Projection differs across embedding operators—but not like you think

We present experimental evidence that i) the projection of the content of the clausal complement of attitude predicates varies across entailment-canceling operators (negation, question, modal, conditional) and ii) this by-operator variation differs across attitude predicates. Our results do not align with the long-standing distinction between factive and semi-factive predicates (see, e.g., Karttunen 1971; Djärv etal. 2018). Instead, the observed by-operator variation groups predicates by lexical semantic/pragmatic properties that raise important questions for future research on projection.

Projection across entailment-cancelling operators. Interpreters may infer that a speaker who utters one of the attitude ascriptions in (1) is committed to the truth of the content of the complement (CC), that Julian dances salsa, even though the complement occurs under an entailment-canceling operator, such as negation (1a), a polar question (1b), a modal (1c), or a conditional (1d).

(1) a. Negation: 'Cole didn't discover that Julian dances salsa.'
b. Polar Question: 'Did Cole discover that Julian dances salsa?'
c. Modal: 'Perhaps Cole discovered that Julian dances salsa.'
d. Conditional: 'If Cole discovered that Julian dances salsa, Logan will be joyful.'

Karttunen 1971 suggested that the CC of factive predicates (e.g., regret, forget) projects from under all four operators, whereas that of semi-factive predicates (e.g., discover, realize, see, notice) always projects from under negation, but not always from under polar questions, modals, or conditionals.

There has been, to date, one investigation of by-operator variation: Smith and Hall 2014, who investigated by-operator variation (negation, conditional) for the projective content of six expressions (know, the, win, epithets, clefs, non-restrictive relative clauses (NRRCs)), observed by-operator variation for some contents (e.g., that of know, but not that of clefs) and that this by-operator variation differs across contents (e.g., the content of NRRCs was more projective under conditionals than negation, the opposite pattern was observed for win). It is not clear, however, whether the response task used by Smith and Hall 2014 measured projection, as participants were asked to rate how surprised they would be to learn the content under investigation after observing the utterance.

There has not yet been an experimental investigation of by-operator variation between factive and semi-factive predicates. Djärv etal. 2018 and Tonhauser etal. 2018 did, however, observe by-predicate projection variation under polar questions. Djärv etal. 2018 observed a difference between be happy and appreciate (which they assumed are factive predicates) and be aware and realize (which they assumed are semi-factive predicates). However, the response task (acceptability of an affirmation of the CC while the main clause content was denied) did not measure projection of the CC. Tonhauser etal. 2018 measured projection of the CC of a broad range of attitude predicates from under polar questions: The by-predicate projection differences they observed did not align with what would be expected from Karttunen's classification (e.g., the CC of semi-factive realize was as projective as that of factive be annoyed and more projective than that of semi-factive discover).

Experiment. We present the results of an experiment designed to investigate by-operator projection variation for the CCs of 20 attitude predicates, including purported factive and semi-factive predicates (e.g., be annoyed, discover). Projection was measured for the same contents across all four operators in (1) using the 'certain that' diagnostic for projection (see also, e.g., Tonhauser etal. 2018; Djärv and Bacovcin 2017; Mahler 2020).

Methods and expectations. Projection of the CC of the 20 attitude predicate was measured in four sets of experiments: The attitude predicates were embedded under polar questions in Exps.1, under negation in Exps.2, under perhaps in Exps.3, and in the antecedent of a conditional in Exps.4. (Each set of experiments consisted of three experiments that differed in the at-issueness measure used in a separate block. We focus on the projection ratings here.) In each experiment, participants were asked to read utterances like those in (1) and judge whether the speaker (who was named) was certain of the CC (e.g.: Is [the speaker] certain that Julian dances salsa?). Participants gave their response on a slider marked 'no' (coded as 0) at one and and 'yes' (coded as 1) on the other

end. Each participant rated the projection of the CC of all 20 attitude predicates (each paired with a unique content from a set of 20 contents) under one operator. We analyze the data from 2,682 self-reported native speakers of American English recruited on Prolific or Amazon's MT platform. We expect the CC of factive predicates to consistently receive relatively high projection ratings under all four operators, and the CC of semi-factive predicates to exhibit high projection ratings under negation and possibly lower ratings under the other operators.

Results. Fig.1 plots the mean projection ratings for the 20 attitude predicates by embedding operator; the predicates are ordered by their mean projection across all operators (be annoyed has the highest overall projection mean). We observe by-operator variation in projection means as well as differences across the predicates in by-operator variation: For instance, whereas the CC of be annoyed projects more from under questions and negation than from under conditionals and modals, the CC of know projects more from under questions than from under conditionals and negation, and the CC of discover projects more from under questions and conditionals than from under negation and modals. These results are not aligned with the distinction between factive and semi-factive predicates proposed in Karttunen 1971 or assumed in Djärv etal. 2018: Contrary to assumption, the CC of the purportedly factive predicate be annoyed does not project invariably from all four operators, and the CC of the purportedly semi-factive predicate discover does not project more from under negation than the other three operators. For know, we observe a third pattern – one that is not aligned with a classification as a factive nor as a semi-factive predicate.

==== THIS IS AS FAR AS I've COME ====

The data was analyzed using a mixed effects linear regression (using `lme4, lmertest` in `R`; Bates etal., 2015; Kuznetsova and Christensen, 2016; Team, 2014), with `be_annoyed` and `negation` as reference levels, and random intercepts for participants and items. We found highly significant main effects of `operator`: For our baseline `be_annoyed`, both `conditional` and `modal` are clearly less projective than negation, thereby supporting the claim that the embedding context does matter. We also found many interactions of `operator` and `verb` across the board, suggesting that the effect of embedding context diffes by verb. Notably, 'discover' is more projective in polar questions and conditional antecedents than under negation, patterning opposite to Karttunen's claims about semi-factives. For the emotive predicate 'be annoyed' no significant effect is found for `question` (vs `negation`), as would be expected based on Karttunen, but we do find unexpected differences between `negation` $>$ `conditional, modal`. know shows effects that would be incompatible with a characterization as either factive or semi-factive: `question` $>$ `conditional, negation` $>$ `modal`. If 'know' is a factive predicate, no difference would be expected. If it is semi-factive, we would, again, expect higher projectivity under negation than in questions and conditionals.

Discussion.

We observe that projection varies by predicate (e.g., the CC of be annoyed is more projective than that of discover; replicating the results of **?**).

No categorical distinction between factive and non-factive predicates either

add discussion about verb classes here

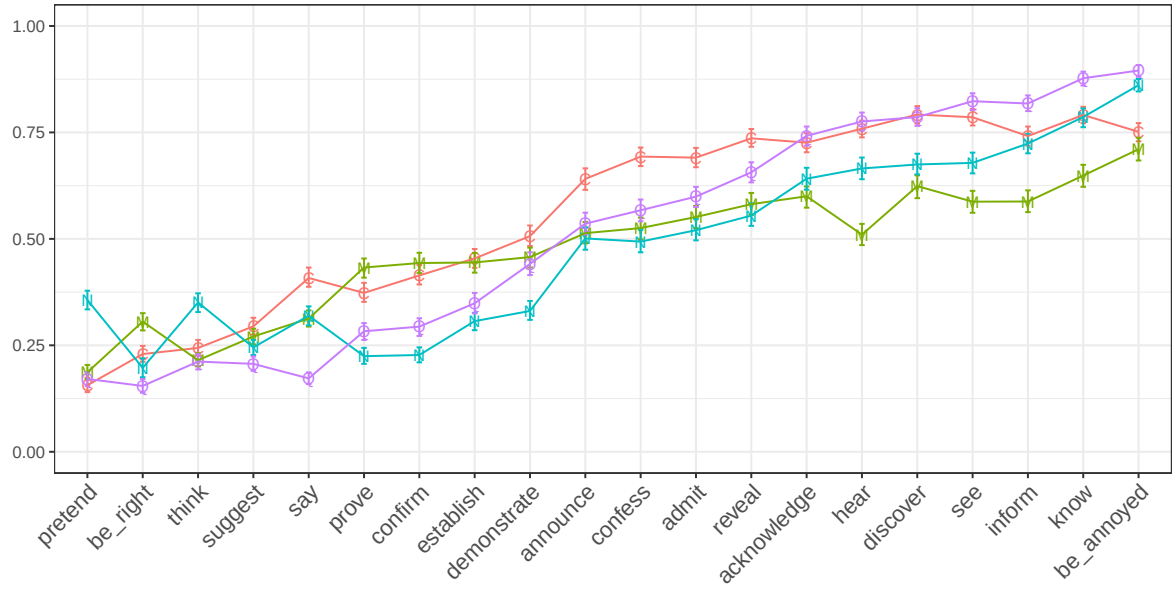

Figure1: Mean certainty ratings by predicate and operator with 95% bootstrapped confidence intervals. Embedding operator coded by letter and color: `N` (blue): negation, `M` (green): modals, `C` (red): conditional antecedents, `Q` (purple): polar questions.

References

Douglas Bates, Martin Mächler, Ben Bolker, and Steve Walker. Fitting Linear Mixed-Effects Models Using lme4. Journal of Statistical Software, 67(1):1–48, 2015. doi: 10.18637/jss.v067.i01.

Kajsa Djärv and Hezekiah Akiva Bacovcin. Prosodic effects on factive presupposition projection. Semantics and Linguistic Theory, 27:116–133, 2017. doi: 10.3765/salt.v27i0.4134.

Kajsa Djärv, Jérémy Zehr, and Florian Schwarz. Cognitive vs. emotive factives: An experimental differentiation. In Proceedings of Sinn und Bedeutung, volume21, pages 367–386, 2018. Issue: 1.

Lauri Karttunen. Some observations on factivity. Research on Language & Social Interaction, 4 (1):55–69, 1971. Publisher: Taylor & Francis.

Per BruunBrockhoff Kuznetsova, Alexandra and Rune HauboBojesen Christensen. lmertest package (version 2.0.33), 2016.

Taylor Mahler. The social component of projection behavior of clausal complements. Linguistic Society of America, 5:777–791, 2020. doi: 10.3765/plsa.v5i1.4703.

E.Allyn Smith and KathleenCurrie Hall. The relationship between projection and embedding environment. In Proceedings of the 48th Meeting of the Chicago Linguistics Society. Citeseer, 2014.

RCore Team. R: A Language and Environment for Statistical Computing, 2014. URL `https://www.r-project.org/`.

Judith Tonhauser. Prosodic cues to speaker commitment. Semantics and Linguistic Theory, 26: 934–960, 2016. doi: 10.3765/salt.v26i0.3788. Publisher: Ithaca, NY: CLC Publications.

Judith Tonhauser, DavidI. Beaver, and Judith Degen. How projective is projective content? Gradience in projectivity and at-issueness. Journal of Semantics, 35(3):495–542, 2018. Publisher: Oxford University Press.