How do the entailments of a *that*-clause-embedding predicate modulate the projection of its CC?

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1 The gist

- Traditionally, projection of the CC of a *that*-clause-embedding predicates is explained in terms of factivity: if a predicate is factive, its CC is presupposed and therefore projects; if it non-factive, the CC does not project (Kiparsky and Kiparsky 1970).
- However, the categorical factive/non-factive distinction does not predict the projection ratings obtained in experiments, which show high levels of variability (Degen and Tonhauser 2022).
- The predicate type (cognitive, communicative, emotive, evidential) is another category that predicts projection ratings to some extent. However, within each type we again observe high variability, including within those predicate types thought to reflect the factive/non-factive distinction, i.e., the emotives, considered mostly factive, and the communicatives, considered generally non-factive (Anand and Hacquard 2014).
- A good starting point for trying to find an explanation for the observed variability are the communicatives, precisely because their CC is not predicted to project and yet often does, with some of these predicates receiving even higher projection ratings than the cognitive *know* (White and Rawlins 2018), which is commonly considered factive.
- As White and Rawlins's (2018) participants provided their ratings based on "low-content items" without any context, it is reasonable to assume that the differences in projection ratings in the MegaVeridicality dataset are the result of differences in the lexical meaning of these communicative predicates.
- Since the meaning of a clause embedding predicate can be defined as the set of its entailments, in order to better understand if and how the meaning of these predicates modulates projection, a closer examination of their entailments is required. To this end, I am going to collect ratings on the entailments of communicative predicates and the projection of their CC.

2 Predicates

2.1 The MegaVeridicality dataset

The starting point for this investigation is White and Rawlins's (2018) MegaVeridicality (MV) dataset, which contains veridicality judgements for 517 predicates, 348 of which occur in an"active frame" and 142 in a "passive frame", containing either passivised verbal predicates, like be advised or adjectival predicates, such as be delighted. The 27 predicates that occur in both frames are considered separately for each of them, resulting in a total number of 544 predicates.

- Stimuli: White and Rawlins's (2018) participants saw either utterances as in (1) below, which were followed by the question "Did that thing happen?", or as in (2), in which the question was already included.

  (1) a. Someone {thought, didn't think} that a particular thing happened.
      b. Someone {was, wasn't} told that a particular thing happened. (White and Rawlins 2018)

  (2) a. If someone {did, didn't} know that a particular thing happened, did that thing happen?
      b. If someone {was, wasn't} told that a particular thing happened, did that thing happen?
      (White and Rawlins 2018, slightly modified)

- Projection ratings in the MV dataset are therefore based on three different environments, with the predicates embedded under different (combinations of) entailment-cancelling operators: negation, the antecedent of a conditional and a polar question, or a combination of all three operators.

- White and Rawlins (2018) asked their participants to answer "yes", "maybe or maybe not" or "no". These responses were recoded as 1, 0 and -1, respectively.

- The MV dataset furthermore includes acceptability ratings given by participants on a 7-point Likert scale for each utterance they evaluated.

2.2 Classification of predicates

- Because many of the predicates in the MV dataset can take on different meanings depending on how they are used, my classifications of these predicates are strictly based on their meaning in the stimuli used by White and Rawlins (2018).
  - The predicates in the MV dataset only occur in the past tense, therefore all classifications regarding their lexical meaning are based solely on their use in the past tense.
  - The meaning of the predicates was only considered in the context of the specific "low lexical content" complement clause used by White and Rawlins (2018).

- The main distinction made for this investigation is that between communicative and private predicates.
  - A predicate *P* is communicative if and only if "*X P*ed that *m*" requires *X* to have externalised *m*. This externalisation may be have been verbal or nonverbal.
  - A predicate *P* is private if and only if "*X P*ed that *m*" conveys that *m* stands in some relation to *X*'s mental representation of the world. *X* does not have to believe that *m* is true.

- Amongst the private predicates I distinguish between three subtypes: cognitives, emotives and evidentials.
  - A predicate *P* is cognitive if and only if "*X P*ed that *m*" conveys something about *X*'s relation to *m*.
  - A predicate *P* is emotive if and only if "*X P*ed that *m*" conveys that *X* has a feeling or emotion towards *m*.
  - A predicate *P* is evidential if and only if "*X P*ed that *m*" conveys the source of information by which *X* received the information about *m*.

- 12 predicates that can be used both as communicative and private predicates were excluded from analysis, as well as the 29 predicates that could not be assigned to any of the predicate types, leaving 503 predicates, including 217 communicatives.
- Because of a strong positive correlation between acceptability ratings and projection ratings, only the 474 predicates with a mean acceptability rating of greater than 4 (midpoint of the scale) are included in my analysis, 201 of which are communicatives.

3 Entailments of communicatives

3.1 Emotion entailment

3.1.1 Classification

Fig. 1 shows that the mean projection rating of the emotives in the MV dataset is much higher than that of the other predicate types defined above.

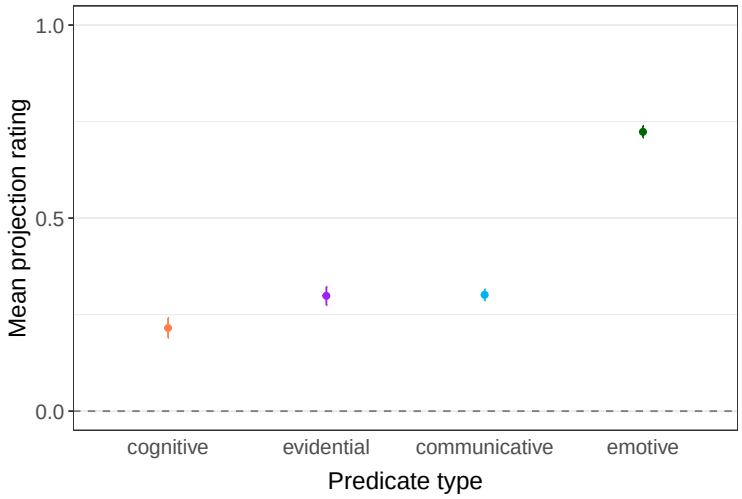

Figure 1: Mean projection rating by predicate type.

Because the emotives were found to be more projective overall than predicates of the other types, the communicative predicates were subcategorised depending on whether they have an 'emotion entailment' or not. Communicatives with an 'emotion entailment' entail that the subject has an emotion / a feeling about the CC. That this is in fact an entailment can be confirmed with the defeasibility and reinforcement diagnostics:

(3) a. # John groaned that a particular thing happened, but he had no emotion/feeling about the matter.
b. # John groaned that a particular thing happened, and he had some emotion/feeling about the matter.

As (1a) is contradictory and (1b) sounds redundant, the subject's having an emotion/feeling is an entailment of the predicate.

Fig. 2 shows that the mean projection rating of the 27 communicatives with an emotion entailment, although not nearly as high as for the emotives, is significantly higher than that of the cognitives, evidentials and communicatives without an emotion entailment.

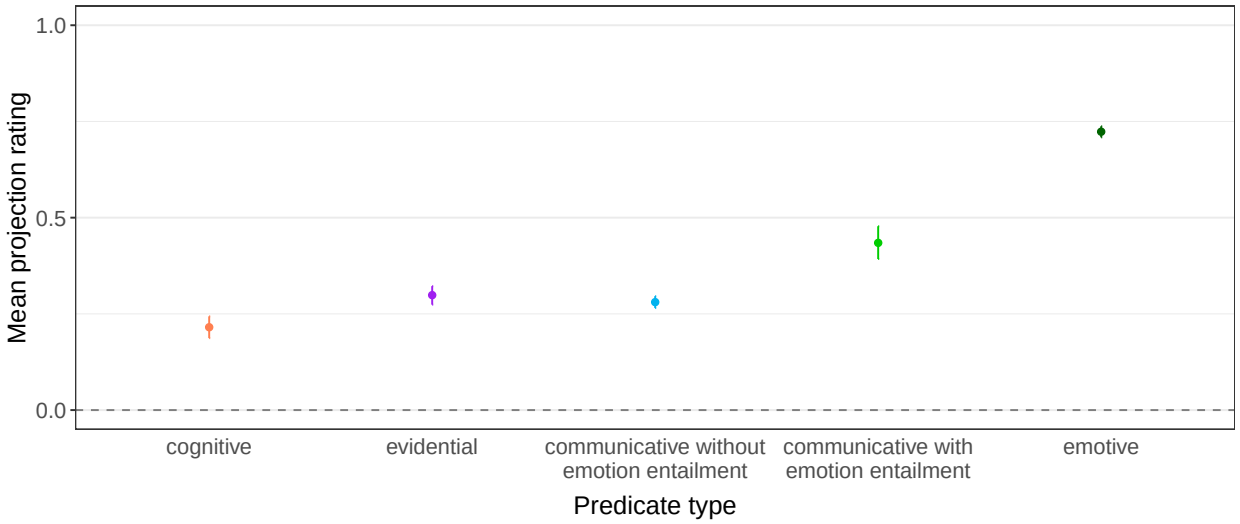

Figure 2: Mean projection rating by predicate type with distinction between communicatives with and without an emotion entailment.

3.1.2 Measures of emotivity

That the quality identified by the diagnostics above is indeed emotion and not merely an attitude towards the CC is supported by an investigation of ratings of emotional valence, arousal and dominance (VAD) for the predicates in question, as these are the three measures that are traditionally considered to make up emotions (Warriner et al. 2013). Warriner et al.'s (2013) collection of valence, arousal and dominance ratings for 13,915 English lemmas contains ratings for 388 of the predicates in the MV dataset that are part of the present investigation, including 177 communicatives, 25 of which have an emotion entailment.

- Original ratings: Warriner et al.'s (2013) participants provided their ratings on scales of 1 to 9, ranging from
  - Valence: completely unhappy to completely happy.
  - Arousal: completely calm to completely aroused.
  - Dominance: Completely controlled to completely in control.
- Rescaled ratings: the researchers suggest that on all three scales, a rating of 5 would indicate a neutral state. However, whilst valence and dominance do in fact have a neutral state between the extremes, the neutral state of arousal is not in the middle of the "calm – aroused" scale, but at its lower end: calmness is the absence of arousal; there is no such thing as 'negative' arousal.
- Hence, for this investigation
  - Valence and dominance ratings are converted into absolute values of their distance from the neutral state and the direction of this distance is recorded as an additional variable.
  - The ratings for all three measures are rescaled to range from 0 to 1. On this new scale, 0 indicates neutrality and 1 indicates the highest level of emotional valence, arousal or dominance.

As Fig. 3 shows, for communicatives with an emotion entailment, valence and arousal ratings are much higher than for those without it. Furthermore, arousal ratings of the communicatives with an emotion entailment are like those of the emotives, i.e., the difference between the mean arousal ratings for these two

predicate types is not statistically significant. The similarity of this subgroup of communicatives with the emotives in this respect suggest that they share some of their meaning, specifically the fact that the attitude holder/subject is emotionally affected by the CC.

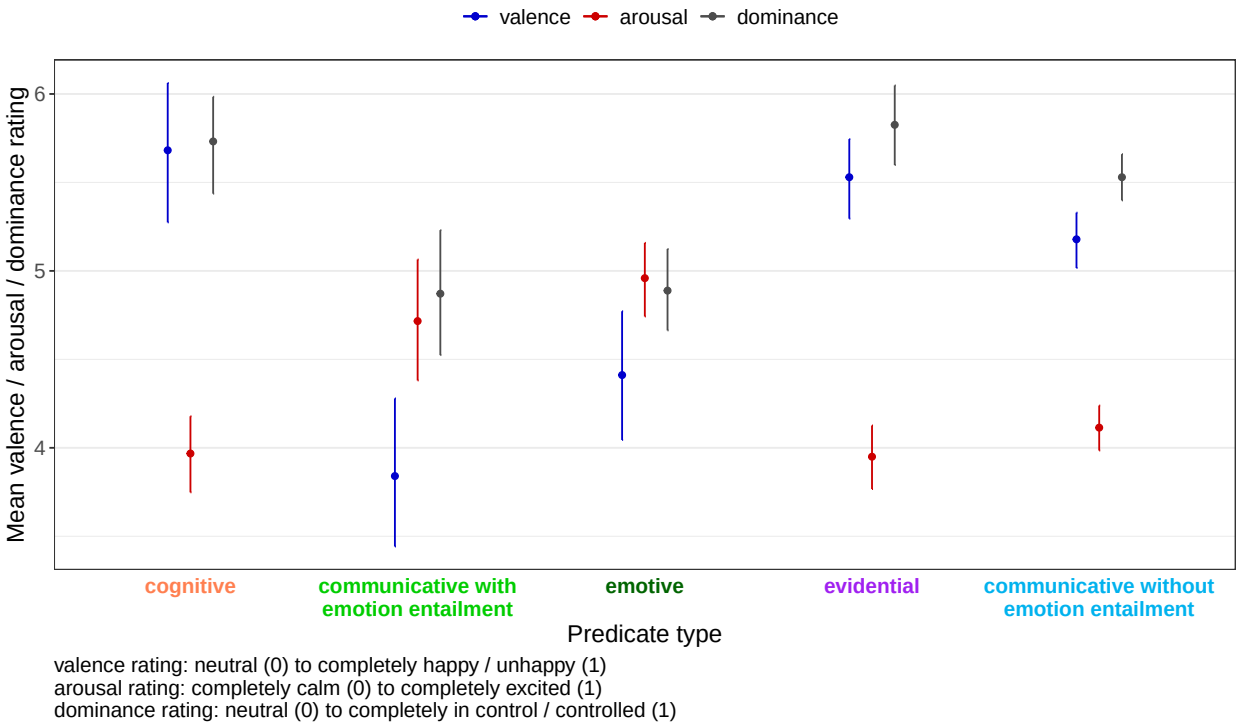

Figure 3: Mean valence/arousal/dominance rating by predicate type.

Further down the line, when the entailment structures of these predicates are defined and related to their projection ratings, VAD ratings may provide more detailed explanations for the differences in projection ratings between individual predicates within the investigated subgroups in several ways:

Across all predicate types, higher valence and arousal ratings are associated with higher projection ratings, as shown in Fig. 4 below.

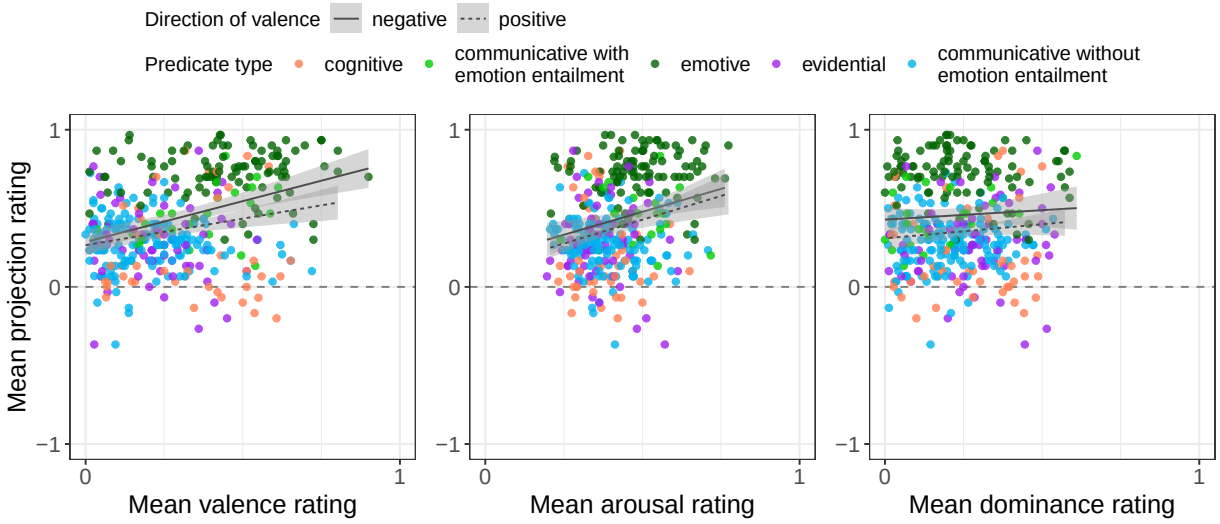

Figure 4: Mean projection rating by mean valence/arousal/dominance rating with separate fitted lines for predicates with negative and positive valence.

Amongst the communicatives, however, only the correlation of valence and projection ratings is significant. Fig. 5 shows that the positive correlation between valence and projection ratings is only significant for those communicatives with an emotion entailment.

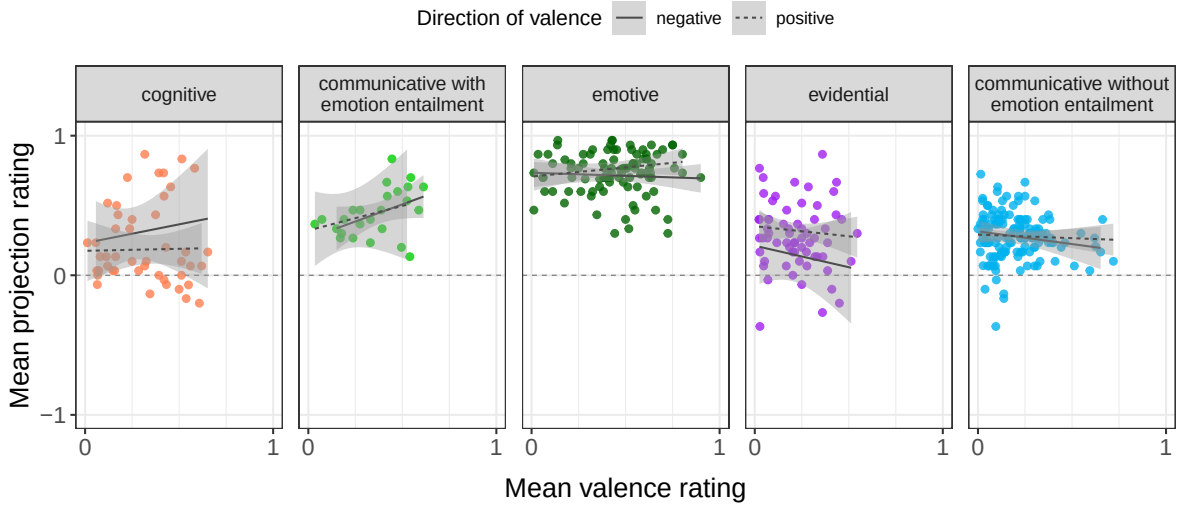

Figure 5: Mean projection rating by mean valence rating for each predicate type.

Although higher dominance ratings are not generally associated with higher projection ratings, as shown in Fig. 4 above, for the communicatives with an emotion entailment, dominance seems to be a significant predictor of projection ratings:

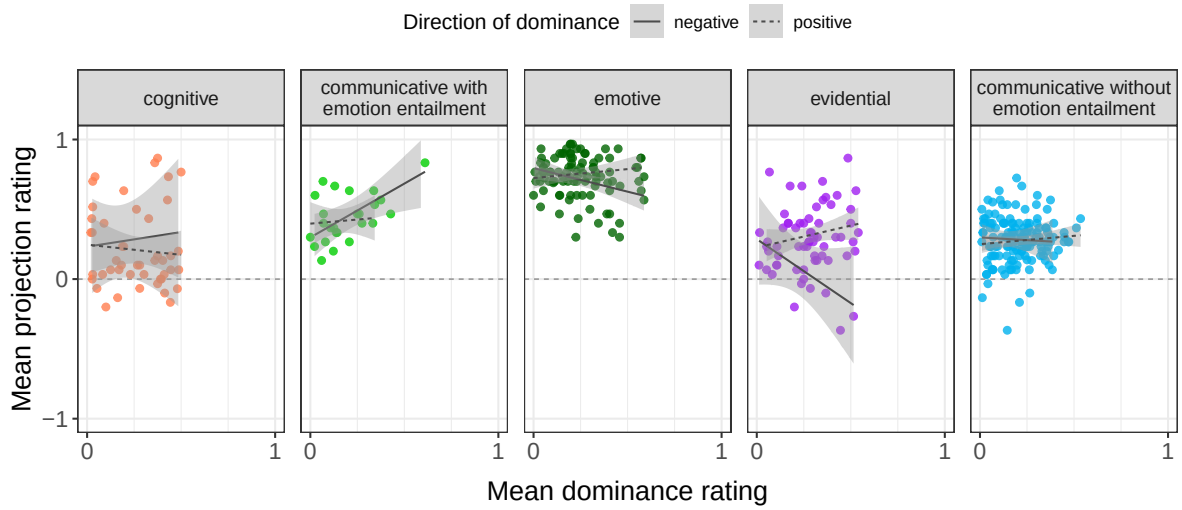

Figure 6: Mean projection rating by mean dominance rating for each predicate type.

Another correlation between projection and VAD ratings is the direction of valence: negative valence is associated with higher projection ratings compared to positive valence. A cumulative link mixed model fitted with the R package *ordinal* (Christensen 2023) predicting projection ratings from direction of valence with random intercepts for participant and entailment-cancelling environment identifies an effect of direction of valence on projection ratings at the 0.001 significance level.

3.1.3 Sub-classification

Although the presence of an emotion entailment in communicative predicates is positively correlated with higher projection ratings, the very wide range of projection ratings of the individual predicates shown in Fig. 7 indicates that this entailment alone does not explain the high projection ratings of many members of this group of communicative predicates.

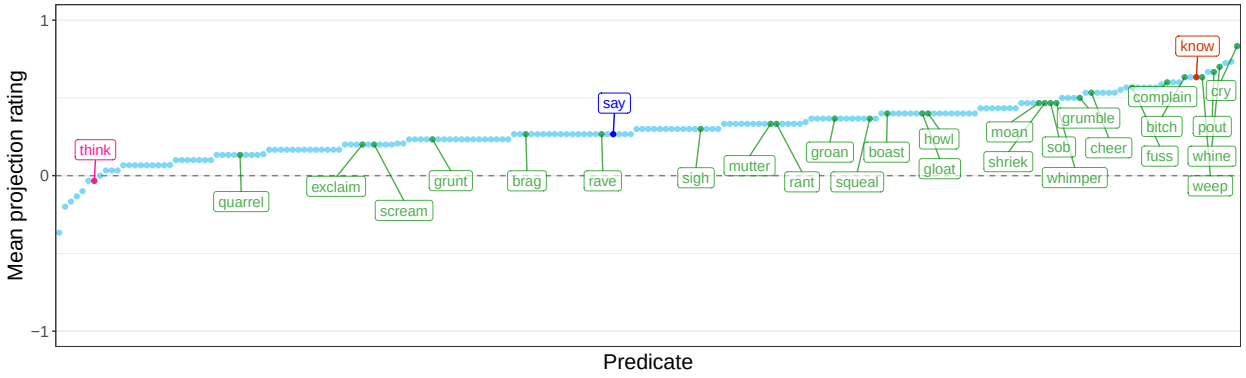

Figure 7: Mean projection rating by communicative predicate with communicatives with an emotion entailment labelled in green. The cognitives *think* and *know* are included for reference.

3.2 Other entailments

Further important entailments of communicative predicates are

- The communication entailment:
  - Part of all communicatives.
  - The CC is communicated in some way.
  - For many communicatives with an emotive component, this entailment seems to project when the predicate is stressed.
- The belief entailment:
  - Part only of some communicatives, including those with an emotion entailment.
  - If the subject truly has an emotion about the CC, then they must also believe it.
- The manner entailment:
  - Part of some of the communicatives with an emotion entailment, roughly Levin's (1993) "verbs of manner of speaking", such as *groan*, *moan* and *squeal*.
  - "... distinguished from each other by the manner in which the sound is expressed." (Levin 1993: 206)
- The subject attitude entailment:
  - Part of some of the communicatives with an emotion entailment, roughly Grimshaw's (2015) "SAY-with-attitude verbs", such as *bitch*, but also Levin's (1993) "complain verbs", like *boast*, *brag* and *complain*.
  - The subject's attitude as perceived by the speaker.
- The speaker attitude entailment:
  - Part of some of the communicatives with an emotion entailment, including some of Levin's (1993) "complain verbs", like *boast* and *brag*.
  - The speaker judges *how* something is said.
  - It seems that these 'the speaker dislikes how the subject says something' predicates have no positive counterparts.
  - It seems that neither of these two 'attitude' entailments ever occurs without the other.
- The speaker evaluation entailment:
  - The speaker expresses uncertainty or disbelief about *what* is said with predicates like *allege* or *lie*.
  - It seems that these 'the speaker believes the CC is (possibly) not true' predicates have no positive counterparts.

There are many more entailments that can be part of subtypes of communicatives predicates. Fig. 8 shows that on both ends of the mean projection rating range some such subtypes that may share certain entailments can be identified:

- High: disclose-reveal; fess up-admit; explain-detail; document-log; ...
- Low: fake-lie; jest-joke; hint-imply; contend-debate, ...

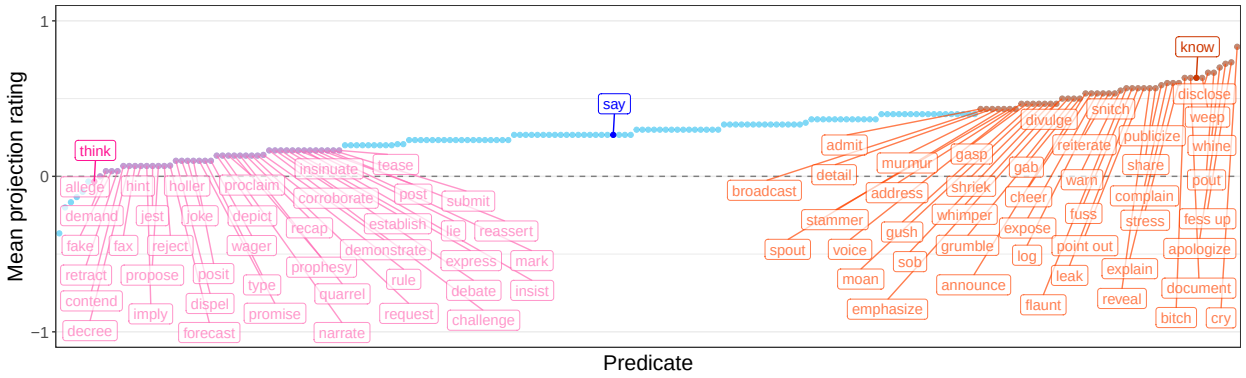

Figure 8: Mean projection rating by communicative predicate with labels for predicates with lowest and highest projection ratings. The cognitives *think* and *know* are included for reference.

For this investigation, the next steps are the following:

- Identify some subtypes of communicatives and all members of these groups included in the new dataset.
- Define the set of the most important entailments for each group.
- Select a few interesting groups. Each should share one entailment (other than the communication entailment) with one other group.
- Collect projection, acceptability and entailment ratings for some or all members of these groups.

4 Experiments

4.1 Experiment 1: projection ratings

A closer inspection of participants' acceptability ratings in the MV dataset reveals that these seem highly subjective, which calls into question the reliability of their projection ratings:

- Only four of the 544 predicates in the MV dataset have mean acceptability ratings of less than 3.
- Even for the least acceptable predicates, most individual ratings are somewhere in the middle and some even on the high end of the scale. This indicates that many participants considered a stimulus acceptable if it was interpretable (e.g. *John was overheard that a particular thing happened.* ≈ *John was overheard saying that a particular thing happened.*)
- It therefore seems plausible that some veridicality and projection ratings might be based on utterances that differ from the original stimulus in unpredictable ways.
- As a result, I have to collect my own projection ratings for the communicatives investigated here.

4.1.1 Methods

Participants and data exclusion 350 participants were recruited via Prolific. Due to unclear circumstances only 347 participants' responses were recorded on the server that hosted the experiment. Each participant was paid £0.39. Only the responses of participants who are self-declared native speakers of American English were included in the analysis. 28 participants who failed at least one of two attention

checks in the experiment were excluded from analysis. Of the remaining 314 participants, 206 are female, 106 male and 2 non-binary.

Materials The purpose of this experiment is to find possible additional evidence for the patterns in the MV dataset described above. Therefore, the stimuli used here were designed to be comparable to the MV stimuli, just with 'a little bit more content', i.e., the utterances are something that people would actually say or hear, unlike White and Rawlins's (2018) rather artificial "low context items". The stimuli are like those in White and Rawlins (2018) in that

- The past tense is used both for the matrix clause and the complement.
- The complement describes an event, not a state.
- The complement consists of a "particular thing", which here is realised as a definite DP, and an unaccusative verb.
- The complement does not contain aspect or mood marking.

However, for some of the communicatives in the MV dataset considered here, applying these rules would result in ungrammatical utterances. The following 10 predicates were therefore not included in this experiment:

- *decree*, *demand*, *dictate*, *ordain*, *request* and *rule* require a subjunctive mood complement.
- *forecast*, *foretell*, *predict* and *prophesy* do not combine with a past tense complement.

Most of the remaining communicatives combine reasonably well with complements based on the rules above. Therefore, the following 11 complement clauses are used for the collection of projection ratings for these communicative predicates:

(4) a. The balloon popped.
b. The airbag deployed.
c. The bolt loosened.
d. The room darkened.
e. The computer restarted.
f. The sauce thickened.
g. The gate opened.
h. The factory closed.
i. The paper burnt.
j. The egg cracked.
k. The knot tightened.

These complement clauses are relatively neutral, i.e., not clearly positive or negative, to avoid mismatches with communicatives with an emotion entailment, as such unexpected combinations could affect whether the CC is perceived as projecting. At the same time, an emotional reaction to these CCs is still plausible. As the complement clause in White and Rawlins (2018) describes an event, only complement clauses that cannot be interpreted as describing a state were used for this experiment. Sentences like, e.g., *the fabric stretched*, which could also be interpreted as describing a property, in this case as *the fabric was stretchable*, were therefore not used as complement clauses in this experiment. Since the predicate *feign*, which refers to the subject's pretending to have a feeling or condition, is not compatible with the complement clauses

above, this predicate is not included in the experiment, leaving 190 predicates to be investigated here. The cognitive predicates *think* and *know* were included in the experiment for reference. The total number of predicates in this experiment was therefore 192.

The stimuli were created by randomly combining each of the complement clauses above with a gender-neutral name and one of the predicates, and then negating the resulting statement. As native speakers of American English were recruited as participants, to ensure comparability with White and Rawlins's (2018) results, American spelling conventions were used for the stimuli.

Procedure For each of the utterances created as described above, participants were asked to judge whether the CC is true, as shown in (5a).

(5) a. *Reese didn't reply that the sauce thickened.*
According to this statement, did the sauce thicken?

b. *Alex didn't fall when the cane broke.*
According to this statement, did the cane break?

c. *Taylor smiled when the vase didn't shatter.*
According to this statement, did the vase shatter?

In addition to the 11 trial items, each participant saw two control items, designed to elicit either a clear 'yes' (5b) or a clear 'no' (5c) response. For their responses participants use a slider marked 'no' at one end and 'yes' at the other, as shown in Fig. 9 below.

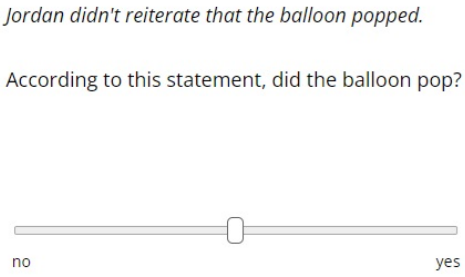

Figure 9: Example stimulus for the collection of projection ratings.

After providing their ratings for the stimuli, participants filled in a demographics questionnaire. On average, it took participants 2 min 39 sec to complete the survey.

4.1.2 Results

Responses ...

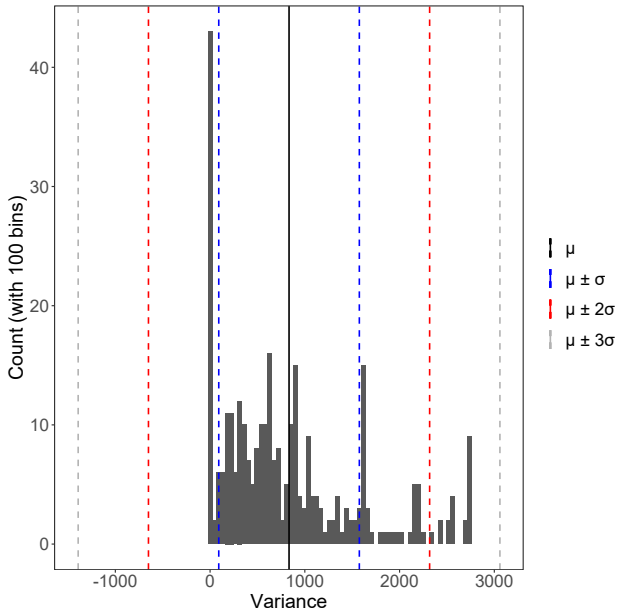

Figure 10: Histogram of the variance of participants' ratings with 100 bins.

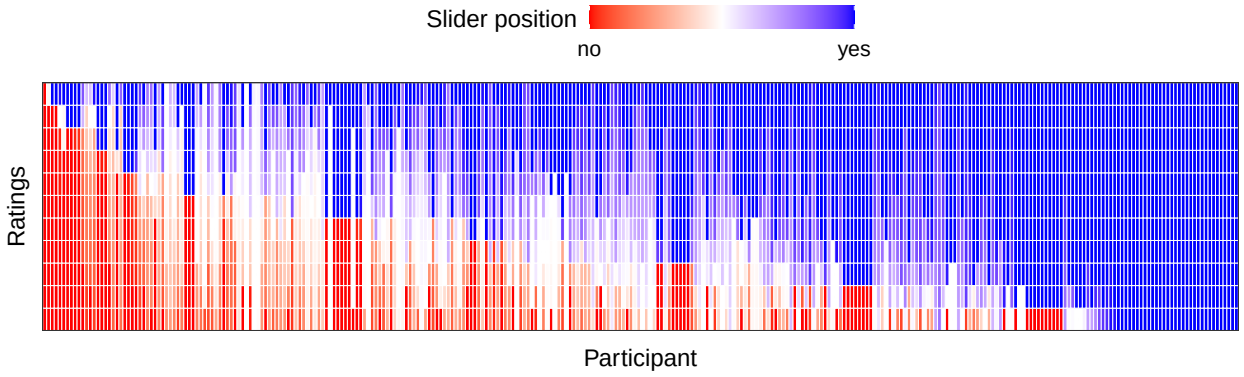

Figure 11: The 11 ratings each participant provided, ordered by their numerical value, i.e. ratings closer to -1 ("no") are lower on the y-axis, and vice versa. Participants are ordered by the sum of the numerical values of their ratings, i.e. the more high ratings a participant gave, the further to the right they are in the plot.

Projection ...

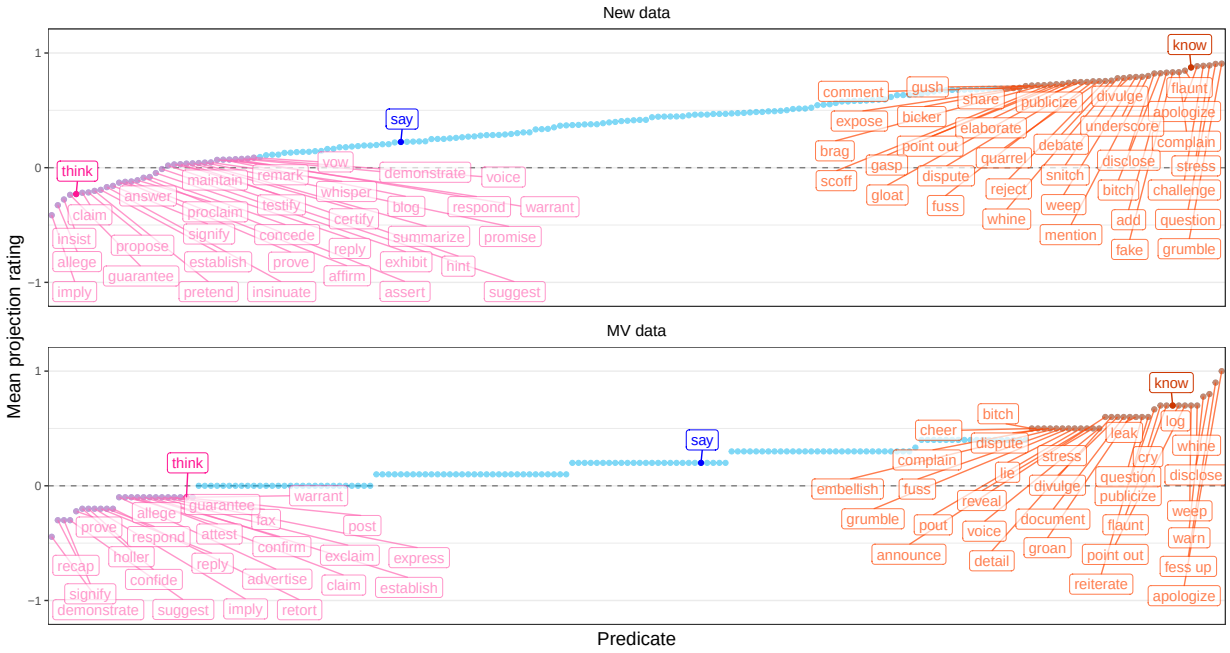

Figure 12: Mean projection rating by communicative predicate with labels for predicates with mean projection ratings at least one standard deviation below or above the mean of these ratings. Mean projection ratings from the MV dataset include only ratings based on stimuli with a negation-only embedding environment. The cognitives *think* and *know* are included for reference.

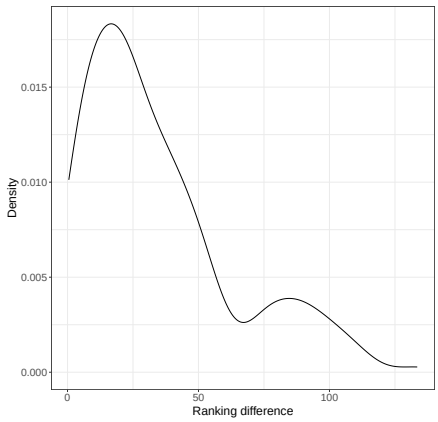

Figure 13: Distribnution of ranking differences in mean projection ratings between the new data and the MV dataset.

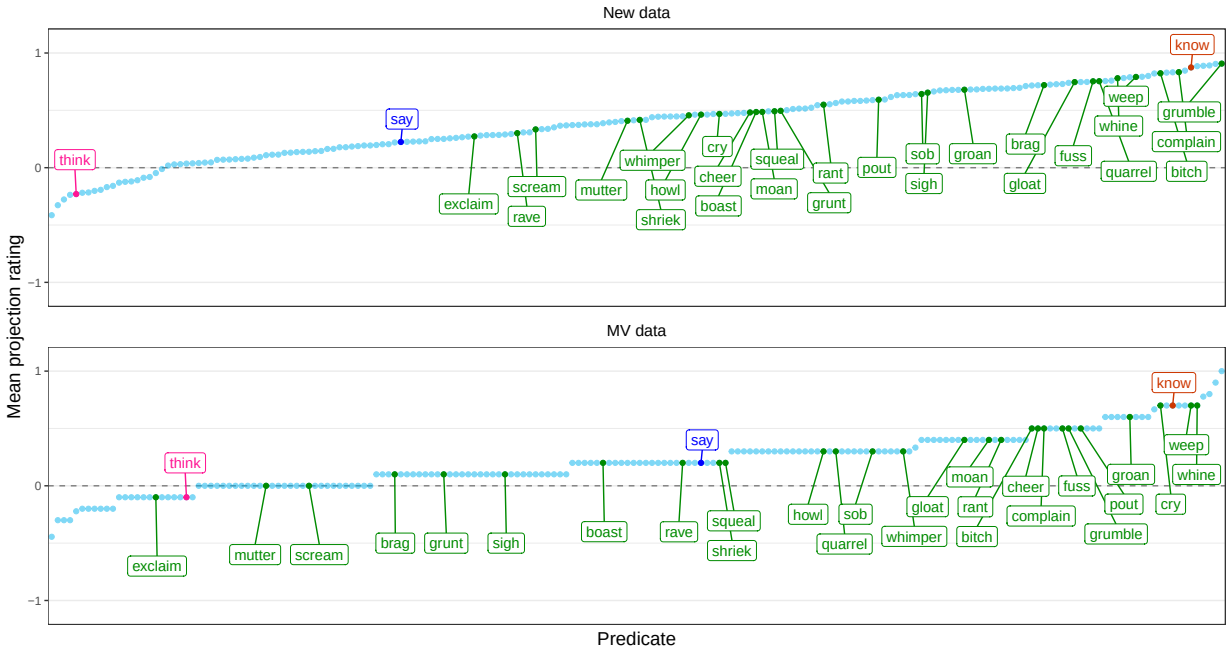

Figure 14: Mean projection rating by communicative predicate with labels for predicates with an emotion entailment. Mean projection ratings from the MV dataset include only ratings based on stimuli with a negation-only embedding environment. The cognitives *think* and *know* are included for reference.

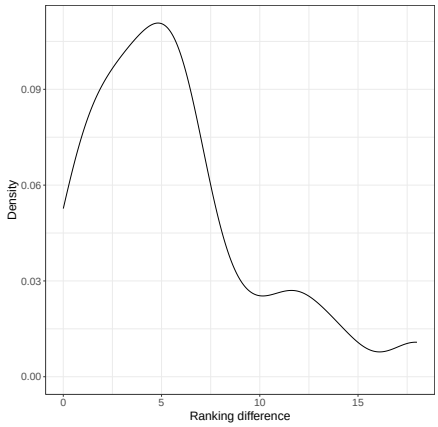

Figure 15: Distribnution of ranking differences in mean projection ratings between the new data and the MV dataset for predicates with an emotion entailment.

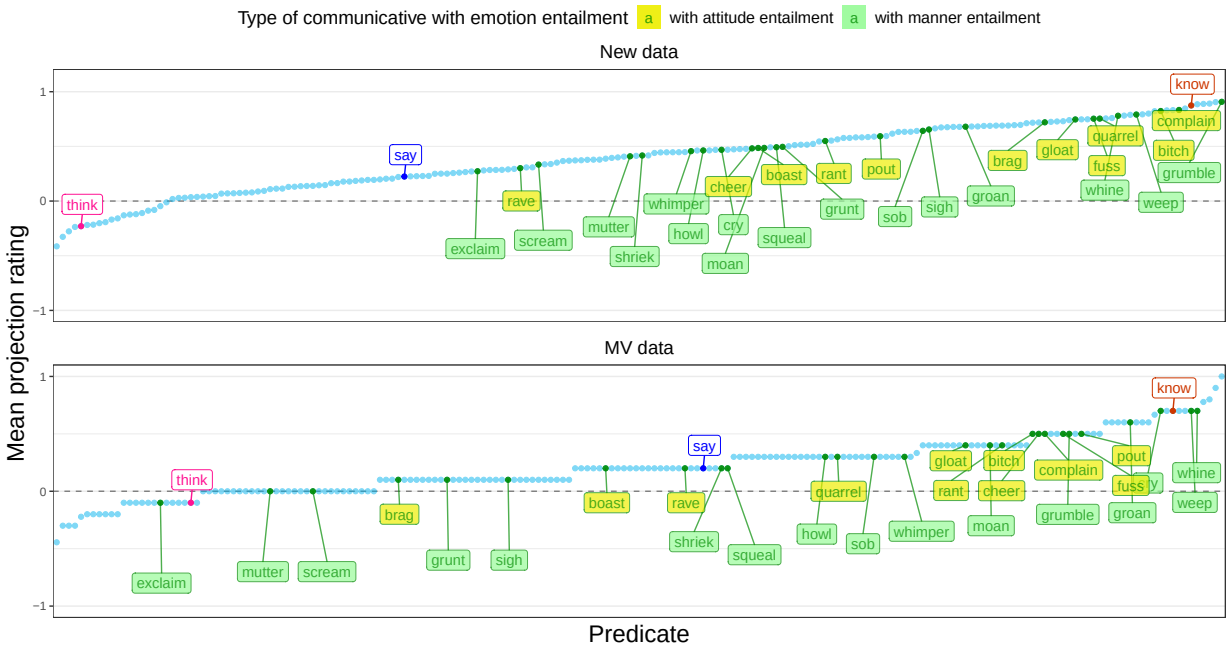

Figure 16: Mean projection rating by communicative predicate with labels for predicates with an emotion entailment. Predicates with a lighter green label also have a manner entailment, those with a darker label also have an attitude entailment. Mean projection ratings from the MV dataset include only ratings based on stimuli with a negation-only embedding environment. The cognitives *think* and *know* are included for reference.

4.2 Experiment 2

4.2.1 Entailment ratings

...

4.2.2 Projection ratings

Because the interpretation of some of these predicates is affected by focus, getting entailment and projection ratings for the same predicates from the same participants is desirable in these cases. If the communication entailment projects, the predicate was most likely read in a stressed manner.

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