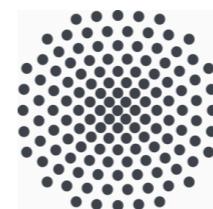


Projection inferences: Integrating linguistic and extra-linguistic cues

Göttingen University, 15.12.2022

Judith Tonhauser



Universität Stuttgart

Projection inferences: The standard picture

- (1) Scott: “Does Cole **know** that Julian dances salsa?”

Yes, Scott is committed! (“CC projects out of the question”)

Do you, the interpreter, infer that Scott is committed to the truth of the content of the complement (CC), that Julian dances salsa?

- (2) Scott: “Does Cole **think** that Julian dances salsa?”

No, Scott is not committed! (“CC does not project”)

Projection inferences: The standard picture

Factive

know

be annoyed

discover

reveal

see

know Non-factive

think

confirm

establish

announce

confess

admit

acknowledge

think

hear

inform

pretend

prove

say

suggest

be right

demonstrate

CC typically
projects

CC typically
does not project

Projection analyses

- All extant analyses predict projection inferences for factive predicates, not for non-factive predicates.
e.g., Heim 1983; van der Sandt 1992; Abrusán 2011, 2016; Romoli 2015; Simons et al 2010, 2017
- Heim 1983 / van der Sandt 1992: lexical triggering
 - non-factive predicates: $\text{think}'(x,p)$
 - factive predicates: $\text{know}'(x,p) \& \partial p$

p is presupposed to be true
- Simons, Beaver, Roberts & Tonhauser 2017
 - Content projects if it is entailed by the QUD.
 - Because only the CC of factive predicates is entailed (we assumed), the CC is predicted to possibly project for factive predicates, but not for non-factive ones.

Goals of today's talk

1. The lexical meaning of predicates matters, but not as assumed in the standard picture.

Experiment 1 (from Degen & Tonhauser 2022, *Language*)

2. Projection analyses must predict the probabilistic integration of linguistic and extra-linguistic cues.

Experiment 2 (from Tonhauser & Degen under review)

Motivation for Experiment 1 (Degen & Tonhauser, *Language*)

- English has hundreds of clause-embedding predicates:
be annoyed, be right, know, announce, confirm, realize, acknowledge, pretend, confirm, think, consider,...
- Mostly factive predicates have been investigated. E.g.:
Tonhauser, Beaver, and Degen 2018 (*Journal of Semantics*)
know, notice > discover > reveal
- Some empirical evidence that the content of the complement of some non-factive predicates may also project. (e.g., Simons, Beaver, Roberts & Tonhauser 2017; de Marneffe, Simons & Tonhauser 2019)

Motivation for Experiment 1 (Degen & Tonhauser, *Language*)

- Given that formal analyses only predict projection inferences for factive predicates, we wanted to understand which predicates are factive.
- Does projection distinguish factive and non-factive predicates?
 - Tonhauser, Beaver, and Degen 2018 (*Journal of Semantics*)
know, notice > *discover* > *reveal* > confess > establish
- Kiparsky & Kiparsky 1970
factive > neither factive nor non-factive > non-factive
- Karttunen 1971, Beaver 2010: some factive predicates are merely semi-factive, perhaps all of them are?

Experiment 1: Materials

Degen & Tonhauser 2022, *Language*

Factive

know

be annoyed

discover

reveal

see

Non-factive

think

confirm

establish

announce

confess

admit

acknowledge

hear

inform

pretend

prove

say

suggest

be right

demonstrate

20 clause-embedding predicates

20 complement clauses (*Julian dances salsa*)

= 400 polar questions (Does Scott know that Julian dances salsa?)

Experiment 1: Projection ratings

utterance

Scott asks: "*Did Cole suggest that Julian dances salsa?*"

complement

projection
question

Is Scott certain that Julian dances salsa?

response

no

yes

Next

Each participant rated the projection of 20 unique combinations of a predicate with a CC, and 6 main clause contents.

Projection inferences do not support a binary distinction

between factive and non-factive predicates

OOS of factive

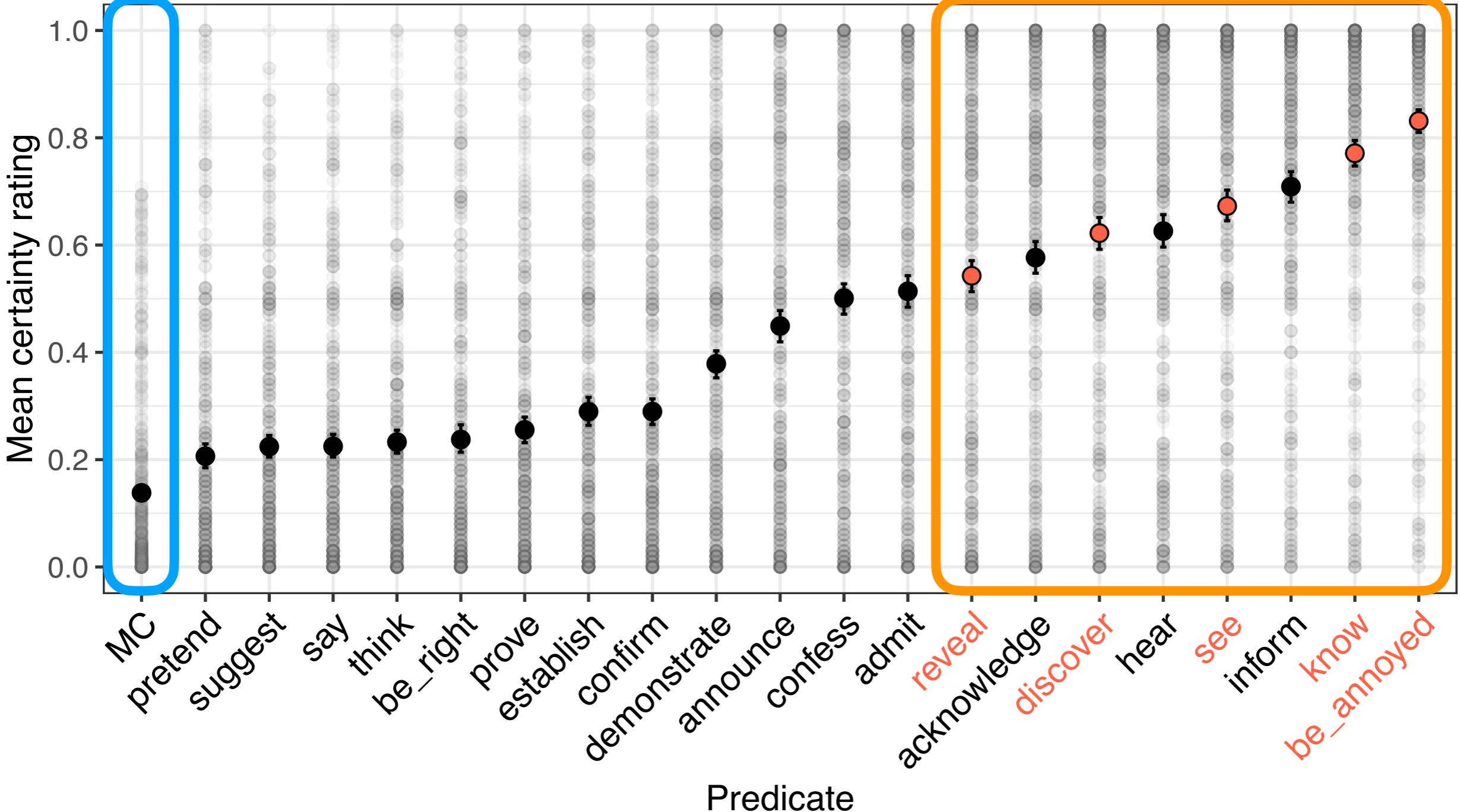
predicates are among

the most projective

main clause content is

not projective

266 self-declared native speakers of American English

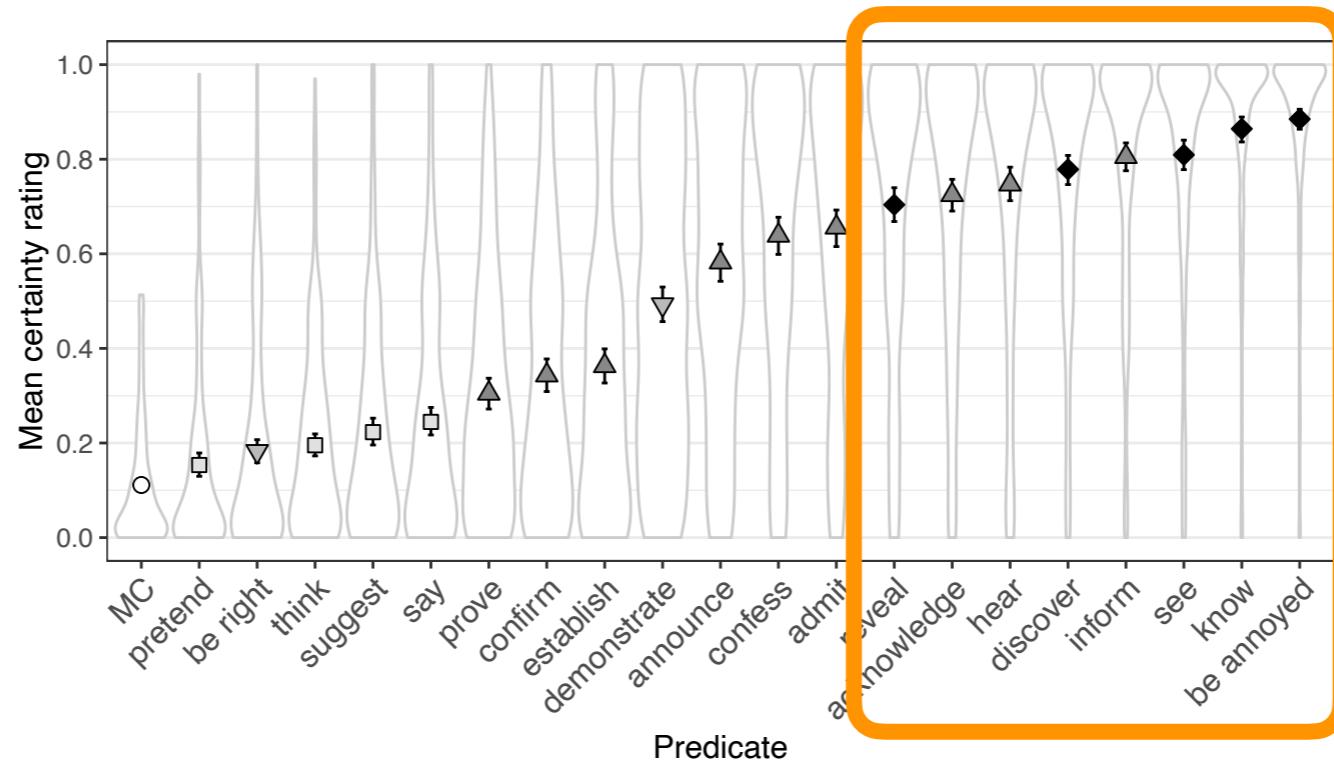


Degen & Tonhauser 2022 *Language*: The CC of all 20 predicates is projective compared to (non-projective) main clause content, albeit to different degrees.

Converging evidence

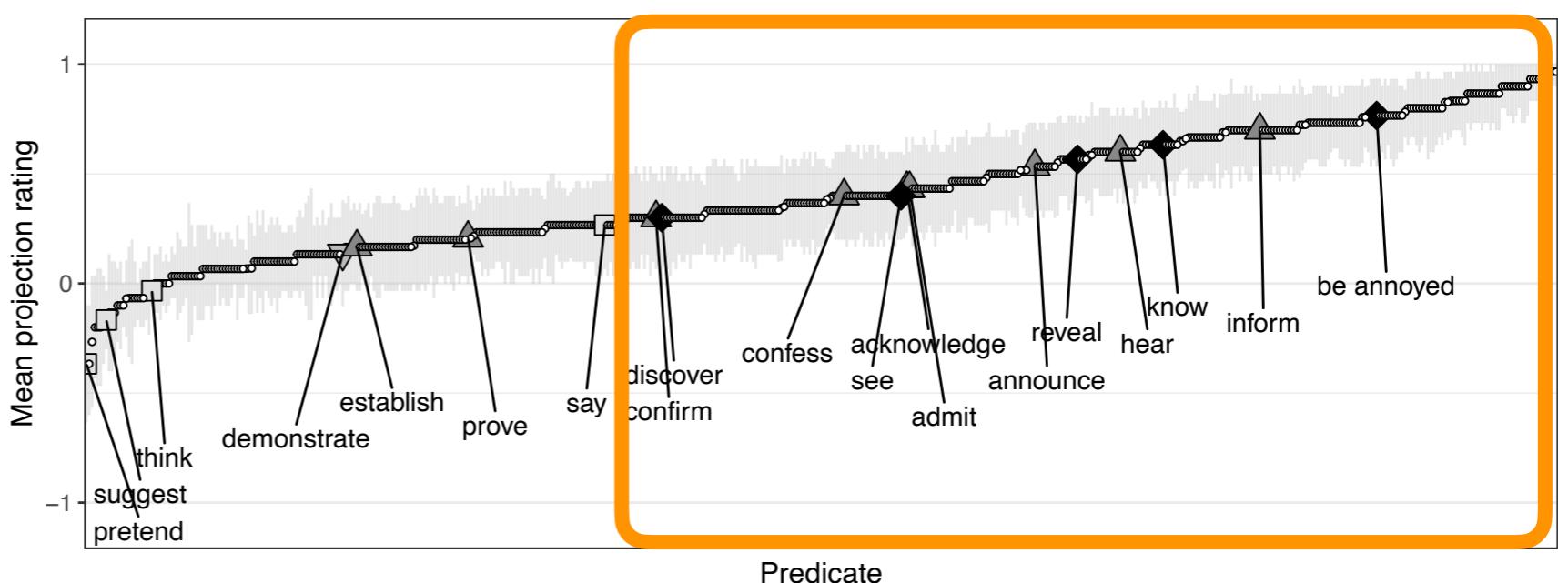
Degen & Tonhauser 2022, *Language*

Forced choice (yes/no) response task



Three datasets annotated for projection inferences

- CommitmentBank (de Marneffe et al 2019)
- VerbVeridicality (Ross & Pavlick 2019)
- MegaVeridicality (White & Rawlins 2018), 517 predicates



- The standard picture is not empirically adequate: The lexical meaning of clause-embedding predicates modulates projection, but a binary, categorical factive/non-factive distinction is not empirically supported.

- Desiderata for projection analyses:

WiSe 2022/23

1. Predict projection inferences for a broader set of clause-embedding predicates, not just factive ones.
2. Predict by-predicate projection variation based on lexical semantic analyses.
3. Predict interactions between lexical meaning and other factors that modulate projection inferences.

Goals of today's talk

1. The lexical meaning of predicates matters, but not as assumed in the standard picture.

Experiment 1 (from Degen & Tonhauser 2022, *Language*)

2. Projection analyses must predict the probabilistic integration of linguistic and extra-linguistic cues.

Experiment 2 (from Tonhauser & Degen under review)

Information sources modulating projection inferences

In drawing projection inferences, which information sources do listeners attend to, and how are they integrated?

- Lexical meaning (Degen & Tonhauser 2022, *Language*)
- At-issueness / information structure (Tonhauser, Beaver & Degen 2018)
- Common ground
- Prior beliefs (Degen & Tonhauser 2021, *Open Mind*)

(e.g., Stalnaker 1972; Karttunen 1974; Gazdar 1979; Heim 1982; Beaver 1995, 2010; Simons 2001; Simons et al 2010, 2017; Schlenker 2010; Beaver et al 2017; Djärv & Bacovcin 2017; Schlenker 2010; Abrusán 2011, 2013, 2016; Tonhauser, Beaver, & Degen 2018; Mahler 2020, 2022)

At-issueness modulates projection

Simons, Tonhauser, Beaver & Roberts 2010 (*SALT*); Beaver, Roberts, Simons & Tonhauser 2017 (*Annual Review of Linguistics*)
Tonhauser, de Marneffe & Degen 2020 (*Glossa*)

Content c projects if and only if it is not-at-issue.

1. Martha, a mathematician, solved the problem.

at-issue: Martha solved the problem

not-at-issue: Martha is a mathematician

2. Did Martha, a mathematician, solve the problem?

doesn't project: Martha solved the problem

projects: Martha is a mathematician

At-issueness modulates projection

Simons, Tonhauser, Beaver & Roberts 2010 (*SALT*); Beaver, Roberts, Simons & Tonhauser 2017 (*Annual Review of Linguistics*)
Tonhauser, de Marneffe & Degen 2020 (*Glossa*)

Content c projects if and only if it is not-at-issue.

1. Context: Henry and Harriet are an academic couple that lives on the West Coast.
 - A: Why is Henry in such a bad mood?
 - B: Did he discover that Harriet was at Princeton for a job interview?
2. Context: Henry is a nosy colleague of Harriet and well-informed about her whereabouts.
 - A: Where was Harriet yesterday?
 - B: Did Henry discover that she was at Princeton for a job interview?

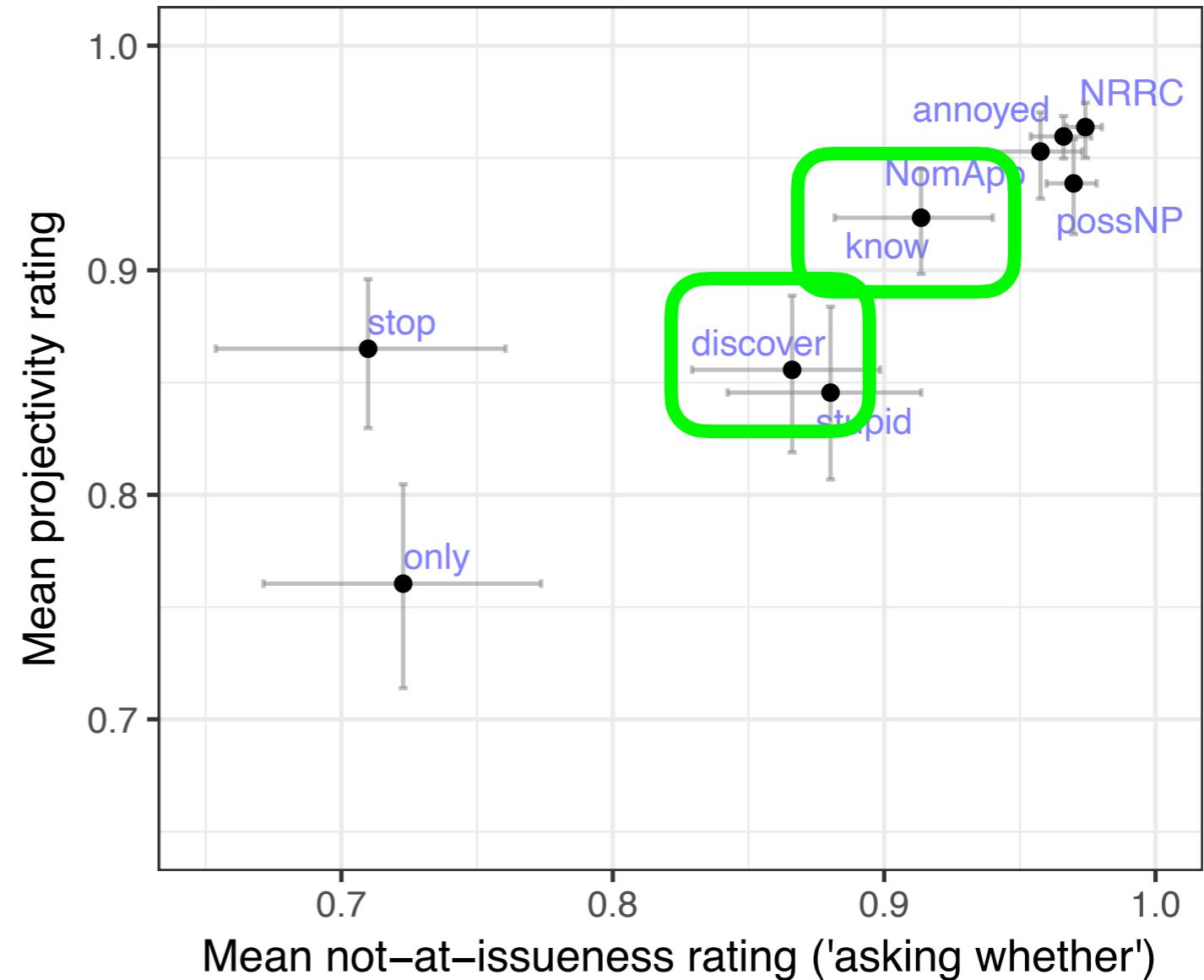
Gradient Projection Principle:
Content projects to the extent that it is not at-issue.

(building on Simons et al 2010, 2017; Xue & Onea 2011; Cummins & Rohde 2015)

Alex:

*"Did Kim discover /
Does Kim know
that Sandy's work is
plagiarized?"*

Question to participants:
Is Alex asking whether
Sandy's work is
plagiarized?



Prior beliefs modulate projection

Listeners bring their beliefs about the world (\approx world knowledge) to bear on utterance interpretation, e.g., in ambiguity resolution or scalar implicatures, and also projection.

e.g., Winograd 1972; Altmann & Kamide 1999; Chambers et al 2002, 2004; Hagoort et al 2004; Bicknell & Rohde 2009; Degen et al 2015; Kravtchenko & Demberg 2015; Tessler & Goodman 2019; Mahler 2020, 2022

Tonhauser, Beaver, & Degen 2018 (Journal of Semantics): Some content is more projective than other content.

Alex: “*Does Kim know that ...Jane has a sick aunt?
...Jack is playing outside with the kids?*”

Hypothesis: Content is more projective the higher its prior probability, i.e., the stronger listeners’ prior belief in the content.

Prior beliefs modulate projection

Degen & Tonhauser (2021, *Open Mind*)

800 combinations of a polar question and a fact

Fact: Julian is German.

Sally: “*Did Cole demonstrate that Julian dances salsa?*”

400 polar questions (as in Experiment 1)

- 20 clause-embedding predicates (e.g., *discover*, *confirm*)
- 20 complements (e.g., *Julian dances salsa*)

2 facts per complement to manipulate the prior:

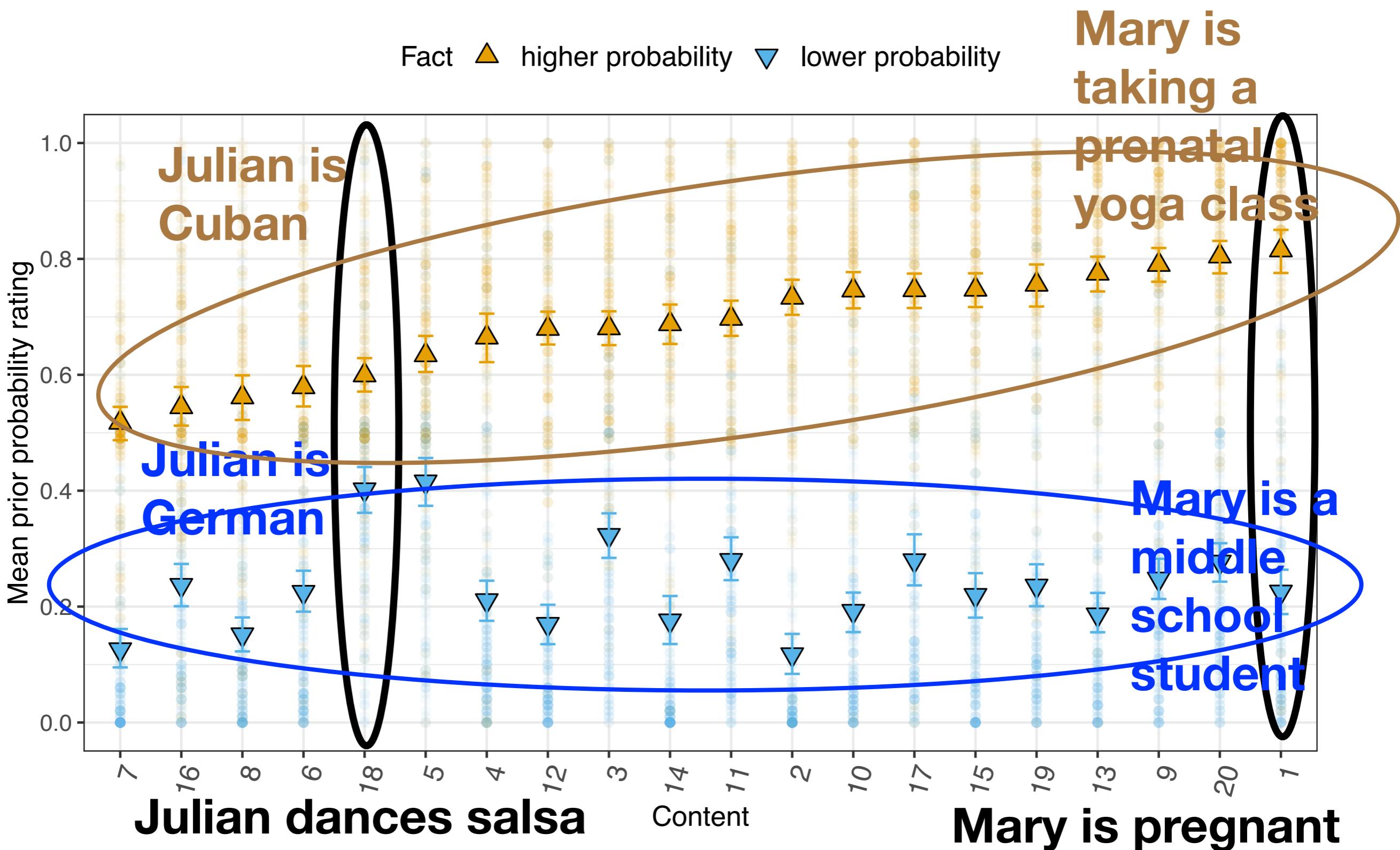
High probability fact: Julian is Cuban.

Low probability fact: Julian is German.

Block 1: Prior probability of the CC, given the fact

Each participant rated the prior probability of their 20 CC/fact combinations (10 with higher and 10 with lower probability facts).

Prior probability of the 20 CCs is influenced by their facts



Block 2: Projection of the CC, given fact and predicate

fact +
utterance

projection
question

response

lower
probability
fact

complement

Fact (which Brian knows): Julian is German.

Brian asks: "*Did Cole demonstrate that Julian dances salsa?*"

Is Brian certain that Julian dances salsa?

no

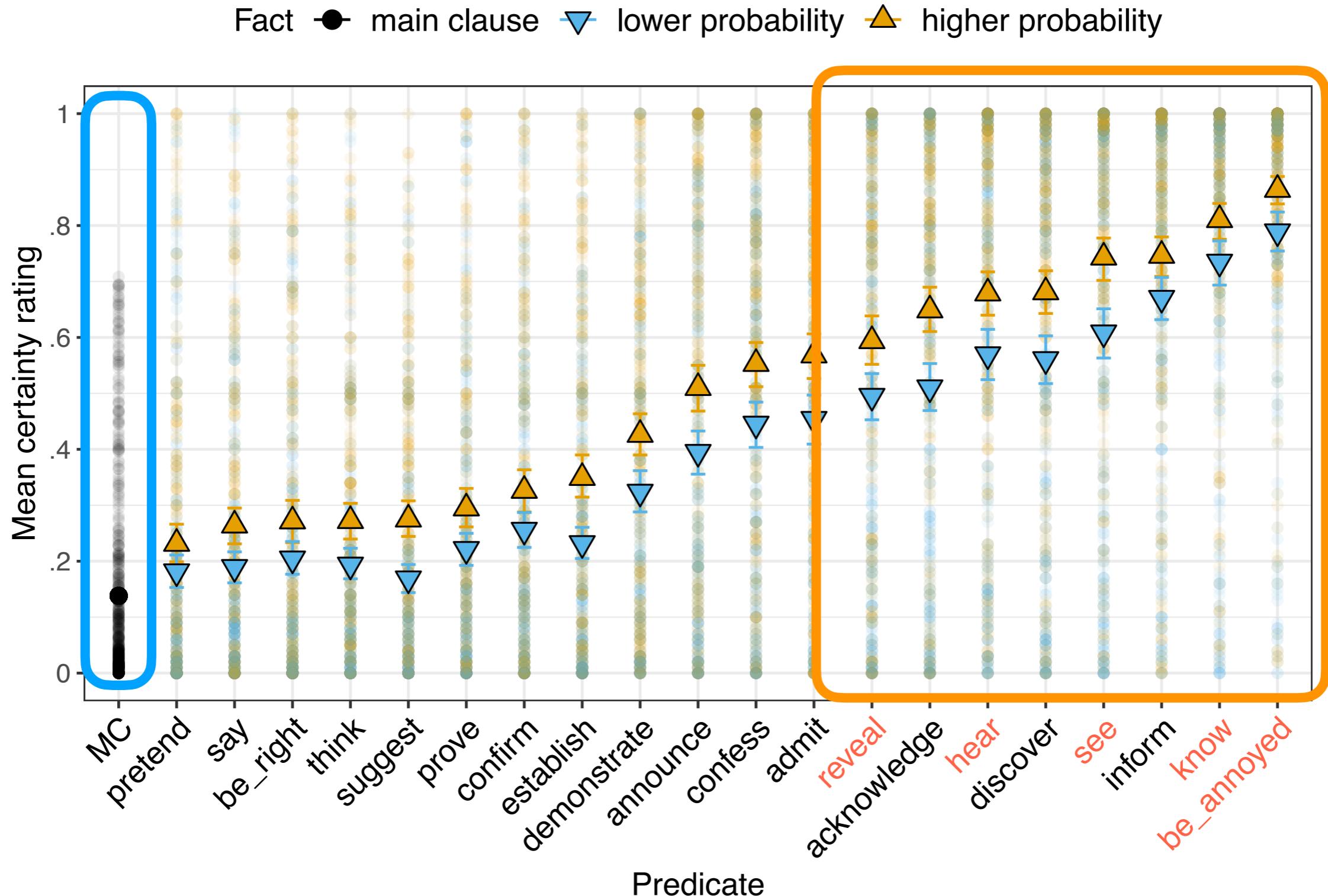
yes

Next

Each participant rated the projection of their 20 CCs, given a fact and a predicate (and 6 main clause controls).

Higher probability content is more projective

Degen & Tonhauser (2021, *Open Mind*)



Information sources modulating projection inferences

In drawing projection inferences, which information sources do listeners attend to, and how are they integrated?

- Lexical meaning (Degen & Tonhauser 2022 *Language*)
- At-issueness / information structure (Tonhauser, Beaver & Degen 2018)
- Common ground
- Prior beliefs (Degen & Tonhauser 2021 *Open Mind*)

(e.g., Stalnaker 1972; Karttunen 1974; Gazdar 1979; Heim 1982; Beaver 1995, 2010; Simons 2001; Simons et al 2010, 2017; Schlenker 2010; Beaver et al 2017; Djärv & Bacovcin 2017; Schlenker 2010; Abrusán 2011, 2013, 2016; Tonhauser, Beaver, & Degen 2018; Mahler 2020, 2022)

(1) Scott: “*Does Cole know that Julian dances salsa?*”

We want to investigate the interaction between

- the lexical meaning of clause-embedding predicates,
- interpreters’ prior beliefs about utterance content, and
- the at-issueness of utterance content.

Experiment 2 collected multiple ratings from each participant:

- Prior beliefs about ‘Julian dances salsa’
- At-issueness of ‘Julian dances salsa’
- Projection of ‘Julian dances salsa’

Experiment 2: Materials (as in Degen & Tonhauser *Open Mind*)

800 combinations of a polar question and a fact

Fact: Julian is German.

Sally: “*Did Cole demonstrate that Julian dances salsa?*”

400 polar questions

- 20 clause-embedding predicates (e.g., *discover*, *confirm*)
- 20 complements (e.g., *Julian dances salsa*)

2 facts per complement to manipulate the prior:

High probability fact: Julian is Cuban.

Low probability fact: Julian is German.

Experiment 2: Participants and procedure

505 self-declared native speakers of American English

Each participant: 20 randomly created combinations of a polar question (20 unique predicates and complements) and a fact (10 higher probability, 10 lower probability).

Fact: Julian is German.

Sally: “*Did Cole demonstrate that Julian dances salsa?*”

Three blocks (order of 2./3. random)

1. Prior belief (of the CC, given the fact)
2. Projection (of the CC, given the fact and the predicate)
3. At-issueness (of the CC, given the fact and the predicate)

Block 1: Prior probability of the CC, given the fact

Each participant rated the prior probability of their 20 CC/fact combinations (10 with higher and 10 with lower probability facts).

Block 2: Projection of the CC, given fact and predicate

fact +
utterance

projection
question

response

lower
probability
fact

complement

Fact (which Brian knows): Julian is German.

Brian asks: "*Did Cole demonstrate that Julian dances salsa?*"

Is Brian certain that Julian dances salsa?

no

yes

Next

Each participant rated the projection of their 20 CCs, given a fact and a predicate (and 6 main clause controls).

Block 3: At-issueness of the CC, given fact and predicate

fact +
utterance

at-issueness
question

response

lower
probability
fact

complement

Fact (which Brian knows): Julian is German.

Brian asks: "*Did Cole demonstrate that Julian dances salsa?*"

Is Brian asking whether Julian dances salsa?

no

yes

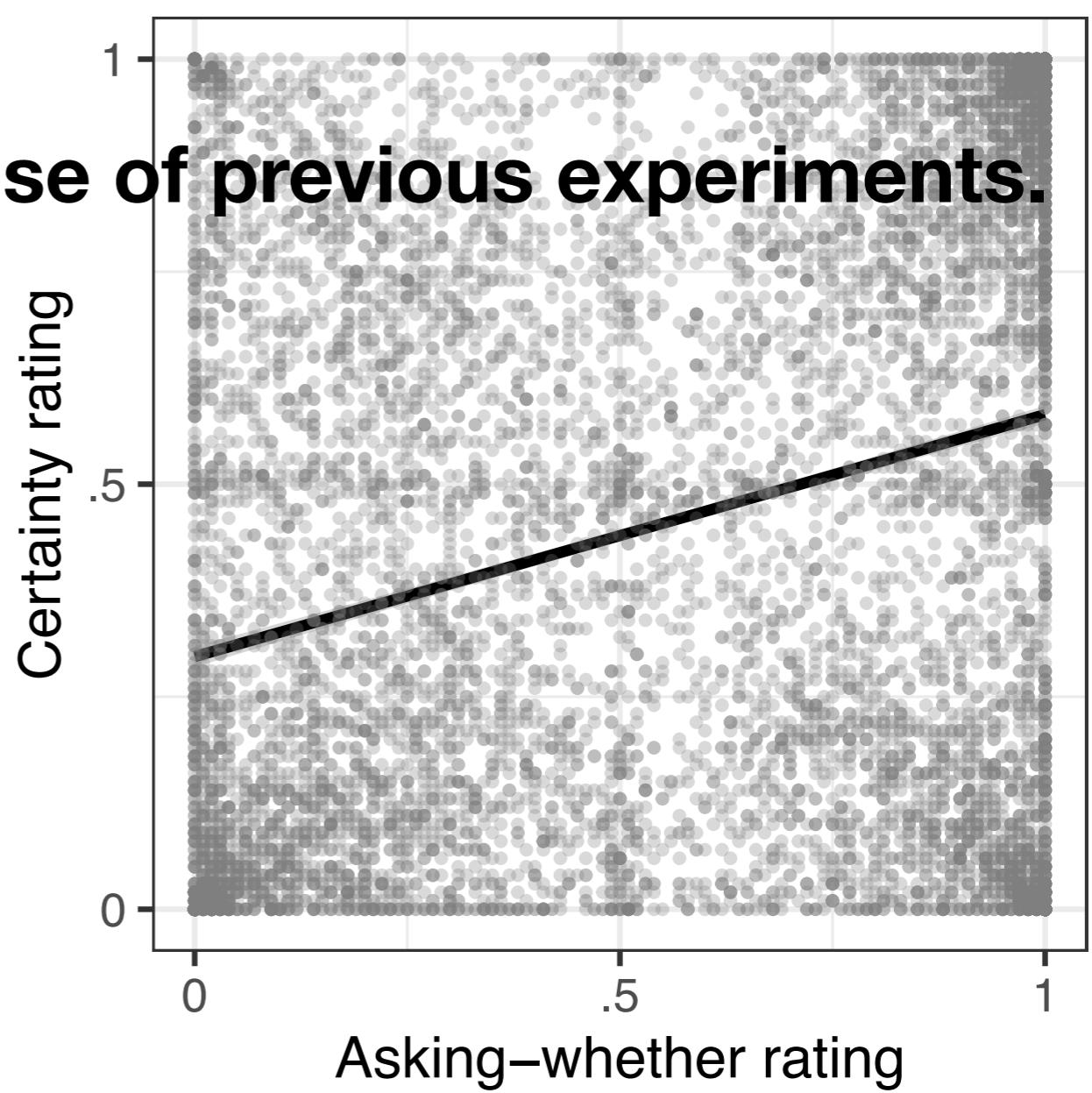
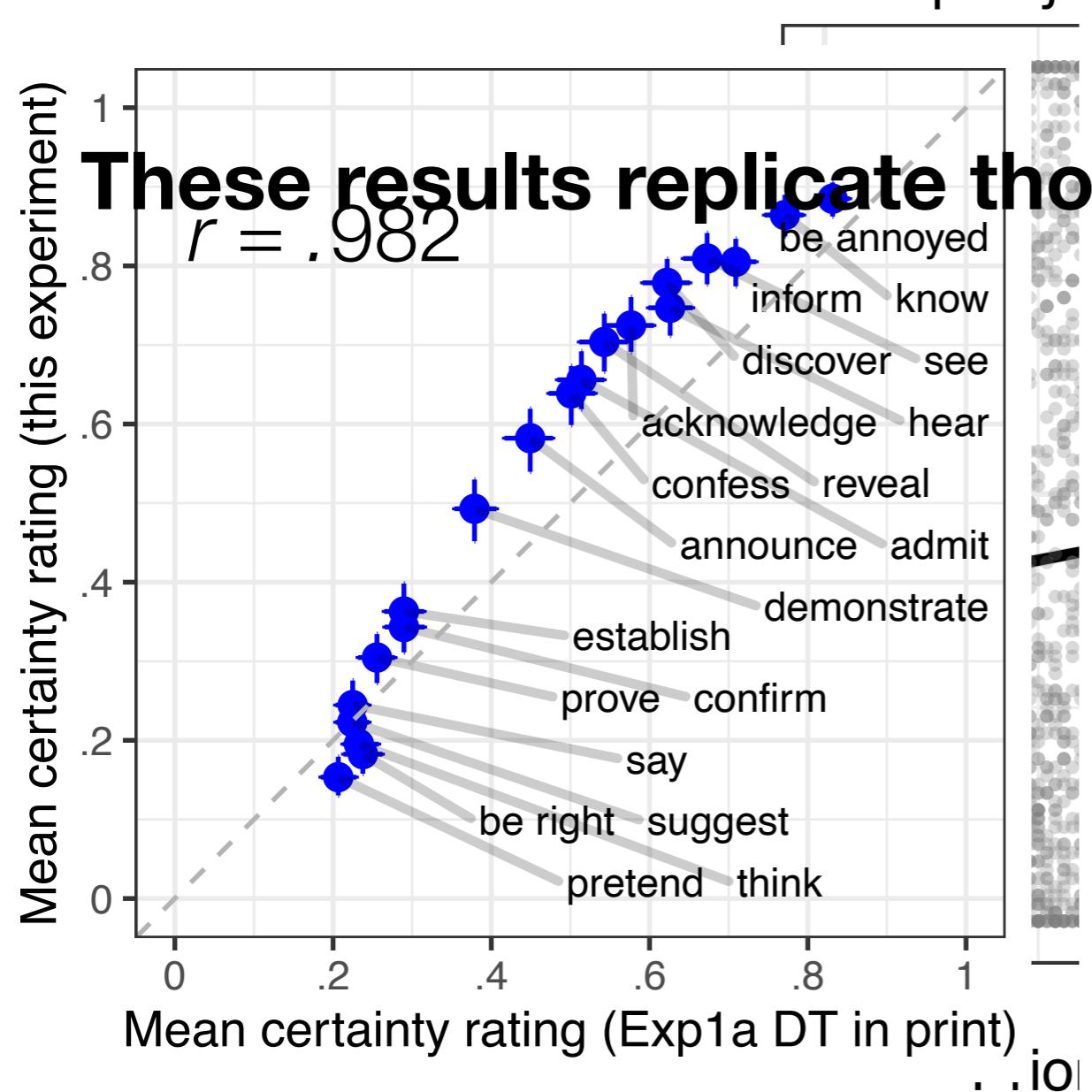
Next

Each participant rated the projection of their 20 CCs, given a fact and a predicate (and 6 main clause controls).

Exp 2 results

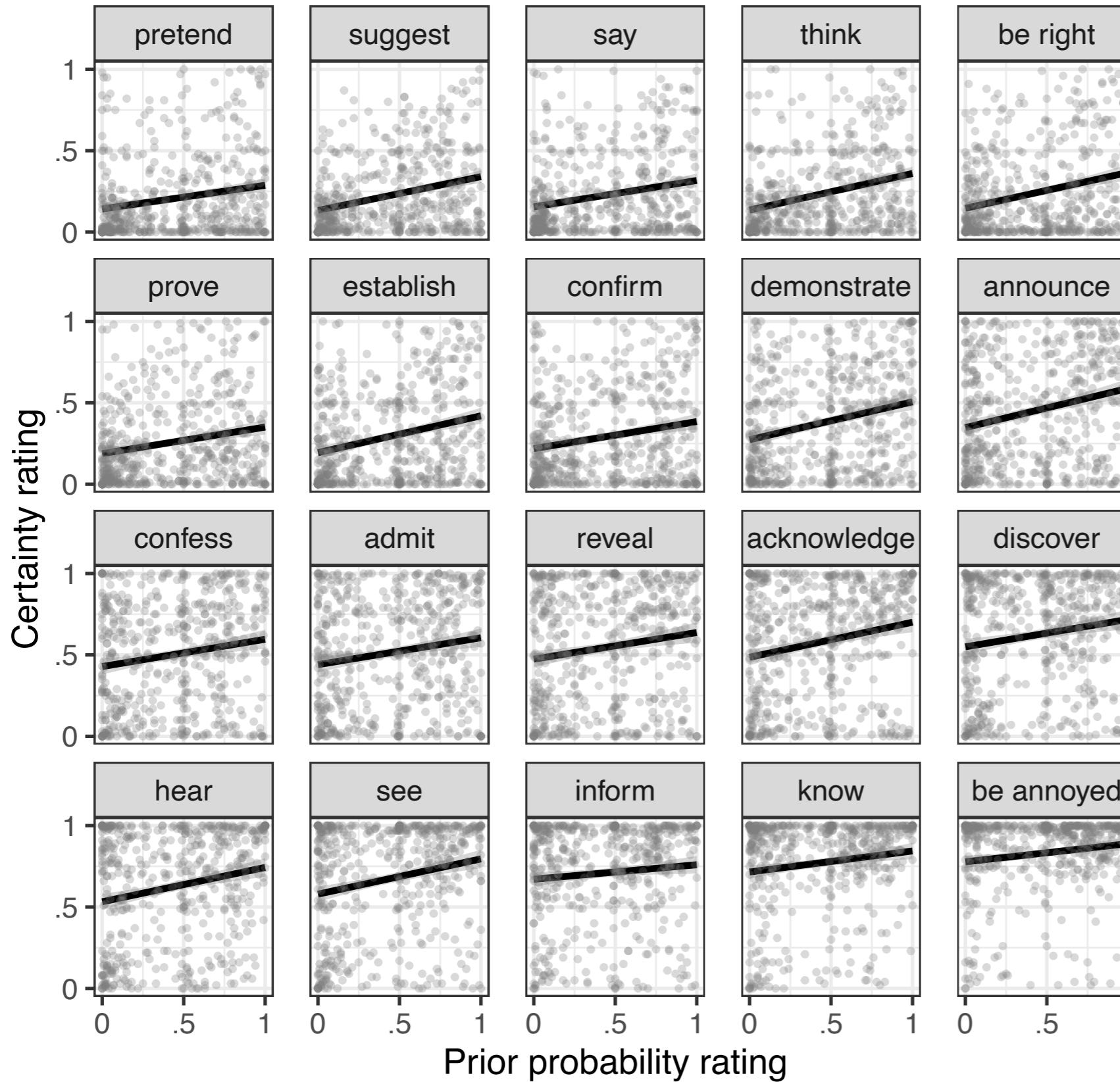
Tonhauser & Degen (under review)

- Lexical meaning modulates projection (as in Degen & Tonhauser *Language*)
- Prior beliefs modulate projection (as in Degen & Tonhauser 2021, *Open Mind*)
- At-issueness modulates projection (as in Tonhauser, Beaver & Degen 2018)



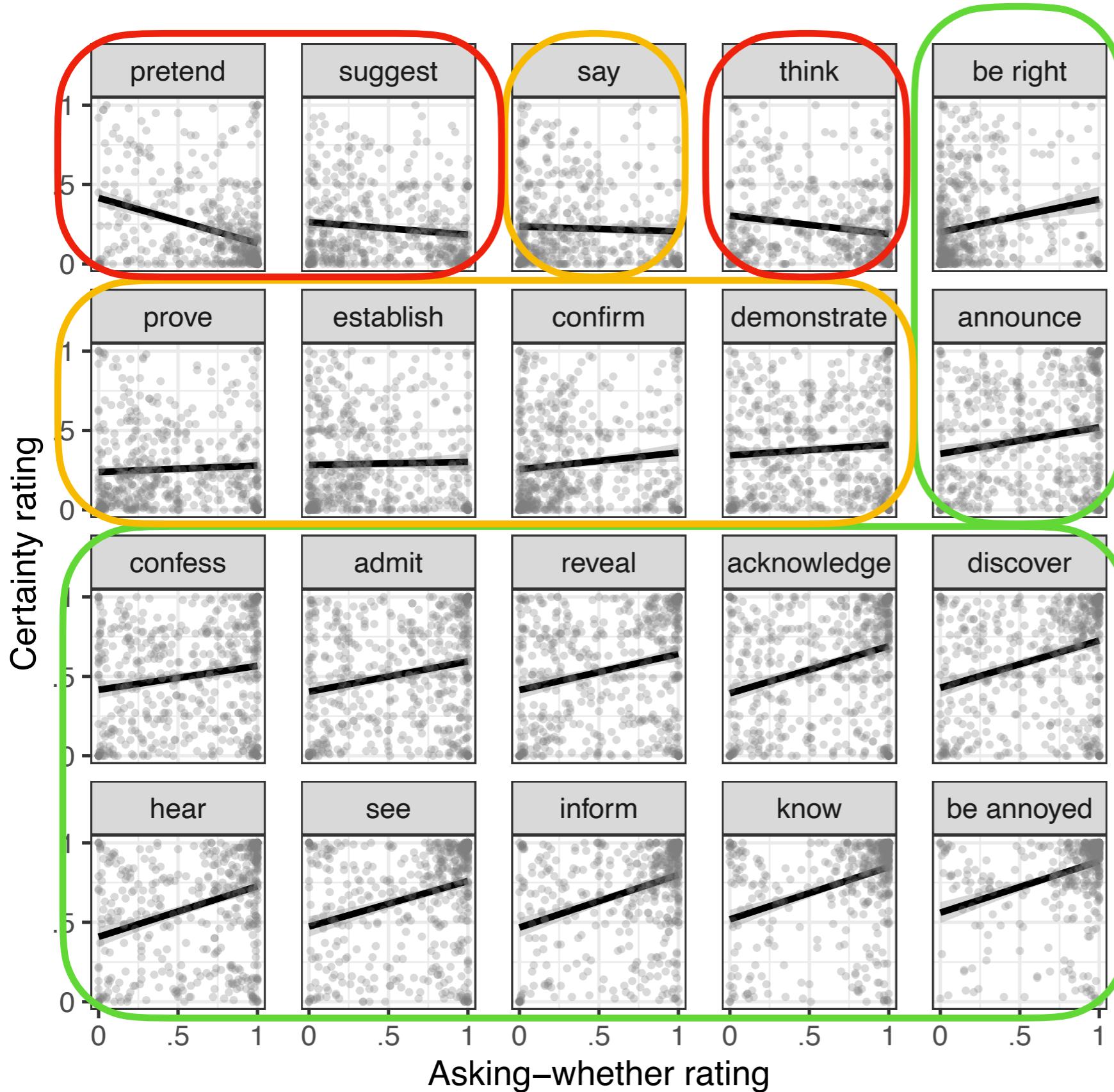
No interaction between prior beliefs and lexical content

Tonhauser & Degen
(under review)



The higher the prior belief in the CC, the more the CC projects, regardless of the predicate meaning.

At-issueness interacts with lexical content



Tonhauser & Degen
(under review)

Negative effect of at-issueness on projection.

No effect of at-issueness on projection.

The more not-at-issue the CC, the more it projects, as predicted by the Gradient Projection Principle.

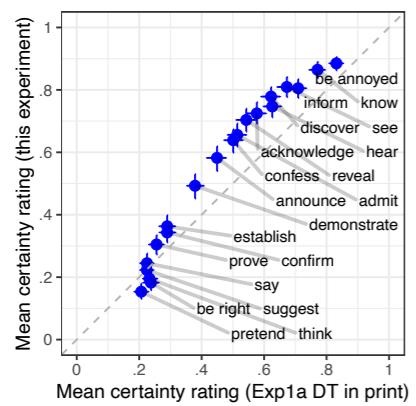
Goal #2: Projection analyses must predict the probabilistic integration of linguistic and extra-linguistic cues

- (1) Scott: “*Does Cole PRED that Julian dances salsa?*”

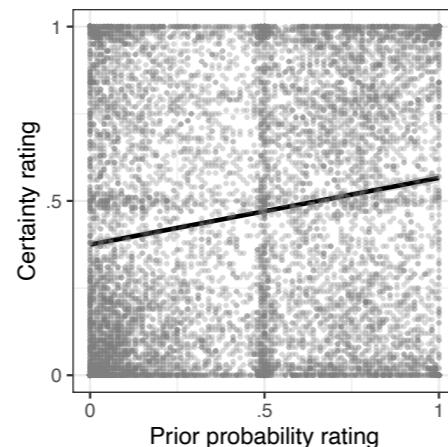
Do you, the interpreter, infer that Scott is committed to the truth of the content of the complement (CC), that Julian dances salsa?

The strength of the projection inference depends on several bottom-up and top-down information sources:

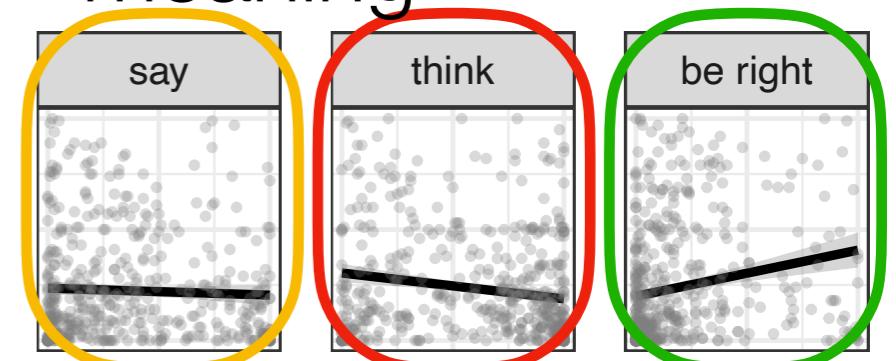
predicate
meaning



prior beliefs
about the CC



at-issueness of the
CC and predicate
meaning

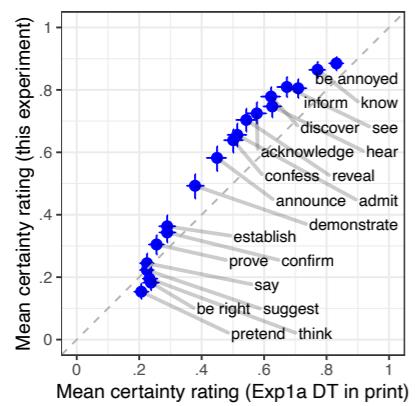


Goal #2: Projection analyses must predict the probabilistic integration of linguistic and extra-linguistic cues

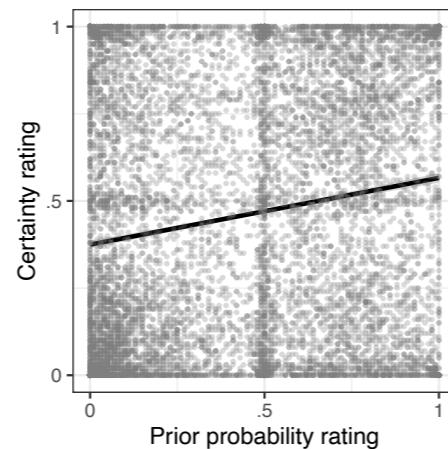
Constraint-based approaches to utterance interpretation assume that interpreters “integrate multiple probabilistic sources of information in a weighted manner”. (Degen & Tanenhaus 2019:22)

The strength of the projection inference depends on several bottom-up and top-down information sources:

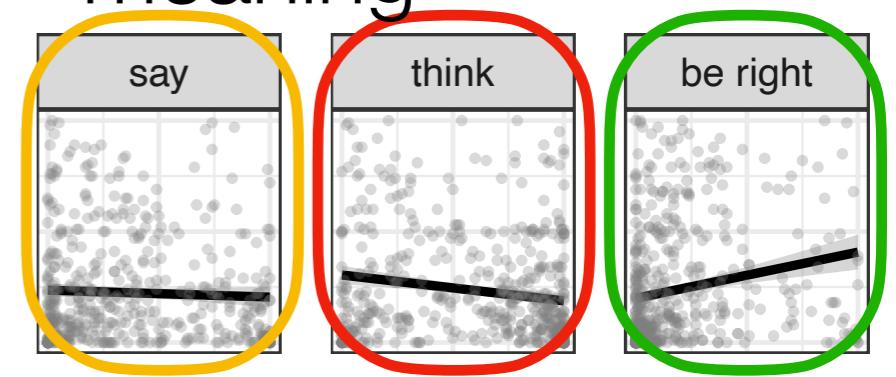
predicate meaning



prior beliefs about the CC



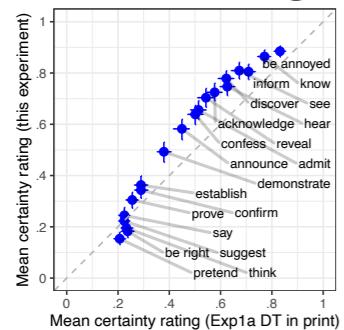
at-issueness of the CC and predicate meaning



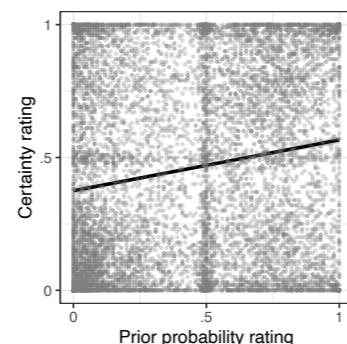
Conclusions

- Degen & Tonhauser 2022 *Language*: Lexical meaning modulates projection inferences. A categorical factive/non-factive distinction is neither empirically supported nor empirically sufficient.
- Projection inferences depend on information from multiple bottom-up and top-down sources that interact with one another.

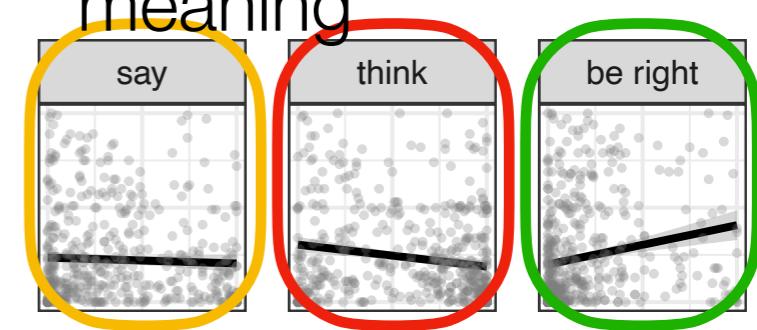
predicate
meaning



prior beliefs about
the CC



at-issueness of the
CC and predicate
meaning



- Developing a constraint-based, predictive theory of projection inferences is the next, urgent step.