Projection variability of clausal complements across different operators

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Does the projection of content differ across entailment-canceling environments?

- **Yes!** Projection differs by entailment-cancelling operator
- By-operator effects differ by predicate (operator/predicate interaction)
- Current theories of projective content do not predict our results

Projection of clausal complements

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

(1) a. Rachel: *'Does Cole know that Julian dances salsa?'*
✓ Yes, CC projects out of the question

b. Rachel: *'Does Cole think that Julian dances salsa?'*
✗ No, CC does not project

Frege (1892); Strawson (1950); Kiparsky and Kiparsky (1970); Karttunen (1971); Karttunen and Peters (1979), and many more

Entailment-cancelling operators

Family-of-sentences test:
No mention of differences in projection between different operators

(2)
- i. Polar question: *Does Cole know that Julian dances salsa?*
- ii. Negation: *Cole doesn't know that Julian dances salsa.*
- iii. Epistemic modal: *Perhaps Cole knows that Julian dances salsa.*
- iv. Conditional antecedents: *If Cole knows that Julian dances salsa, Logan will be joyful.*

(e.g. Chierchia and McConnell-Ginet 1990; Coppock and Champollion 2020)

Hints at by-operator variation

- Karttunen (1971) proposes **factive vs semi-factive** distinction
- Smith & Hall (2014): Experiment with **English projective contents**
  - Effect of operator differs by projective content
- Sieker & Solstad (2022): Exp. with **German clause-embedding predicates**
  - No by-predicate variation, no evidence for factive/semi-factive distinction

		Neg	Cond	PQ	Mod
Karttunen (1971)	factives (*be annoyed, regret, …*)	✓	✓	✓	✓
	semi-factives (*discover, realize, see, notice, …*)	✓	not always	not always	not always
Smith & Hall (2014)	epithets (e.g. *idiot*), CC of *know*	more projection	less projection	N/A	N/A
	Appositive RCs, prep. content of *win*	less projection	more projection	N/A	N/A
Sieker & Solstad (2022)	CCs of German 'factives' & 'semi-factives'	more projection	less projection	less projection	less projection

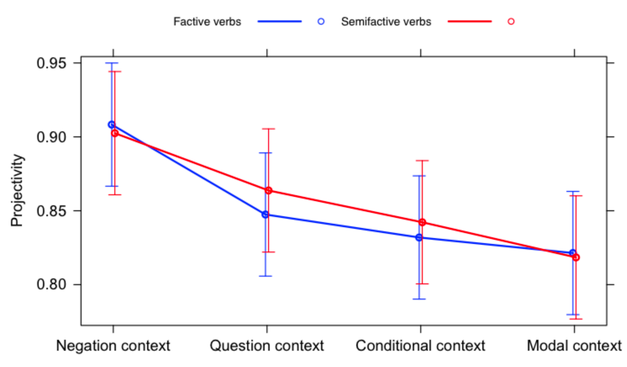
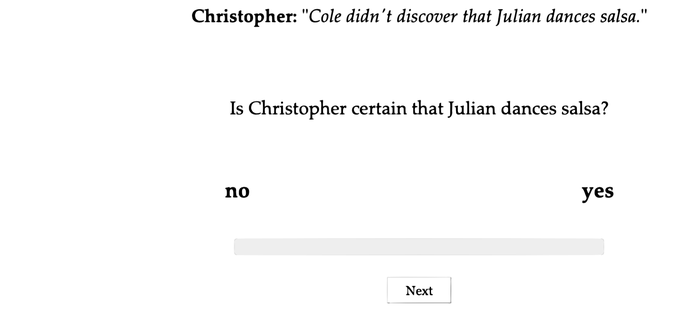


Figure 1. Sieker & Solstad 2022, p. 286: Projection-ratings by embedding operator, for purported factive and semi-factive predicates

'Certain-that' task for projection inferences



Tonhauser (2016); Djärv and Bacovcin (2017); Tonhauser et al. (2018); de Marneffe et al. (2019); Mahler (2020); Degen and Tonhauser (2022); Sieker and Solstad (2022)

Variation among clause-embedding predicates

20 predicates that have shown projection variability in PQs (Degen and Tonhauser 2022)

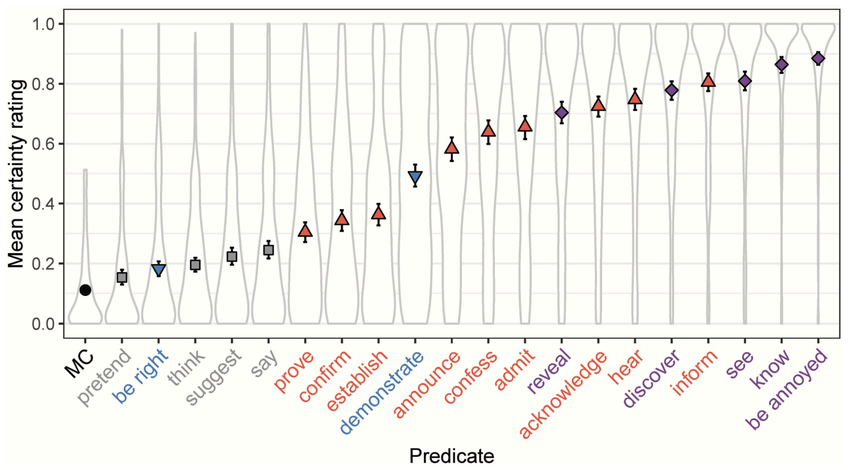


Figure 2. Degen and Tonhauser 2022, p. 562: Mean certainty ratings by predicate

Materials

To assess the effect of operator and predicate on **projection**:

4 experiments (roughly 750 participants each)

- One per operator: polar questions, negation, modal *perhaps*, conditional

Participants saw:

- **20 clause embedding predicates**
  - Crossed with 20 CCs ($20 \times 20 = 400$ combinations)
- (6 controls for exclusion)

(Experiments also used different at-issueness measures in separate block, not analyzed here)

Effects of operator & predicate on projection

By-operator variation aggregating across predicates (Figure 3)

- Conditional > Question > Negation, Modal

Model #1: Linear mixed effect regression
response: **certainty ratings**; fixed effect: operator (base level: Question); random intercepts: participants, items;
MLEs: question (intercept) 0.51, conditional +0.05, modal −0.04, negation −0.03; with all $p < 0.001$

- But small differences, as in Sieker & Solstad's (2022) study
- Sieker & Solstad's results for German: Negation > Question, Conditional, Modal

Effect of operator differs by predicate (Figure 4), e.g.

- CC of be annoyed: Question, Negation > Conditional, Modal

Model #2: Linear mixed effect regression
response: **certainty ratings**; fixed effects: operator, predicate, and interaction (base lvl: **be annoyed** / negation); random intercepts: participant; MLEs: negation (intercept) 0.87, conditional −0.12, modal −0.16; ($p < 0.001$); question +0.02 (n.s.)

- CC of know: Question > Negation, Conditional > Modal

Model #3: Linear mixed effect regression
response: **certainty ratings**; fixed effects: operator, predicate, and interaction (base level: **know** / negation); random intercepts: participant;
MLEs: negation (intercept) 0.79, modal −0.14, question +0.08; with $p < 0.001$; , conditional +/ − 0, (n.s.)

- CC of discover: Conditional, Question > Negation > Modal

Model #4: Linear mixed effect regression
response: **certainty ratings**; fixed effects: operator, predicate, and interaction (base level: **discover** / negation); random intercepts: participant;
MLEs: negation (intercept) 0.68, conditional +0.11, question +0.10, modal −0.06; with $p < 0.001$

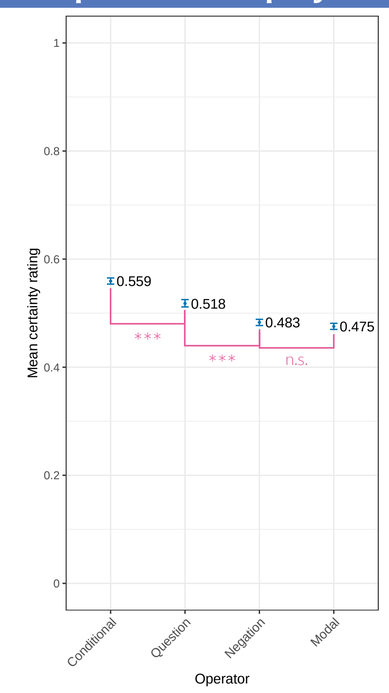


Figure 3. Mean certainty ratings by operator

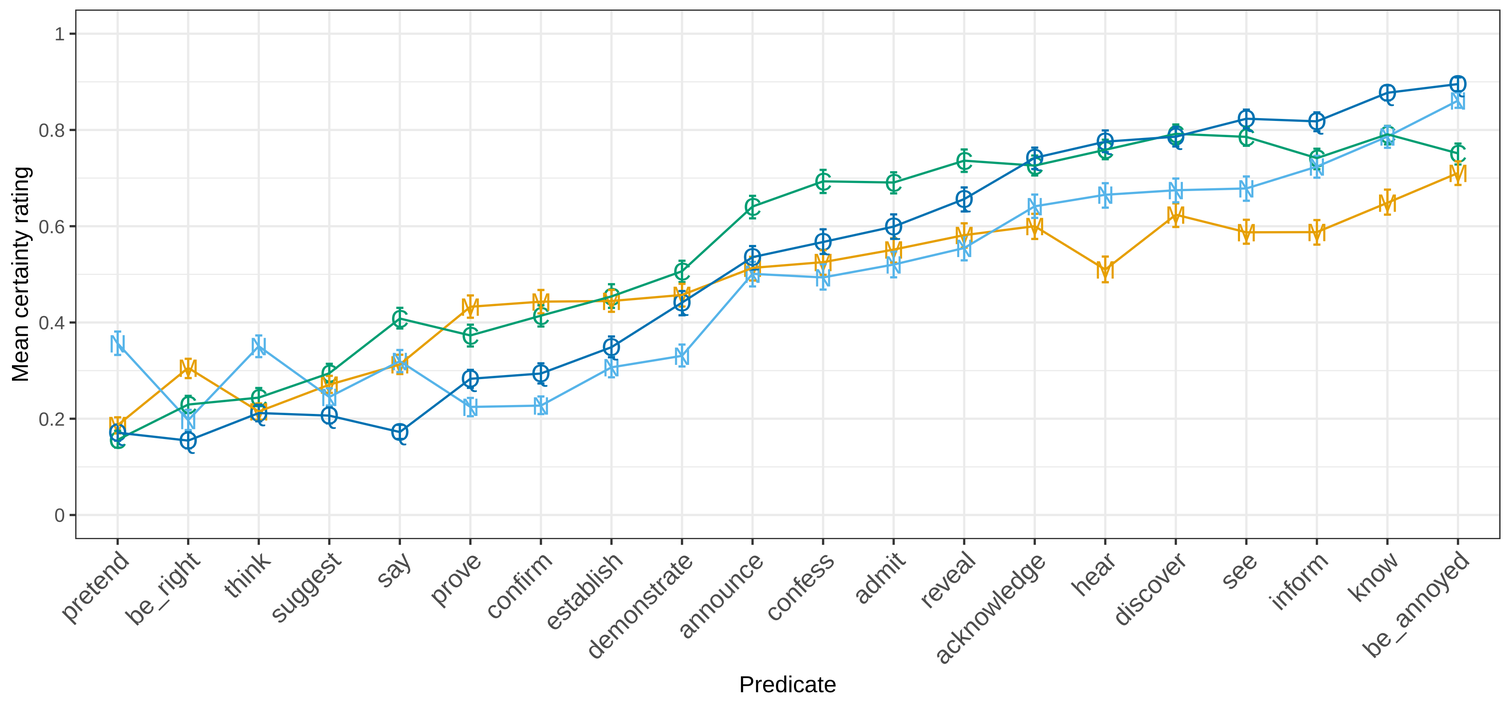


Figure 4. Mean certainty ratings by predicate with 95% bootstrapped confidence intervals, grouped by operator. Entailment-cancelling operator coded by letter and color: N: negation, M: modals, C: conditional antecedents, Q: polar questions.

Discussion — By-predicate variation in the effect of operator

- Concurs with Smith & Hall (2014), who found content/operator interactions for English projective contents
- Differs from Sieker & Solstad (2022): found no predicate/operator interaction for CCs of German clause-embedding predicates

No evidence for factive vs. semi-factive distinction (Karttunen 1971)

- CC of purported factive *be annoyed* does not invariably project across operators
- CC of purported semi-factives (*discover, see*) do not project more across negation than other operators

Provides support (from negation, modals, conditionals) for Degen & Tonhauser's (2022) result:

- Projection does not categorically differentiate between (semi-)factive/-factive predicates

Existing theories of projection do not predict our results

Dynamic accounts of projection: Lexical triggering + dynamic semantics (Heim 1992; van der Sandt 1992)
Distinguish factive and non-factive predicates:
- factive predicates (*be annoyed, regret, …*): CC conventionally required to be contextually entailed in common ground
- non-factive predicates (*believe, say, …*): no such requirement

Factive content projects globally, unless not admitted by common ground

Lexical entailments + discourse-based triggering (Abrusán 2011; Simons et al. 2017)
Distinguish veridical predicates (CC is entailed) from non-veridical ones:
- veridical predicates (*be right, demonstrate, …*): entailed CC projects if not at-issue
- non-veridical predicates (*believe, say, …*): no predictions / CC projects if required by discourse coherence

Contextual entailments + triggering based on cognitive inertness (Schlenker 2021)
Potential of projection for contents that are contextually entailed (given a context C and the utterance U), including inferences from:
- Lexically veridical predicates
- 'Distributed veridicality' contexts (Roberts 2019) (*Cole {was not wrong, can't believe} that Julian dances salsa.*)
- Other sources of contextual inference ((Cole is honest + knowledgeable.) *Cole said that Julian dances salsa.*)

Contextually entailed CC projects if it is an epistemic precondition of U in C (it is typically/likely already known).

	Predictions		
Our data	Lexical triggering + dynamic semantics	Lexical entailments + discourse-based triggering	Contextual entailments + triggering based on cognitive inertness
Superadditive predicate/operator interaction	Meaning of entailment-canceling operators (invariably) encodes interaction with conventional content of embedded factives	No systematic predictions for how veridicality or at-issueness interact with the meaning of entailment-canceling operators	May be extended to our data by making explicit how combinations of operator + predicate are associated with contextual inferences
Projection variability for all predicates Projection for some non-factive (/non-veridical) predicates as high as for some factive (/veridical) ones (see also D&T'22)	No predictions for non-factive predicates	No systematic predictions for non-veridical predicates	Makes predictions about CCs of all clause-embedding predicates
Out-of-the-blue contexts Projection variability in the out-of-the-blue contexts used in experiment (see also D&T'22)	Consistent projection of factive CCs	Veridical predicates: analyses may be extended by assuming that the CCs of veridical predicates differ in at-issueness in out-of-the-blue contexts	"Out-of-the-blue" contexts do not warrant assumption of contextual entailment: No projection expected

Theoretical implications

- Previous work: projection analyses need to consider the effect of **lexical meaning** (e.g. Kiparsky and Kiparsky 1970; Karttunen 1971, et. seq.), **world knowledge** (de Marneffe et al. 2012; Degen and Tonhauser 2021), and **discourse structure** (e.g. Simons et al. 2017; Tonhauser et al. 2018)
- Add to that the effect of various entailment-cancelling operators
- An analysis of projection needs to be able to address operator / predicate interaction effects.

References

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