# Testing a PPI analysis of superlative-modified numerals

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# Comparative- vs. Superlative-modified numerals

- Truth-conditionally equivalent [Cohen and Krifka 2011, 2014]:

  John has more than 2 / at least 3 diamonds.

  = John has 3/4/5/... diamonds.

**the epistemic contrast:**

- Both CMs and SMs are compatible with speaker ignorance about the exact value, but SMs require it [Nouwen 2015]:

  I don't know how many diamonds John has, but it's definitely more than 2 / at least 3.

  John has exactly 3 diamonds, so that's more than 2 / *at least 3.

# Comparative vs. Superlative-modified numerals

- Truth-conditionally equivalent [Cohen and Krifka 2011, 2014]:

  John has more than 2 / at least 3 diamonds.

  = John has 3/4/5/... diamonds.

**the polarity contrast:**

- Unlike CMs, SMs are bad under negation [Nilsen 2007; Geurts and Nouwen 2007; Cohen and Krifka 2011, 2014; Spector 2014, 2015]:

  John doesn't have more than 2 / *at least 3 diamonds.

  => SMs are positive polarity items (PPIs)?

# Positive polarity items [e.g., Spector 2014, 2015]

**(1) (Anti)licensing:**

- Every PPI is bad under sentential negation:

  *Jack is **not** still sleeping.

- No PPI is bad in the antecedent of a conditional / restriction of a universal:

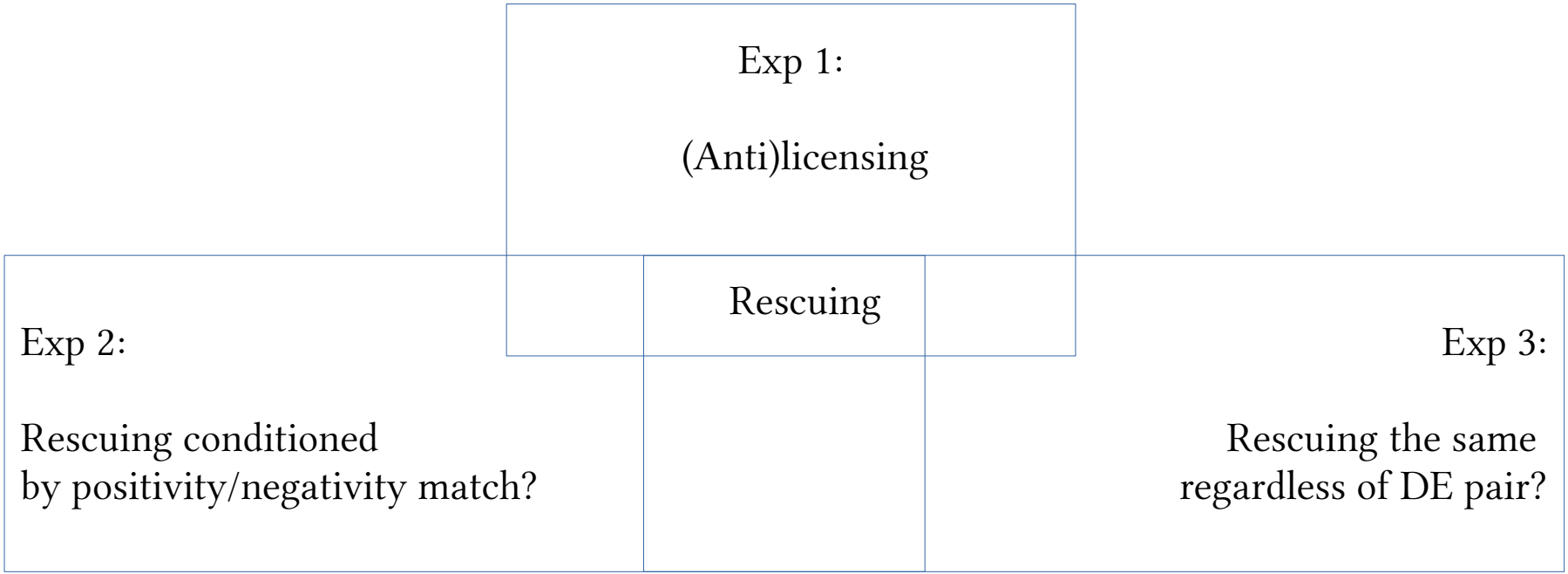
  If [Jack is still sleeping], we'll go out without him.

  Every [student who is still sleeping] will fail the exam.

**(2) "Rescuing" if the negation is further embedded in another (Strawson) downward-entailing environment:**

If [it was**n't** still fun], I wouldn't be here.

# Plan: To take the PPI analysis for SMs seriously



# Experiment 1

# Hypotheses

- SMs worse than CMs under negation
- SMs on a par with CMs in the antecedent of conditionals / restriction of universals
- SMs on a par with CMs under negation if negation further embedded, for example, in the antecedent of a conditional / restriction of a universal

# Participants, design, and statistical model

- 27 native speakers of English on MTurk; 2 excluded prior to analysis
- Factorial design:

  3 (sentence types: declarative, conditional, universal)

  x 2 (polarity: positive, negative)

  x 2 (modifier types: CM, SM) / 4 (modifiers: at least / most 3, less / more than 3)

  = 12/24 conditions
- Mixed-effects logistic regression model:

  response ~ ModType/Mod * Polarity * SenType + (1|Subject)

# Schematic structure of trials

Y ∈ {diamonds, spades, hearts, clubs}

| Sentence type | Polarity | Schematic structure of item |
|---|---|---|
| declarative | positive | I have CM/SM 3 Y |
| | negative | I don't have CM/SM 3Y |
| conditional | positive | If you have CM/SM 3 Y, then we have something in common |
| | negative | If you don't have CM/SM 3 Y, then we have something in common |
| universal | positive | Everyone who has CM/SM 3 Y has something in common with me |
| | negative | Everyone who doesn't have CM/SM 3 Y has something in common with me |

# Instructions

In this survey you will answer questions about a group of friends playing a game.

At the beginning of the game each player gets dealt a hand of seven cards. After taking a quick look at them, they must place the cards face down and try to remember their hands. Then they take turns giving clues about their hands to the other players in the form of statements describing their hands.

we wanted to ensure ignorance (card game adapted from Cremers & Chemla 2016)

You will see what a player remembers about his/her cards and the statement s/he makes, then you will be asked if you think the other players will understand what s/he said.

we didn't want to prejudge the source of the contrast

# Example trial

Charizard remembers:

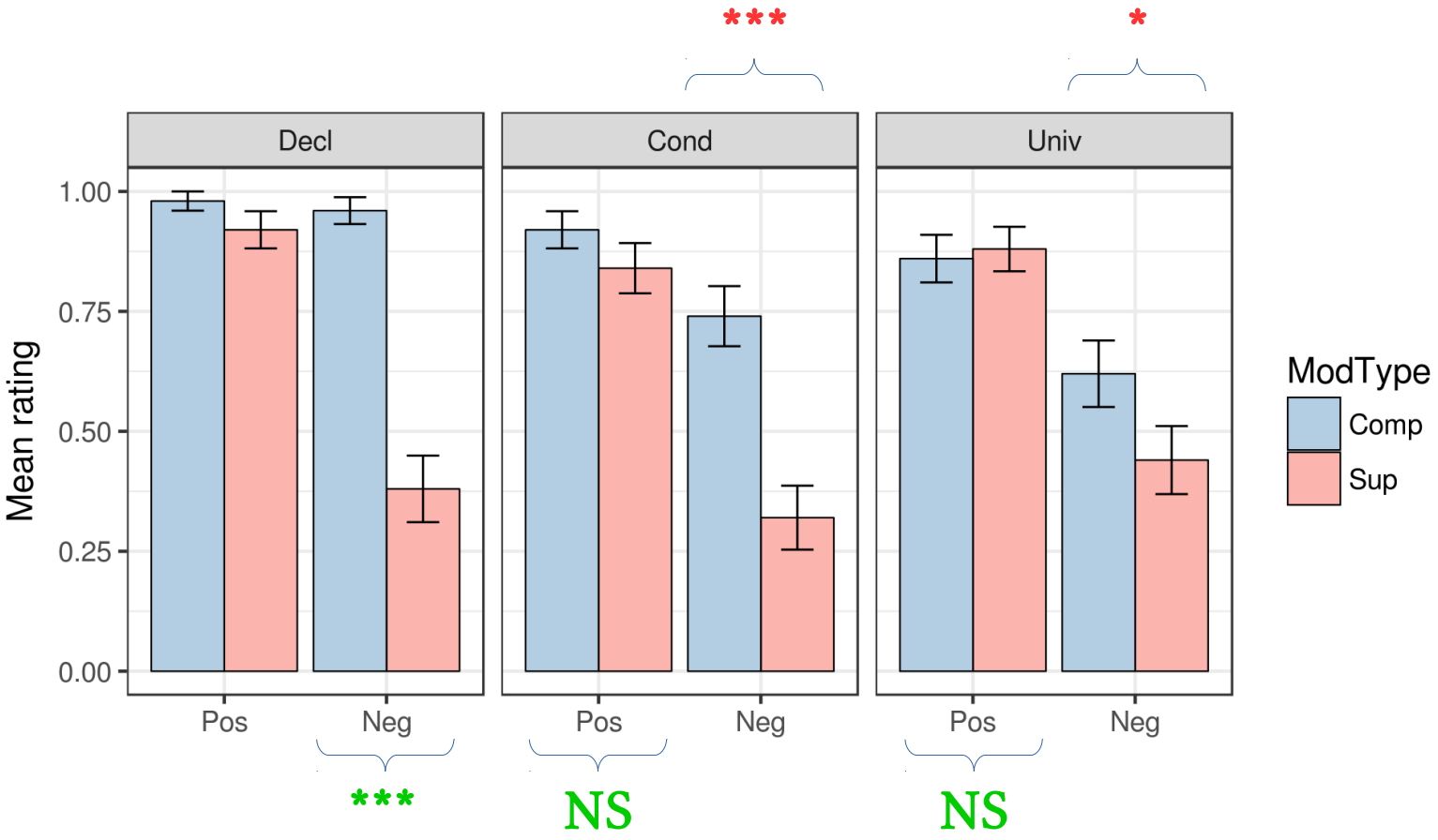

Charizard says: I don't have at most 3 hearts.

Do you think the other players will understand what he said?

Yes.

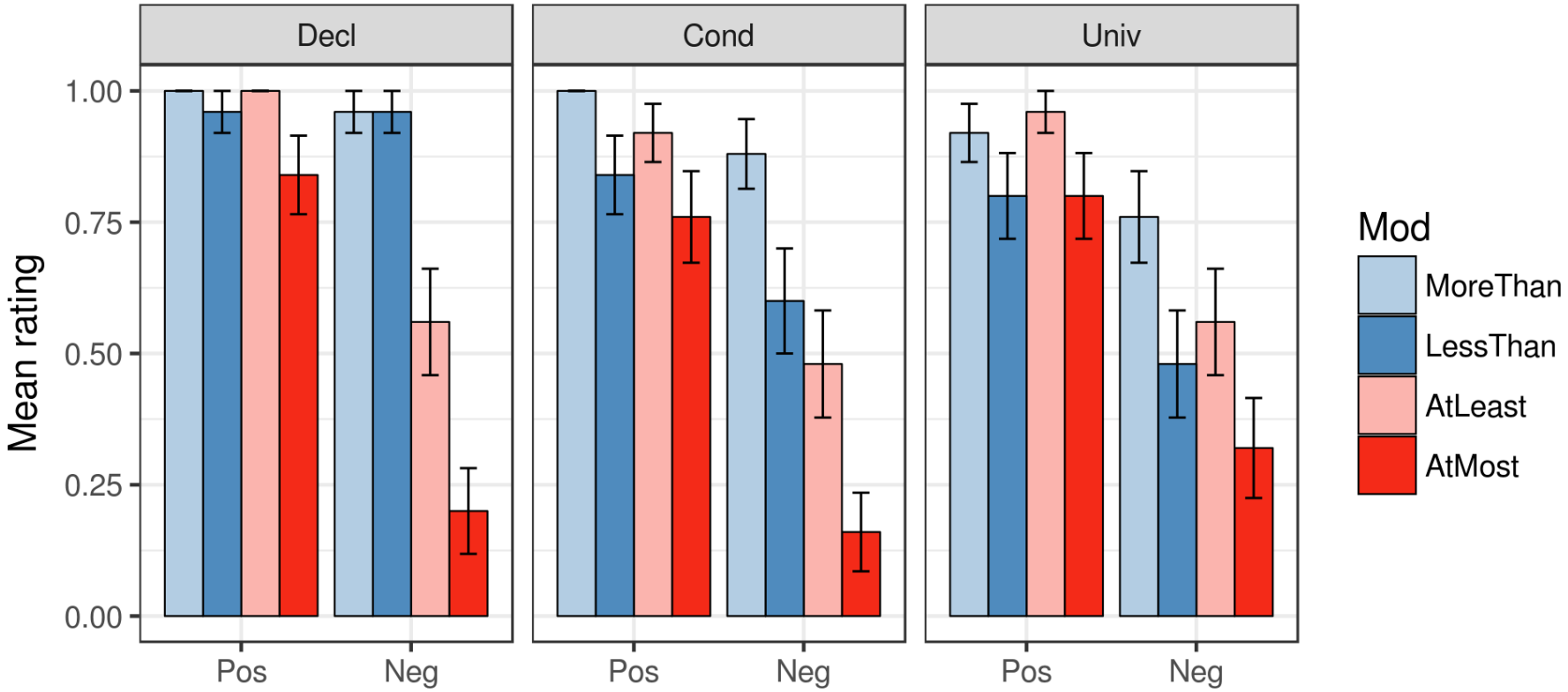
No.

# Results – by Modifier Type



# Results – by Modifier

*at least* generally better than *at most*; however, differences from CMs not driven just by *at most*



# Discussion

- The pattern of (dis)similarity between CMs and SMs seems to follow the predictions of a PPI analysis for SMs, except when it comes to rescuing.
- Is rescuing further conditioned by something else?

# Discussion

- It has been noted that SMs (but not CMs) in positive antecedents / restrictors require the continuation to have a positive valence; by extension, in negative antecedents / restrictors SMs require the continuation to have a negative valence [Nilsen 2007; Cohen & Krifka 2014]:

  If you click at least twice, …

  … #the transaction will be canceled.

  … you will get a prize.

  If you don't click at least twice, …

  … the transaction will be canceled.

  … #you will get a prize.

# Discussion

- It has been noted that SMs (but not CMs) in positive antecedents / restrictors require the continuation to have a positive valence; by extension, in negative antecedents / restrictors SMs require the continuation to have a negative valence [Nilsen 2007; Cohen & Krifka 2014]:

    Everybody who donates at least $10...

        ... will get a thank you postcard.

        ... #is a fool.

    Everybody who doesn't donate at least $10...

        ... #will get a thank you postcard.

        ... is a fool.

# Discussion

- In Experiment 1 our negated antecedents/restrictions always had a continuation with a positive valence (*… (then) we have something in common*), thus suffering from positivity/negativity mismatch.
- Will rescuing obtain if the polarity embedding antecedent/restrictor and the valence of the continuation had the same value?

# Experiment 2:

IF/EVERY [ POS/NEG SM ] [POS/NEG]

# Participants, design, and statistical model

- 45 native speakers of English on Mturk; 5 excluded prior to analysis
- Factorial design:

  **2 (sentence types: conditional, universal)**

  x 2 (polarity of the antecedent/restrictor: positive, negative)

  x **2 (valence of the continuation: positive *win*, negative *lose*)**

  x 2 (modifier types: CM, SM) / 4 (modifiers: at least/most 3, less / more than 3)

  = 16/32 conditions
- Mixed-effects logistic regression model:

  response ~ ModType/Mod * Polarity * Match * SenType + (1|Subject)

# Schematic structure of trials

Y ∈ {diamonds, spades, hearts, clubs}

| Sentence type | Polarity | Valence | Schematic structure of item |
|---|---|---|---|
| conditional | positive | positive | If you have CM/SM 3 Y, you win |
| | | negative | If you have CM/SM 3 Y, you lose |
| | negative | positive | If you don't have CM/SM 3 Y, you win |
| | | negative | If you don't have CM/SM 3 Y, you lose |
| universal | positive | positive | Everyone who has CM/SM 3 Y wins |
| | | negative | Everyone who has CM/SM 3 Y loses |
| | negative | positive | Everyone who doesn't have CM/SM 3 Y wins |
| | | negative | Everyone who doesn't have CM/SM 3 Y loses |

# Instructions

In this survey you will answer questions about a group of friends playing a game.

At the beginning of the game each player gets dealt a hand of seven cards. They are not allowed to see their own cards but they are allowed to take a quick look at their neighbor's hand. They try to remember their neighbor's hand as well as they can because in the next step they have to come up with a rule that would make that neighbor (and possibly other players too) lose or win.

You will see what a player remembers about their neighbor's hand and the rule they make up, then you will be asked if you think the other players will understand what they said.

# Example trial

Meowth remembers:

Meowth says: If you don't have at least 3 hearts, you lose.

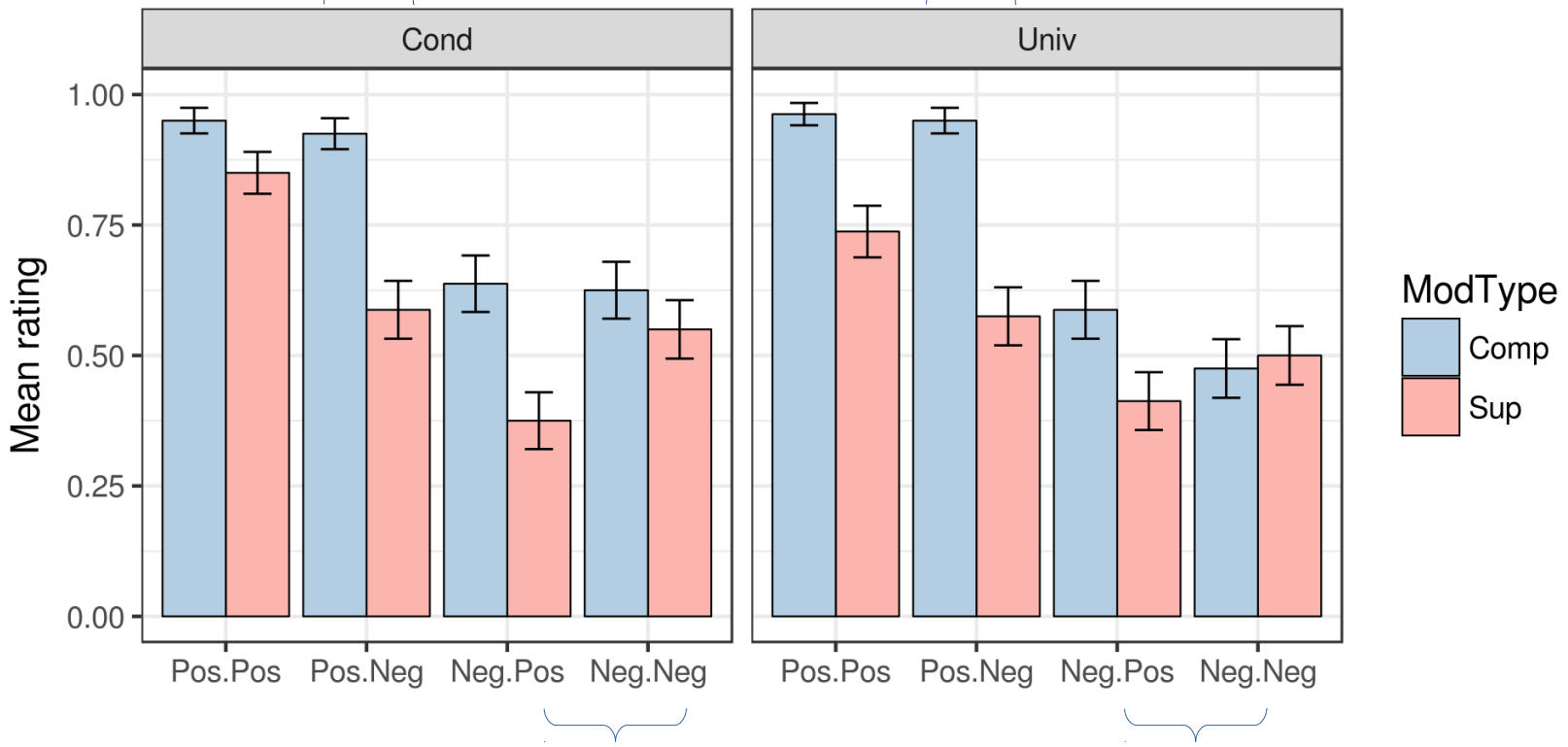
Do you think the other players will understand what he said?

Yes.

No.

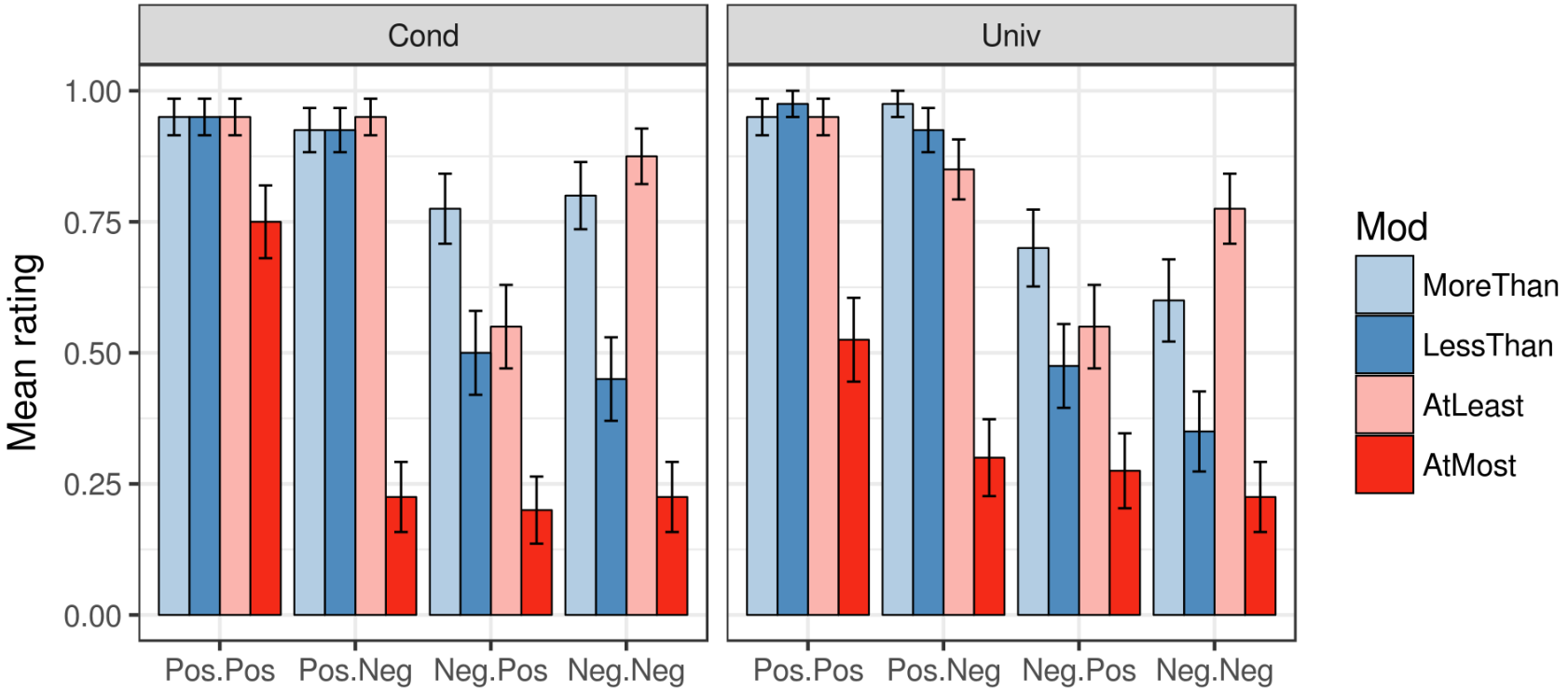
# Results – by Modifier Type

surprising for the PPI analysis



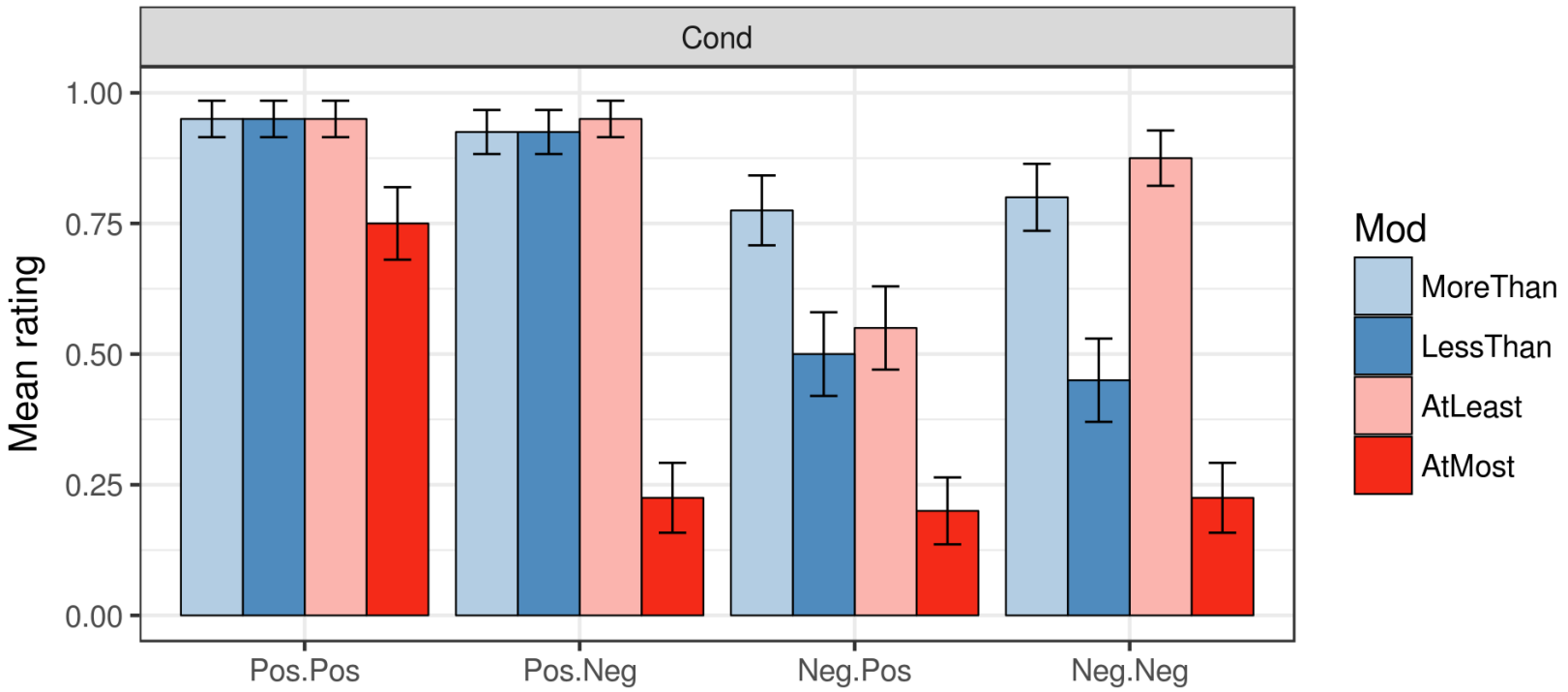

rescuing with negativity match

# Results – by Modifier



# Results – by Modifier – Zoom in on Conditional

only *at most* bad with Pos-Neg mismatch




only *at least* is rescued (**)

# Discussion

- *At most* not rescued with negativity match.

  → surprising for the PPI analysis

  → surprising for positivity / negativity match

- *At least* okay with mismatch so long as negative element only in continuation

  → surprising for positivity /negativity match

- Many questions we could ask at this point. One question we asked in Experiment 3 was: Does the combination of any two DE operators/environments behave the same with respect to the rescuing part of a PPI analysis?

**NOT NOT** SM  vs.  IF **[ NOT** SM **]**[...]

# Experiment 3:

IF/NOT [ POS/NEG SM ]

# Participants, design, and statistical model

- 45 native speakers of English on MTurk
- Factorial design:

  **2 (additional DE element: matrix negation, antecedent of conditional)**

  **x 2 (polarity of the embedded clause: positive, negative)**

  x 2 (modifier types: CM, SM) / 4 (modifiers: at least/most 3, less / more than 3)

  = 8/16 conditions
- Mixed-effects logistic regression model:

  response ~ ModType/Mod * PolEmbCl * AddDE + (1|Subject)

# Schematic structure of trials

X ∈ {[Pokemon names]}, Y ∈ {diamonds, spades, hearts, clubs}

| Matrix DE element | Polarity of embedded clause | Schematic structure of item |
|---|---|---|
| negation | positive | X doesn't know that s/he has CM/SM 3 Y |
| | negative | X doesn't know that s/he doesn't have CM/SM 3 Y |
| antecedent of conditional | positive | If X knew that s/he  has CM/SM 3 Y, she would bet differently |
| | negative | If X knew that s/he doesn't have CM/SM 3 Y, she would bet differently |

# Instructions

In this survey you will consider a commentator for a televised card-playing game, and answer questions about how understandable the commentator is.

At the beginning of the game each player gets dealt seven cards, two of which are hidden. Then in each round some rule is issued, and players can choose whether or not to bet on their own hand. A commentator, who knows what the hidden cards are for each player, discusses the player's move.

You will see a player's hand and the commentator's comment, then you will be asked if you think the viewers will understand what the commentator said.

# Example trial

Scyther's hand:

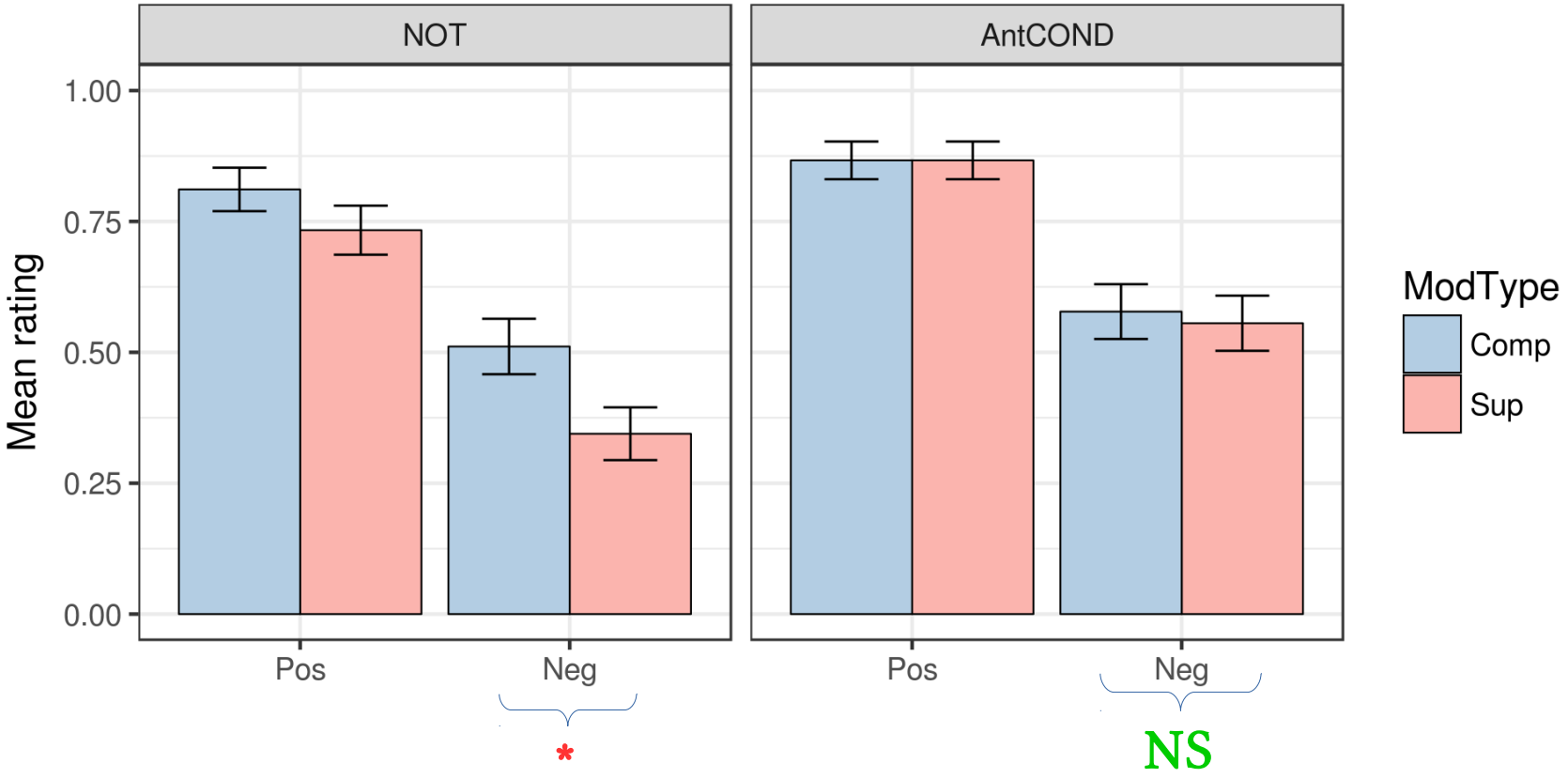
The commentator says: Scyther doesn't know that he doesn't have at most three hearts.

Do you think the viewers will understand what the commentator said?

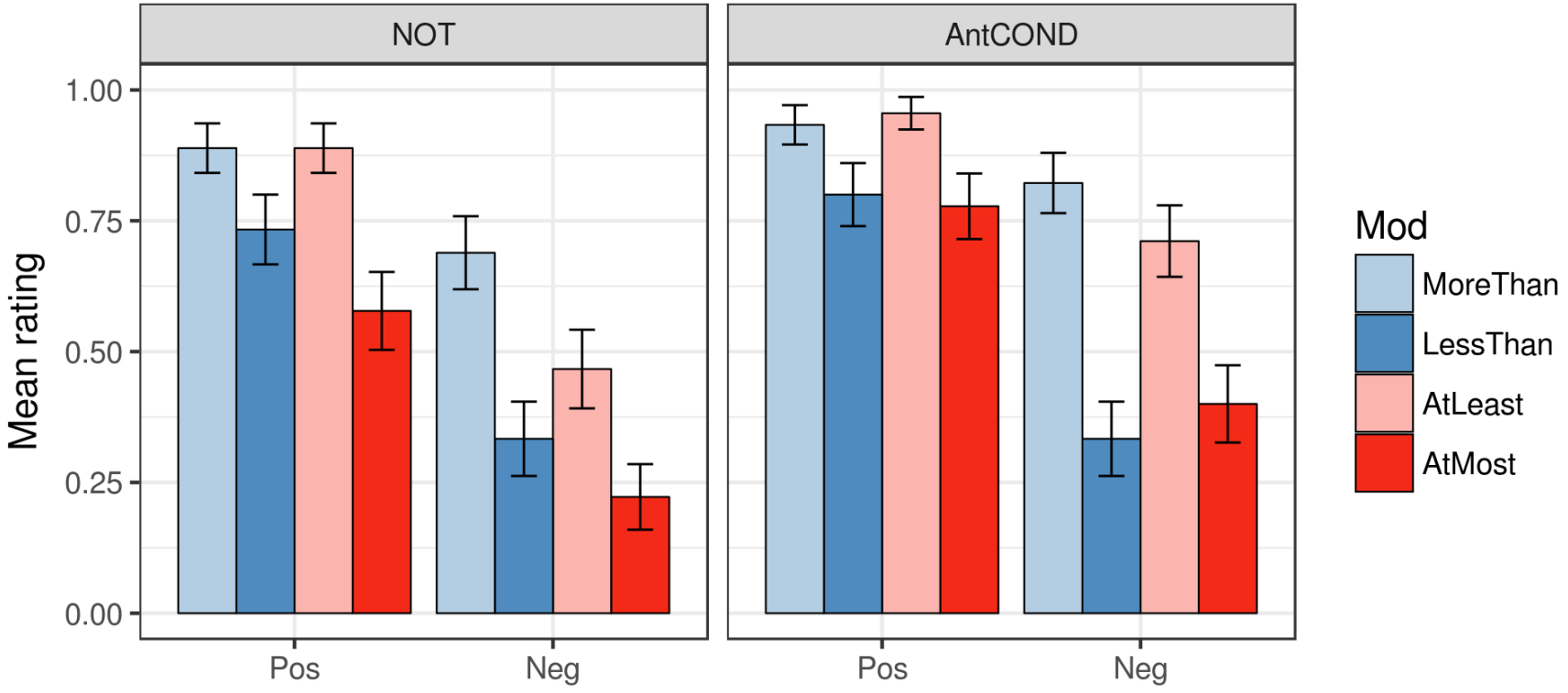
Yes.

No.

# Results – by Modifier Type



# Results – by Modifier



# Discussion

- not all DE operator/environment pairs are equal when it comes to rescuing

# General discussion and conclusion

# Classic PPIs? [Spector 2015]

- Do SMs behave like PPIs?
  - SMs are bad under negation ✓
  - SMs are OK in the antecedent of conditionals /restriction of universals ✓/ ✘
  - SMs under negation are rescued if the negation is further embedded in another DE environment ✓ / ✘

    **=> Yes and No.**

# PPIs + rescuing conditioned by pol-val match?

- Do SMs behave like PPIs with rescuing conditioned on negativity match between the polarity of the embedding antecedent/restrictor and the valence of the continuation?

✓ ***at least***

✘ ***at most*** (did not improve in Neg-Neg; also bad in Pos-Neg)

**=> Yes and No.**

# Positivity/negativity match alone? [Cohen & Krifka 2014]

- Do SMs behave as expected if the only requirement was that there be positivity/negativity match between the antecedent/restrictor and the continuation?

✘ ***at least*** (was not bad in Pos-Neg); however, remember:

If you click at least twice, #the transaction will be cancelled.

✘ ***at most*** (did not improve in Neg-Neg)

**=> Yes and No.**

# Summary and outlook

- Support for a PPI analysis of SMs: SMs are bad under negation! More theories of SMs need to take this seriously. (Currently, to our knowledge, only two do [Cohen & Krifka 20014; Spector 2015].)
- Challenge for a PPI analysis of SMs, but also for the mismatch story: Striking and poorly understood behavior of SMs in conditionals and universals.
- Interestingly, Cohen & Krifka [2014:77] note that NPIs require the continuation to have a negative valence:

  If you eat any spinach, #I will give you $10 / I will whip you.

- We take this as evidence that we need to integrate our story of polarity sensitivity with another kind of polarity – valence.

# Acknowledgements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# Appendix: Spector's analysis of SMs (1)

- Spector (2015) derives all the signature properties of SMs (no scalar implicatures in unembedded contexts, obligatory ignorance about exact value, infelicity under negation) from two assumptions about SMs (they are Hurford disjunctions, at least 3 = (exh(at least 3) or at least 4) = (exactly 3 or at least 4); they must be obligatorily exhaustified) and general assumptions about exhaustification (Fox 2007; Meyer 2015).
- If we cast CMs as Hurford disjunctions also but make exhaustification optional, all the differences between CMs and SMs (w.r.t. scalar / inference implicatures, negation) follow. (See next two slides.)
- Spector's account integrates the epistemic contrast between CMs and SMs with their polarity-sensitivity contrast.

# Appendix: Spector's analysis of SMs (2)

John read at least 3 books

a. *K(exactly 3 or at least 4)

b. *K(exh(exactly 3 or at least 4))

c. exh(K(exactly 3 or at least 4)) $\rightsquigarrow$ ¬K exactly 3, ¬K at least 4

*John didn't read at least 3 books.

a. *K¬(exactly 3 or at least 4)

b. *K(¬(exh(exactly 3 or at least 4)))

c. *K(exh(¬(exactly 3 or at least 4)))

d. *exh(K(¬(exactly 3 or at least 4)))

# Appendix: Extension to CMs (same story, minus obligatory exh)

John read more than 3 books

a. K(exactly 4 or more than 4)

b. *K(exh(exactly 4 or more than 4))

c. exh(K(exactly 4 or more than 4)) $\rightsquigarrow$ ¬K exactly 4, ¬K more than 4

John didn't read more than 3 books.

a. K¬(exactly 4 or more than 4)

b. *K(¬(exh(exactly 4 or more than 4)))

c. *K(exh(¬(exactly 4 or more than 4)))

d. *exh(K(¬(exactly 4 or more than 4)))