

# I don't know if naturalness ratings distinguish presuppositions from nonpresuppositions. Did Mandelkern et al. 2020 discover that they do?

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## Abstract

Presuppositions have long been taken to be a well-defined class of content that is characterized by typically projecting and by being conventionally associated with particular lexical items or constructions (e.g., Heim 1983; van der Sandt 1992; Mandelkern et al. 2020; Beaver et al. 2024). While the strength of the projection inference is often taken to distinguish presuppositions from nonpresuppositions, experimental investigations that used inference tasks suggested that the strength of the projection inference does not distinguish the two (e.g., de Marneffe et al. 2019; Tonhauser et al. 2018; Degen and Tonhauser 2022). Mandelkern et al. 2020 proposed that a different measure, namely comparison of naturalness ratings in explicit ignorance and support contexts, distinguishes presuppositions from nonpresuppositions. This paper presents the results of an experiment designed to investigate Mandelkern et al.'s 2020 proposal in the domain of factive and nonfactive clause-embedding predicates. The results do not support Mandelkern et al.'s 2020 proposal, which means that the question of how presuppositional projection inferences can be distinguished from nonpresuppositional ones is still open.

**Keywords:** Projection inferences, presuppositions, naturalness ratings in explicit ignorance and support contexts.

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## Abstract

Presuppositions have long been taken to be a well-defined class of content that is characterized by typically projecting and by being conventionally associated with particular lexical items or constructions (e.g., Heim 1983; van der Sandt 1992; Mandelkern et al. 2020; Beaver et al. 2024). While the strength of the projection inference is often taken to distinguish presuppositions from nonpresuppositions, experimental investigations that used inference tasks suggested that the strength of the projection inference does not distinguish the two (e.g., de Marneffe et al. 2019; Tonhauser et al. 2018; Degen and Tonhauser 2022). Mandelkern et al. 2020 proposed that a different measure, namely comparison of naturalness ratings in explicit ignorance and support contexts, distinguishes presuppositions from nonpresuppositions. This paper presents the results of an experiment designed to investigate Mandelkern et al.'s 2020 proposal in the domain of factive and nonfactive clause-embedding predicates. The results do not support Mandelkern et al.'s 2020 proposal, which means that the question of how presuppositional projection inferences can be distinguished from nonpresuppositional ones is still open.

## 1 Introduction

Projection inferences are inferences to content that is contributed by an expression in the scope of an entailment-canceling operator (e.g., Potts 2005; Tonhauser et al. 2013, 2018; Degen and Tonhauser 2022). For instance, if an interpreter infers from an utterance of any of the sentences in (1) that Julian dances salsa, this would be considered a projection inference, as the content that Julian dances salsa is contributed by an expression in a polar question:

- (1) a. Is my friend Julian, who dances salsa, invited to your party?
- b. Does Cole know that Julian dances salsa?
- c. Did Cole acknowledge that Julian dances salsa?
- d. Does Cole think that Julian dances salsa?

The projection inferences arising from (1a-b) have received specialized analyses: The content of the non-restrictive relative clause in (1a) is typically analyzed as a conventional implicature, and the content of the clausal complement of *know* in (1b) as a presupposition (see, e.g., Chierchia and McConnell-Ginet 1990; Potts 2005; Tonhauser et al. 2013). Projection inferences arising from utterances of (1c-d), on the other hand, have traditionally not been considered presuppositions. A pressing question for formal analyses of presuppositions is how to empirically distinguish supposed presuppositions, like the content of the clausal complement of (1b), from supposed nonpresuppositions, like (1c-d).

A long-standing assumption is that presuppositions differ from nonpresuppositions in the strength of the projection inference, which is assumed to be stronger for presuppositions than nonpresuppositions. This assumption has recently been challenged, however, by experimental research showing that the strength of the projection inference for some supposed nonpresuppositions is as strong or even stronger than that of some supposed presuppositions (e.g., de Marneffe et al. 2019; Tonhauser et al. 2018; Degen and Tonhauser 2022). A sample illustration is in Fig. 1 from Degen and Tonhauser's 2022 Exp. 1a, which shows the mean projection ratings of five supposed presuppositions contributed by the clausal complements of factive predicates in orange and 15 supposed nonpresuppositions contributed by the clausal complements of nonfactive

predicates in black.<sup>1</sup> As shown, the strength of the supposed nonpresuppositional projection inferences associated with *acknowledge*, *hear* and *inform* are at least as strong, if not stronger, than the strength of the supposed presuppositional projection inferences associated with *reveal*, *discover* and *see*. Thus, the strength of the projection inference does not appear to distinguish presuppositional projection inferences from nonpresuppositional ones.

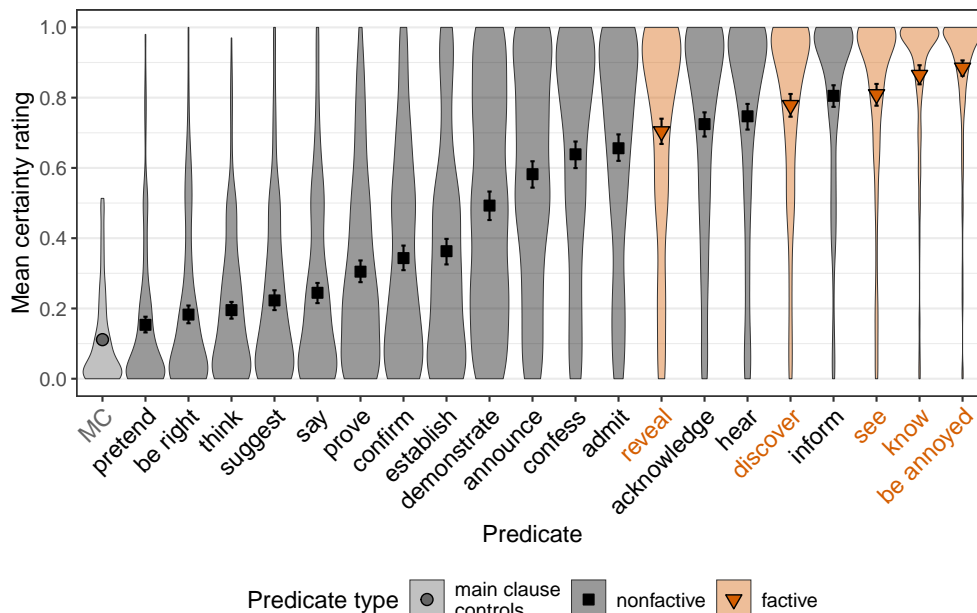


Figure 1: Mean certainty rating (measuring projection) of main clause (‘MC’) content and the contents of the complements of the 20 **factive** and nonfactive predicates investigated in Exp. 1a of Degen and Tonhauser 2022. Error bars indicate 95% bootstrapped confidence intervals. Violin plots indicate the kernel probability density of the individual participants’ ratings.

A different proposal for how to distinguish presuppositional projection inferences from nonpresuppositional ones was made in Mandelkern et al. 2020.<sup>2</sup> Specifically, they proposed (p.497) that “comparing contexts which support the inference to contexts in which it has been made clear that the speaker is ignorant about the inference provides a way to distinguish a broad class of natural and invited pragmatic inferences from those that are really encoded as presuppositions”. On this proposal, the presupposition contributed by *stop* in (2c) is expected to receive higher naturalness ratings in the support context in (2b) than in the explicit ignorance context in (2a). On the other hand, the naturalness ratings for the nonpresupposition contributed by *now frowns on* in (2c) are not expected to vary by context. This measure is taken to distinguish between projection inferences that are merely “natural and invited pragmatic inferences” and projection inferences that are “encoded as presuppositions, and thus have no choice but to project” (Mandelkern et al. 2020:497)

(2) Mandelkern et al. 2020:490f.

a. Explicit ignorance context:

Mary always was involved in a lot of sports, but I don’t know whether she ever did any yoga.

<sup>1</sup>The data from Degen and Tonhauser’s 2022 Exp. 1a were accessed here: <https://github.com/judith-tonhauser/projective-probability/tree/master/results/5-projectivity-no-fact>. The script that was used to create Fig. 1 can be found in the GitHub repository linked in footnote 7.

<sup>2</sup>How to distinguish presuppositions from nonpresuppositions was not the main research question of Mandelkern et al. 2020. Rather, this paper was primarily concerned with the question of whether presupposition filtering is symmetric.

- b. Support context:  
Mary always was involved in a lot of sports, and she used to do yoga, too.
- c. Sentence with presupposition / nonpresupposition:  
If Mary {has stopped / now frowns on} doing yoga, then Matthew will interview her for his story.

The data reported on in Mandelkern et al. 2020:Exp. 3 supports their proposal, as shown in panel (a) of Fig. 2.<sup>3</sup> This figure shows the mean naturalness ratings, by context, of the four supposed presuppositions (in orange) and four supposed nonpresuppositions (in black) featured in their Exp. 3 in sentences like those in (2c). As shown, the ratings for the supposed presuppositions of *continue*, *be happy*, *stop* and *be aware* are higher in the support context than in the explicit ignorance context, whereas the ratings for the supposed nonpresuppositions of *now frown on*, *be sure*, *be hoping* and *enjoy* do not exhibit by-context variation.

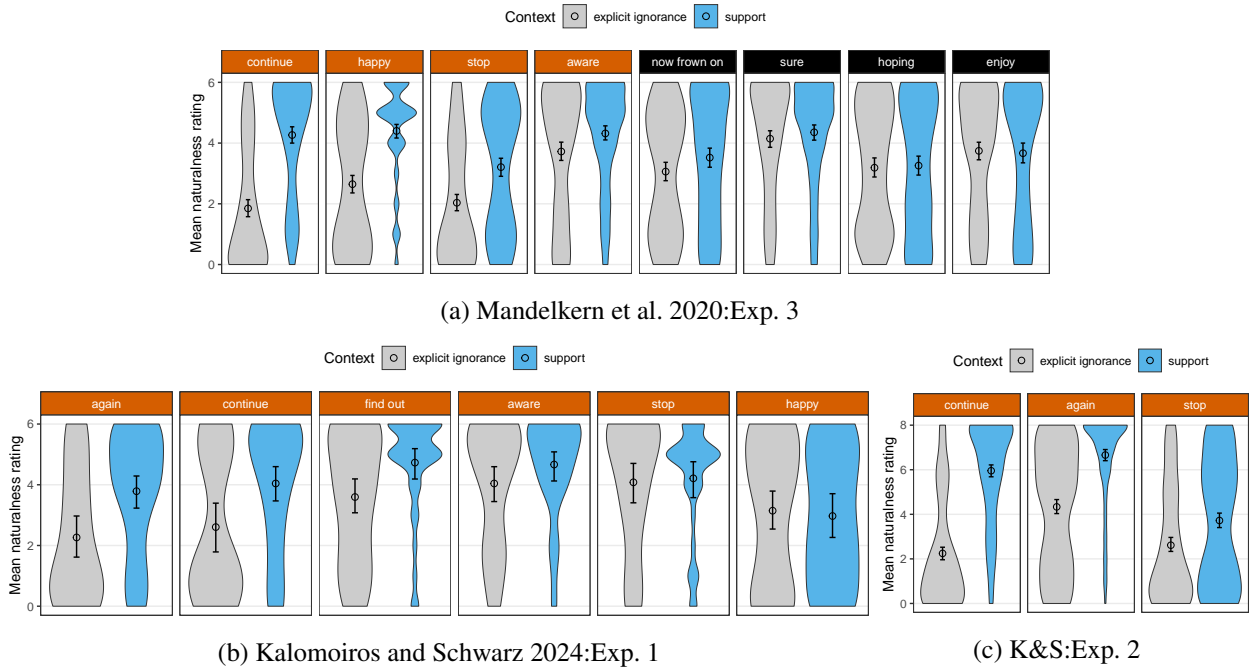


Figure 2: Mean naturalness ratings in explicit ignorance and support contexts for the (a) eight supposed presuppositions and nonpresuppositions investigated in Mandelkern et al. 2020:Exp. 3, (b) six supposed presuppositions investigated in Kalomoiros and Schwarz 2024:Exp. 1, and (c) three supposed presuppositions investigated in Kalomoiros and Schwarz 2024 (K&S) Exp. 2. Supposed presuppositions given in orange, supposed nonpresuppositions in black. Expressions associated with the (non)presuppositions ordered from left to right by decreasing difference between naturalness rating means in the two contexts. Error bars indicate 95% bootstrapped confidence intervals. Violin plots indicate the kernel probability density of the individual participants’ ratings.

Mandelkern et al.’s 2020 proposal can also be evaluated on the basis of data collected in two experiments reported on in Kalomoiros and Schwarz 2024, which also included sentences like those in (2c) in explicit ignorance and support contexts.<sup>4</sup> Panels (b) and (c) of Fig. 2 show the mean naturalness ratings, by

<sup>3</sup>The data from Mandelkern et al. 2020:Exp. 3 are available at <https://osf.io/2b9m7/>. The R script that generates the figure in panel (a) of Fig. 2 can be found in the repository linked in footnote 7.

<sup>4</sup>As with Mandelkern et al. 2020, the distinction between presuppositions and nonpresuppositions was not the main research question of Kalomoiros and Schwarz 2024, but rather the question of whether presupposition filtering is symmetric.

context, of the expressions featured in their Exps. 1 and 2, respectively.<sup>5</sup> As shown in panel (b), the supposed presuppositions of *again*, *continue* and *find out* appear to be sensitive to the context manipulation, but those of *be aware*, *stop* and *be happy* are not, contrary to expectation. As shown in panel (c), the relevant data from their Exp. 2 support Mandelkern et al.’s 2020 proposal for the supposed presuppositions of *continue*, *again* and *stop*. Because the data from Kalomoiros and Schwarz 2024:Exp. 1 does not fully support Mandelkern et al.’s 2020 proposal,<sup>6</sup> it is an open question whether comparison of naturalness ratings in explicit ignorance and support contexts distinguishes presuppositional projection inferences from nonpresuppositional ones.

This paper presents the results of an experiment designed to investigate Mandelkern et al.’s 2020 proposal in the domain of factive and nonfactive predicates.<sup>7</sup> To allow for comparison with the results of the inference task used in Degen and Tonhauser 2022, the contents of the complements of the same 20 (non)factive clause-embedding predicates shown in Fig. 1 were investigated.

Our experiment also included control stimuli with *stop*, *continue*, *again*, *too*, *also* and an *it*-cleft in explicit ignorance contexts. The inclusion of these stimuli was motivated by the fact that some research on presuppositions assumes that presuppositions vary in their acceptability in explicit ignorance contexts. Specifically, Simons 2001 and Abusch 2010 assumed that acceptability in explicit ignorance contexts distinguishes nondefeasible (or: hard) presuppositions from defeasible (or: soft) ones. For instance, the presuppositions associated with *stop*, *discover* and *win* were assumed to be defeasible because they were judged to be acceptable in explicit ignorance contexts, as shown in (3a-c), respectively. By contrast, the presuppositions associated with *again*, the *it*-cleft and *too* were assumed to be nondefeasible because they were judged to be unacceptable in explicit ignorance contexts, as shown in (4a-c).

- (3) a. I have no idea whether Jane ever smoked, but she hasn’t stopped smoking. (Simons 2001:443)
- b. Context: “two people [...] know that Henry is searching for Jane, but who don’t themselves know where Jane is:”  
          If Henry discovers that Jane is in New York, there’ll be trouble. (Simons 2001:434)
- c. I have no idea whether John ended up participating in the Road Race yesterday. But if he won it, then he has more victories than anyone else in history. (Abusch 2010:39)
- (4) a. #I don’t know if Jane ever rented “Manhattan” before, but perhaps she’s renting it again. (Simons 2001:443)
- b.?I have no idea whether anyone read that letter. But if it is John who read it, let’s ask him to be discreet about the content. (Abusch 2010:40)
- c.?I have no idea whether John read that proposal. But if Bill read it too, let’s ask them to confer and simply give us a yes-no response. (Abusch 2010:40)

There is disagreement in the later literature and in the experimental results about the defeasibility of a variety of presuppositions. For instance, Abrusán 2016:193 suggested that the presupposition of *stop* is not defeasible, contra Simons 2001. Roberts and Simons 2024:734ff., in turn, suggested that the presupposition of *stop* is relatively more defeasible than that of *continue*, which they took to be associated with an anaphoric contextual requirement. The results of experimental investigations also suggest that the defeasibility of presuppositions is not yet well-understood. For instance, the mean naturalness rating of *again* is quite

<sup>5</sup>The data from Kalomoiros and Schwarz 2024 are available at <https://osf.io/3p68r/>. The R script that generates the figures in panels (b) and (c) of Fig. 2 can be found in the repository linked in footnote 7.

<sup>6</sup>The experiments in Mandelkern et al. 2020 and Kalomoiros and Schwarz 2024 differed on several dimensions, including whether nonpresuppositional projection inferences were included, the number and type of presuppositional projection inferences investigated, and whether the target stimuli investigated presupposition filtering in conjunctions and disjunctions, or only in conjunctions. It is an open question which factors are responsible for the differences in the results.

<sup>7</sup>The experiment was approved by the ethics review committee of [university name suppressed]. The experiment, materials, data, and analysis scripts can be accessed here: <https://anonymous.4open.science/r/naturalness-in-EIC-5847>.

low in Kalomoiros and Schwarz’s 2024 Exp. 1 in panel (b), while that of *stop* is quite high, in line with Abusch’s 2010 claim that the presupposition of *again* is nondefeasible and Simons’s 2001 claim that the presupposition of *stop* is defeasible. However, the results of Kalomoiros and Schwarz’s 2024 Exp. 2 in panel (c) show the opposite pattern for *stop* and *again*, which might be taken to mean that *stop* is not soft, as also suggested in Abrusán 2016:193. For French, Jayez et al. 2015 found that *aussi* ‘too’ and the cleft received mean naturalness ratings of 6.25 and 5.92 on a scale from 1-7, respectively, which is unexpectedly high if these expressions are associated with nondefeasible presuppositions. Given the disagreements in the literature and the experimental results, our experiment measured the acceptability of presuppositions of English *stop*, *continue*, *again*, *too*, *also* and the *it*-cleft in explicit ignorance contexts.

## 2 Experiment

To investigate Mandelkern et al.’s 2020 proposal that comparison of naturalness ratings in explicit ignorance and support contexts distinguishes presuppositional projection inferences from nonpresuppositional ones, participants read two-sentence discourses consisting of a declarative (which provided the context) and an interrogative (which realized a factive or nonfactive predicate), and rated the naturalness of the interrogative in the context of the declarative.

### 2.1 Methods

#### 2.1.1 Participants

We recruited 425 participants on Prolific. Due to a programming error, the data of only 398 participants was recorded (ages: 19-73, mean: 40.8; 187 women, 201 men, 8 non-categorical, 2 preferred to not disclose). The recruited participants were required to live in the USA, to speak English as their first language, to have completed at least 100 tasks, and to have an approval rating of at least 99%. The median time spent on the task was 6:24 minutes. Participants were paid \$1.78, corresponding to an hourly pay of \$16.6.

#### 2.1.2 Materials

Participants read two-sentence discourses consisting of a declarative followed by an interrogative, as shown in (5). In the target stimuli, the interrogatives combined the 20 (non)factive predicates of Degen and Tonhauser 2022 (see Fig. 1) with the 20 complement clauses of Degen and Tonhauser 2022, for a total of 400 interrogatives. The preceding declaratives implemented a three-level context condition: In the ‘explicit ignorance’ context (5a), the declarative sentence conveyed the speaker’s ignorance about the content of the complement. The other two contexts were support contexts, in the sense that they were compatible with the content of the complement: In the ‘lower prior probability’ context (5b), the content of the complement had a comparatively lower prior probability, whereas it had a comparatively higher prior probability in the ‘higher prior probability’ context (5c). The two contexts for each of the 20 complement clauses were normed in Degen and Tonhauser 2021. This prior probability manipulation was included to investigate whether naturalness ratings are sensitive to prior probabilities, as Degen and Tonhauser 2021 observed that inference ratings are sensitive to prior probabilities. See Supplement A for the full set of 20 complement clauses and the two contexts for each complement clause.

- (5) a. Explicit ignorance context:  
I have no idea if Julian dances salsa. Did Cole discover that Julian dances salsa?
- b. Lower prior probability context:  
Julian is German. Did Cole discover that Julian dances salsa?

- c. Higher prior probability context:  
Julian is Cuban. Did Cole discover that Julian dances salsa?’

In addition to the 1,200 target stimuli (400 interrogatives  $\times$  3 contexts), the materials also included the six control stimuli in (6). The interrogatives of these stimuli featured six expressions typically analyzed as presupposition triggers, namely *stop*, *continue*, *again*, *too*, *also*, and an *it*-cleft. The preceding declaratives conveyed the speaker’s explicit ignorance about presuppositions associated with these expressions, namely the pre-state contents of *stop* and *continue*, the prejacent of *again*, the content that there is an alternative true proposition of *too* and *also*, and the existential content of the *it*-cleft.<sup>8</sup> As noted in §1, Simons 2001 took *stop* to be a soft trigger and *again* a hard trigger; Abusch 2010 assumed that *too* and *it*-clefts are hard triggers. The control stimuli were included for comparison to the target stimuli, to the claims of Simons 2001, Abusch 2010, Abrusán 2016 and Roberts and Simons 2024, and to the results of Mandelkern et al. 2020:Exp. 3 and Kalomoiros and Schwarz 2024:Exps. 1-2, where *continue*, *stop* and *again* were target expressions.

- (6) a. I don’t know if Stephen was ever in the habit of vaping. Has Stephen recently stopped vaping?  
b. I don’t know if John was ever reading “Dune”. Has John recently continued reading “Dune”?  
c. I don’t know if William was ever interested in history. Is William interested in history again?”  
d. I don’t know if Ann plays any instrument. Does Ann play the flute, too?  
e. I don’t know if Svenja plays any sport. Does Svenja also play soccer?  
f. I don’t know if anyone was playing outside with the kids. Was it Jack who was playing outside with the kids?

The experiment also included 4 filler stimuli that were used to exclude the data of participants not attending to the task (see Supplement B). The filler stimuli, which also consisted of a declarative followed by an interrogative, were expected to receive high naturalness ratings.

A random set of 30 stimuli was created for each participant. Each set contained 20 target stimuli in which each of the 20 complement clauses was paired with a unique clause-embedding predicate. Twelve of the target stimuli were presented in the explicit ignorance context, and the other eight in a low or a higher prior probability context (four each). Each participants’ set also contained the same six control stimuli and the same four filler stimuli. Each of the 30 stimuli were presented as utterances by a unique named speaker. Trial order was randomized for each participant.

### 2.1.3 Procedure

Participants were instructed to rate how natural the question sounds in the context of the statement. As shown in Figure 3, they were asked give their rating on a slider from ‘totally unnatural’ (coded as 0) to ‘totally natural’ (coded as 1).<sup>9</sup> The experiment began with four practice trials to familiarize participants with the task (see Supplement B for details). After rating the 30 trials, participants filled out a short optional demographic survey. To encourage truthful responses, participants were told that they would be paid no matter what answers they gave in the survey.

<sup>8</sup>The contents investigated for *too* and *also* in (6d) and (6e) are that Ann plays an instrument other than the flute and that Svenja plays a sport other than soccer. This interpretation arises if *too* and *also* associate with *the flute* and *soccer*, respectively. While prosody was not controlled for, this focus association is made plausible by the preceding explicit ignorance statements, which evoke the question of whether Ann plays any instrument and whether Svenja plays any sport, respectively.

<sup>9</sup>In Mandelkern et al. 2020:Exp. 3 and Kalomoiros and Schwarz 2024:Exp.1, participants gave their responses on a 7-point Likert scale with endpoints labeled ‘completely unnatural’ and ‘completely natural’; in Kalomoiros and Schwarz 2024:Exp. 2, the responses were given on a 9-point Likert scale with the aforementioned endpoints.

**Thomas:** *"I don't know if Mary is pregnant. Does Patrick know that Mary is pregnant?"*

How natural does the question sound in this context?

totally unnatural  totally natural

Continue

Figure 3: Sample trial with explicit ignorance context.

#### 2.1.4 Data exclusion

We excluded the data of 5 participants who did not self-identify as native speakers of American English and that of 23 participants whose mean responses to the fillers (which were expected to be natural) were more than 2 sd below the group mean.<sup>10</sup> The data of 370 participants entered into the analysis (ages: 19-80, mean: 40.7; 175 women, 185 men, 8 nonbinary, 2 did not disclose). The 20 predicates each received at least 200 ratings in the explicit ignorance context (mean: 222 ratings), at least 59 ratings in the lower prior probability context (mean: 74), and at least 61 ratings in the higher prior probability context (mean: 74). The six controls received 370 ratings each.

## 2.2 Results

We first investigate Mandelkern et al.'s 2020 proposal that comparison of naturalness ratings in explicit ignorance and support contexts distinguishes presuppositional projection inferences from nonpresuppositional ones (§2.2.1). We then address the question of how projection inferences behave in explicit ignorance contexts and, specifically, whether naturalness ratings in such contexts distinguish nondefeasible and defeasible presuppositions, as proposed in Simons 2001 and Abusch 2010 (§2.2.2).

### 2.2.1 Comparison of naturalness ratings in explicit ignorance and support contexts

Does comparison of naturalness ratings of in explicit ignorance and support contexts distinguish between presuppositional projection inferences and nonpresuppositional ones, as proposed in Mandelkern et al. 2020? Fig. 4 shows mean naturalness ratings for the CCs of the 20 **factive** and **nonfactive** predicates in the three contexts featured in our experiment with predicates ordered left-to-right (and top-to-bottom) by decreasing difference in the ratings in the higher prior probability and explicit ignorance contexts. The figure also includes the results of the statistical analysis, namely posthoc pairwise comparisons of the estimated means for each context using the 'emmeans' package (Lenth 2023); a separate comparison was conducted for each of the 20 predicates. The input to the pairwise comparisons were 20 Bayesian mixed-effects beta regression models with weakly informative priors that were fit using the 'brms' package (Bürkner 2017). The

<sup>10</sup>Contrary to what was planned, one of the four filler stimuli was not used to exclude participants' data because it had a mean rating of only .5. See Supplement B for details.



models predicted naturalness ratings<sup>11</sup> from a fixed effect of context (with treatment coding and ‘explicit ignorance’ as reference level) and included a random by-item intercept (where an item is a complement clause) and a random by-item slope for context.<sup>12</sup> The output of the pairwise comparison for each expression was the 95% HDI of estimated marginal mean differences between each of the three contexts. We assume that two contexts differ if their HDI does not include 0. In Fig. 4, a solid line spanning two contexts indicates that the ratings in the two contexts differ.<sup>13</sup>

As shown, the effect of context is not uniform for the projection inferences of the purported factive predicates. For *be annoyed*, *know* and *discover*, the mean naturalness rating is lower in the explicit ignorance context than in the higher prior probability context, but this is not the case for *see* and *reveal*, which pattern like several nonfactive predicates in this regard. Thus, on Mandelkern et al.’s 2020 proposal, only inferences to the contents of the complements of *be annoyed*, *know* and *discover* would be considered presuppositional projection inferences, though see, e.g., Karttunen 2016 and Djärv 2019 for differences between emotive, cognitive stative and cognitive change-of-state predicates. We note that the difference between the two contexts for *be annoyed* and *know* are driven primarily by the low naturalness ratings in the explicit ignorance contexts, a point we return to in §2.2.3. Inferences to the contents of the complements of *see* and *reveal* would be considered nonpresuppositional projection inferences, like those to the contents of the complements of communication predicates like *inform* and *announce* (for discussion, see Anand and Hacquard 2014).<sup>14</sup> Alternatively, the results suggest that comparison of naturalness ratings in explicit ignorance and support contexts does not reliably distinguish presuppositional projection inferences from nonpresuppositional ones.

We also observe that the prior probability of content modulates naturalness ratings for all predicates, except *confess*, *demonstrate*, *pretend* and *confirm*, such that content is rated as more natural in a context in which it has a higher prior probability than in a context in which it has a lower prior probability. This result dovetails with the result of Degen and Tonhauser 2021 that projection is modulated by prior probability. Thus, a methodological implication of our experiment is that future investigations of projection inferences using naturalness ratings will need to consider the effect of the prior probability of the inference.

## 2.2.2 Naturalness ratings of projection inferences in explicit ignorance contexts

Recall that Simons 2001 and Abusch 2010 assumed that presuppositions vary in their acceptability in explicit ignorance contexts and that, specifically, nondefeasible presuppositions are unacceptable in such contexts and defeasible ones acceptable. Figure 5 shows mean naturalness ratings in the explicit ignorance context by expression (in distinct colors: **factive predicates**, nonfactive predicates, **controls**). Consistent with Simons’s 2001 and Abusch’s 2010 assumption, there is variation in the mean naturalness ratings of the projection inferences investigated. Looking first at the six control stimuli (for which there was only one item each), the naturalness means for *continue*, *too*, *also* and *again* are at floor, which would suggest, given Simons’s 2001 and Abusch’s 2010 assumption, that the projection inferences associated with these expressions are not defeasible. This result is in line with Simons’s 2001 assumption for *again*, Abusch’s 2010 assumption

<sup>11</sup>To model the ratings using a beta regression, the ratings were first transformed from the interval [0,1] to the interval (0,1) using the method proposed in Smithson and Verkuilen 2006.

<sup>12</sup>By-participant random effects were not included because each participant saw each predicate only once and in only one context condition.

<sup>13</sup>The full model output is available in the folder /results/main/models/analysis2/fullModelOutput/fullModelOutput.pdf in the repository linked in footnote 7.

<sup>14</sup>Our five purportedly factive predicates received ratings in the higher prior probability support context that are roughly comparable to the ratings that the factive predicates of Mandelkern et al. 2020 received in their support context (which entailed the relevant content). Specifically, the mean naturalness ratings in the higher prior probability support context ranged from .64 (*reveal*) to .78 (*know*) on a scale from 0 to 1; the mean naturalness ratings in the support context of Mandelkern et al. 2020 were 4.32 for *be aware* and 4.4 for *be happy* on a scale from 1 to 7.

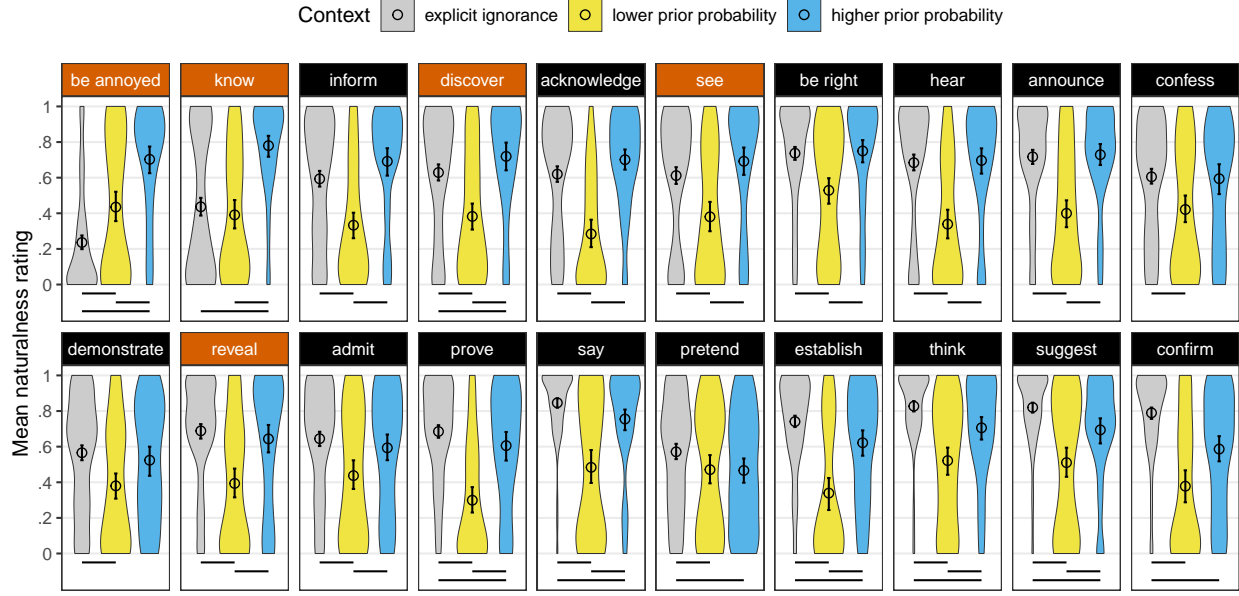


Figure 4: Mean naturalness rating by predicate ( **factive**, **nonfactive** ) and context, with predicates ordered from left to right (and top to bottom) by decreasing difference between the mean rating in the higher prior probability support context (in blue) and the explicit ignorance context (in gray). Error bars indicate 95% bootstrapped CIs. Violin plots indicate kernel probability density of participants' ratings. Below each facet, a solid line spanning two contexts indicates that the 95% HDI of estimated marginal mean differences between the two contexts does not include 0, that is, that the ratings in the two contexts differ.

for *too* and Roberts and Simons's 2024 assumption for *continue*. Recall, however, that in Kalomoiros and Schwarz 2024:Exp. 2 the mean rating for *again* was much higher than that those of *continue* and *stop*.

The results for the two items with *stop* and the *it*-cleft are less clear: The mean naturalness ratings are higher than those of *continue*, *too*, *also* and *again*, but not as high as for some of the other contents investigated. These results suggest that naturalness ratings in explicit ignorance contexts do not categorically distinguish between defeasible and nondefeasible projection inferences.

The results of our experiment further complicate the picture for *stop*, whose presupposition was taken to be defeasible in Simons 2001, but whose mean rating is lower than the mean rating for the *it*-cleft, whose presupposition was taken to be nondefeasible in Abusch 2010. Recall from §1 that the pre-state content of *stop* received quite low naturalness ratings in Mandelkern et al. 2020:Exp. 3 and Kalomoiros and Schwarz 2024:Exp. 2, but not in Kalomoiros and Schwarz 2024:Exp. 1. These observations suggest that it is still an open question of how defeasible the pre-state content of *stop* is.

The naturalness ratings for the five purportedly factive predicates in explicit ignorance contexts exhibit a heterogeneous pattern, with the mean for *be annoyed* as low as that of *stop*, that of *know* higher but not as high as that of *see*, *discover* and *reveal*. These means suggest that the projection inferences associated with *see*, *discover* and *reveal* are defeasible, in line with Simons's 2001 assumption about *discover*. As already noted in §2.2.1, the means for *be annoyed* and *know* are quite low, a point we return to in §2.2.3.

These observations were confirmed by a posthoc pairwise comparison of the estimated means for each target and control expression in the explicit ignorance context using the 'emmeans' package (Lenth 2023) in R (R Core Team 2016). The input to the pairwise comparison was a mixed-effects beta regression model with weakly informative priors that was fit using the 'brms' package (Bürkner 2017). The model predicted

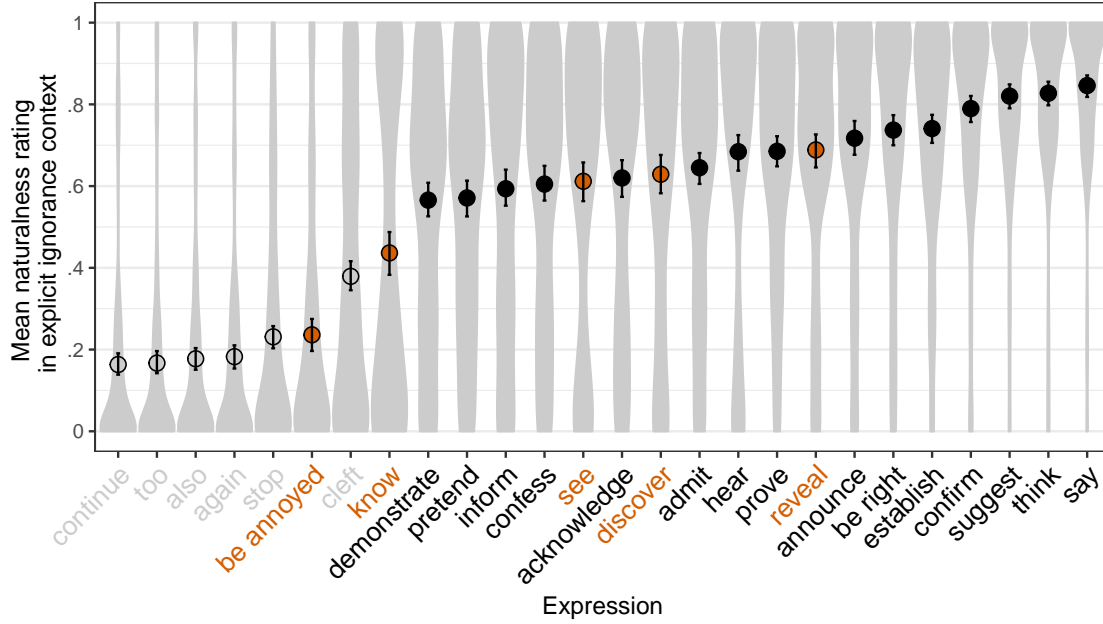


Figure 5: Mean naturalness rating in explicit ignorance context by expression (*factive*, *nonfactive*, *control*). Error bars indicate 95% bootstrapped confidence intervals. Overlaid violin plots indicate the kernel probability density of the participants’ ratings.

naturalness ratings<sup>15</sup> from a fixed effect of expression (with treatment coding and ‘continue’ as reference level) and included random by-participant and by-item intercepts (where an item is a complement clause). The output of the pairwise comparison were 95% highest density intervals (HDIs) of estimated marginal mean differences between each of the expressions. We assume that two expressions differ in their naturalness in the explicit ignorance context if their HDI does not include 0. As shown in Table 1,<sup>16</sup> the pairwise comparison suggests that the naturalness ratings are lowest for *continue*, *too*, *also* and *again*, slightly higher for *stop* and *be annoyed*, slightly higher again for the *it*-cleft and *know*, and higher yet again for *see*, *discover* and *reveal*. Overall, the results suggest that projection inferences vary in how defeasible they are in explicit ignorance contexts, but the observed variation does not suggest a binary, categorical distinction in defeasibility, contrary to what is assumed in Simons 2001 and Abusch 2010.

### 2.2.3 Discussion

The analysis in §2.2.1 investigated Mandelkern et al.’s 2020 proposal that comparison of naturalness ratings in explicit ignorance and support contexts distinguishes presuppositional projection inferences from nonpresuppositional ones. What we found was that only the contents of the complements of *be annoyed*, *know* and *discover* were identified as presuppositional projection inferences, not those of *see* and *reveal*, which patterned like presumed nonpresuppositional projection inferences. This result could be taken to mean that the contents of the clausal complements of *see* and *reveal* are not presuppositions or that the measure proposed by Mandelkern et al. 2020 does not reliably distinguish presuppositional projection inferences from nonpresuppositional ones. This latter conclusion is further supported by the observation in §1 that the projection

<sup>15</sup> As in the model reported in the previous section, the ratings were transformed to the interval (0,1); see footnote 11.

<sup>16</sup> While the naturalness ratings collected from the participants range from 0 to 1, the greater than |1| estimated marginal mean differences are the result of the beta regression using a logit link function for the mean parameter. The full model output is available in the folder /results/main/models/analysis1/fullModelOutput/fullModelOutput.pdf in the repository linked in footnote 7.

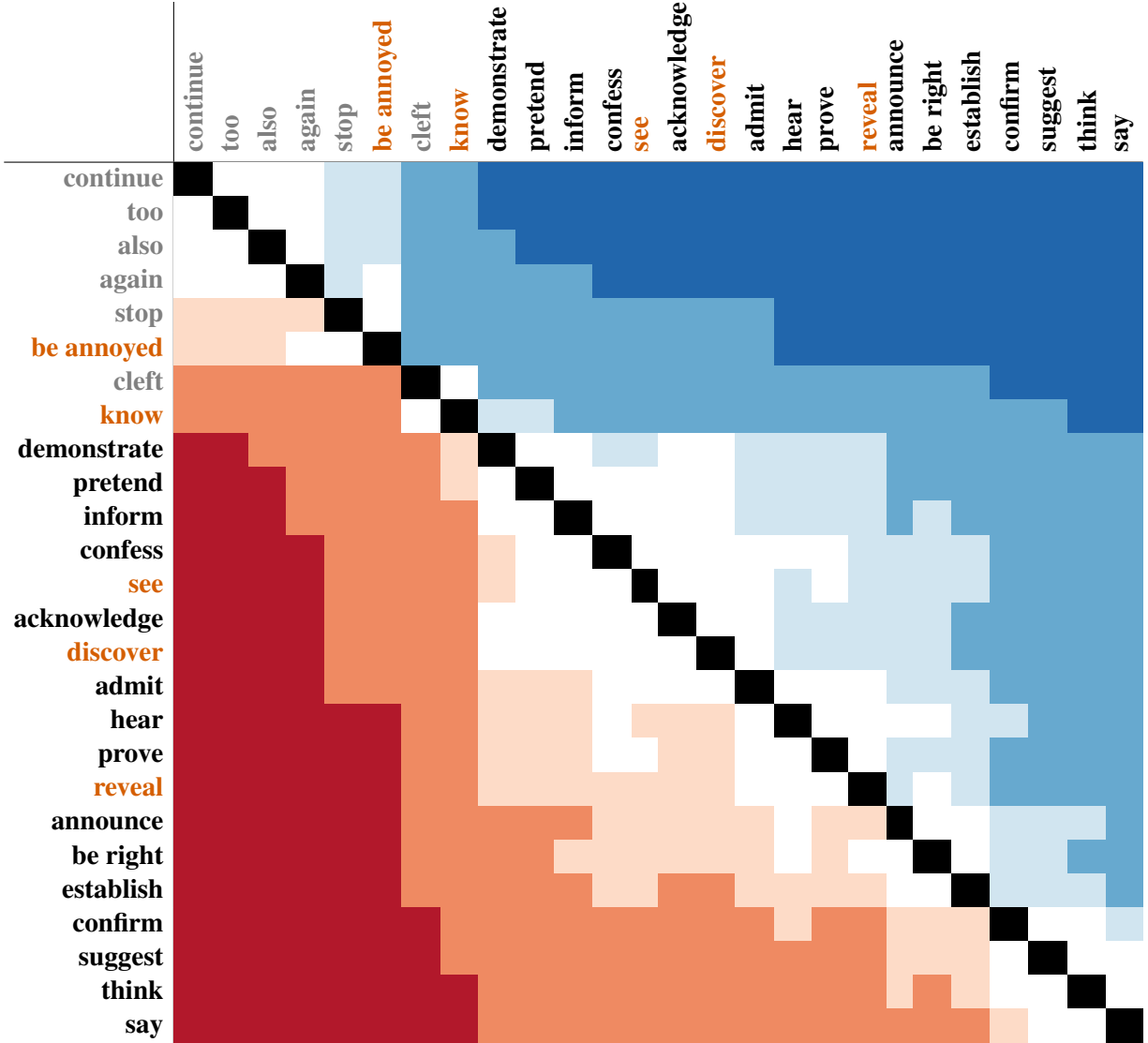


Table 1: Pairwise differences between expressions in the explicit ignorance context: **controls**, **factives** and **nonfactives**. The color coding for each pair indicates whether the difference between the means of row expressions and column expressions was positive or negative, as well as the size of the difference. A white cell means that the 95% HDI included 0.

Positive difference:  $\geq 1.5$ ,  $(1.5, 0.5]$ ,  $(0.5, 0]$

Negative difference:  $\geq -1.5$ ,  $(-1.5, -0.5]$ ,  $(-0.5, 0]$

inferences of *be aware*, *stop* and *be happy* were also not identified as presuppositional projection inferences in Kalomoiros and Schwarz’s 2024 Exp. 1. A third position, which we engage with in the General Discussion in §3, is that presuppositions are not a well-defined subset of projection inferences and are therefore also not identified as such by comparison of naturalness ratings in explicit ignorance and support contexts.

As pointed out in §2.2.1, the difference in the naturalness mean in the two contexts for *be annoyed* and *know* was primarily due to the mean rating being low in the explicit ignorance context. As shown in §2.2.2, the low mean naturalness ratings of these two predicates in the explicit ignorance context stand out from those of the other 18 clause-embedding predicates. In the following, we consider why these two predicates

might have received such low ratings in explicit ignorance contexts.

For *be annoyed*, it is worth emphasizing that the projection inference investigated was the inference to the truth of the content of the complement, just like for the other predicates. In the explicit ignorance condition, participants rated how natural a question sounds in the context of the explicit ignorance statement:

- (7) Sandy: I don't know if Julian dances salsa. Is Sam annoyed that Julian dances salsa?

As shown by the violin plot in Fig. 5, participants' ratings were quite low overall, suggesting that the question was judged to be quite unnatural in the context of the explicit ignorance statement. This result cannot, however, be attributed to the speaker (Sandy in (7)) presupposing the truth of the content of the clausal complement because it is well-known that emotive predicates like *be annoyed* merely require that the attitude holder (Sam in (7)) is committed to the truth of the content of the complement (e.g., Heim 1992; Karttunen 2016; Djärv 2019). (8), for instance, is acceptable even though the speaker is not committed to the truth of Sue being able to stay in bed.<sup>17</sup>

- (8) Mary, who was under the illusion that it was Sunday, was glad that she could stay in bed.  
(Klein 1975, as cited in Gazdar 1979:122)

If naturalness ratings in explicit ignorance contexts were only sensitive to speaker presuppositions, we would expect items like (7) to be rated as natural in explicit ignorance contexts because the inference (contributed by *be annoyed*) that the attitude holder is committed to the truth of the content of the complement does not conflict with the explicitly stated speaker ignorance. Why, then, did items like (7) with *be annoyed* receive such low ratings in explicit ignorance contexts (which, in turn, contributed to the content of its complement being identified as a presupposition on Mandelkern et al.'s 2020 measure)?

One hypothesis is that naturalness ratings in explicit ignorance contexts to the at-issueness of the projection inference, that is, in (7), the at-issueness of the content of the complement. On this hypothesis, the explicit ignorance statement (e.g., *I don't know whether Julian dances salsa*) does not merely convey the speaker's ignorance about the content *c* to be investigated, but also identifies that the speaker takes the question under discussion (QUD) to be whether *c* is true (?*c* e.g., *Does Julian dance salsa?*). The speaker's immediately following interrogative utterance is interpreted with respect to the QUD ?*c*. The naturalness of the interrogative is then modulated by whether the QUD ?*c* and the interpretation of the interrogative constitute a felicitous strategy of inquiry (Roberts 2012:32f.), that is, by whether the interrogative can be interpreted as inquiring about *c*. As shown in Tonhauser et al. 2018, projection inferences differ in at-issueness. The inference to the content of the complements of emotive predicates, including *be annoyed*, were particularly resistant to being interpreted as at-issue. Thus, an interrogative with *be annoyed* (e.g., *Is Cole annoyed that Julian dances salsa?*) is unlikely to be interpreted as felicitous with respect to a QUD about the content of the complement (e.g., *Does Julian dance salsa?*), which may be why *be annoyed* received quite low naturalness ratings in the explicit ignorance context. This hypothesis is in line with the results of Mandelkern et al. 2020:Exp. 3 and Kalomoiros and Schwarz 2024:Exp. 1, shown in Fig. 2, where the mean naturalness ratings for the emotive predicate *be happy* were (at least numerically) lower than for the cognitive predicate *be aware*. However, if this hypothesis is on the right track, it also means that the low naturalness mean of *be annoyed* is not necessarily connected to a nondefeasible projection inference, but rather to the not-at-issueness of the content of the complement. This, in turn, may call into question the assumptions behind Mandelkern et al.'s 2020 proposal that comparison of naturalness ratings in explicit ignorance and support contexts distinguish "encoded" presuppositions that "have no choice but to project" from "natural and invited pragmatic inferences" (p.497).

<sup>17</sup>Karttunen 2016 suggested that the inference to speaker commitment is a generalized conversational implicature that comes about in contexts that support the "default assumption" that the commitments of the speaker and the attitude holder are aligned (p.712). There is, obviously, no such alignment in examples like (7); for discussion, see also Djärv 2019.

For *know*, the violin plot in Fig. 5 shows that participants’ naturalness ratings exhibit a bimodal pattern, with about half of the participants rating *know* as relatively unnatural in the explicit ignorance context and about half as relatively natural. For the first group of participants, one could assume either that they reacted to the contradiction between the speaker’s explicit ignorance statement and an “encoded” projection inference. Under this hypothesis, the projection inference is not defeasible for this group of participants. An alternative hypothesis is that for these participants the projection inference is not at-issue, and therefore in conflict with the implicit QUD, as suggested for *be annoyed* above. This latter hypothesis is supported by the observation that the content of the complement of *know* is also resistant to being interpreted as at-issue (e.g., Simons 2007; Tonhauser et al. 2018).

For the second group of participants, those who judged speakers’ utterances like (9) as fairly natural, one hypothesis is that they read the utterances with a (possibly implicit) prosody on which (9) sound natural. Two possible prosodies are indicated by the ToBI transcriptions of in (9): In both, the interrogative is realized with the so-called rise-fall-rise contour (see, e.g., Ward and Hirschberg 1985; Büring 1997, 2003; Wagner et al. 2013).<sup>18</sup>

- (9) a. I don’t **know** if Julian dances **salsa**. Does **Cole** know that Julian dances **salsa**?  
           L\* H-                      L\* L-H%            L\*+H                      L-H%
- b. **I** don’t **know** if Julian dances **salsa**. Does **Cole** know that Julian dances **salsa**?  
           L\*+H            L\* H-                      L\* H-H%            L\*+H                      L-H%

If there are prosodies on which sentences like (9) sound natural,<sup>19</sup> then naturalness ratings in explicit ignorance contexts do not merely reflect the defeasibility of a projection inference but are rather also sensitive to (implicit) prosody. This sensitivity must be taken into consideration in the interpretation of the results.

In sum, these considerations about the low naturalness ratings of *be annoyed* and *know* in explicit ignorance contexts suggest that naturalness ratings in such contexts may not just be sensitive to whether the associated projection inference is defeasible, but also to its at-issueness and its information structural status.

### 3 General discussion

Presuppositions have long been taken to be a well-defined subset of inferences, namely ones that are typically backgrounded, typically projective and associated with particular expressions or constructions (see, e.g., Heim 1983; van der Sandt 1992; Potts 2005; Beaver et al. 2024). As noted in §1, a pressing question for analyses of presuppositions is to identify which projection inferences are presuppositions and which ones are not. The results of experimental investigations suggest that the strength of the projection inference does not distinguish presuppositional projection inferences from nonpresuppositional ones (see, e.g., de Marneffe et al. 2019; Tonhauser et al. 2018; Degen and Tonhauser 2022). And the results of the experiment reported on in §2 (as well as the results of Kalomoiros and Schwarz 2024:Exp. 1) suggest that comparison of naturalness ratings in explicit ignorance and support contexts may also not reliably distinguish presuppositional projection inferences from nonpresuppositional ones. Where do we go from here?

One possibility is to keep the conceptual assumptions about presuppositions in place and to ask whether there are more suitable measures to distinguish presupposed projection inferences from nonpresupposed ones than inference rating tasks or comparison of naturalness ratings across contexts. Another possibility

<sup>18</sup>ToBI refers to the Tones and Break Indices annotation system of Beckman and Ayers 1997. In this system, L\*+H identifies a pitch accent whose low target is aligned with the stressed syllable and which is followed by a trailing high target. A L\* pitch accent may also be followed by a low (L-) or high (H-) intermediate phrase tone. An intonational phrases may end with a low intermediate phrase tone and a high intonational phrase tone (L-H%) or a high intermediate and intonational phrase tone (H-H%).

<sup>19</sup>These prosodic realizations are not available for utterances with *be annoyed* like (7) because of the statement and the interrogative feature different predicates. This may explain why a bimodal rating distribution was not observed for *be annoyed*.

is to take the results of empirical investigations at face value and reconsider the conceptual assumptions about presuppositions. Even though presuppositions have long been assumed to be typically backgrounded and typically projective, empirical research suggests that presuppositions are heterogeneous along several dimensions, including backgroundedness and projection: Contents traditionally called presuppositions exhibit variation in projection strength and at-issueness (e.g., Xue and Onea 2011 on German, Tonhauser 2020 on Paraguayan Guaraní, and de Marneffe et al. 2019; Tonhauser et al. 2018; Degen and Tonhauser 2022 on English). For instance, the CC of *discover* is less projective and more at-issue than the CC of *know*. These results challenge the traditional characterization of presuppositions as contents that “typically project” and are “typically backgrounded”.

A third dimension of variation is whether the content is associated with what Tonhauser, Beaver, Roberts, and Simons 2013 referred to as a ‘strong contextual felicity’ constraint. Some presumed presuppositions are not associated with such a constraint, which means that they are judged to be acceptable in a context that is neutral with respect to the content. This is the case for the CC of *know*, illustrated in (10a), which is informative in such a context. Other presumed presuppositions are associated with such a constraint, that is, they are judged to be unacceptable in a context that does not entail or satisfy the content. This is the case for the existence requirement of *too*, illustrated in (10b).

(10) Tonhauser et al. 2013:78, 80

- a. A girl backs out of a driveway and hits Susi’s car. A woman comes running out of the house, apologizes that her daughter hit Susi’s car, and says:  
She knows that she has to use her glasses to drive.
- b. Malena is eating her lunch, a hamburger, on the bus going into town. A woman who she doesn’t know sits down next to her and says:  
#Our bus driver is eating empanadas, too.

Finally, there is the dimension investigated in our experiment, referred to as defeasibility in Simons 2001 and Abusch 2010. The results of our experiment suggest that contents traditionally called presuppositions exhibit variation in how natural they are in explicit ignorance contexts. For instance, the pre-state content of *continue* was rated as less natural than the pre-state content of *stop*, which was rated as less natural than the existential content of the *it*-cleft, which was rated as less natural than the CC of *see*, which was rated as less natural than the CC of *reveal*.

In response to this observed variation, some works gave up on the assumption that there is a unified set of projection inferences called presuppositions and developed analyses tailored to particular subsets. Abusch 2010, for instance, advocated for a pragmatic analysis of defeasible presuppositions, leaving an analysis like that of Heim 1983 or van der Sandt 1992 for nondefeasible ones; for similar considerations see Abrusán 2011 or Romoli 2015. These analyses, we argue, are in line with the second possibility we proposed above, that of taking the results of empirical investigations at face value and reconsidering the conceptual assumptions about presuppositions.

## 4 Conclusions

Presuppositions have long been assumed to be a well-defined subset of projection inferences, but the results of experiments that used inference rating tasks suggest that the strength of the projection inference does not distinguish presuppositional projection inferences from nonpresuppositional ones. This paper suggested that comparison of naturalness ratings in explicit ignorance and support contexts also does not reliably distinguish presuppositional projection inferences from nonpresuppositional ones, contrary to what Mandelkern et al. 2020 proposed. Methodologically, we found that naturalness ratings of projection inferences are sensitive to the prior probability of the content and may also be sensitive to its at-issueness and information

structural status. We proposed that a fruitful path for future research on projection inferences is to take seriously the observed variation among inferences that have traditionally been called presuppositions.

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## Supplemental materials

### A Experiment stimuli

The twenty clause-embedding predicates used in the experiment are the same as in Degen and Tonhauser 2021, 2022:

- (11) a. Factive: be annoyed, discover, know, reveal, see  
b. Non-factive: acknowledge, admit, announce, be right, confess, confirm, establish, hear, inform, pretend, prove, say, suggest, think

Eventive predicates, like *discover* and *hear*, were realized in the past tense and stative predicates, like *know* and *be annoyed*, were realized in the present tense. The direct object of *inform* was realized by the proper name *Sam*. Each clause-embedding predicate was paired with a unique subject proper name. The speaker of the target stimuli was realized by a randomly sampled unique proper name.

The following list shows the 20 clauses that realized the complements of the predicates in the target stimuli, together with their lower and higher probability facts, respectively, that realized the preceding declarative sentences in the two support contexts.

1. Mary is pregnant. Facts: Mary is a middle school student / Mary is taking a prenatal yoga class
2. Josie went on vacation to France. Facts: Josie doesn't have a passport / Josie loves France
3. Emma studied on Saturday morning. Facts: Emma is in first grade / Emma is in law school
4. Olivia sleeps until noon. Facts: Olivia has two small children / Olivia works the third shift
5. Sophia got a tattoo. Facts: Sophia is a high end fashion model / Sophia is a hipster
6. Mia drank 2 cocktails last night. Facts: Mia is a nun / Mia is a college student
7. Isabella ate a steak on Sunday. Facts: Isabella is a vegetarian / Isabella is from Argentina
8. Emily bought a car yesterday. Facts: Emily never has any money / Emily has been saving for a year
9. Grace visited her sister. Facts: Grace hates her sister / Grace loves her sister
10. Zoe calculated the tip. Facts: Zoe is 5 years old / Zoe is a math major
11. Danny ate the last cupcake. Facts: Danny is a diabetic / Danny loves cake
12. Frank got a cat. Facts: Frank is allergic to cats / Frank has always wanted a pet
13. Jackson ran 10 miles. Facts: Jackson is obese / Jackson is training for a marathon
14. Jayden rented a car. Facts: Jayden doesn't have a driver's license / Jayden's car is in the shop
15. Tony had a drink last night. Facts: Tony has been sober for 20 years / Tony really likes to party with his friends
16. Josh learned to ride a bike yesterday. Facts: Josh is a 75-year old man / Josh is a 5-year old boy
17. Owen shoveled snow last winter. Facts: Owen lives in New Orleans / Owen lives in Chicago
18. Julian dances salsa. Facts: Julian is German / Julian is Cuban
19. Jon walks to work. Facts: Jon lives 10 miles away from work / Jon lives 2 blocks away from work
20. Charley speaks Spanish. Facts: Charley lives in Korea / Charley lives in Mexico

## **B Filler and practice stimuli**

The following list shows the four filler stimuli where the interrogative was expected to receive high naturalness ratings in the context of the preceding declarative sentence. The values in parentheses indicate the mean naturalness rating that each of the four filler stimuli received. As shown, the third filler stimulus did not receive the expected high naturalness mean ratings, probably because participants were unwilling to accommodate that Hendrick has a car in a context in which Hendrick was looking to buy a car. This filler stimulus was therefore not used to exclude participants' data.

1. I don't know if Samantha has a new hat. Does Samantha have a new hat? (.89)
2. I don't know if this pizza has mushrooms on it. Does this pizza have mushrooms on it? (.87)
3. Hendrick was looking to buy a car. Was Hendrick's car expensive? (.5)
4. Mary visited her aunt yesterday. Is Mary's aunt sick? (.91)

The following list shows the four practice stimuli in the order in which they were presented to the participants. Participants were able to advance to the experiment only if they gave a naturalness rating higher than .6 for the first and third stimulus, and a naturalness rating lower than .4 for the second and fourth stimulus.

1. I have no idea where Natalie is from. Is Natalie from the USA?
2. I don't have any sisters. Have you met my sister yet?
3. I am going on vacation to Ireland. Does Fritz realize that Joe is going with me?
4. I have no idea if Anna has any dogs. Is Samuel glad that Anna fed her dogs?