# Which predicates are factive?
# An empirical investigation

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# Factive versus non-factive predicates

The content of the complement (CC) of factive predicates is presupposed; that of non-factive predicates is not.

(e.g., Kiparsky & Kiparsky 1970, Karttunen 1971, Heim 1983, van der Sandt 1992, Abrusán 2011, 2016, Anand & Hacquard 2014, Simons, Beaver, Roberts & Tonhauser 2017, Tonhauser, Beaver & Degen 2018)

Factive

1.  a. Kim knows that it's raining.          → it's raining

    b. Does Kim know that it's raining?      → it's raining


Non-factive

2.  a. Kim thinks that it's raining.          ↛ it's raining

    b. Does Kim think that it's raining?      ↛ it's raining

# Factive versus non-factive predicates

The categorization of predicates into factive and non-factive ones plays a central role in linguistic theorizing on a diverse range of topics, including:

- presupposition projection (e.g., Karttunen and Peters 1979, van der Sandt 1992)

- embedded questions (e.g., Hintikka 1975, Guerzoni and Sharvit 2007, Spector and Egré 2015)

- extraction (e.g., Hukari and Levine 1995, Rooryck 2000, Abrusán 2014)

- exclamatives (e.g., Zanuttini and Portner 2003)

- control (e.g., Landau 2001)

- mood (e.g., van Gelderen 2004, Givón 1995, Heycock 2006)

- negative polarity and free choice (e.g., Giannakidou 1998, 2001)

- predicates of personal taste (e.g., Lasersohn 2009)

- acquisition of language and theory of mind (e.g., de Villiers 2005)

**Today's talk**

1. **Problem:** Disagreement in the literature about how factive predicates are defined and which predicates exhibit properties attributed to factive predicates.

2. **Investigation** of properties of clause-embedding predicates, to understand how they can be classified.

   Findings: Factive predicates are more heterogeneous than assumed. There is little empirical support for a categorical distinction between factive and other predicates.

3. **Implications** for theories of projective content

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# How to identify whether a predicate is factive

A predicate is **factive** iff the truth of the CC is presupposed, i.e., the speaker presupposes the truth of the CC.

(e.g., Kiparsky & Kiparsky 1970, Karttunen 1971)

Does the CC project from under entailment-canceling operators?

Sandy: *"Does Kim { think / acknowledge / know } it's raining?"*

non-factive

*think*

*suppose*

*claim*

neither factive
nor non-factive

*acknowledge*

*announce*

factive

*know*

*regret*

*be aware*

# How to identify whether a predicate is factive

A predicate is **factive** iff the truth of the CC is presupposed and entailed. (e.g., Gazdar 1979a, Chierchia & McConnell-Ginet 1990, van der Sandt 1992, Abbot 2006, Anand & Hacquard 2014, Spector & Egré 2015, Simons, Beaver, Roberts & Tonhauser 2017)

Does the CC project from under entailment-canceling operators?
Sandy: *"Does Kim { think / acknowledge / know } it's raining?"*

Is the CC entailed by unembedded sentences?
Kim { thinks / acknowledges / knows } that it's raining.

|  | <u>non-factive</u> |  | <u>factive</u> |
|---|---|---|---|
| *think* | *acknowledge* |  | *know* |
| *suppose* | *announce* |  | *regret* |
| *claim* |  |  | *be aware* |

# Predicates on which the two definitions come apart

*remember*  (nowadays typically considered factive)

(1) Kim remembered that it was raining.    (neither factive nor non-
(2) Did Kim remember that it was raining?  factive for K&K 1970)

*take into account, bear in mind, make clear*  (factive for K&K 1970)

(3) Rahim: *Did Joan take into account that Sherlock is unreliable?*

(4) Joan took into account that Sherlock is unreliable but she
    was wrong to do so, because Sherlock is reliable.

**Next:** Disagreements about properties of predicates

**Projection**

Projection is not a categorical but a gradient property of utterance content.  (Tonhauser, Beaver & Degen 2018, *Journal of Semantics*)

Is Sandy certain that it was snowing?

Sandy: *"Was Kim annoyed that it was snowing?"*

Sandy: *"Did Kim discover that it was snowing?"*

Sandy: *"Did Kim reveal that it was snowing?"*

decreasing certainty, i.e., decreasing projection

**Question:** If we investigate the projectivity of the CC of factive and non-factive predicates, can we draw a non-arbitrary line between projecting and non-projecting CCs, to distinguish factive from other predicates?

## Entailment

There are disagreements about whether the CC of predicates assumed to be factive is entailed.

*establish*

1. Kim established that it was snowing. (Wyse 2010, Swanson 2012)
2. Jew Sing [...] falsely established that he was an American citizen. (https://law.justia.com/cases/federal/appellate-courts/F2/202/715/216831)

*regret* (and emotive predicates more generally)

1. John regrets that it's raining. (Gazdar 1979, Abrusán 2011, Anand & Hacquard 2014)
2. Falsely believing that he had inflicted a fatal wound, Oedipus regretted that he killed the stranger on the road to Thebes. (adapted from Klein 1975; Schlenker 2003, Spector & Egré 2008)

# Entailment

There are disagreements about whether the CC of predicates assumed to be factive is entailed.

*know*

1. Kim knew that it was snowing.
2. John suffers from paranoia. He falsely believes that the police is spying on him and what is more he knows they are listening to his phone calls. (Abrusán 2011:514; also Hazlett 2010)

**Question:** Can we empirically distinguish entailed CCs from non-entailed ones, to distinguish factive from other predicates?

# Interim summary: Which predicates are factive?

1. Disagreements:

    A. About how **factive** predicates are **defined**: is the CC presupposed and entailed, or merely presupposed?

    B. About the **properties** of the CC of predicates presumed to be **factive**: for any given predicate, is the CC entailed? does it project?

2. Given the findings of Tonhauser et al 2018, **how projective** does the CC of a predicate have to be in order for the predicate to be **factive**?
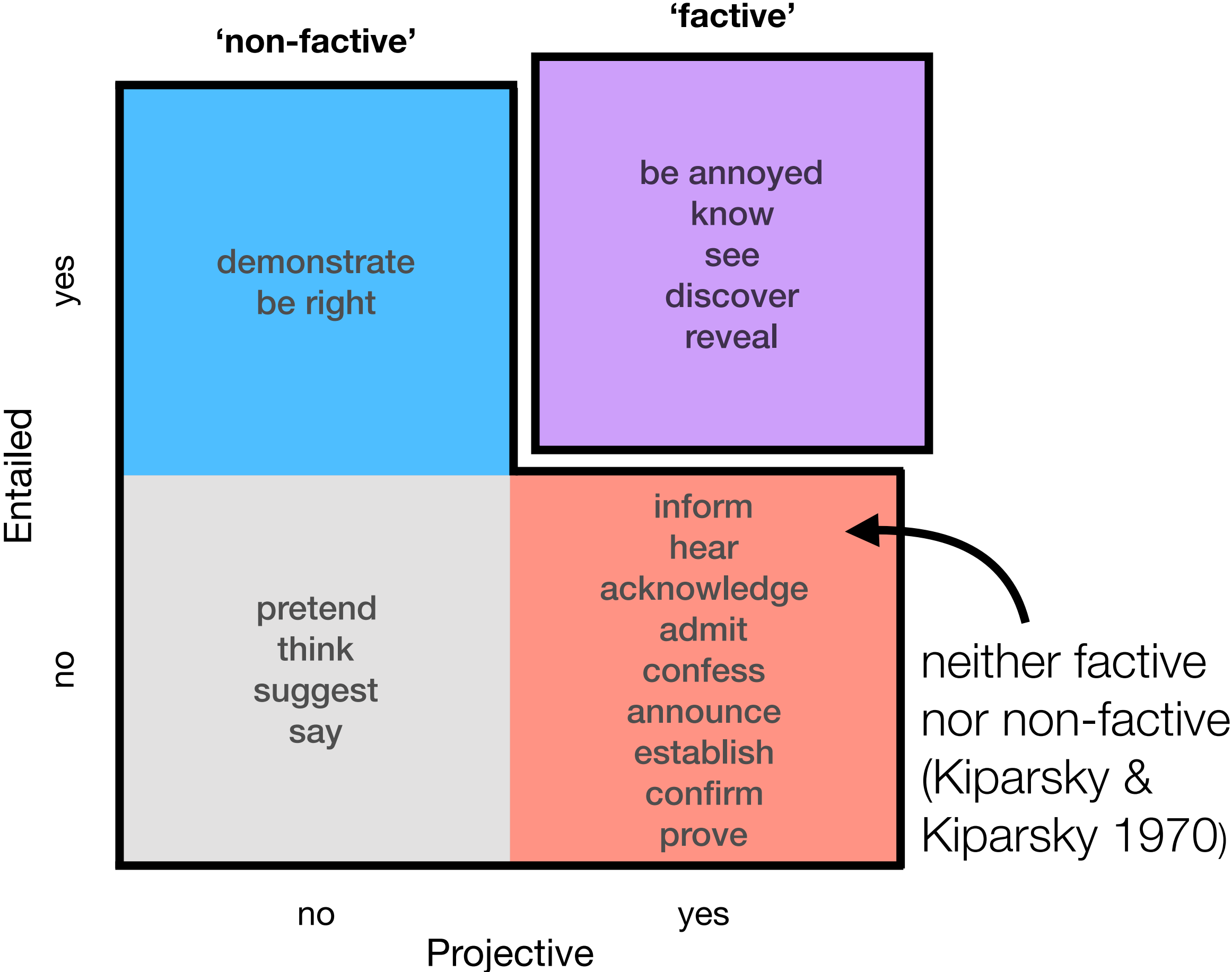
**Today's talk**

1. **Problem:** Disagreement in the literature about how factive predicates are defined and which predicates exhibit properties attributed to factive predicates.

2. **Investigation** of properties of clause-embedding predicates, to understand how they can be classified.

   Findings: Factive predicates are more heterogeneous than assumed. There is little empirical support for a categorical distinction between factive and other predicates.

3. **Implications** for theories of projective content

# Standard categorical classification of predicates by the CC

**'non-factive'**                    **'factive'**

Entailed

**yes**

demonstrate
be right

be annoyed
know
see
discover
reveal

**no**

pretend
think
suggest
say

inform
hear
acknowledge
admit
confess
announce
establish
confirm
prove

neither factive
nor non-factive
(Kiparsky &
Kiparsky 1970)

**no**                    **yes**

Projective

# Three experiments

- 400 target stimuli: 20 clause-embedding predicates paired with 20 complement clauses

1. Projection experiment

Does the CC project out of polar questions?

2a. / 2b. Entailment experiments

Is the CC entailed?
(two standard entailment diagnostics)

- 300 participants per experiment (recruited on Amazon's Mechanical Turk platform)

**'non-factive'**

**'factive'**

be annoyed
know
see
discover
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demonstrate
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acknowledge
admit
confess
announce
establish
confirm
prove

Entailed

yes

no

Projective

no                    yes

# 1. Projection experiment (400 target stimuli)

'certain that' diagnostic for projection

(e.g., Tonhauser 2016, Djärv & Bacovcin 2017, Tonhauser, Beaver & Degen 2018)

**Helen asks:** *"Did Amanda discover that Danny ate the last cupcake?"*

Is Helen certain that Danny ate the last cupcake?

**no**        **yes**

Next

Each participant rated the projectivity of the CC for each of the 20 clause-embedding predicates and 6 non-projecting controls.

# Projection experiment: 6 non-projecting controls

1. **Sandy:** *"Is Zack coming to the meeting tomorrow?"*

   Is Sandy certain that Zack is coming to the meeting tomorrow?

2. **Carlos:** *"Is Mary's aunt sick?"*

   Is Carlos certain that Mary's aunt is sick?

# Projection experiment: Results



266 self-declared speakers of American English
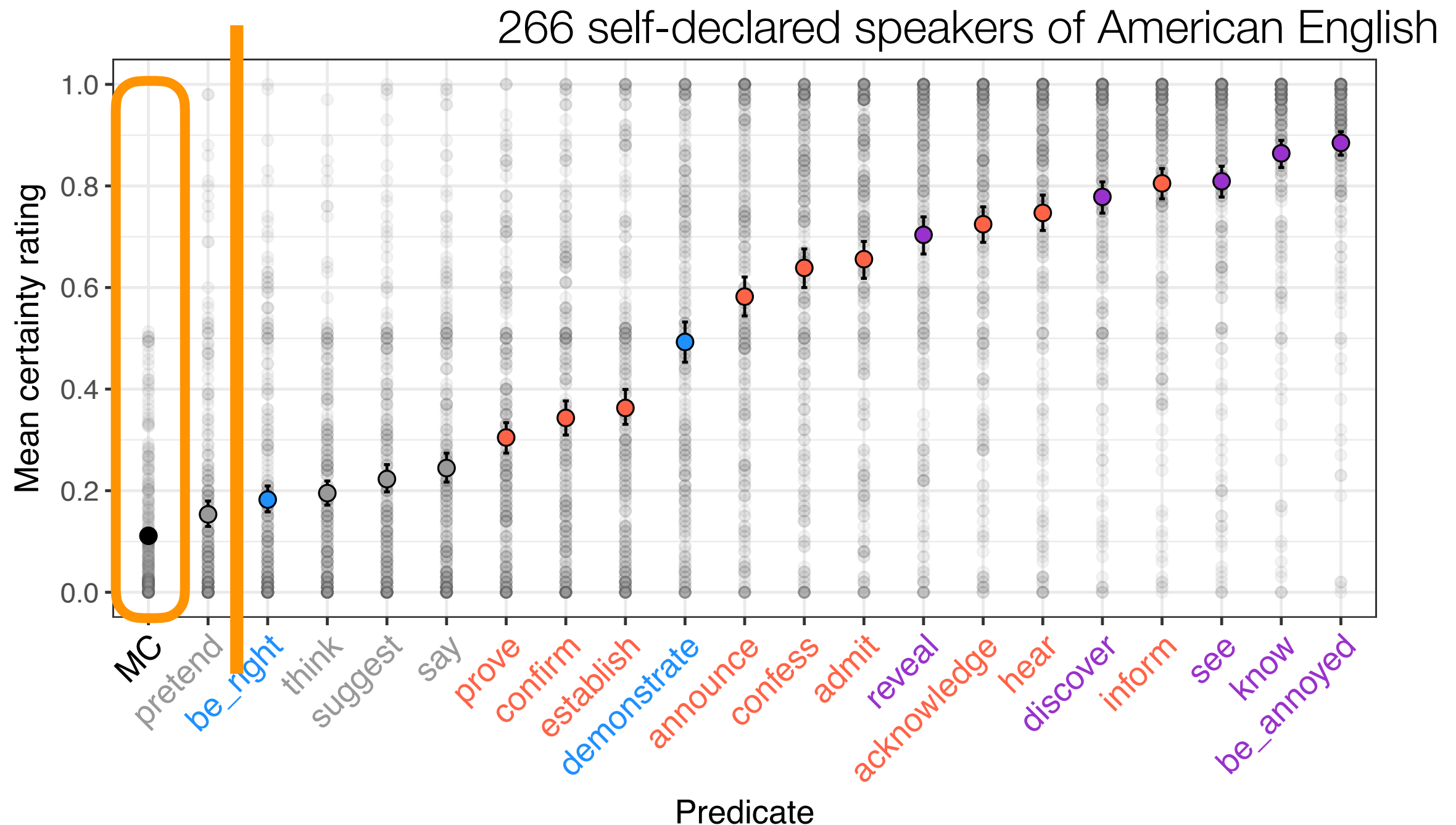
CC of all predicates except *pretend* are projective; projectivity is gradient, even when non-factives are included (Tonhauser, Beaver & Degen 2018).

(BLMEM predicting rating from predicate; controls as reference level; random by-participant and -item intercepts)

**Question:** If we investigate the projectivity of the CC of **factive** and non-factive predicates, can we draw a non-arbitrary line between projecting and non-projecting CCs, to distinguish **factive** from other predicates?

**No:** The CCs of most clause-embedding predicates investigated are at least mildly projective and projectivity is a gradient property.

The observed projection variability among presumed factive predicates does not align with the distinction between 'factive' and 'semi-factive' predicates and is not captured by any currently available analysis (see also Tonhauser et al 2018).

## 2a Entailment experiment

Inference diagnostic:

A entails B iff B necessarily follows from the truth of A.

Expectations:

**What is true:** Kim knows / is right that it's raining.
  'it's raining' definitely follows

**What is true:** Kim thinks / announced that it's raining.
  'it's raining' doesn't definitely follow

## 2a Entailment experiment (400 target stimuli)

Inference diagnostic:

A entails B iff B necessarily follows from the truth of A.

**What is true:** Edward proved that Grace visited her sister.

Does it follow that Grace visited her sister?

definitely doesn't follow                                        definitely follows

Next

Each participant rated whether the CC follows for each of the 20 clause-embedding predicates and 8 controls.

## 2a Entailment experiment: Controls

4 entailing controls

1. **What is true:** Tara broke the window with a bat.

   The window broke

2. **What is true:** Frederick managed to solve the problem.

   Frederick solved the problem

4 non-entailing controls

1. **What is true:** Dana watched a movie last night.

   Dana wears a wig

2. **What is true:** Hendrick is renting an apartment.

   The apartment has a balcony
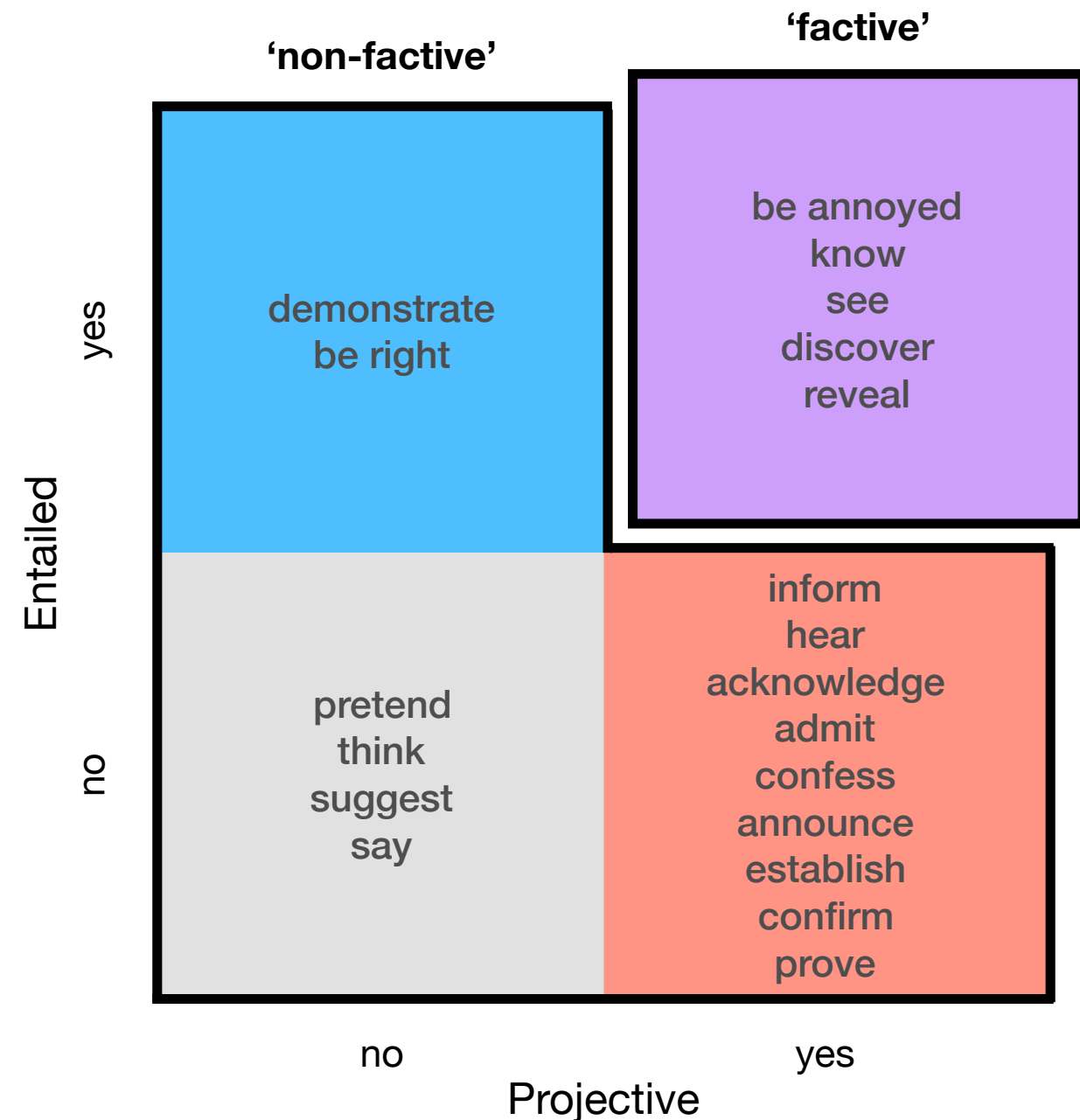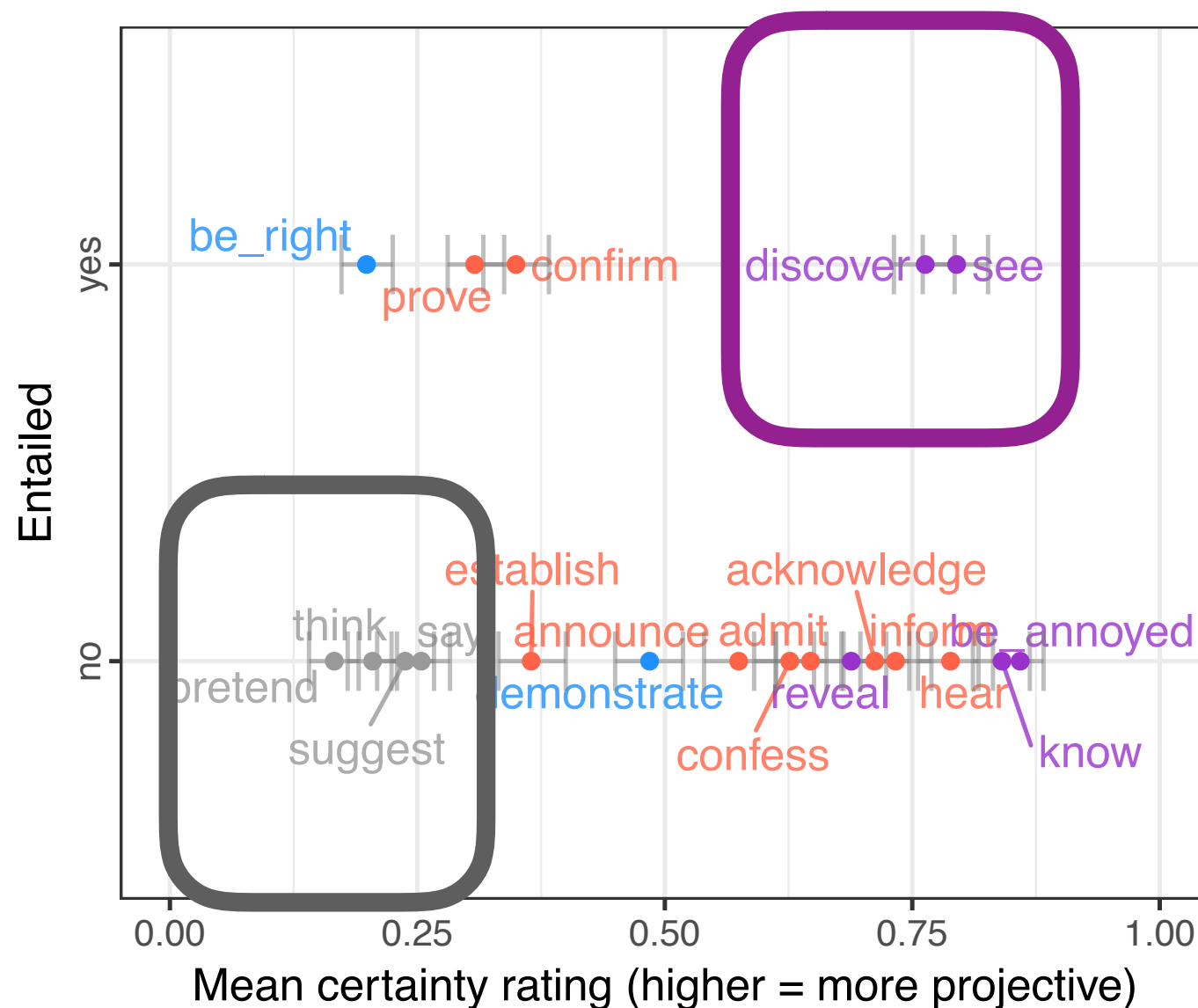
# 2a Entailment experiment: Results

259 self-declared speakers of American English

*Mean inference rating* vs *Predicate*

Predicates (x-axis): non-ent. C, pretend, think, suggest, hear, say, announce, inform, demonstrate, confess, reveal, establish, acknowledge, admit, be_annoyed, know, confirm, discover, see, be_right, prove, entailing C
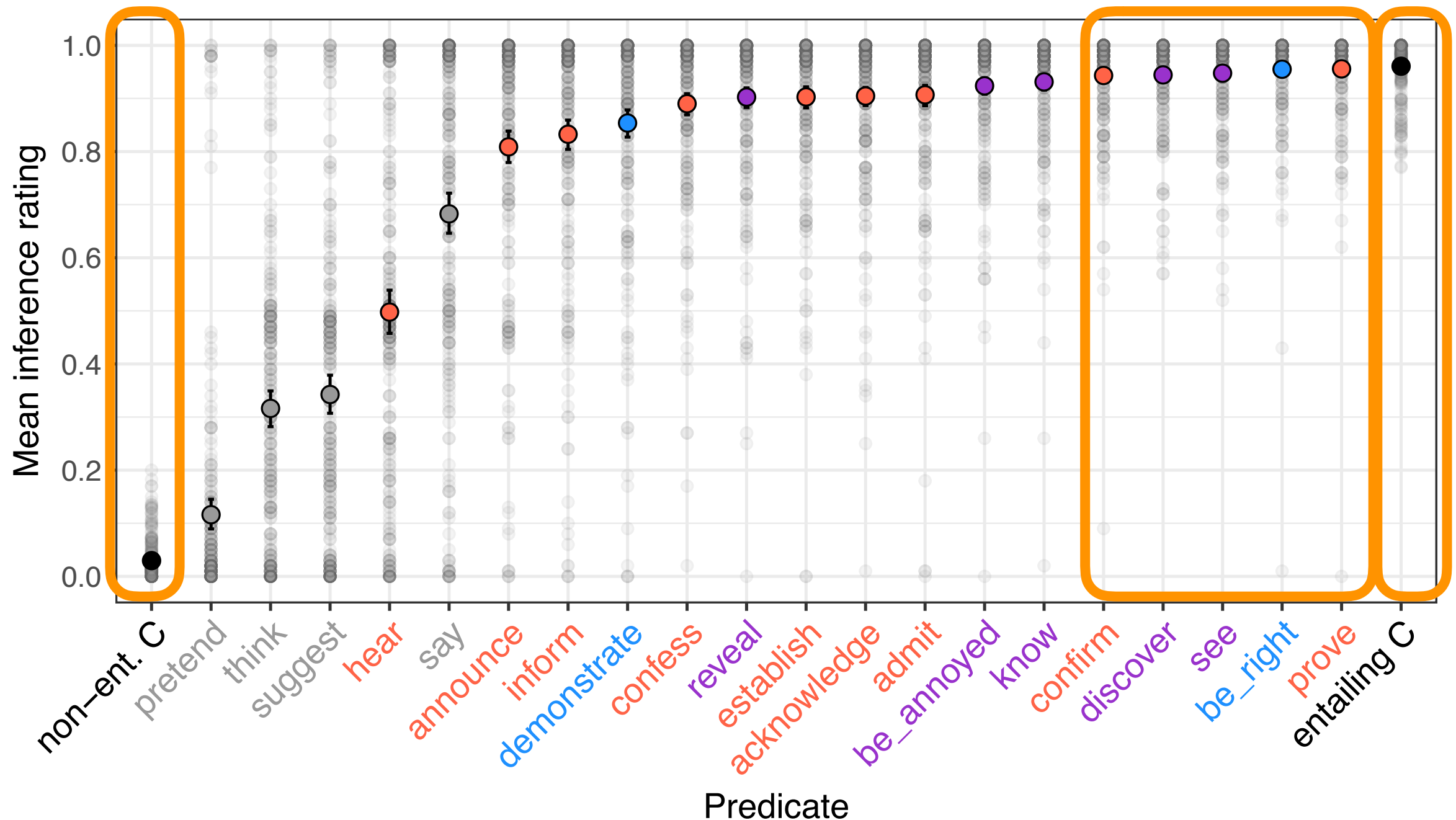
The CC of *confirm*, *discover*, *see*, *be right* and *prove* is entailed.

(BLMEM predicting rating from predicate; entailing controls as reference level; random by-participant and -item intercepts and by-participant slopes for predicate)

**Question:** Can we empirically distinguish entailed CCs from non-entailed ones, to distinguish **factive** from other predicates?

**Not with the inference diagnostic:** There are entailed and non-entailed CCs, but the difference does not align with the standard assumptions.

# Summary: Inference diagnostic



- As long assumed, there are predicates with entailed, highly projective CCs and predicates with non-entailed, weakly projective CCs.

- But for many predicates the assumed categorization is not empirically supported.

# 2b Entailment experiment

Contradictoriness diagnostic:

A entails B iff an utterance '*A but not B*' is contradictory.

Expectations:

Sandy: "*Kim knows / is right that it's raining, but it's not raining*".

Contradiction

Sandy: *"Kim thinks / announced that it's raining, but it's not raining."*

Not a contradiction

## 2b Entailment experiment (400 target stimuli)

Contradictoriness diagnostic:

A entails B iff an utterance '*A but not B*' is contradictory.

**Margaret:** "*Edward heard that Mary is pregnant, but she isn't.*"

Is Margaret's utterance contradictory?

**definitely no** _____ **definitely yes**

Next

Each participant rated the contradictoriness of utterances for each of the 20 clause-embedding predicates and 8 controls.

## 2b Entailment experiment: Controls

4 contradictory controls

1. Dana has never smoked in her life and she stopped smoking recently.

2. Sebastian lives in the USA and he has never been to the USA.

4 non-contradictory controls

1. Tara wants me to cook for her and I'm a terrific cook.

2. Frederick is both smarter and taller than I am.

# 2b Entailment experiment: Results

263 self-declared speakers of American English

Mean contradictoriness rating

Predicate: non-contrd. C, think, pretend, hear, suggest, say, announce, inform, reveal, be_annoyed, confess, acknowledge, admit, demonstrate, establish, confirm, discover, see, know, prove, be_right, contradictory C
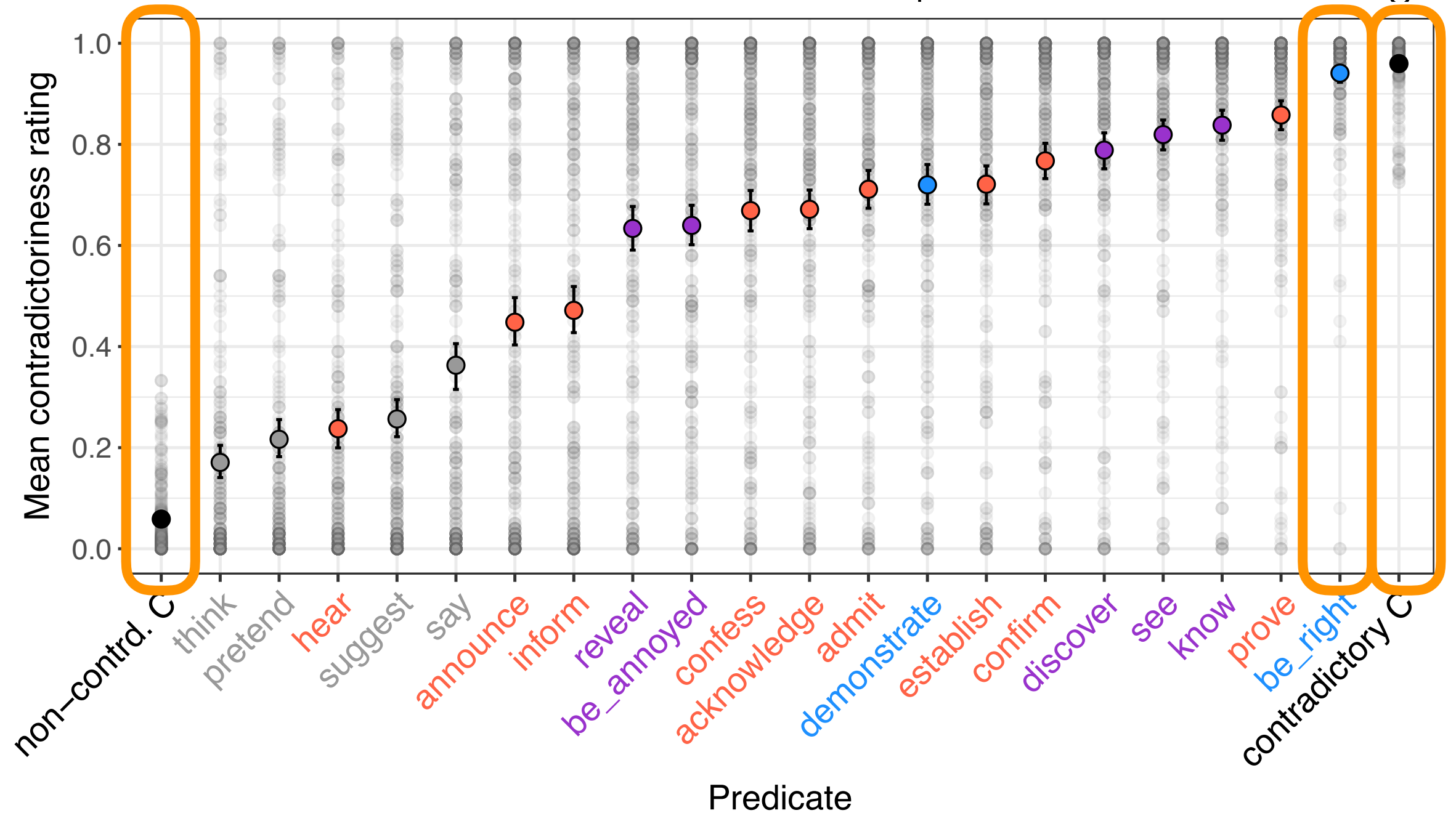
Only the CC of *be right* is entailed.

(BLMEM predicting rating from predicate; entailing controls as reference level; random by-participant and -item intercepts and by-participant slopes for predicate)

**Question:** Can we empirically distinguish entailed CCs from non-entailed ones, to distinguish **factive** from other predicates?

**Not with the contradictoriness diagnostic:** There are entailed and non-entailed CCs, but the difference does not align with the standard assumptions.

# Summary: Contradictoriness diagnostic
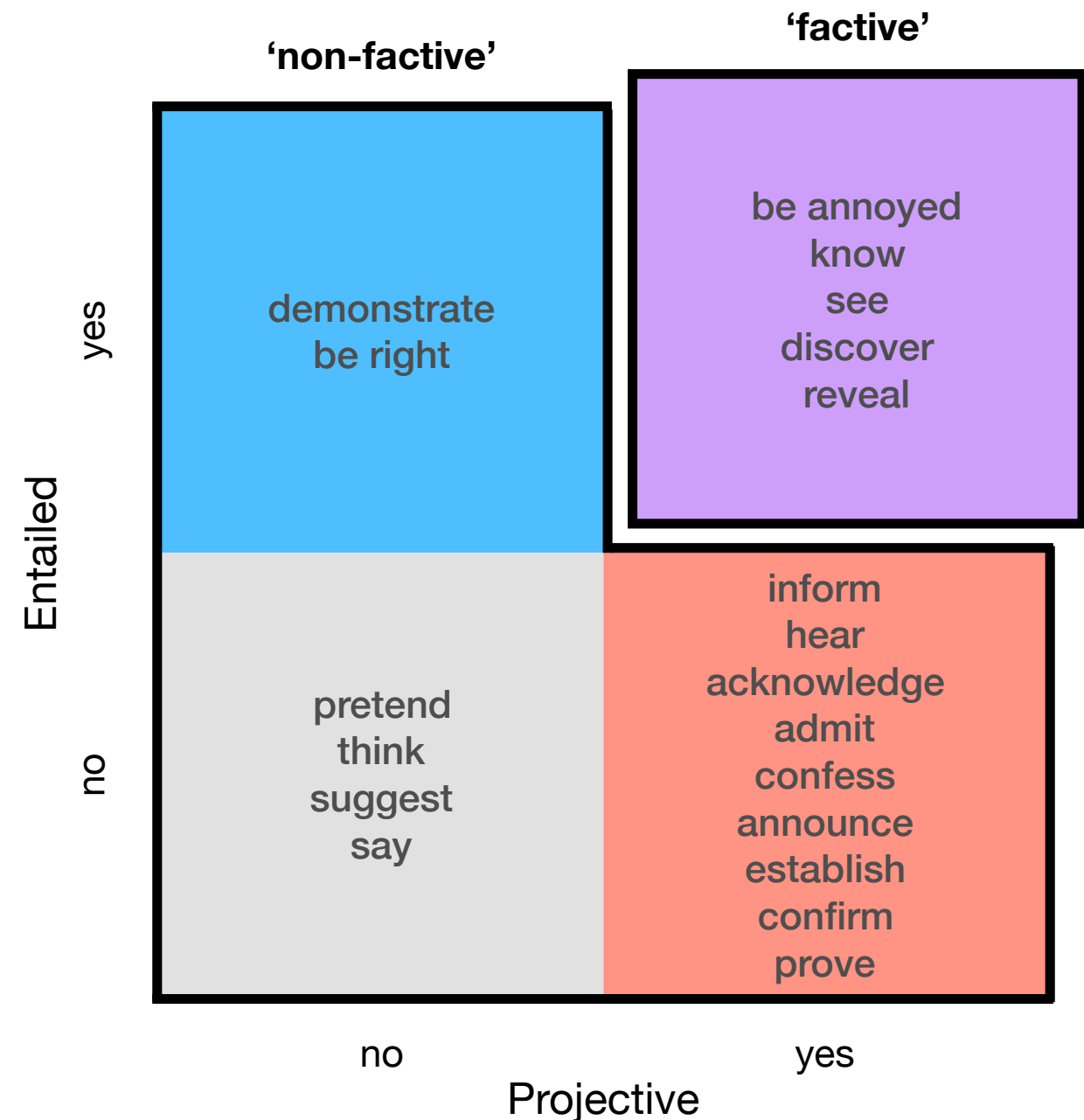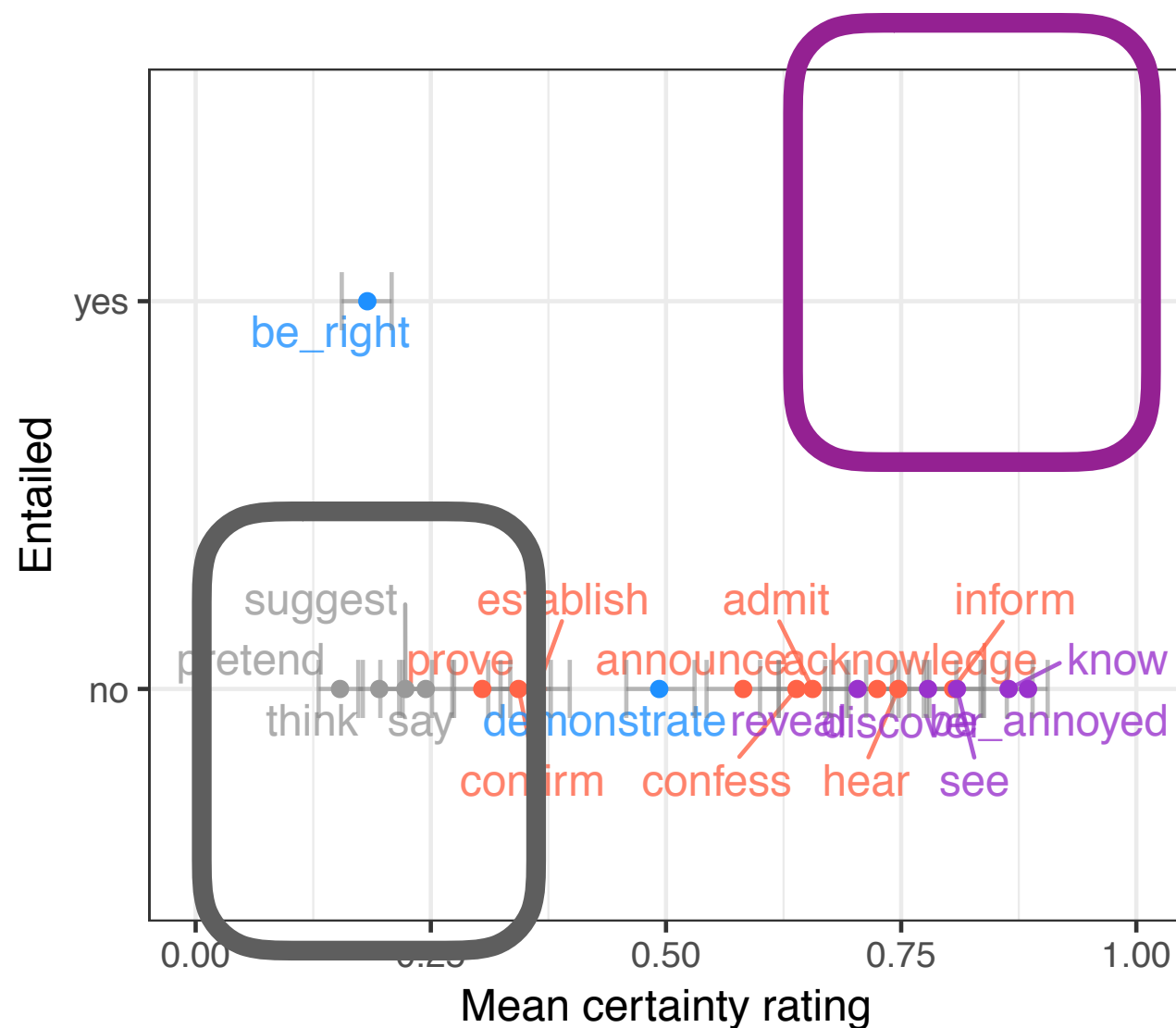


- On this diagnostic, there are predicates with non-entailed, weakly projective CCs, but no entailed highly projective ones.

- For many predicates the assumed categorization is not empirically supported.

# Summary of findings

1. **Projection:**

   Projectivity is a gradient property of utterance content (Tonhauser et al 2018), even when both factive and non-factive predicates are investigated.

   There are non-projecting CCs, but the CCs of most non-factive predicates investigated are projective (as are those of factives).

2. **Entailment:**

   Two standard diagnostics for entailment identify entailed and non-entailed CC, but the divisions do not align with standard assumptions.

These findings challenge the standardly assumed categorical division between factive and non-factive predicates.

**Today's talk**

1. **Problem:** Disagreement in the literature about how factive predicates are defined and which predicates exhibit properties attributed to factive predicates.

2. **Investigation** of properties of predicates, to understand how such predicates can be classified.

   Findings: Factive predicates are more heterogeneous than assumed. There is little empirical support for a categorical distinction between factive and non-factive predicates.

3. **Implications** for theories of projective content

# Neither definition of factive predicates is satisfactory

A predicate is **factive** iff the truth of the CC is presupposed, i.e., the speaker presupposes the truth of the CC.
                                            (e.g., Kiparsky & Kiparsky 1970, Karttunen 1971)

Predicates presumed factive and non-factive are not distinguished categorically in the projectivity of their CC.

A predicate is **factive** iff the truth of the CC is presupposed and entailed.   (e.g., Gazdar 1979a, Chierchia & McConnell-Ginet 1990, van der Sandt 1992, Abbot 2006, Anand & Hacquard 2014, Spector & Egré 2015, Simons, Beaver, Roberts & Tonhauser 2017)

Predicates presumed factive and non-factive are not distinguished categorically by whether the CC is projective and entailed.

# Are there better ways to draw the line?
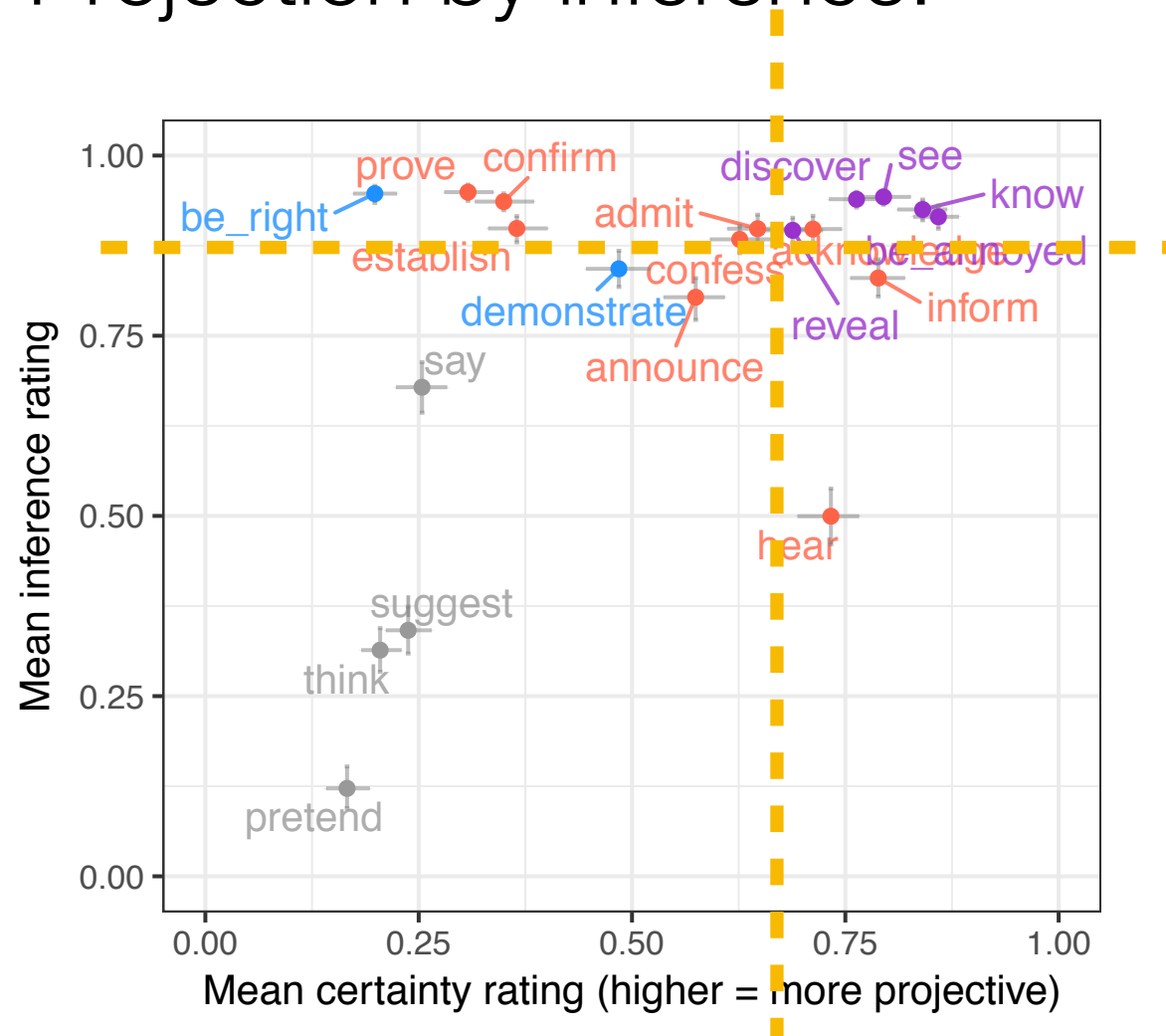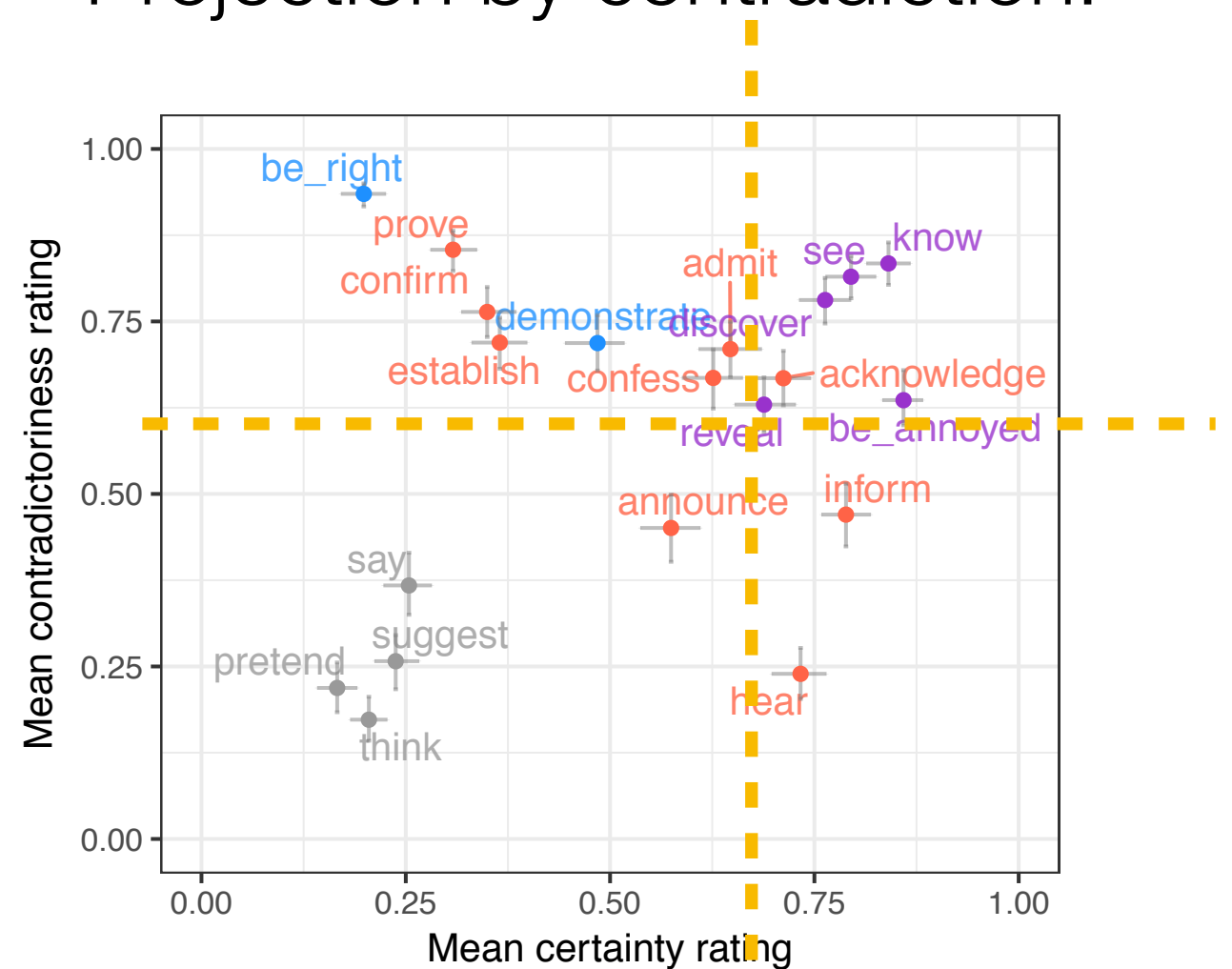


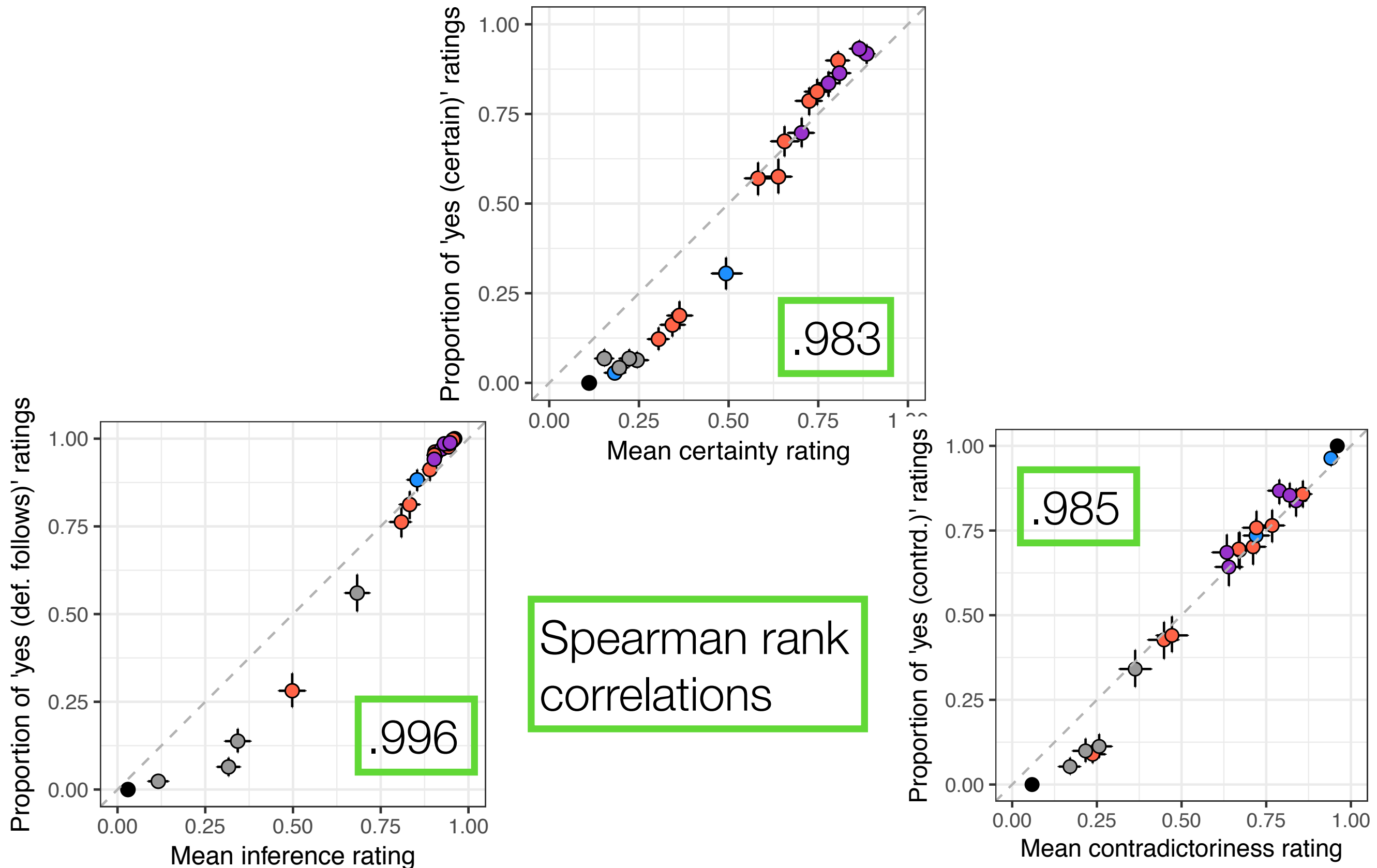There are no non-arbitrary ways to draw the lines such that the assumed categorical distinction between factive and other predicates emerges.

**Are there better diagnostics?** We ran the same experiments with binary response tasks and obtained the same results.

Spearman rank correlations

.983

.996

.985

**Let's take the findings at face value**

There are systematic differences in the projectivity of the CCs of clause-embedding predicates. This is an explanandum.

The extent to which the CCs projects align with semanticists' intuitions (at a coarse-grained level).

But it is not empirically motivated to categorize predicates into factive and non-factive ones, and to build theories of projection on a categorical notion of factivity.

- Heim 1983, van der Sandt 1992: factive predicates are lexically marked as such

- Abrusán 2011, 2016; Simons, Beaver, Roberts & Tonhauser 2017: projection of factive CCs tied to entailment

# Towards empirically adequate projection analyses
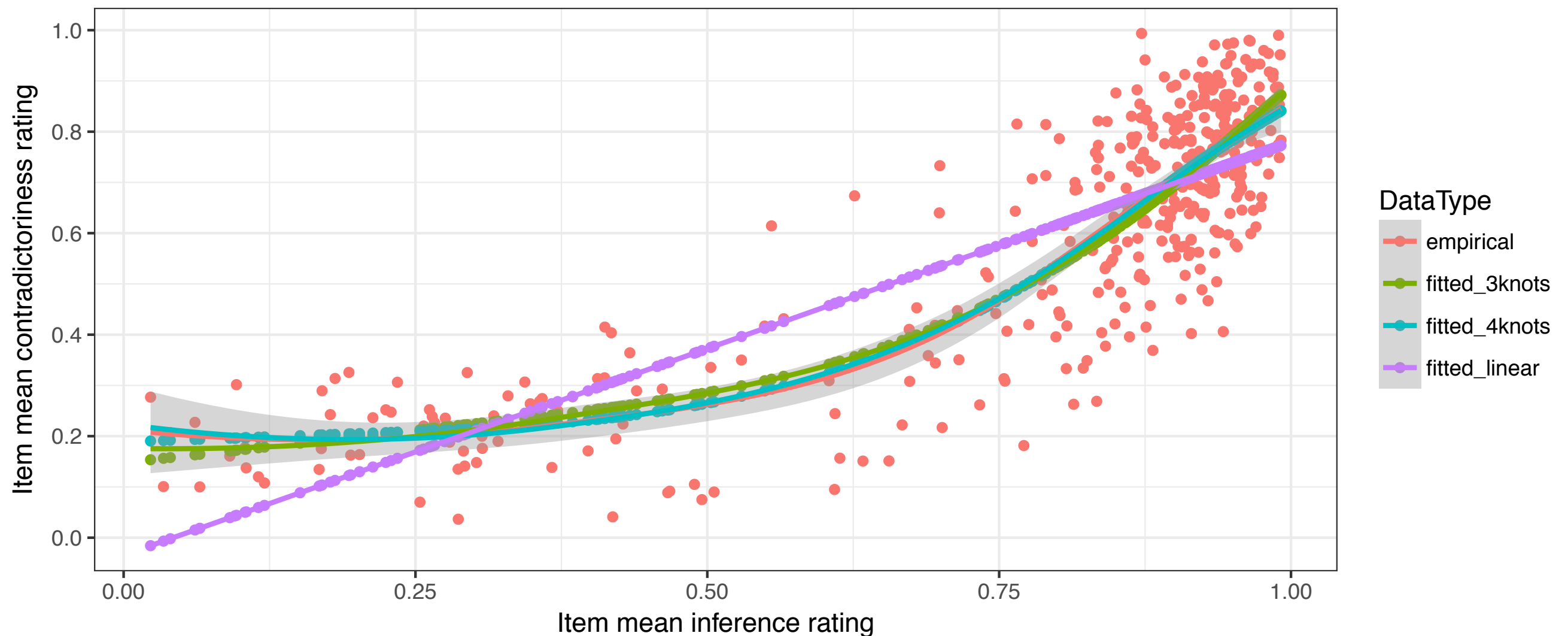
Factors that influence projection:

- Meaning of the clause-embedding predicate: e.g., *announce* versus *discover* versus *be annoyed*

- At-issueness, i.e., relevance of the content to the Question Under Discussion

- Information structure: Is the content given or in focus?

- Prior content probability
  (a) Did Mary discover that there's a dog in her yard?
  (b) Did Mary discover that there's an alien in her yard?

e.g., Beaver 2010; Simons et al 2010; Tonhauser 2016; Stevens et al 2017; Tonhauser, Beaver & Degen 2018; de Marneffe, Simons & Tonhauser 2019; Tonhauser et al 2019; Degen & Tonhauser ms.

# At-issueness predicts projectivity

(Tonhauser, Beaver & Degen 2018)
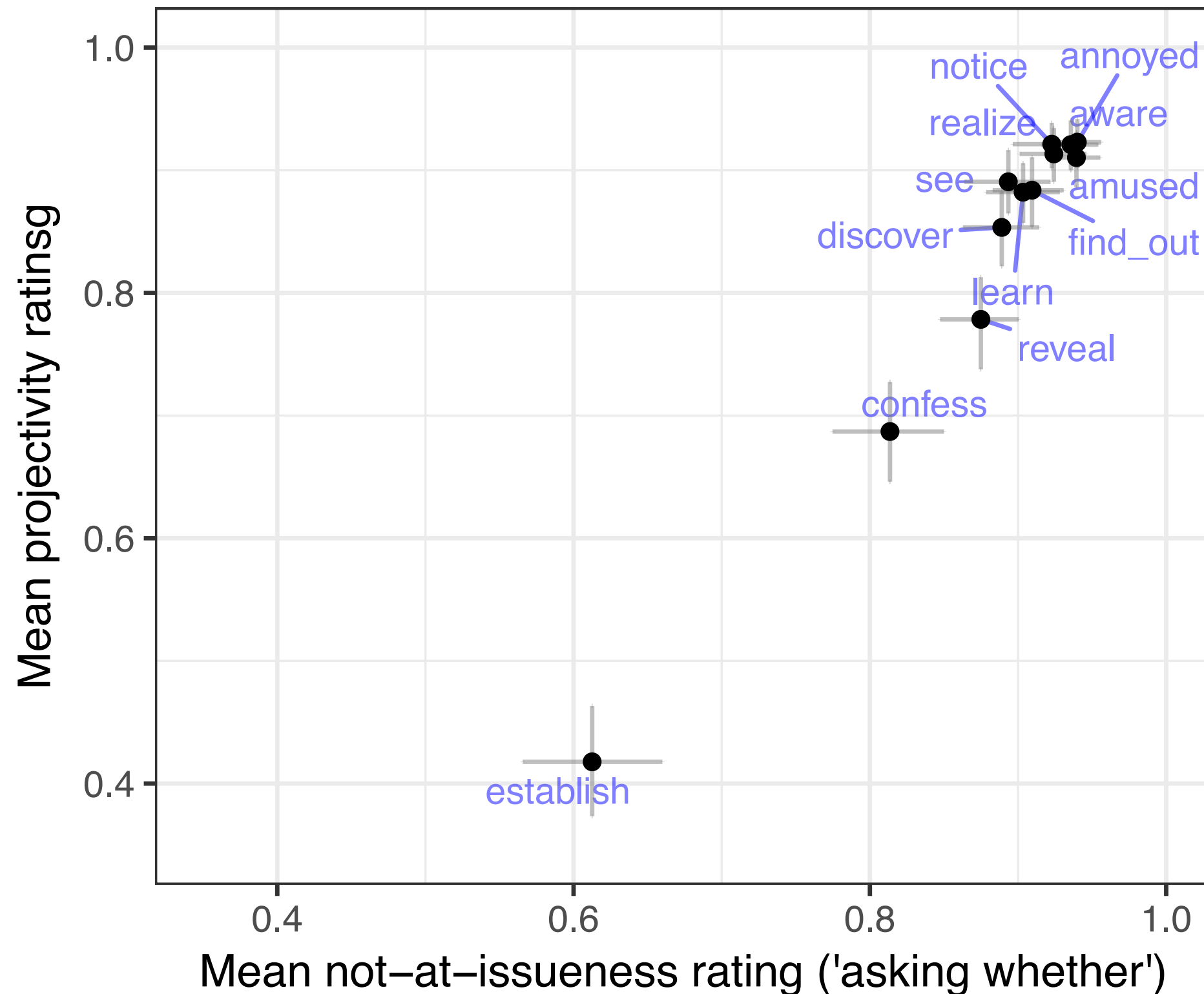
# Prior content probability modulates projectivity

Tonhauser & Degen 2019 (XPRAG)