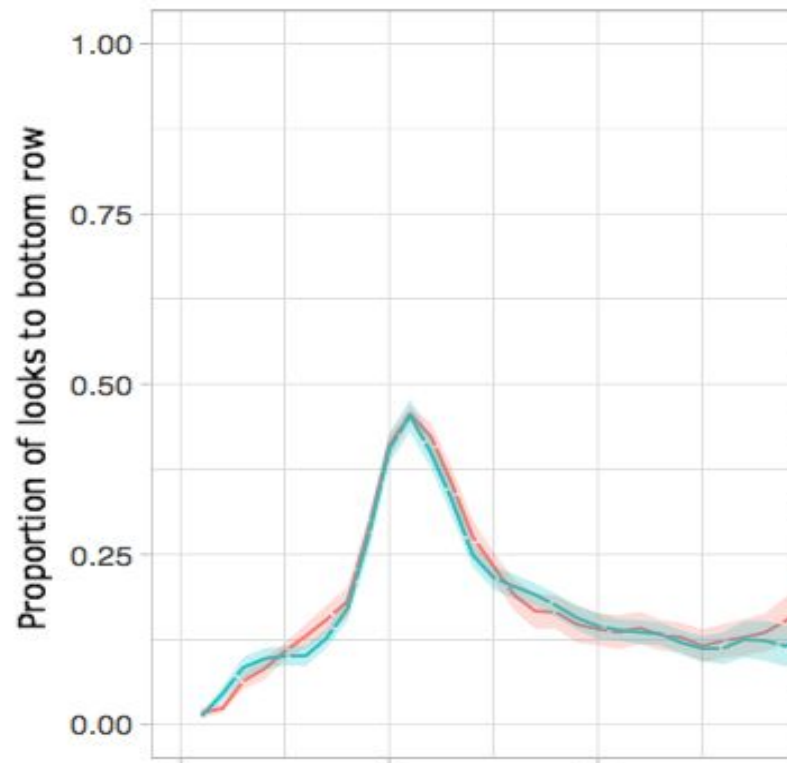
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“The top row contains the frog ...

*It **doesn’t** contain the ...*

Experiment 1: Results

The top row contains the frog; it



condition

 Neg

 Aff

Experiment 1: Results

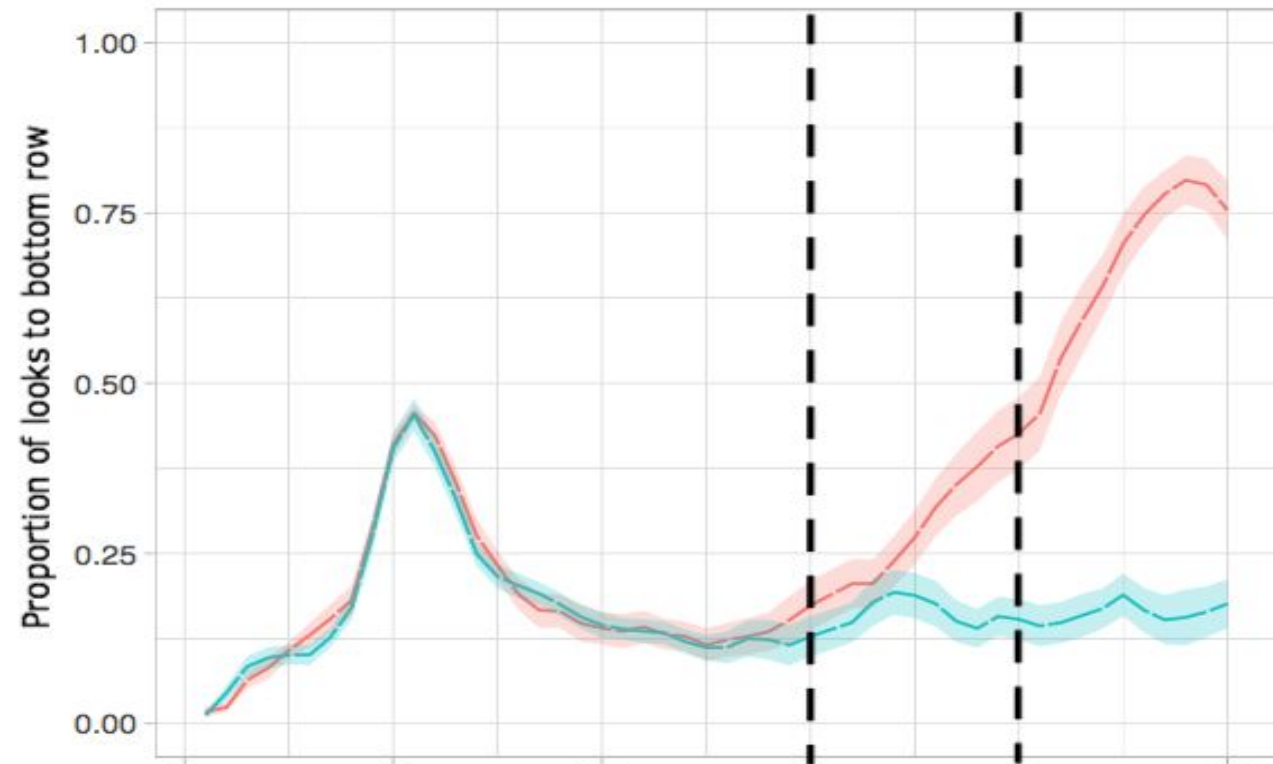
The top row contains the frog; it **also** contain(s) the **camera**.
doesn't **dumbbell**.



condition

Neg

Aff



Recap of Findings

Experiment 1:

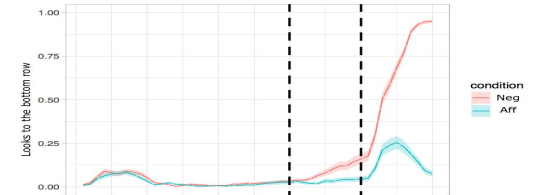
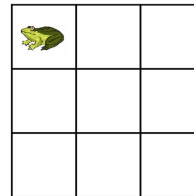
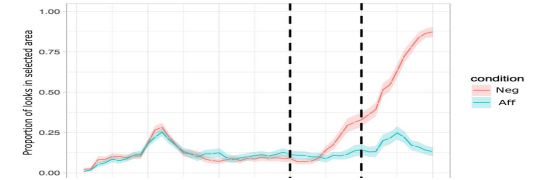
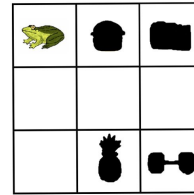
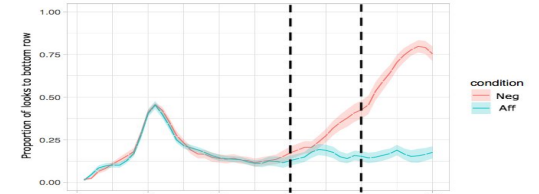
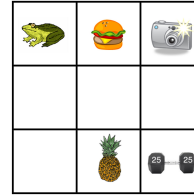
Incremental interpretation of negation

Experiment 2:

Not an artifact of shallow processing

Experiment 3:

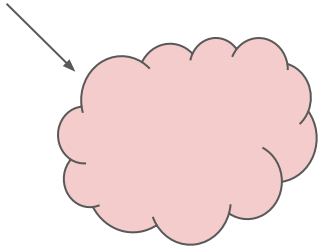
Visual scene facilitates anticipatory looks



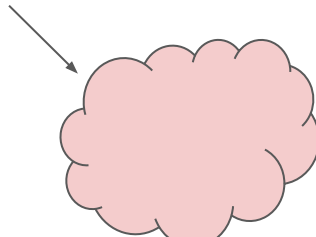
Incremental Interpretation

(How) do we interpret NEG before prejacents is known?

It doesn't ...



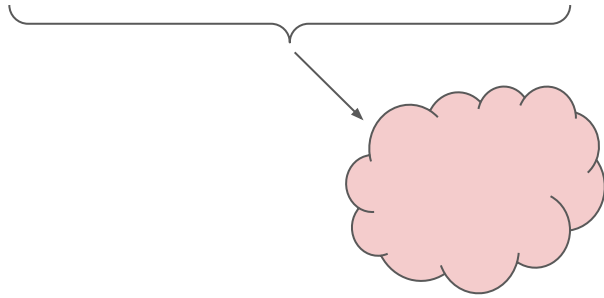
The authors [that **no** critics recommended ...



Pause for discussion

Basic Phenomenon

(6) *The authors [that **no** critics recommended] have *ever* written a best-selling novel.



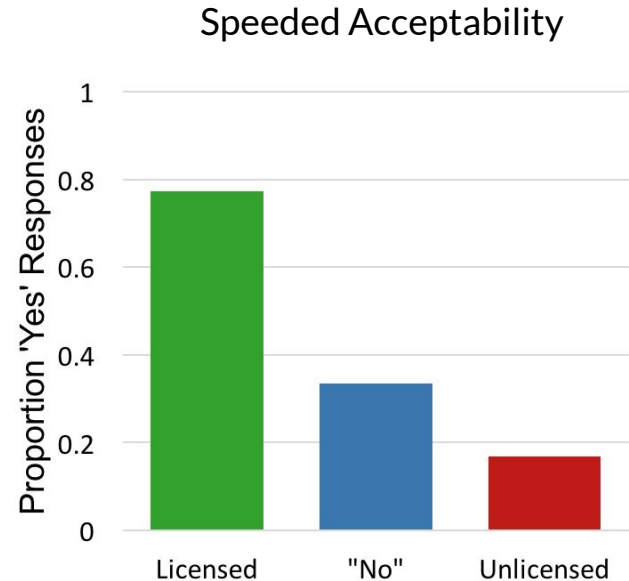
NPI Illusions

(3) **No** authors [that the critics recommended] have *ever* written a best-selling novel.

(4) *The authors [that **no** critics recommended] have *ever* written a best-selling novel.

(5) *The authors [that the critics recommended] have *ever* written a best-selling novel.

The authors that the critics recommended have written *any* best-selling novels.



NPI Illusions

(4) *The authors [that **no** critics recommended] have *ever* written a best-selling novel.

NPI Illusions

(4) *The authors [that **no** critics recommended] have..... *ever* written a best-selling novel.

NPI Illusions

(6a) The journalists [that **no** editors recommended for the assignment] *ever* thought that the readers would understand the complicated situation.

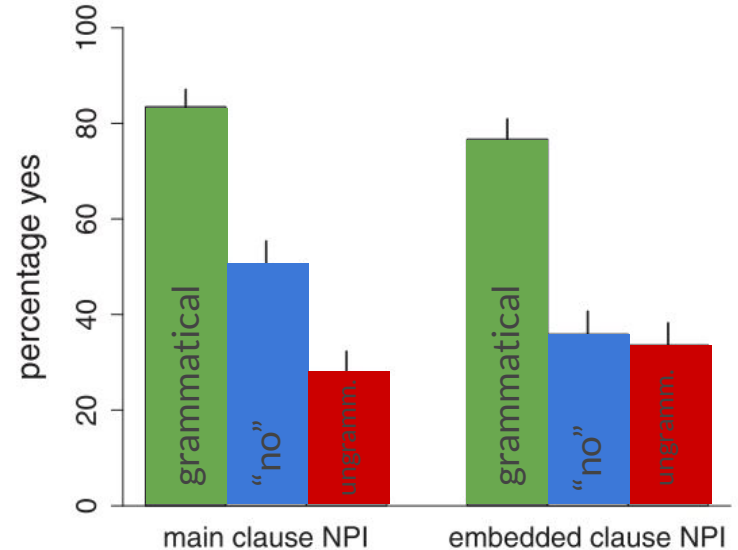
(6b) The journalists [that **no** editors recommended for the assignment] thought that the readers would *ever* understand the complicated situation.

The distance effect

(17) **No** journalists [that the editors recommended for the assignment] (*ever*) thought that the readers would (*ever*) understand the complicated situation.

(18) *The journalists [that **no** editors recommended for the assignment] (*ever*) thought that the readers would (*ever*) understand the complicated situation.

(19) *The journalists [that the editors recommended for the assignment] (*ever*) thought that the readers would (*ever*) understand the complicated situation.



Which distance?

(A) *The journalists [that **no** editors recommended for the assignment] (*ever*) thought that the readers would (*ever*) understand the complicated situation.

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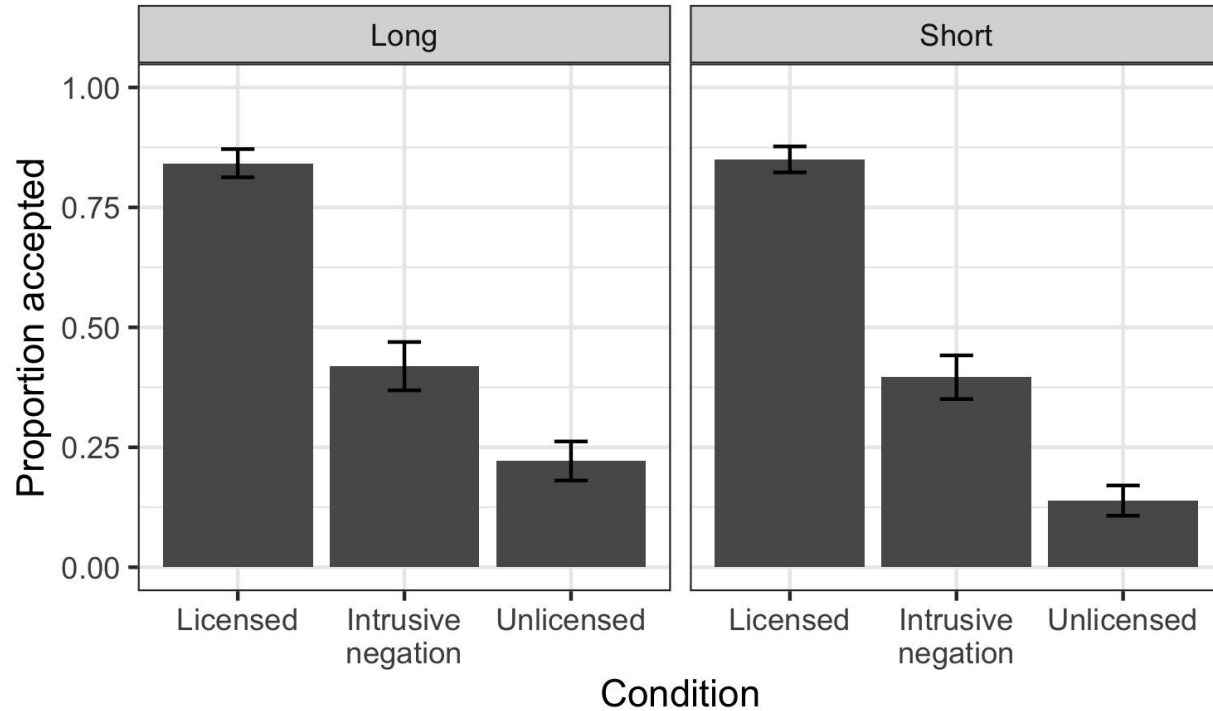


The distance effect - Exp 1

(20) *The journalists [that **no** editors recommended **for the assignment**] (*ever*) thought that the readers would understand the complicated situation.


(21) *The journalists [that **no** editors recommended] (*ever*) thought that the readers would understand the complicated situation.

The distance effect - Exp 1




The distance effect - Exp 2

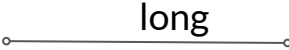
(a-c) No/The surgeons [that no/the patients trusted] have *ever* prescribed new experimental medications.



(d-f) No/The surgeons [that no/the patients trusted **to heal their injuries**] have *ever* prescribed new experimental medications.



(g-i) No/The surgeons [that no/the patients have trusted] have **healed** *any* injuries with experimental medications.



The distance effect - Exp 2

short

(a-c) No/The surgeons [that no/the patients trusted] have *ever* prescribed new experimental medications.

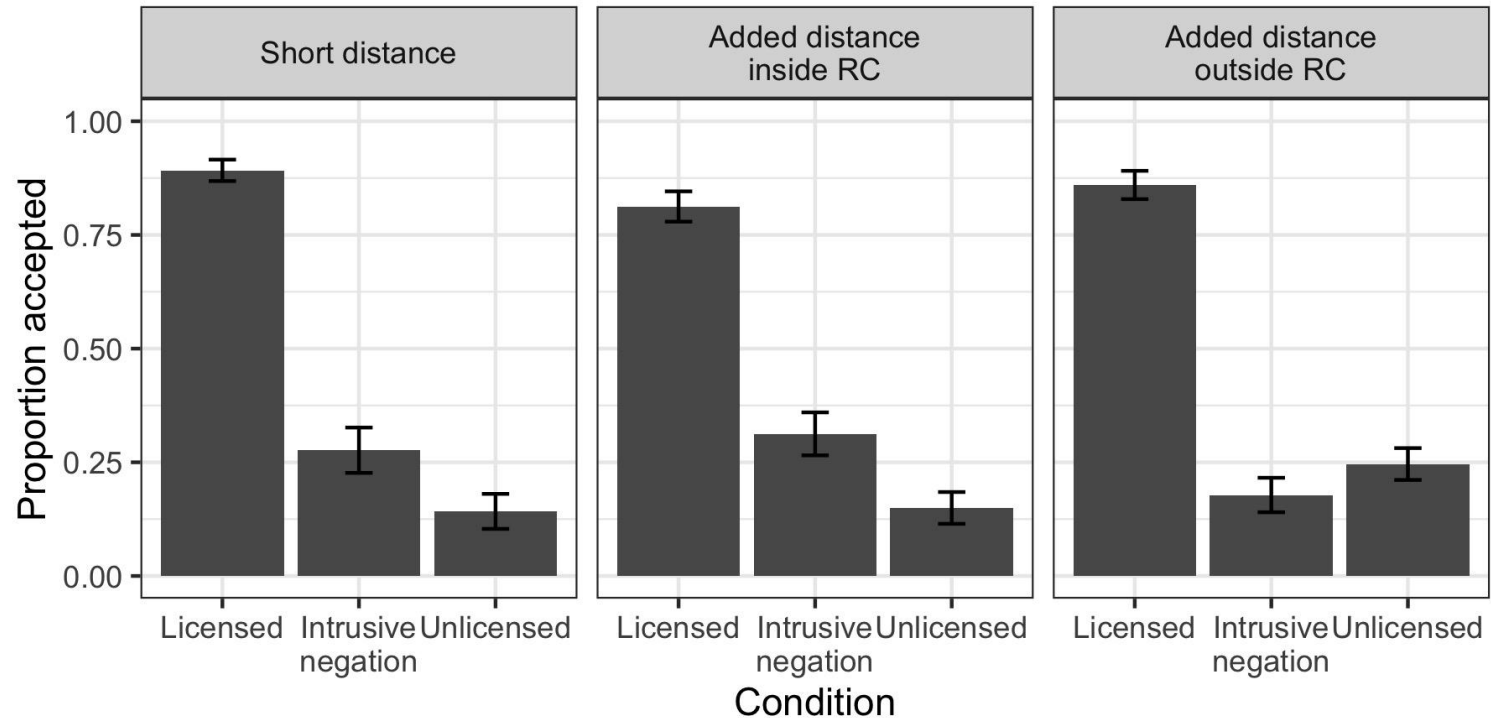
long

(d-f) No/The surgeons [that no/the patients trusted **to heal their injuries**] have *ever* prescribed new experimental medications.

long

(g-i) No/The surgeons [that no/the patients have trusted] have **healed** *any* injuries with experimental medications.

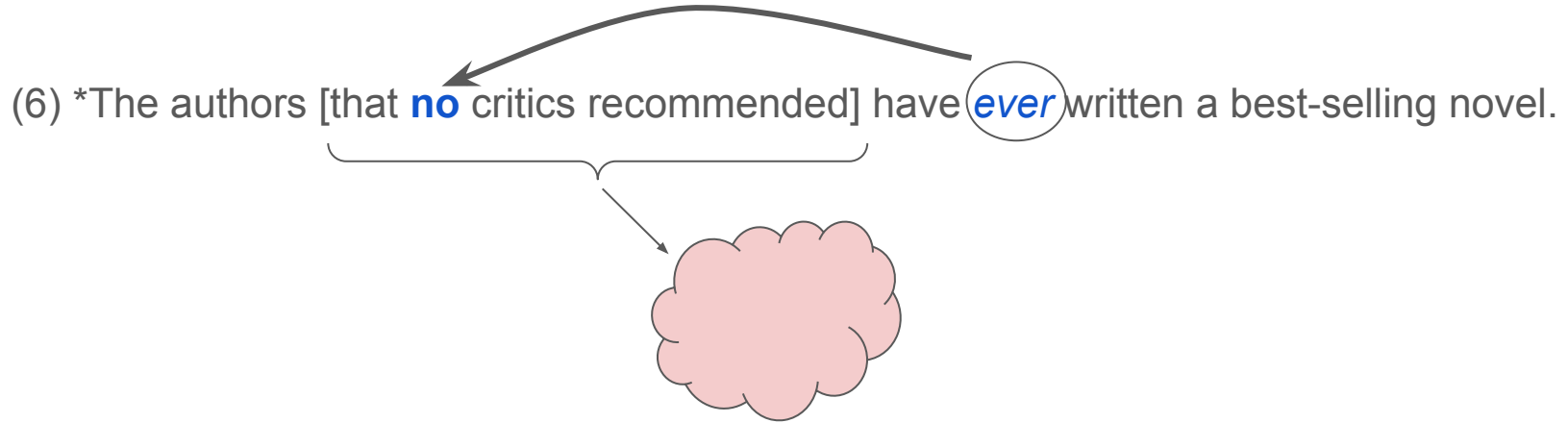
The distance effect - Exp 2



The distance effect

- Short distances from the *licensing environment* to the NPI are critical for illusions to occur
- NPI illusions are insensitive to the distance between the intrusive licensor and the NPI

Basic Phenomenon

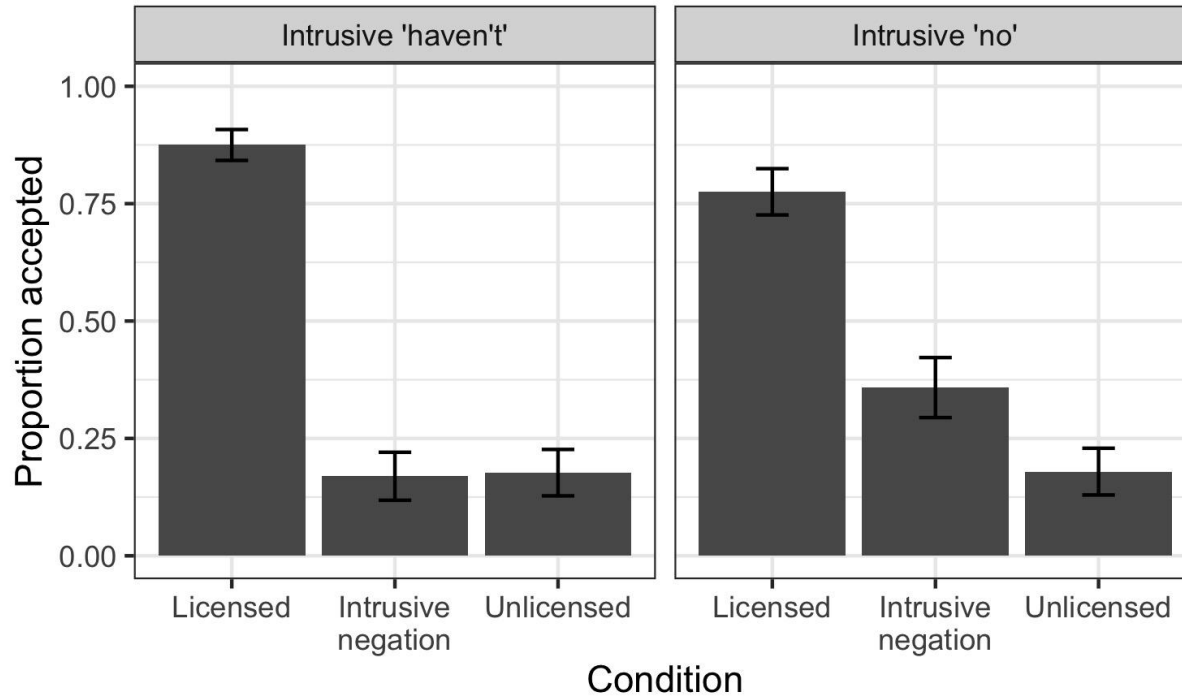


The licensor effect

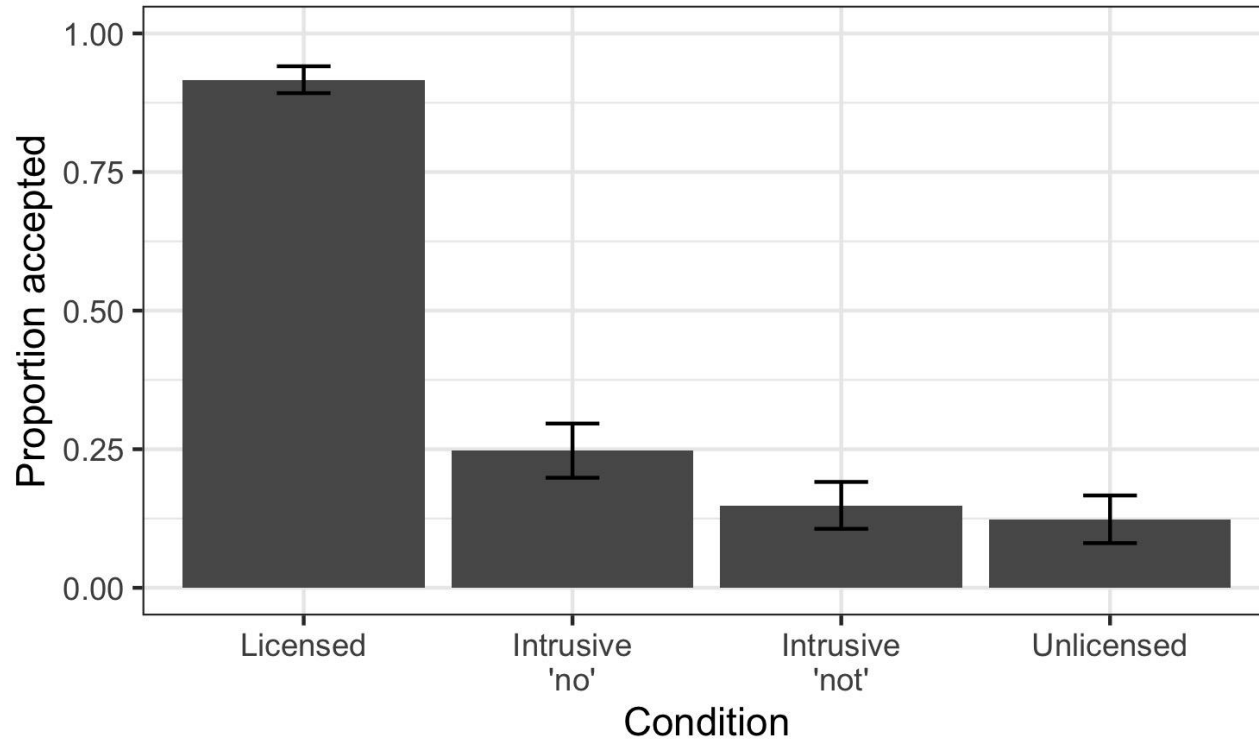
The authors [that **no** critics have recommended for the award] have ever received acknowledgement for a best-selling novel.

The authors [that the critics **haven't** recommended for the award] have ever received acknowledgement for a best-selling novel.

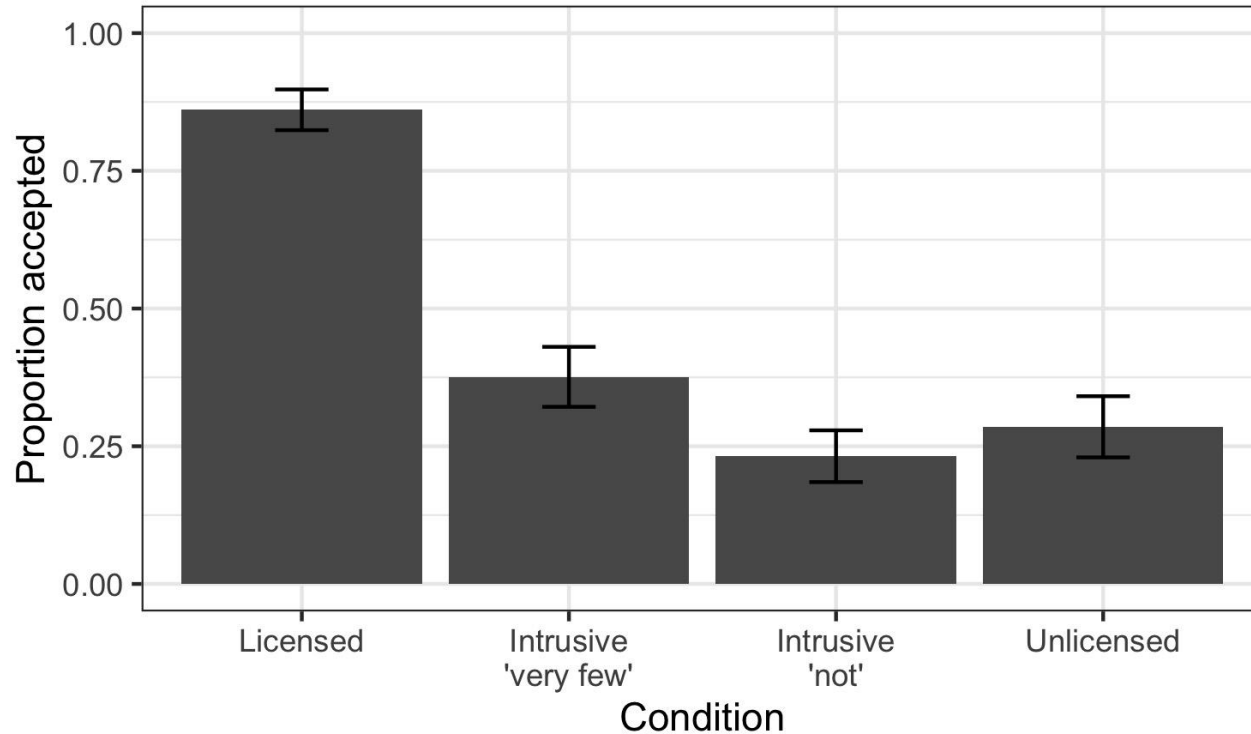
The licenser effect - Exp 3



The licenser effect - Exp 4




The licenser effect in subject relative clauses - Exp 5




Two key generalizations

(6) *The authors [that **no** critics recommended] have **ever** written a best-selling novel.

The type of
licensor matters

A vertical arrow pointing upwards from the text 'The type of licensor matters' to the word 'no' in the sentence above.

The distance to a
licensing environment
matters

A vertical arrow pointing upwards from the text 'The distance to a licensing environment matters' to the word 'ever' in the sentence above.

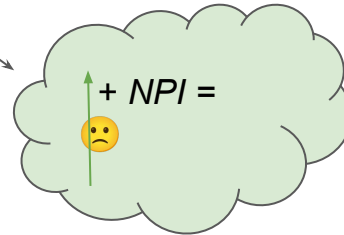
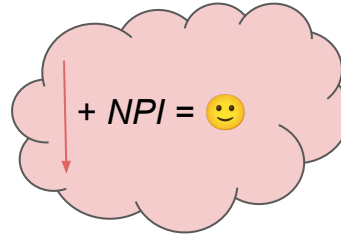
Pause for discussion

Why don't all licensors yield illusions?

What's special about negative quantifiers?

NPI processing

- (1) We **haven't** left the house *in months*.
- (2) * We have left the house *in months*.



strong

I haven't **ever** been to Paris.

I haven't been to Paris **in the last five years**.

I haven't been to Paris **today**.

weak

weak



*I have **ever** been to Paris.

I have been to Paris **in the last five years**.

I have been to Paris **today**.

strong

Negative quantifiers vs sentential negation

“The boy doesn’t have a pencil.”

“No one has their school supplies!”

Negative quantifiers vs sentential negation

The authors [that no critics have recommended ...

The authors [that the critics haven't recommended ...

Quantifier scope

*The authors [that **no** critics recommended] have *ever* written a best-selling novel.

Quantifier scope

*The authors [that no critics recommended] have *ever* written a best-selling novel.



Quantifier scope

*[**No** authors]_{*i*} [The authors [that *t_i* recommended] have *ever* written a best...]



Quantifier scope

*[No authors]_{*i*} [The authors [that *t_i* recommended] have *ever* written a best...]



(8) Three referees read every abstract. (from Szabolcsi 1997)

(9) Someone from every city despises it. (from May 1985)

Quantifier scope

*[No authors]_{*i*} [The authors [that *t_i* recommended] have *ever* written a best...]



(8) Three referees read every abstract. (from Szabolcsi 1997)

(9) Someone from every city despises it. (from May 1985)

Quantifier scope

*[No authors]_{*j*} [The authors [that *t_i* recommended] have *ever* written a best...]



(8) Three referees read every abstract. (from Szabolcsi 1997)

(9) Someone from every city despises it. (from May 1985)

(But note that the inverse reading is systematically unavailable for DE quantifiers)

(10) Three referees read few abstracts. (from Szabolcsi 1997)

Quantifier scope

*[No authors]_{*i*} [The authors [that *t_i* recommended] have *ever* written a best...]



Scoping negation over the whole sentence should impact interpretations

Probing interpretations - Exp 6

The authors that no critics recommended have ever received acknowledgment for a best-selling novel.

Was that sentence acceptable? Yes / No

Did the authors receive acknowledgment? Yes / No / I don't know

Probing interpretations - Exp 6

The authors that no critics recommended have **ever** received acknowledgment for a best-selling novel.

Was that sentence acceptable? Yes / No

Did the authors receive acknowledgment? Yes / No / I don't know

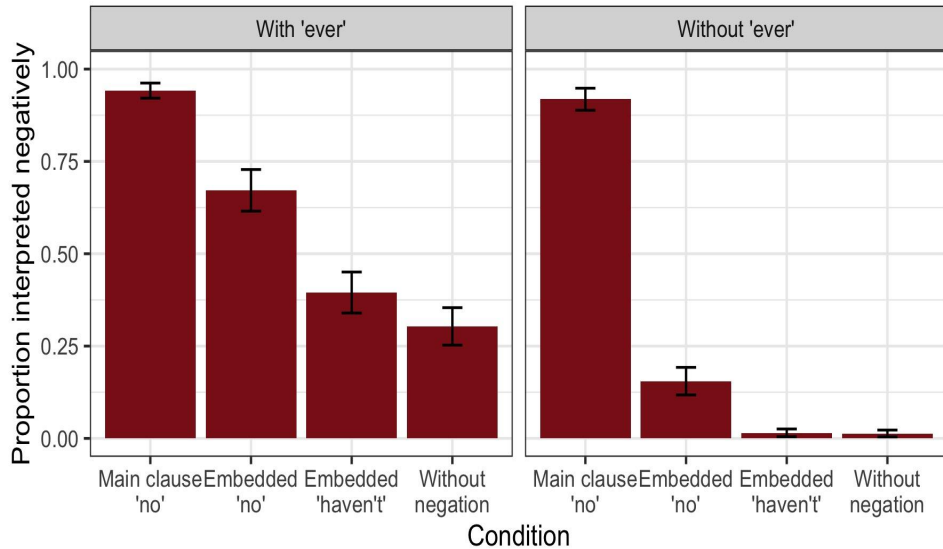
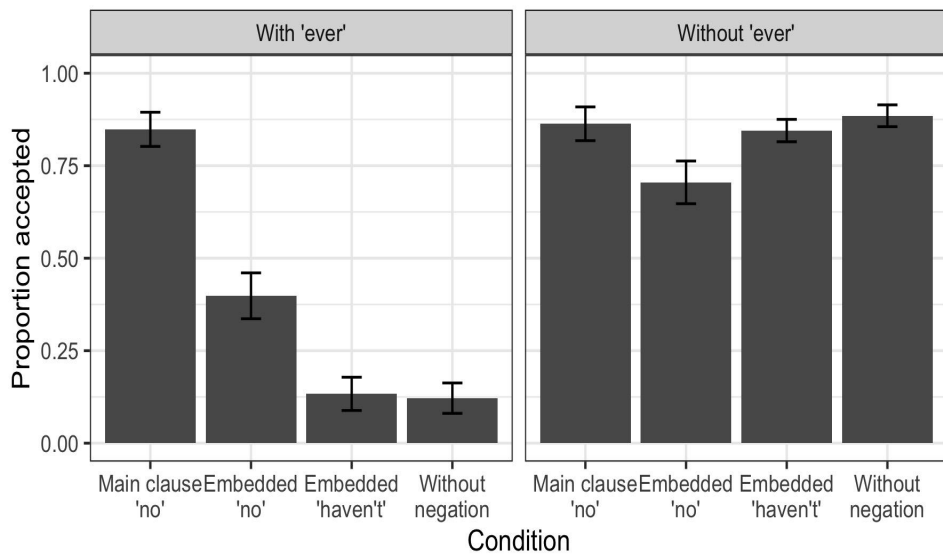
Probing interpretations - Exp 6

The authors that no critics recommended have received acknowledgment for a best-selling novel.

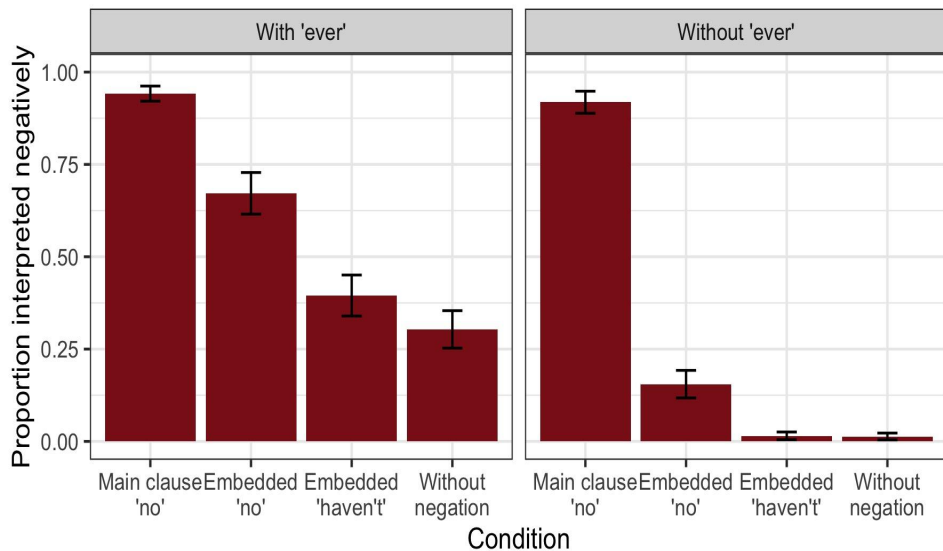
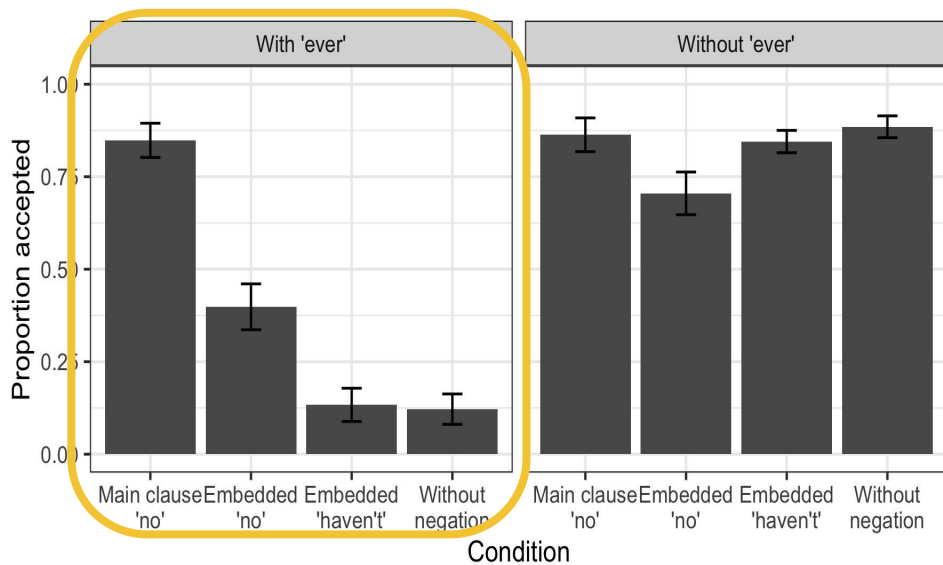
Was that sentence acceptable? Yes / No

Did the authors receive acknowledgment? Yes / No / I don't know

Probing interpretations - Exp 6



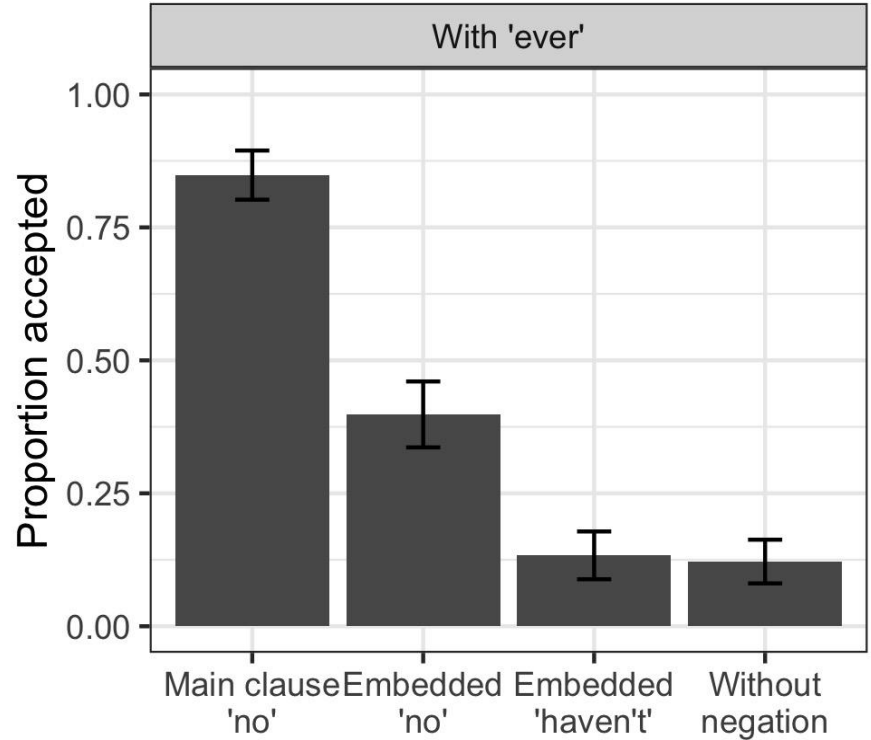
Probing interpretations - Exp 6



Probing interpretations - Exp 6

- a. **No** authors [that the critics recommended] have **ever** received acknowledgment for a best-selling novel.
- b. The authors [that **no** critics recommended] have **ever** received acknowledgment for a best-selling novel.
- c. The authors [that the critics **didn't** recommend] have **ever** received acknowledgment for a best-selling novel.
- d. The authors [that the critics recommended] have **ever** received acknowledgment for a best-selling novel.

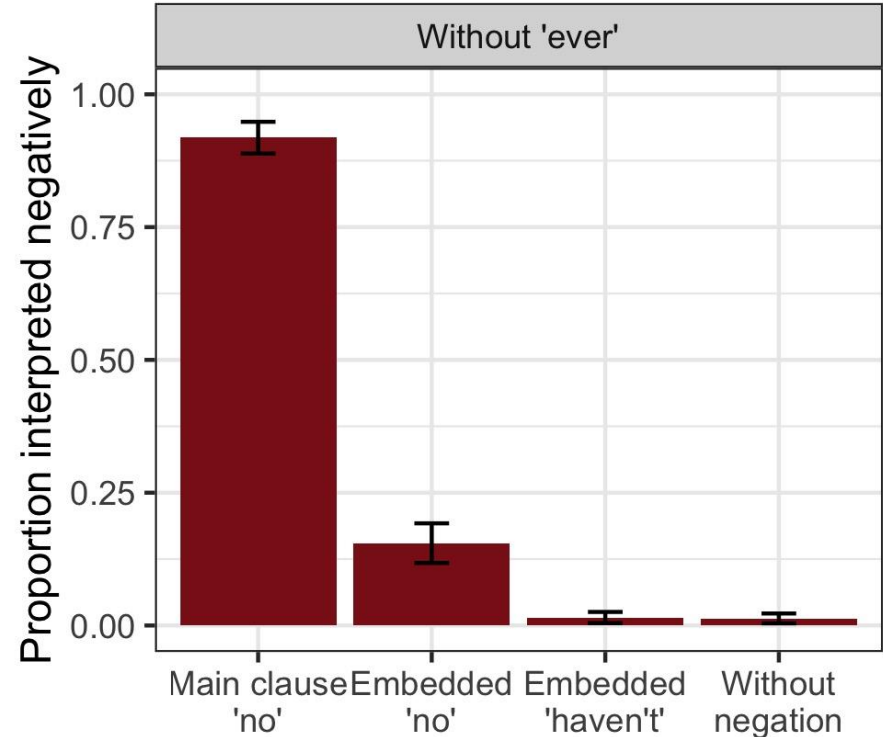
Was that sentence acceptable? Yes / No



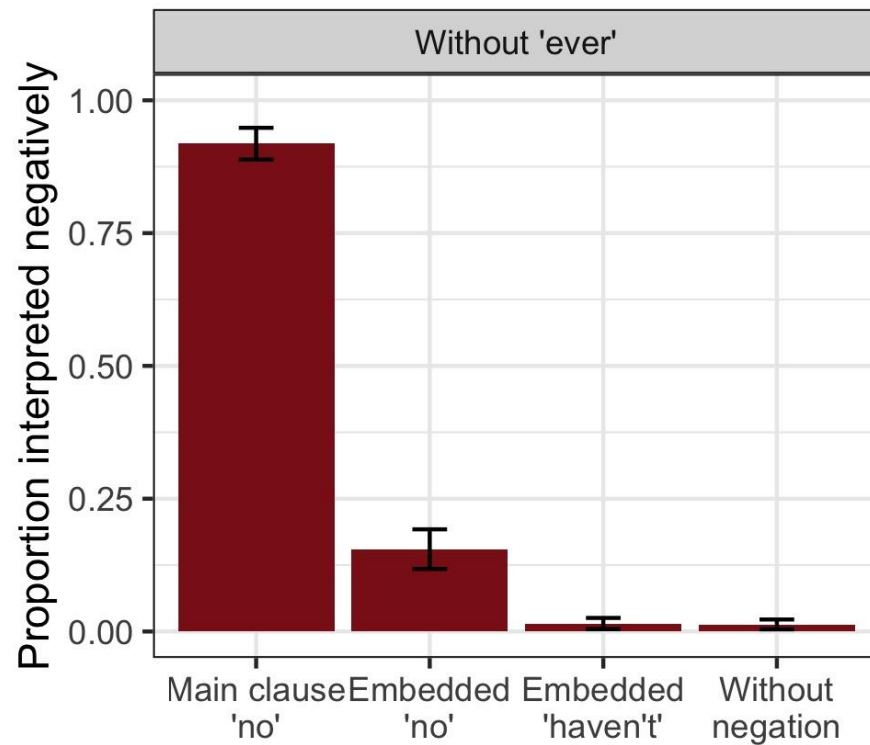
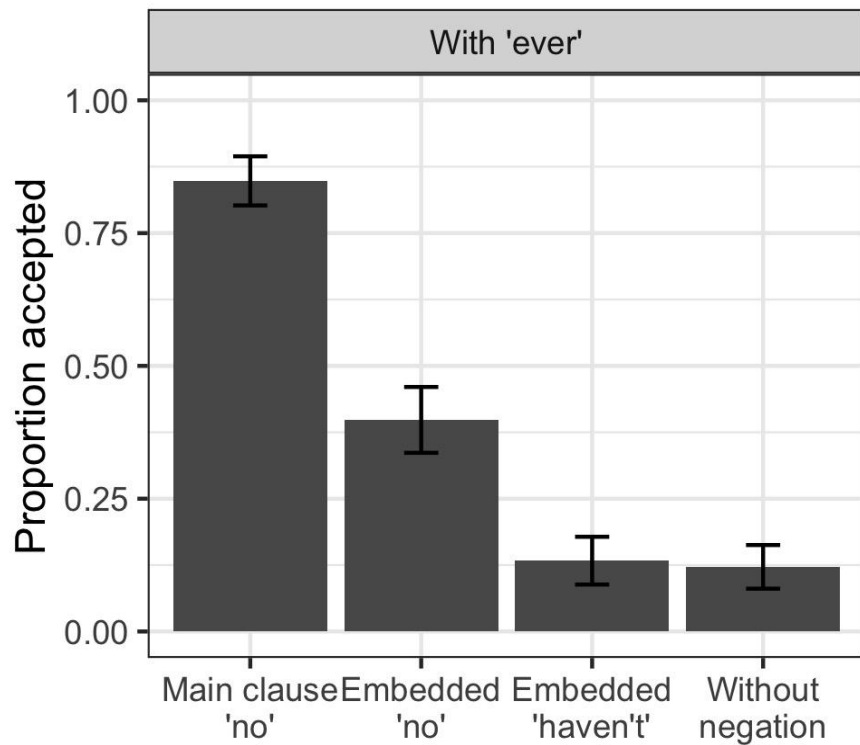
Probing interpretations - Exp 6

- a. **No** authors [that the critics recommended] have received acknowledgment for a best-selling novel.
- b. The authors [that **no** critics recommended] have received acknowledgment for a best-selling novel.
- c. The authors [that the critics **didn't** recommend] have received acknowledgment for a best-selling novel.
- d. The authors [that the critics recommended] have received acknowledgment for a best-selling novel.

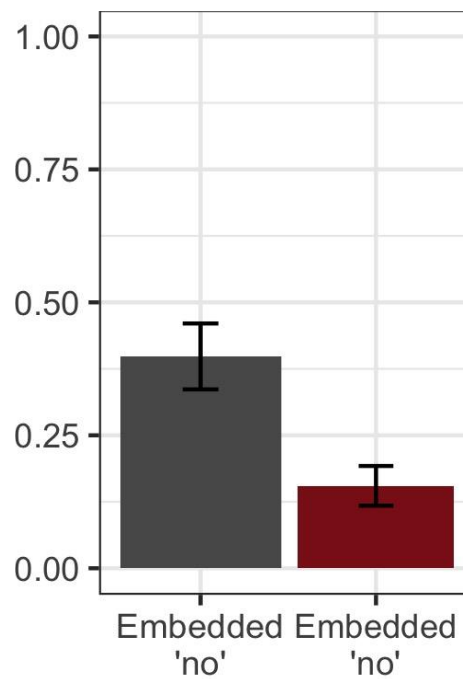
Did the authors receive acknowledgment? Yes / No / I don't know



Probing interpretations - Exp 6



Probing interpretations - Exp 6



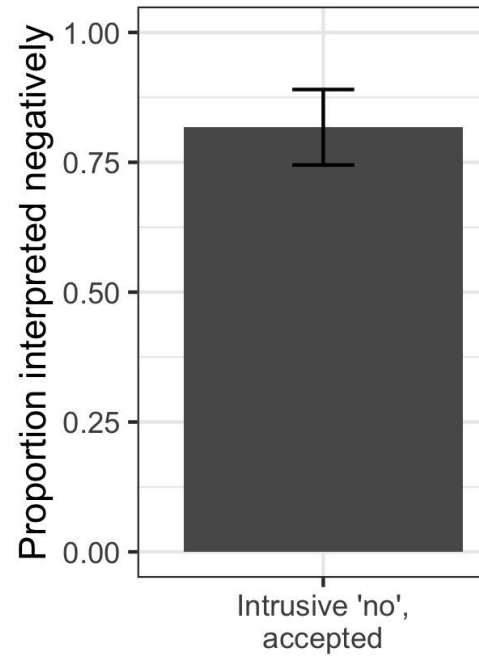
Probing interpretations - Exp 6

The authors that no critics recommended have ever received acknowledgment for a best-selling novel.

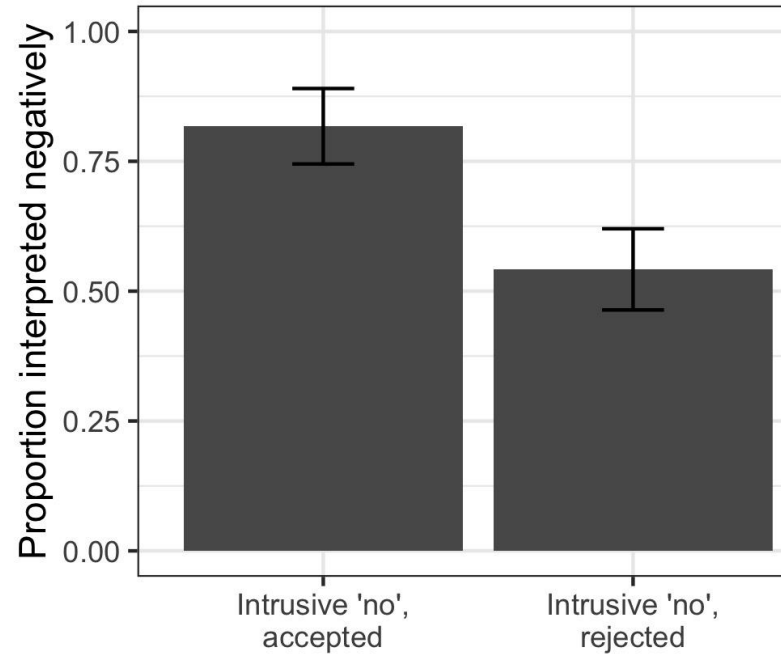
Was that sentence acceptable? Yes / No

Did the authors receive acknowledgment? Yes / No / I don't know

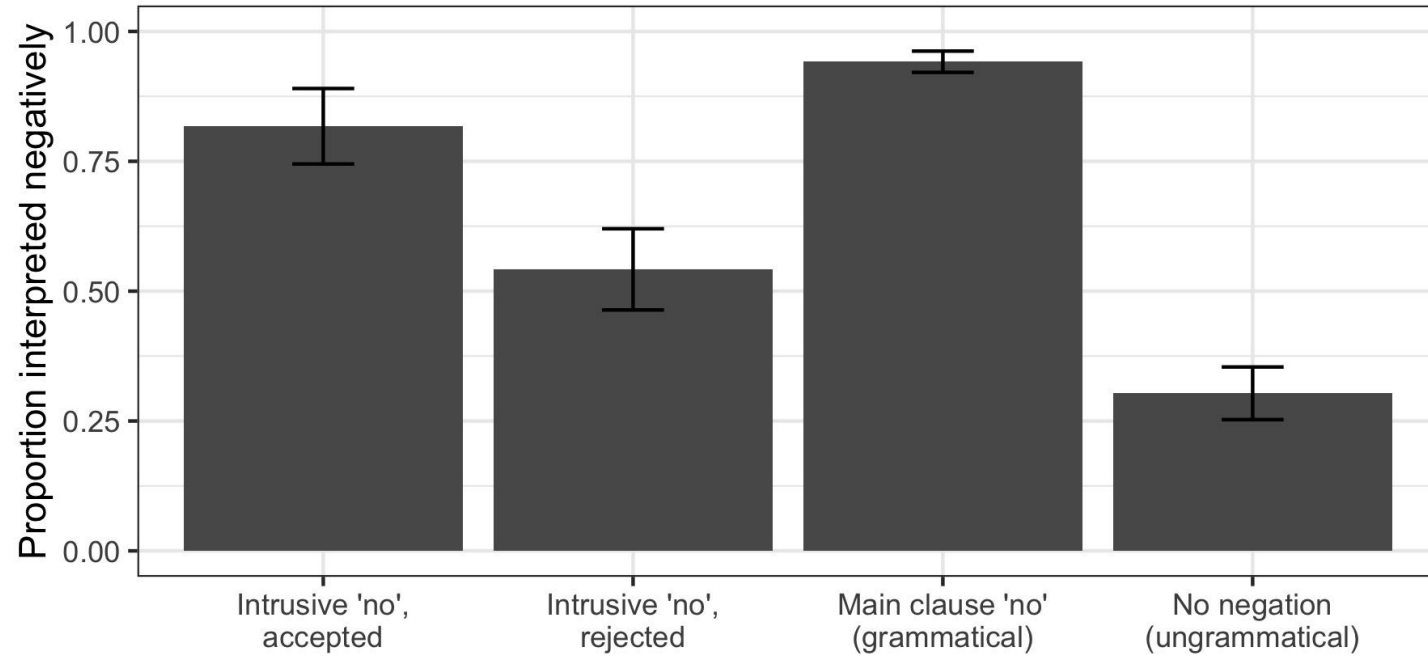
Quantifier scope - Exp 6



Quantifier scope - Exp 6



Quantifier scope - Exp 6



Probing interpretations - Exp 6

The authors [that no critics recommended] have ever received acknowledgment for a best-selling novel.

Was that sentence acceptable? Yes / No

Did the authors receive acknowledgment? Yes / No / I don't know

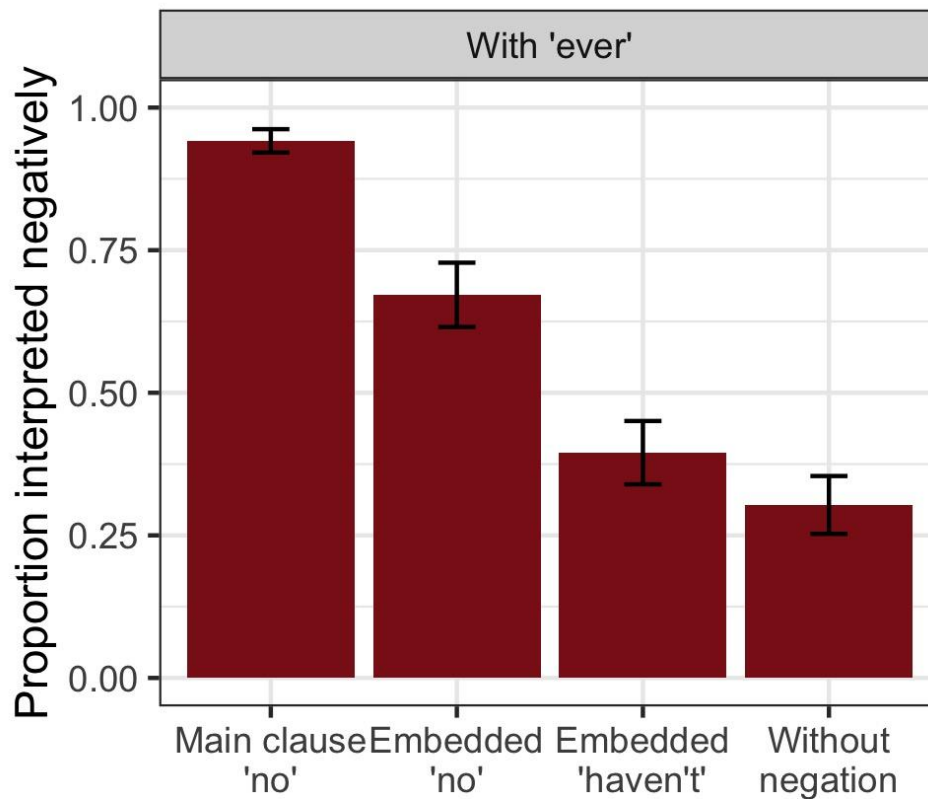
Probing interpretations - Exp 6

The authors [that no critics recommended ~~have~~ ever] received acknowledgment for a best-selling novel.

Was that sentence acceptable? Yes / No

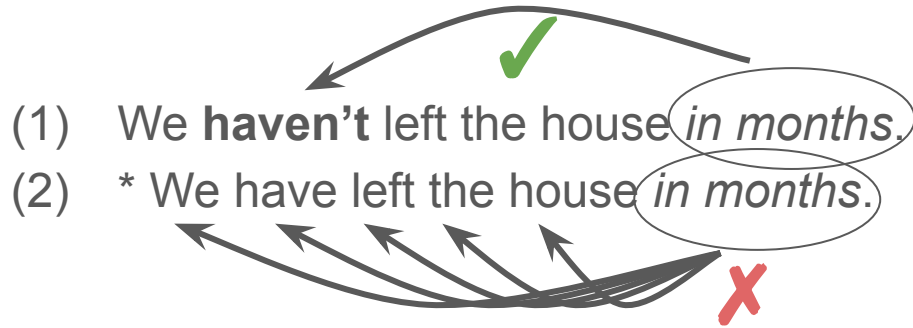
Did the authors receive acknowledgment? Yes / No / I don't know

Quantifier scope - Exp 6

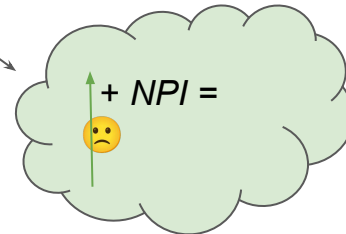
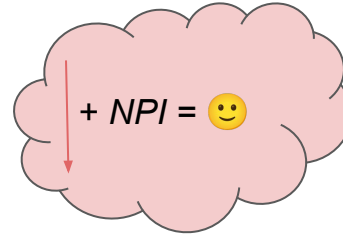


Summing up

NPI processing

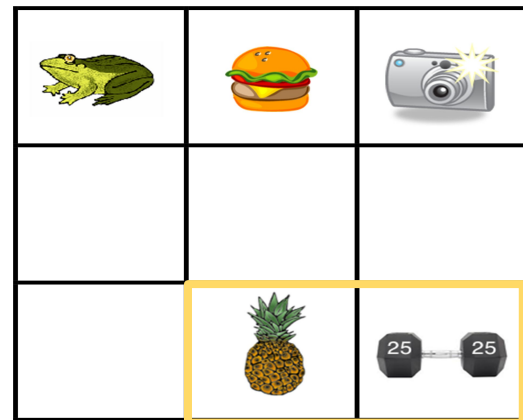


- (1) We **haven't** left the house *in months*.
- (2) * We have left the house *in months*.

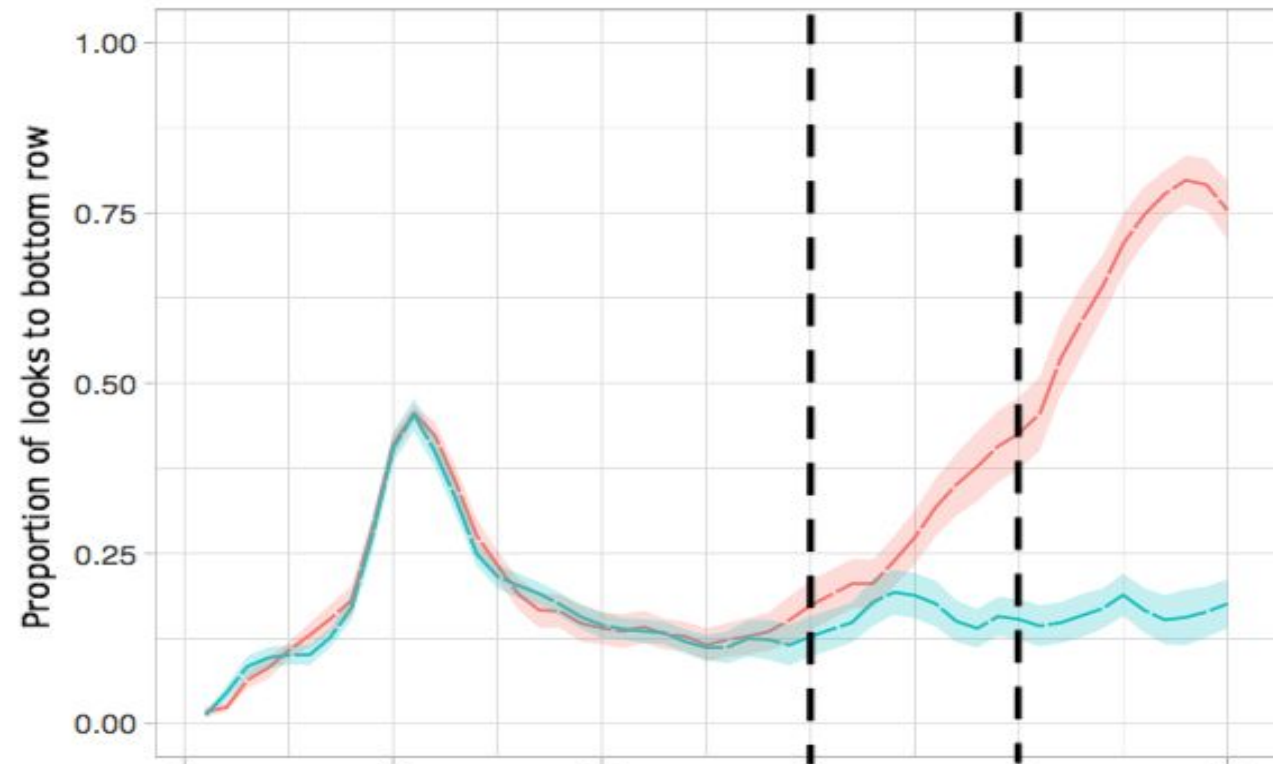


Negation processing

The top row contains the frog; it **also** contain(s) the **camera**.
doesn't **dumbbell**.

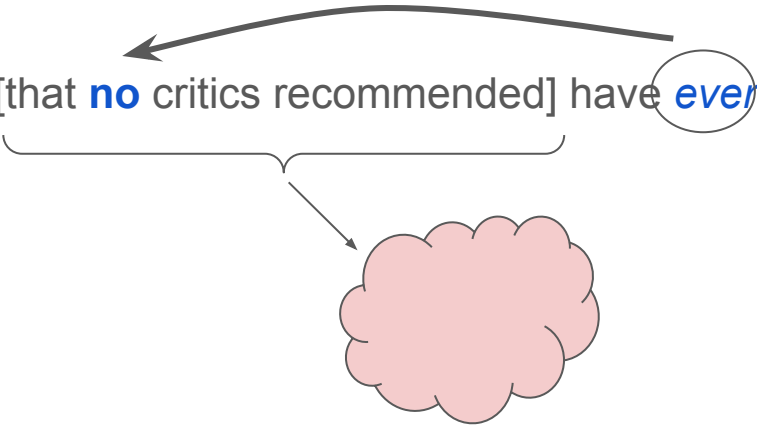


condition
— Neg
— Aff

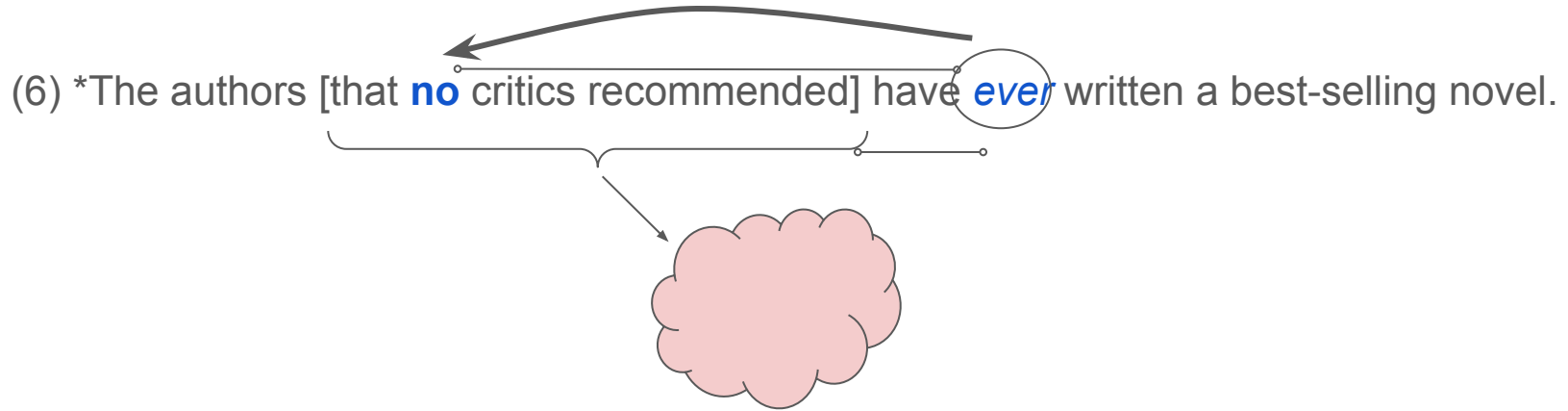


NPI Illusions

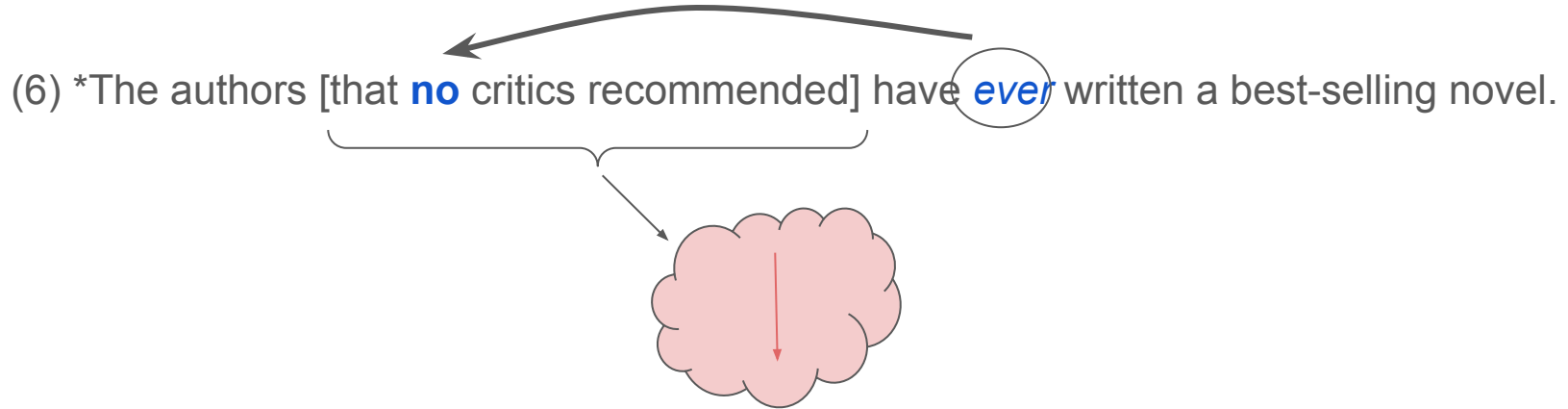
(6) *The authors [that **no** critics recommended] have **ever** written a best-selling novel.



NPI Illusions



NPI Illusions



Thank you!