

Prosodic effects on factive presupposition projection

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Abstract

This paper investigates the interaction between prosodically mediated pragmatics and factive presupposition projection. In particular, it addresses a set of proposals, articulated most clearly in Abrusán (2011, 2016); Simons et al. (2010), and Simons et al. (2017), which argue that prosodically mediated focus, as a signal of the Question Under Discussion (Roberts, 1996, 2012), determines whether or not particular content becomes presupposed (Abrusán) or ends up projecting from the scope of entailment-targeting operators (Simons et al.). We present experimental results demonstrating that the predictions made by these proposals are too strong: although focus is shown to have an effect on factive presupposition projection, it does not completely eliminate the factive inference, as argued by these authors. Rather, we find that the main factor determining whether or not a factive inference projects is the identity of the predicate. We argue that this supports a view whereby factive presuppositions are lexically triggered, and may only be cancelled in a particular set of embedded contexts via *local accommodation* (Heim, 1983). However, focus may give rise to inferences via the QUD, to the effect that the factive inference is *weakened* (although not completely eliminated).

1 Introduction

A central question in presupposition theory concerns the conditions under which presuppositions arise—and those under which they fail to arise, specifically in embedded environments. We investigate this question with respect to factive presupposition triggers; i.e., predicates such as *know*, *regret*, *discover*, and *be happy*, which presuppose the truth of their complements. This can be demonstrated by the fact that the inference that the embedded proposition p is true tends to survive (project) when embedded under entailment canceling operators (2-b), unlike regular entailments (1-b):

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|-----|----|--|-----------------------------|
| (1) | a. | It's raining. | \leadsto it's raining |
| | b. | It might be raining. | \nrightarrow it's raining |
| (2) | a. | John knows that [p it's raining]. | \leadsto it's raining |
| | b. | John might know that [p it's raining]. | \leadsto it's raining |

However, since Karttunen (1971, 1974), Stalnaker (1974) and Gazdar (1979), it has been observed that it is possible, at least for certain presupposition triggers, to exhibit a non-presuppositional reading when occurring in an embedded context (e.g., under modals, questions, antecedents of conditionals), as illustrated for the factive clause-embedding predicate *realize* in (3), and *discover* in (4) and (5).

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|-----|---|------------------|
| (3) | If I realize later that [p I have not told the truth], I will confess it to everyone. | $\nrightarrow p$ |
| | (Karttunen, 1971, pg. 64) | |
| (4) | ...I haven't tried this with wombats, though, & if anyone discovers that [p the method is also wombat-proof], I'd really like to know! | $\nrightarrow p$ |
| | (Beaver, 2010, pg. 14) | |
| (5) | I have no idea if Mary is cheating on John. But if he discovers that [p she is], he will be sad. | $\nrightarrow p$ |
| | (Abrusán, 2016, pg. 167) | |

The presupposition literature has traditionally focused on two problems: the *triggering problem*, and the *projection problem*. The *triggering problem* concerns the question of how presuppositions arise, or are triggered. A key aspect of the triggering problem is the question of why it is that (only) certain content becomes presupposed to begin with. For a sentence like (2-a), which conveys both John's belief that it's raining, and that it is in fact raining; why is it that the former proposition is asserted and foregrounded, whereas the latter becomes presupposed and backgrounded? However, there is also another side to the triggering problem, which is the question of where the presupposed content comes from to begin with. As we see in Section 2.1 below, different theoretical positions differ with respect to their answers to both of these questions. The *projection problem* concerns the status of presupposed content in embedded environments; why it is that presuppositions (*typically*) survive in embedded contexts.

In various attempts to answer these two questions, recent theoretical and experimental work has pointed to the importance of pragmatic factors, or discourse structure. This paper addresses a set of proposals, articulated most clearly in Abrusán (2011, 2016); Simons et al. (2010), and Simons et al. (2017), which although the details of their proposals differ, all argue that prosodically mediated focus, as a signal of the Question Under Discussion [QUD], can determine whether the proposition embedded under a factive attitude predicate ends up projecting.

We present experimental results (Section 3), replicating the findings reported in Tonhauser (2016) (reviewed in Section 2.2), that prosody does have an impact on factive presupposition projection (focus on material in the embedded clause decreases the strength of the projected inference that *p* is true). However, we find that the focus-based difference was an order of magnitude smaller than the difference between lexically factive and non-factive predicates, independently of focus placement. This finding is important, as it undermines the central empirical underpinning of these accounts; that focusing embedded content is able to either entirely eliminate the factive presupposition, or prevent it from projecting. Surprisingly, focus placement impacted projection judgments also for clauses embedded under non-factive predicates, in the *opposite direction* from factives. For non-factives, focus in the embedded clause gave rise to a weak ‘projection-like’ inference, something that is unexpected on previous theoretical accounts.

Based on our experimental results, we argue that factive presuppositions are lexically triggered. Focus, however, may give rise to inferences about the Common Ground, via the QUD, that are completely independent of factivity, thus giving rise to a weak effect of prosody *across* predicate types (Section 4), whereby focusing material in the embedded clause may either slightly weaken the strength of the projected inference that *p* is true (with factive predicates), or give rise to a weak ‘factive-like’ inference (with non-factive predicates). We propose a general, probabilistic, mechanism for integrating multiple (potentially conflicting) inferences about the Common Ground, and discuss how that mechanism interacts with the projection of factive presuppositions. In particular, we take the final interpretation of an utterance to be a synthesis of multiple inferences based on lexically encoded content, presupposition triggering and projection, and pragmatic reasoning about QUDs (as well as other inferences not discussed here, e.g., implicatures). An important, and unique, property of our proposal is that it captures, without additional assumptions, the effect of focus for both factive and non-factive predicates.

In Section 5, we present the results of a second experiment, demonstrating that focusing content in the embedded clause makes available a QUD that weakens the factive inference, thus providing empirical justification for the theoretical assumptions of our account in Section 4. Section 6 discusses the implications of our findings, and Section 7 concludes. In the following section, we review the relevant theoretical and experimental literature.

2 Background

2.1 Theoretical background

Following Karttunen (1974) and Stalnaker (1974, 1978), a basic tenet in current presupposition theory is that a key function of an utterance is to update the context, construed as the Common Ground. This is the set of propositions that, at a given point in the discourse, is mutually taken for granted by all discourse participants. The Common Ground characterizes a set of worlds, the context set, which is the intersection of all of the propositions in the Common Ground, or the worlds in which all of the propositions in the Common Ground are true (i.e. the candidates for the actual world). If a context update (an ASSERTION, in Stalnaker’s terms) is successful, the asserted proposition *P* is added to the Common Ground, thus restricting the context set by removing the worlds in which *P* is false; keeping only those in which *P* is true. Besides the asserted content of an utterance, an utterance generally comes with some PRESUPPOSITIONS. These are the propositions that are already part of the Common Ground (i.e. entailed by the context set), and upon which the context update rests. The intuition behind this is illustrated with the cleft-sentence in (6):

- (6) It was Anna who left town. ASSERTS: Anna left town
PRESUPPOSES: someone left town

Intuitively, in uttering (6), the speaker is taking for granted that *someone* left town, and that this can be assumed without further debate. They then add to this context that the person who left was Anna. That assertion can then be explicitly accepted or rejected, as in (7) (thus determining whether ‘Anna left town’ gets added to the Common Ground or not). The presupposition, however, that someone left town, remains unaffected by this further discourse move (cf. (2-b)):

- (7) No, it wasn’t. $\leadsto \neg(\text{Anna left town})$
 $\nrightarrow \neg(\text{someone left town})$

In the following subsections, we discuss two types of approaches to this assertion–presupposition dichotomy; focusing specifically on how presuppositions are triggered and why they (typically) project. Of central concern

for current purposes is the question of whether the pragmatics of the utterance, in particular the QUD, can determine the (global) presence of a factive presupposition (in embedded contexts). In Section 2.1.1, we review the ‘classic’ view (from Kamp 1981 and Heim 1982, 1983), according to which presuppositions are *lexically* encoded on their hosts—in our case, the factive predicate—as admittance conditions on the context. In Section 2.1.3, we review a more recent approach (e.g. Abrusán 2011, 2016; Simons et al. 2010, 2017), which argues that presuppositions are pragmatically backgrounded, or non-*at issue*, entailments of their triggers, and that whether or not a presupposition is generated, or projects, depends crucially on pragmatic properties of the utterance; specifically, the QUD. As we shall see, while the former, lexical approach makes no predictions regarding any effects of the QUD, accounting for such effects is a core desideratum of the latter, pragmatic approach.

2.1.1 Lexical approaches to presupposition triggering and projection

On the classic view following Kamp (1981); Heim (1982, 1983), building on Karttunen (1974) and Stalnaker (1974, 1978) (see also Heim 1992; Van der Sandt 1992; Groenendijk & Stokhof 1990; Kamp & Reyle 1993; Chierchia 1995 and subsequent work), presuppositions are taken to be lexically encoded on their triggers as an admittance or domain condition on the context, which must be satisfied in order for a context update (an assertion) to be defined.

In Heim’s dynamic framework, the semantic value of a sentence is not its truth conditions, but its *context change potential*. Applying the context change potential of a sentence S to a context c results in the intersection of c with the set of worlds such that S is true in those worlds. Importantly, however, such *context incrementation* is only defined if c entails the presuppositions p of S ; since both p and c are sets of worlds, c must be a subset of p . Context-change potentials are thus partial functions from contexts to contexts. Crucially, for our purposes, this framework encodes the pragmatics of presupposition directly as part of the semantics of lexical items. A simplified lexical entry for the factive verb *know* is given in (8), where material between the colon and full stop represent restrictions on the Common Ground (the presupposition), and the material after the period is the asserted content (using notation from Heim & Kratzer 1998, pg. 81).

$$(8) \quad [[\text{know}]]^w = \lambda p. \lambda x : \underline{p(w)} . [\forall w' \in \text{Dox}_x(w) \rightarrow p(w')]$$

This, then, is how these approaches address both aspects of the triggering problem (the source of the p -inference, and why this inference is presupposed rather than asserted; see Section 1); factive verbs come with a lexically encoded requirement that the embedded proposition p is entailed by the context. If this condition is met, as in (9) (where John and Mary mutually share the belief that Nadiya won the Bake Off), John’s assertion (regarding his happiness about this state of affairs) is defined.

- (9) John and Mary are discussing the last season finale of The Great British Bake Off, which they watch together every week.
- a. Mary: How did you like the season finale? Were you pleased with the outcome?
 - b. John: I’m so happy that [_P Nadiya won]! She was always my favorite. $\leadsto p$

There are also cases where the presupposition is not obviously met in the context, but where the context is still consistent with the presupposition. In this case, the hearer is understood to be able to silently add p to the Common Ground, intersecting c with p before the context update takes place (this is typically referred to as GLOBAL ACCOMMODATION; e.g. Stalnaker 1974; Lewis 1979; Heim 1983; Thomason 1990; Von Stechow 2008). Suppose, however, that the context is *inconsistent* with the presupposed content p , as in (10):

- (10) Mary doesn’t watch a lot of TV, but her best friend John is obsessed with the Bake Off, so she decides to give it a go and watch the season finale, in order to be able to discuss the outcome with him. Mixing up the various versions of the Bake Off available on Netflix, however, she accidentally ends up watching the final episode of The Great Kiwi Bake Off instead, the winner of which was Annabel.
- a. Mary: How did you like the season finale? Were you pleased with the outcome?
 - b. John: I’m so happy that [_P Nadiya won]! She was always my favourite.
(Djäv, 2019, pg. 262)

In this case, given that the context is inconsistent with p , global accommodation is not an option, as it would result in a contradictory context. The result is ‘presupposition failure’, which is often diagnosed by the ‘hey, wait a minute’ response (Shanon, 1976; Von Stechow, 2004):

- (11) Mary: Hey, wait a minute! I thought Annabel won the Bake Off. . .

Let us now turn to how Heim’s theory deals with embedded sentences. In the example given in (12), where p (as in (9)) is Common Ground, p projects:

- (12) John and Mary are discussing the last season finale of The Great British Baking Show, which they watch together every week.
- a. Mary: How did you like the season finale? Were you pleased with the outcome?
 - b. John: No way – I’m not happy that [_P Nadiya won]! Remember her Black Forest Gâteau?! \rightsquigarrow p (Djäv, 2019, pg. 263)

In this case, context incrementation proceeds in two steps. We first apply the context change potential of the embedded sentence (*I’m happy that Nadiya won*) to c , and then subtract the resulting set of worlds from c , as shown in (13) (following Kadmon 2000, $c + S$ represents context incrementation, i.e. the application of the context change potential of a sentence S to a context c).

$$(13) \quad c + \neg S = c - (c + S)$$

Of course, this will still require that c entails all of the presuppositions of the embedded sentence. If this condition is met, as in (12) (or if the presupposition can be easily accommodated at the global level) the presupposition ends up *projecting* from the scope of the embedding operator.

Suppose, however, that the context is *inconsistent* with the presupposition, as in (10). Unlike in unembedded contexts, in sentences with an embedding operator (like negation), the result is not presupposition failure. Rather, as we saw in (3)–(5), repeated in (14), the presupposition simply fails to project at the global level (and as a consequence, no inconsistency arises). Here, it looks as though the presupposition has been targeted by the embedding operator, along with the asserted content.

- (14) a. If I realize later that [_P I have not told the truth], I will confess it to everyone. \rightsquigarrow p
b. ...I haven’t tried this with wombats, though, & if anyone discovers that [_P the method is also wombat-proof], I’d really like to know! \rightsquigarrow p
c. I have no idea if Mary is cheating on John. But if he discovers that [_P she is], he will be sad. \rightsquigarrow p

Building on Karttunen (1974)’s notion of ‘local context’, Heim (1982, 1983) proposes a special operation, LOCAL ACCOMMODATION, whereby c is adjusted *locally*, as to admit the presupposition for the purpose of the context incrementation. Rather than intersecting c with p before the context update, as in the global case, in the local case, the sentence’s instructions to update the context will instead include $\neg(p \ \& \ S)$. For a sentence like *John isn’t happy that Nadiya won*, the updated context will now include $\neg(\text{Nadiya won} \ \& \ \text{John is happy that Nadiya won})$, effectively allowing the presupposition to take scope under negation:

$$(15) \quad c + \neg(S \ \& \ p) = c - (c + (S \ \& \ p))$$

On this approach, crucially, local accommodation is typically taken to be licensed only in a rather specific set of contexts, specifically when adding p to the Common Ground would lead to a contradiction, un informativity or problems with binding. For instance, in the examples in (14), the presupposition that p is inconsistent with the speaker’s explicit ignorance as to the status of p . Hence, it has commonly been viewed as a ‘last-resort’ repair mechanism.

2.1.2 Presupposition and focus

Recent work, however, has challenged this perspective on the type of contexts that lead to suspension of the presupposed content, claiming that this type of suspension is licensed in a much wider set of contexts than is typically recognized on lexical approaches. For instance, Beaver (2010) provides examples, such as those in (16), illustrating that projection is sensitive to prosodically marked focus.

- (16) A professor to a student:
- a. If the TA discovers that your work is [plagiarized]_F, I will be [forced to notify the Dean]_F.
 - b. If the TA [discovers]_F that your work is plagiarized, I will be [forced to notify the Dean]_F. (Beaver, 2010, pg. 93)

The empirical claim based on examples like that in (16), is that with focus in the matrix clause of the antecedent (16-b), the inference that p is true projects as usual; however, when focus is on content in the embedded clause of the antecedent (16-a), no such inference projects. Taking this as their explanandum, work in this tradition has argued that the lexical approach fails to account for the impact of discourse structure on projection, proposing alternative mechanisms for determining the distribution of presuppositions. In the following section, we review three such approaches from recent work; the projection accounts of Simons et al. (2010), and of Simons et al. (2017) (the latter adopted also in Tonhauser 2016), and the triggering account of Abrusán (2011, 2016). Note that these accounts can be construed as belonging to a broader type of theoretical approach to presuppositions, which—reviving key aspects of earlier work by Stalnaker (1974)—all appeal to some type of pragmatic effects (typically some notion of alternatives, (non-) *at-issue* content, or Question(s) Under Discussion) to account for

the triggering or projection of presuppositions. Other prominent accounts of this general type include Simons (2001, 2004, 2007), Abusch (2002, 2010), and Romoli (2012, 2015). However, we focus here on the former three approaches, as they specifically target the question of how focus affects and interacts with presuppositions.

2.1.3 Previous approaches to presuppositionality and focus

2.1.3.1 Simons et al. (2010)

On the view advanced by Simons et al. (2010), the relevant factor for determining whether or not content projects is the (non-) *at-issue* (or Main Point) status of that content. Specifically, they argue that projection is restricted to only those implications of (embedded) sentences which are not at-issue relative to the Question Under Discussion in the context.¹ They formulate this as an ‘iff’ statement:

- (17) [W]e propose an alternative explanation based on the following claim, which is intended to apply to all content which occurs in embedded contexts: Meanings project IFF they are not at-issue, where at-issueness is defined in terms of the Roberts’ (1996) discourse theory. (Simons et al., 2010, pg. 309)
- (18) **Hypotheses about what projects and why**
- a. All and only those implications of (embedded) sentences which are not-at-issue relative to the Question Under Discussion in the context have the potential to project.
 - b. Operators (modals, negation, etc.) target at-issue content.
- (Simons et al., 2010, pg. 315)

To define *at-issueness*, they adopt the notion of Question Under Discussion [QUD] from Roberts (1996) (and more recently, Roberts 2012). Broadly speaking, the QUD is the topic of discussion in the present discourse. It may, but need not, correspond to an actual question asked. Theoretically, the QUD is formulated as a set of alternative propositions. For instance (allowing for domain restriction), a question like that in (19-a) corresponds to the set of propositions, the QUD, in (19-b):

- (19) a. Where is Anna?
 b. {Anna is at home, Anna is at work, Anna is at the gym, ... }

For a conversational move to be felicitous, it must attempt to contribute to resolving the current QUD. This can be done either by completely resolving it, thereby eliminating all the alternatives but one, as in (20-a), or partially resolving it, thereby eliminating at least one alternative, as in (20-b).

- (20) a. She’s at work.
 b. I’m not sure, though I know she’s not at home...

Additionally, a speaker may give an answer that addresses the current QUD by giving an answer that *contextually entails* an answer to it. The example in (21) is from Simons et al. (2010, pg. 316). Here, given that it is Common Ground that the legal drinking age is 21 (or younger), the answer in (21-b) contextually entails an answer to the QUD raised by the question in (21-a). (For more discussion, see Simons et al. 2010, and Roberts 1996, 2012.)

- (21) a. Is Avi old enough to drink?
 b. He’s twenty-two.

At-issueness then, is defined in terms of relevance to the QUD:

- (22) **Relevance to the QUD**
- a. An assertion is relevant to a QUD iff it contextually entails a partial or complete answer to the QUD.
 - b. A question is relevant to a QUD iff it has an answer which contextually entails a partial or complete answer to the QUD.
- (Simons et al., 2010, pg. 316)

Although they don’t discuss the effect of focus in embedded sentences, as in (16) above, Simons et al. (2010) point out that, given the assumption that focus is a signal of the QUD (Roberts, 1996), their proposal correctly predicts the well-known observation that operators associate with focused material, whereas intonationally backgrounded content projects, as shown in (23):

¹Note that this is intended to target a much wider range of non-projective meanings than what is classically recognized by presupposition theory, including non-restrictive relative clauses, epithets, honorifics, and appositives. For discussion of the differences and similarities between different kinds of non-projective meanings, see Simons et al. (2010) and references cited therein, as well as more recently, Kennedy et al. (2015); Schwarz (2016), and Bill et al. (2016).

- (23) a. Paula isn't registered in [Paris]_F
 (≈ Paula is registered somewhere, not in Paris.)
 b. [Paula]_F isn't registered in Paris
 (≈ Someone is registered in Paris, not Paula.)
 (Simons et al., 2010, pg. 318, their example (18); originally from Kratzer 1989)

Although this paper does not address the type of example given in (16), repeated in (24) for clarity, it seems clear that their mechanism should have the same effect here as in (23).

- (24) A professor to a student:
 a. If the TA discovers that your work is [plagiarized]_F, I will be [forced to notify the Dean]_F.
 b. If the TA [discovers]_F that your work is plagiarized, I will be [forced to notify the Dean]_F.

That is, in the b-sentence (with focus in the matrix clause of the antecedent), what is at issue is something about the TA (whether they discovered that the students work is plagiarized). The embedded proposition (the students work is plagiarized) is *not-at-issue*, and should therefore be able to project. However, in the a-sentence (focus in the embedded clause of the antecedent), what is at issue is something about the student's work (whether it is plagiarized). Hence, the prediction is that the proposition 'the student's work is plagiarized' should not project.

In the following section, we review a recent update of this work. In this work however, the authors focus specifically on the projection behavior of focused sentences with factive attitude verbs, as in (16)/(24).

2.1.3.2 Simons et al. (2017); Tonhauser (2016)

According to Simons et al. (2017), adopted in Tonhauser (2016), the focus-sensitivity of factive presuppositions is accounted for in terms of focus leading the hearer to construe a particular QUD, defined as the Current or Congruent Question [CQ]. The claim is that the content of the embedded clause will project if it is entailed by the CQ.² Tonhauser (2016) provides the following definition of the CQ, adapted from Simons et al. (2017).

- (25) The Current Question of an utterance is a privileged subset of the focus alternatives set of the uttered sentence (given a structural analysis of that sentence, including focus marking) which meets the following conditions:
 a. The proposition expressed is a member of the Current Question and
 b. The Current Question has at least one additional member.
 (Tonhauser, 2016, pg. 952)

For instance, a sentence such as that in (26-a), with narrow focus in the embedded clause, will give rise to the set of focus alternatives in (26-b).

- (26) a. Perhaps John discovered that [Jane]_F left town.
 b. {For some entity *a*, John discovered that *a* left town}

In this case, the CQ for the utterance does not entail the proposition that Jane left town. Therefore, 'Jane left town' should not project. The existential claim that 'someone left town', however, *is* entailed by the CQ and projects. In contrast, a sentence such as (27-a), with narrow focus on the factive predicate, will give rise to the focus alternatives set in (27-b).

- (27) a. Sarah: Perhaps John [discovered]_F that Jane left town.
 b. {For some relation *R*, John *R* that Jane left town}

To the extent that the relations *R* in the focus alternatives set are all veridical (compare (28-a) and (28-b)), the CQ will entail *p*, and *p* will project. Tonhauser (2016) points out that although focus sets are contextually determined, it is still an open question what the most common focus sets are for different predicates in different contexts. The assumption on this account is that for projection to take place, the relevant CQs for these types of sentences contain only veridical relations, as in (28-a). If the CQ involves also non-veridical relations, as in (28-b), the embedded content is not predicted to project.

- (28) Perhaps he [discovered]_F that she's a widow.
 a. Example projective CQ:
 {he discovered that she's a widow, he knew that she's a widow, he was happy that she's a widow}

²Although note that Simons et al. (2017, pg. 192) end up invoking a more complex notion of QUD, involving also a Discourse Question, which "provides the topic of a segment of discourse and imposes relevance constraints on conversational contributions." They thus hypothesize that in some instances "Projection of the content of the complement of an attitude verb occurs if the best explanation for relevance of the CQ to the DQ requires attribution of acceptance of that content to the speaker." (As pointed out by Abrusán (2016), for sentences taken out of context, this still requires the assumption that the implicit CQ is veridical. See Simons et al. 2017, pg. 198 for discussion of this point.)

- b. Example non-projective CQ:
 {he discovered that she's a widow, he thought that she's a widow, he speculated that she's a widow}
 (Tonhauser, 2016, pg. 953-4)

Hence, this account predicts that with focus in the embedded clause, there should be *no* CQ that entails *p*, and *p* should therefore not be able to project.³ With focus on the matrix predicate however, there exists at least one possible CQ that entails *p*, and thus, we expect projection to be more likely, if not obligatory, in this context.

2.1.3.3 Abrusán (2011, 2016)

Abrusán (2011) presents an account, adopted in Abrusán (2016), to address the triggering problem for factive attitude verbs and additive particles. In a nutshell, she argues that entailments of a sentence become presupposed if they do not have Main Point status. Drawing on work in cognitive psychology and computational vision, the idea is that whatever content we don't pay attention to ends up being presupposed. To this effect, Abrusán presents a focus-sensitive triggering mechanism for presuppositions that generates two types of main points; a default (grammatically defined) main point, and a secondary (pragmatically defined) main point.

- (29) a. Default Main Point: these are the semantic entailments of the sentence that are “by nature about the event time of the matrix predicate” (pg. 502)
- b. Secondary Main Point: this is the content that (at the event time of the sentence) most directly addresses a grammatically signalled QUD.

The secondary main point may (but need not) be different from the default main point. If they are different, the sentence ends up with two main points, neither of which is presupposed. The following example from Abrusán (2011, pg. 508) (her example (27)) illustrates the derivation of the default main point:⁴

- (30) John knows (at t_1) that it is raining (at t_1).
- a. ϕ = John believes (at t_1) that it is raining (at t_1).
- b. ψ = It is raining (at t_1).

The sentence in (30) has (at least) two entailments, that in ϕ and that in ψ . The entailment in ϕ (John's belief that *p*) is necessarily about the event time of the matrix predicate (John's knowledge that *p*) — it follows from the lexical meaning of *know* that the attitude holder's belief spans the same temporal interval as their knowledge. However, for the entailment in ψ (that it is raining), this is not so. Although in (30) the event time of ϕ is the same as the event time of ψ , this is not the case across all temporal alternatives, a notion Abrusán invokes to distinguish ‘accidental co-temporaneity’ from ‘non-accidental co-temporaneity’. (31) illustrates:

- (31) a. John knows (at t_1) that it was raining (at t_1).
T-alternative: John knows (at time t_1) that it was raining (at time t_2)
- b. John managed (at time t_1) to solve the exercise (at t_1)
T-alternative: *John managed (at time t_1) to solve the exercise (at t_2)
 (Abrusán, 2011, pg. 508)

Thus, Abrusán's mechanism predicts that, as the default main point is about the ‘matrix event’ (John's attitude towards *p*), we interpret the sentence in (30) as presupposing that it is raining (at t_1), *by default*.

The output of the default triggering mechanism is then subject to further modulation by contextual factors. That is, contextual factors such as focus can ‘point our attention’ to content which otherwise would've been presupposed by default, thus eliminating the presupposition before it ever gets triggered (at a global level).

Thus, the ‘suspension’ facts that we observed above with focus [(16)/(24), KD/HAB] do not in fact show a *removal* of a presupposition by focus; instead, focus has interacted with the presupposition triggering mechanism and has prevented the relevant presupposition from being triggered to begin with. In other words, content that would otherwise be presupposed stays part of the main point (at-issue content) of the sentence. (Abrusán, 2016, pg. 171)

Abrusán's account of the impact of focus on presuppositions is centered around embedded sentences like (16)/(24) (example (60) in Abrusán 2011). Her central analytical claim is that focus in the embedded clause (*If the TA discovers that your work is PLAGIARIZED...*) makes salient the question *What will the TA discover?*. Since the most direct answer to that question is the proposition in the embedded clause (the default

³Although Simons et al. (2017, pg. 192) then add that “Projection of the content of the complement of an attitude verb occurs if the Current Question for the utterance entails this content.”—with the caveat that “this hypothesis presents one circumstance in which projection occurs: this is intentionally formulated with if and not iff.” However, the authors do not formulate a clear hypothesis for what those circumstances should be, and whether they would take projection from such alternative mechanisms to be possible in a context where the CQ does not entail *p*—i.e. when there is focus in the embedded clause.

⁴Note that in order to make more precise the notion of ‘the main event of a sentence’, she uses event times.

presupposition), this content is now a (grammatically signalled) secondary Main Point, and therefore predicted to not be presupposed. Hence, given that focus is (at least in English) prosodically marked, whether or not the complement of a factive predicate will project depends crucially on the prosodic contour of the utterance.

...when the content of what would become the presupposition is focused, no presupposition is predicted to be generated. (Abrusán, 2016, pg. 168)

Besides focus, Abrusán (2011, 2016) also invokes her triggering mechanism in the context of parenthetical uses of factive attitude verbs, as illustrated in (32). As pointed out by Simons (2007) (see also Urmson 1952; Hooper & Thompson 1973; Hooper 1975), in sentences like (32-b), the ‘main point of the utterance’ is the embedded proposition *p*, and the factive verb fills some parenthetical, potentially evidential function.⁵ Given that embedded proposition now constitutes a (secondary) main point, Abrusán argues that it is not predicted to be presupposed (2011, pg. 528).

- (32) a. Why isn’t Louise coming to our meetings these days?
 b. Henry discovered/realized/figured out/learned that she’s left town.
 (Abrusán 2011, pg. 527; adapted from Simons 2007)

While not the core focus of this paper, we believe that a brief note on this case is in order, as it relates in important ways to the bigger question of the various ways in which different kinds of ‘presuppositional’ inferences are impacted by different types of contextual modulation.

We believe there are several problems in trying to group these cases under the same umbrella as those involving focus-placement. To start, Abrusán is very clear that what she intends to address is the *triggering* problem. Recall from above, however, that there are actually two parts to this problem; (i) where the presupposed content, *p*, comes from, and (ii) why *p* ends up backgrounded or assumed to be Common Ground. On the lexical approach discussed in Section 2.1.1, the answer to both of these questions is that factive predicates lexically encode *p* as a definedness condition on the primary, asserted content (regarding the attitude holder’s emotive or cognitive state). On the view advocated by Abrusán however, the *non-at issue* status of *p* (ii) and the inference that *p* is true (i) are attributed to two different sources. The *p*-inference arises simply because factive predicates are *veridical* (similarly to predicates like *be right* and *be true*).⁶ The aim of Abrusán’s account, then, is presumably to address the second question, regarding the backgrounded status of *p*. Nevertheless, her examples illustrating the effect of focus are all complex sentences such as (16)/(24), where we observe what looks like suspension of the inference that *p* is true in *embedded* contexts. Abrusán emphasizes, however, that she takes these examples to illustrate (non-) *triggering*. The fact that they also instantiate (non-) *projection* is taken to be an orthogonal issue.

The example in (32) is different from (16)/(24), however, in two important ways. First, it involves an *unembedded* factive verb. Secondly, the sentence does not involve suspension of the inference that *p* is true.⁷ The way in which (32-b) is ‘non-presuppositional’ then, is in the sense that *p* is not taken to be Common Ground, but is understood to be providing the hearer with new information. Thus, what Abrusán takes to be an effect to ‘paying attention’ to certain content, based on signals of the QUD, is crucially not the same in the case of focus and in the parenthetical case. While focus seems to affect the inference that *p* is true in *embedded* sentences, what we observe in the parenthetical case is that, for *unembedded* sentences, *p* is no longer understood as backgrounded or *non-at issue*. Regarding the parentheticals, we might understand Abrusán’s proposal as a successful development of Simons (2007). It is less clear, however, what her proposal achieves in the case of focus. On the one hand, it seems empirically uncontroversial that what is *at-issue* in (33-a) is different from what is *at-issue* in (33-b), in line with Abrusán’s theoretical claim that focus in the embedded clause signals a QUD which effectively turns the embedded proposition into a secondary main point.

- (33) a. The TA discovered that your work is [plagiarized]_F.
 b. The TA [discovered]_F that your work is plagiarized.

However, in her discussion of focus, the empirical issue which Abrusán focuses on is not the (non-) *at issue* status of *p*, but rather whether or not the sentence gives rise to the inference that *p* is true. In this case, then,

⁵Unlike on the account of Simons et al. (2010), Abrusán (2011) claims that the type of pragmatic modulation required to block presupposition triggering is only possible when there are sentence *internal* factors signalling a shift in the discourse structure via the QUD (such as focus). Hence, simply introducing a particular question into the discourse should not be enough to remove a presupposition. It is not clear then, that the parenthetical case is actually consistent with this claim.

⁶See for instance Anand & Hacquard (2014) for discussion.

⁷It is well-established that unembedded presuppositions are generally not cancellable. This is illustrated with the existential presupposition of the definite article in (i), from Abrusán:

- (i) a. The King of France did not eat the cake: there is no King of France.
 b. #The King of France ate the cake, but there is no King of France.
 (Abrusán, 2016, pg. 166)

it seems like Abrusán’s account, a proposal for a triggering mechanism in *unembedded* sentences, makes too strong predictions, as clearly, focus is not able to suspend the inference that *p* is true in unembedded sentences.⁸ It seems to us then, that the cases involving parenthetical uses of attitude verbs warrant a different treatment from any effects of prosodic focus.⁹

Before moving on to the current experiments and theoretical proposal, we review a previous experimental investigation of this phenomenon, from Tonhauser (2016).

2.2 Experimental Background (Tonhauser, 2016)

Tonhauser’s (2016) experiment was designed to test the predictions of the approach outlined in Section 2.1 for factive presupposition projection. In order to test the effect of discourse structure on projection, the experiment manipulated prosody by placing narrow focus on the factive matrix predicate (in the Matrix Clause (MC); Predicate Stress in (34)) or within the Embedded Clause (EC) (Subject and Content Stress in (34), respectively), using items such as (34).

- (34) Dana (about Scott and Valeria)
 [Context: overhearing a conversation at a party]
- | | | |
|----|---|---|
| a. | Perhaps he [noticed] _F that she is a widow. | H* on predicate [Predicate Stress (MC)] |
| b. | Perhaps he noticed that [she] _F is a widow. | L+H* on pronoun [Subject Stress (EC)] |
| c. | Perhaps he noticed that she is a [widow] _F . | L+H* on content [Content Stress (EC)] |

The target sentences, which included a factive verb and the modal particle *perhaps* (*Perhaps he noticed that she is a widow.*) were presented aurally, as illustrated in Figure 1.

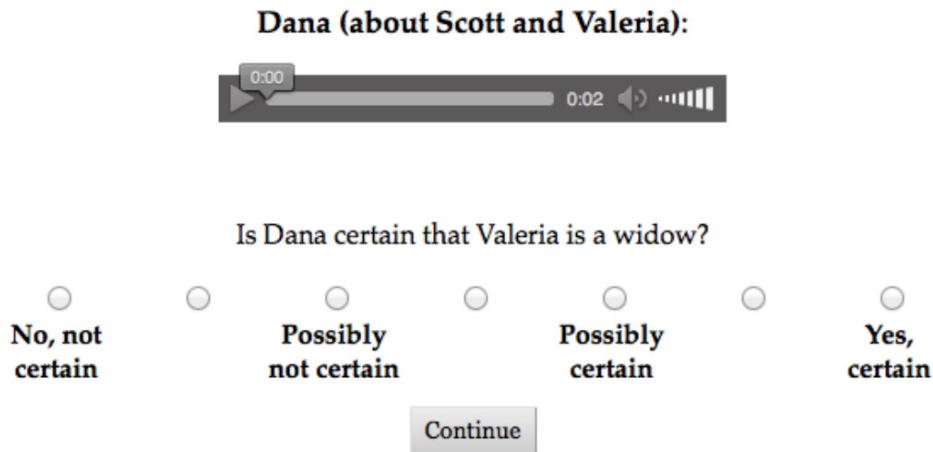


Figure 1: Tonhauser’s experimental set-up (Tonhauser, 2016, pg. 944).

The predicates used were *discover*, *realize*, *know*, *be aware*, and *notice*. Two unembedded control sentences (*I am tired.* and *I was invited to the party.*) were also included to make sure that participants were paying attention.

The prediction was that narrow focus in the embedded clause would reduce projection. Projection was measured as the speaker’s commitment or certainty of the truth of the embedded proposition. Hence, after hearing the target sentence, the participants were presented with a question such as (35). The dependent variable was the participants’ rating of the speaker’s certainty on a 7-point likert scale (1=not certain—7=certain).

- (35) Is Dana certain that Valeria is a widow?

Tonhauser found a significant difference between the Predicate Stress condition and both conditions with stress in the embedded clause (Subject and Content Stress), in the direction predicted by the QUD-based approach (Subject Stress received lower ratings than Predicate Stress; $\beta = -0.68$, $p < .05$, and Content Stress received lower

⁸At least in English. Note, however, that Özyildiz (2018) observes an effect of focus in Turkish similar to that described here, but in *unembedded* sentences.

⁹The insight that these two aspects of what is typically taken to be the ‘factive presupposition’ (the backgrounded status of *p* and the *p*=1 inference) should be dissociated is due to Simons (2007). As Simons points out, this is unexpected on classic accounts. Here, we set this issue aside, as it doesn’t affect our conclusions about the role of focus-driven QUD-effects versus lexically triggered presuppositions; see Djärv (2019) for a different type of lexical account, which does not link the projective inference that *p* is true to the discourse status of *p*.

ratings than Predicate Stress; $\beta = -0.49$, $p < .05$). The results are illustrated in Figure 2 from (Tonhauser, 2016, pg. 945).

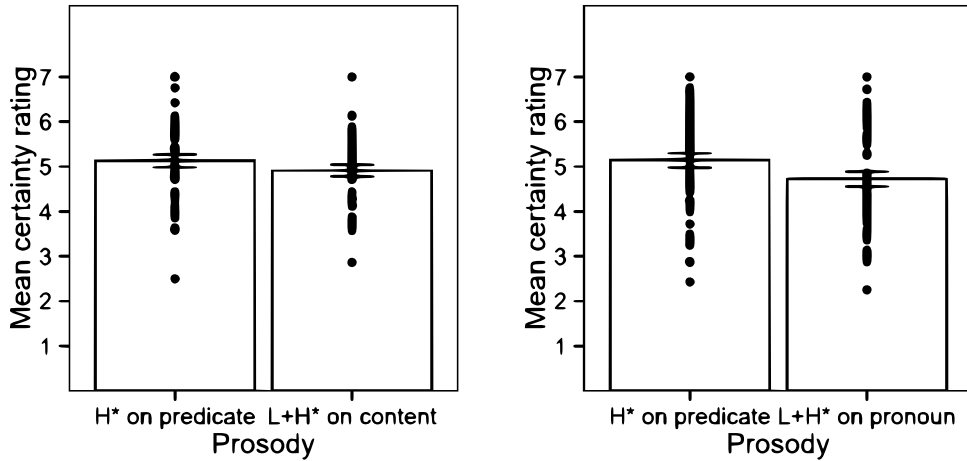


Figure 2: Graph of results from Tonhauser (2016, pg. 945): right-hand bars represent the conditions with focus in the matrix clause (Predicate Stress), and the left-hand bars represent the conditions with focus in the embedded clause (Content Stress and Subject Stress, respectively).

Tonhauser not only concludes from this that prosody *influences* projection for utterances with factive predicates embedded under an entailment canceling operator, but that the results provide evidence for the QUD-based analysis from Simons et al. (2017) outlined in Section 2.1.3.2—whereby information structure (here mediated by focus) *drives* projection. That is, the condition with narrow focus in the matrix clause will give rise to the CQ in (36-a), which (given a domain of veridical relations R) entails p (predicting projection), and the conditions with narrow focus in the embedded clause will give rise to the CQs in (36-b) and (36-c), neither of which entails p (predicting non-projection). On the assumption that presuppositions are derived when a proposition is entailed by the CQ, only (36-a) will generate a factive presupposition, and thereby project.

- (36) a. {For some relation R , John R that she is a widow} (34-a)
- b. {For some entity a , John discovered that a is a widow} (34-b)
- c. {For some property π , John discovered that she is π } (34-c)

She further argues that the classical analyses of projection (Heim (1983) et seq.), where presuppositions are lexically encoded on the factive predicate, are unable to predict the observed results.

Although Tonhauser’s study demonstrates that information structure (mediated by prosody) indeed has an influence on presupposition projection, it is less clear that the results provide strong support for the claim that projection is in fact *driven* by the QUD. To begin with, the contrast observed between the Embedded Clause and Matrix Clause focus conditions was small. Secondly, and more critically, the experiment did not include any baseline conditions for projection and non-projection (i.e., unembedded sentences,¹⁰ and sentences with non-factive clause embedding predicates, respectively). That is, if the construal of a particular CQ is what gives rise to projection (by either entailing or not entailing p), then we would expect to see a distribution of responses like that in the left-hand graph in Figure 3, with stress-placement inside the complement of a factive predicate giving rise to projection on par with non-factives, while stress on the factive predicate should give rise to substantially higher levels of projection.

On the other hand, if presuppositions are lexically encoded on certain (factive) verbs, then we would expect to see a distribution similar to that in the right-hand graph in Figure 3, where stress-placement inside vs. outside of the embedded clause has no effect on projection.¹¹

Without a baseline of comparison between cases where (the equivalents of) projection and non-projection respectively are uncontroversially expected, as reflected in straightforward judgments about the presence or absence of the relevant inference (that the speaker is committed to p), it is difficult to assess the claim that Tonhauser’s results specifically provide evidence in favor of the QUD-based approach of Simons et al. (2017). Hence, our experiment, reported below, crucially includes baseline conditions for projection and non-projection (as in Figure 3) to assess more directly how the effects of prosody and potentially independent lexical factivity

¹⁰The two unembedded control sentences in Tonhauser’s experiment were not included in the analysis.

¹¹Note that, on both accounts, the ceiling projection levels for factives are expected to be lower than for Unembedded sentences. On lexical accounts, this is to take into account potential instances of local accommodation. On the pragmatic account of Simons et al. (2017), this is to allow for non-veridical relations being considered as part of the sentence’s focus alternatives.

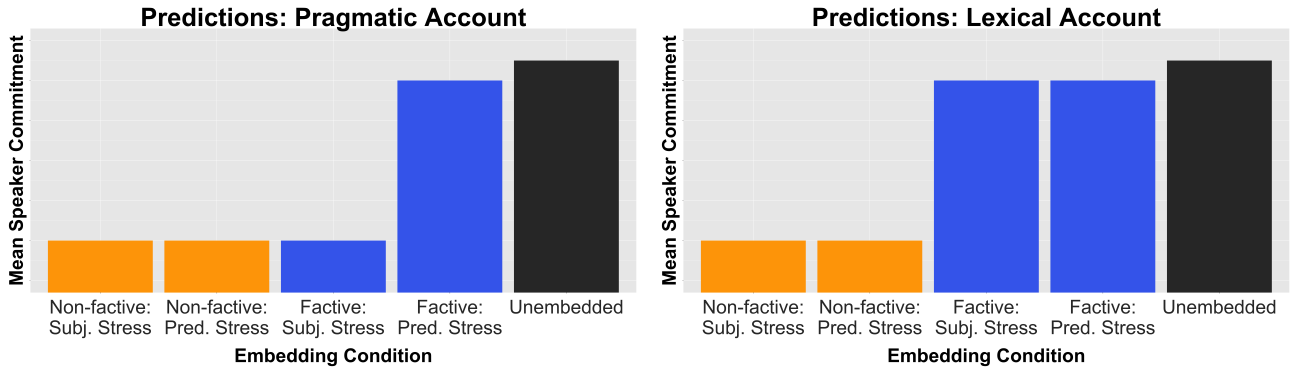


Figure 3: Predictions for (the strong versions of) pragmatic QUD-based (left) and lexically based (right) approaches to presupposition projection.

compare. In the following sections, we present an experiment which provides such baselines (Section 3). Based on our results, we give a novel account of the effect of prosodic focus on interpretation (Section 4), and run a second experiment validating our theories of prosody and QUD (Section 5).

3 Experiment 1 (Projection Experiment)

3.1 Design

Our first experiment closely follows Tonhauser’s design in order to maximize comparability, with some modifications (see Section 3.3 for more detail). We used the same general set-up where the participants were told to imagine that they happened to overhear a conversation at a party, involving sentences similar to those used by Tonhauser. The stimuli were presented aurally, and varied stress in the matrix clause (on the (non-)factive predicate; Predicate Stress (37-a), similar to Tonhauser’s (34-a)) and the embedded clause (on the subject; Subject Stress (37-b), similar to Tonhauser’s (34-b)), as illustrated with the non-factive predicate *say* in (37):

- (37) Prosodic variation (see Section 3.3 and (39) for full details of the experimental conditions)
- a. John might’ve [said]_F that Anna left town. Predicate Stress
 - b. John might’ve said that [Anna]_F left town. Subject Stress

Unlike Tonhauser (2016), we did not include a third condition with stress on the embedded predicate (Tonhauser’s Content Stress/“L+H* on content” condition; (34-c)), given that Tonhauser only observed a very small difference between the two conditions with focus in the embedded clause (Subject Stress and Content Stress), and that the proposals considered here make the same predictions for those two conditions.

The dependent variable was the participants’ rating of the speaker’s certainty about whether the embedded proposition holds, measured on a 7-point Likert scale. The participants were told that there is no right or wrong answer, but to simply choose the answer they preferred.

3.2 Participants

57 undergraduate students, recruited through the University of Pennsylvania’s Psychology department’s subject pool, participated in the study for course credit. They all reported being native speakers of English and having normal hearing. The participants were given a link to the experiment to take the experiment on their own over the internet. The experiment was implemented in Ibex.¹² It took approximately 10 minutes to complete. Data from all participants were included in analysis.

3.3 Materials

In addition to the prosodic variation (illustrated in (37)), the current experiment included three embedding conditions (factive matrix predicate vs. non-factive matrix predicate vs. unembedded), as in (38).

- (38)
- a. John might’ve discovered that Anna left town. Factive
 - b. John might’ve believed that Anna left town. Non-factive
 - c. Anna left town. Unembedded

¹²See <http://spellout.net/ibexexps/SchwarzLabArchive/THProsPs/experiment.html> for an archived version of the experiment.

Unembedded		Verbal
Cognitive Factive (CF)		<i>discover, realize, notice</i>
Emotive Factive (EF)		<i>regret, love, resent</i>
Non-factive (NF)		<i>believe, hope, say</i>
Unembedded		Adjectival
Cognitive Factive (CF)		<i>be informed, be conscious, be aware</i>
Emotive Factive (EF)		<i>be happy, be disappointed, be upset</i>
Non-factive (NF)		<i>be hopeful, be worried, be concerned</i>

Table 1: Factive and non-factive predicates used in the experiment (verbal and adjectival).

The auditory stimuli were recorded on a Blue Snowball microphone in the Phonetics Lab in the Linguistics department at the University of Pennsylvania. The target sentences were produced by splicing together the recordings of the different matrix and embedded sentences to avoid any unintended prosodic variation.¹³ As shown in (38), we also changed the embedding operator from *perhaps* to *might’ve*. This was done to avoid a potential metalinguistic interpretation of *perhaps*, along the lines of ‘I don’t know whether this answers your question, but perhaps the fact that he discovered that p is relevant’.¹⁴

It has been observed in the presupposition literature going back to Karttunen (1971), that cognitive and emotive factives differ in several regards with respect to the status of the factive presupposition concerning the embedded content (see for instance Simons 2001; Abusch 2002, 2010; Chemla 2009; Romoli 2015; Abrusán 2016; Djärv et al. 2017, and Djärv 2019). Hence, the present study included both cognitive and emotive factive predicates. We also considered the possibility that a difference between verbal (e.g., *discover*) and adjectival forms (e.g., *be aware*) could affect projection. Therefore, we balanced the number of verbal and adjectival predicates across the different embedding conditions. The full list of predicates is given in Table 1 (the color and font style, namely italics vs plain style, will be used for these categories throughout the paper).

The 48 test items involved a speaker (Sarah), uttering a sentence about some other people (John and Anna). Each item had variations in all 8 conditions; [Predicate Stress vs. Subject Stress] × [Cognitive Factive matrix predicate vs. Emotive Factive matrix predicate vs. Non-factive matrix predicate vs. Unembedded], as illustrated in (39). Each subject saw all conditions across items, but the different lexical content in the embedded clause associated with an item was only shown in one condition, counter-balanced across subjects using a latin-square design (see the Appendix for a list of all items included in the experiment).

(39) Experimental Conditions

- a. Cognitive Factive (CF), Subject Stress:
Sarah: John might’ve discovered that [Anna]_F left town.
- b. Cognitive Factive (CF), Predicate Stress:
Sarah: John might’ve [discovered]_F that Anna left town.
- c. Emotive Factive (EF), Subject Stress:
Sarah: John might’ve regretted that [Anna]_F left town.
- d. Emotive Factive (EF), Predicate Stress:
Sarah: John might’ve [regretted]_F that Anna left town.
- e. Non-Factive (NF), Subject Stress:
Sarah: John might’ve believed that [Anna]_F left town.
- f. Non-Factive (NF), Predicate Stress:
Sarah: John might’ve [believed]_F that Anna left town.
- g. Unembedded, “Subject Stress”:
Sarah: [Anna]_F left town.
- h. Unembedded, “Predicate Stress”:¹⁵
Sarah: Anna left town.

As in Tonhauser’s study, the target sentence was followed by a question such as (40), asking about the speaker’s commitment to p.

¹³We have included the audio files as supplemental materials for readers interested in the details of the prosodic contours.

¹⁴Thanks to Satoshi Tomioka for this point.

¹⁵No marked stress pattern.

(40) Is Sarah certain that Anna left town?

The set up of the experiment is illustrated in Figure 4.

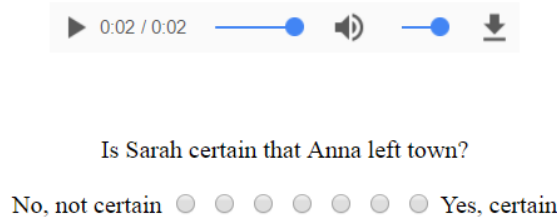


Figure 4: Task used in the current experiment.

3.4 Statistical methods

To test our predictions, we used two different statistical methods: Conditional Inference Trees and Bayesian Mixed Effects Models. The Conditional Inference Trees were used to test whether there was significant clustering of stress conditions and embedding predicates on the basis of certainty ratings. The model was given only the lexical identity of the predicate in each trial, not the a priori assigned category. Conditional Inference trees cluster data by finding clusters within predictors that have a significant effect on the dependent variable. We used them to validate the a priori identification of *types* of predicates (i.e., Factive/Non-factive, Emotive/Cognitive). They were fit using the *partykit* package in R (Hothorn & Zeileis 2015 and Hothorn et al. 2006).

Bayesian Linear Mixed Effects models were used to test whether there was a substantial effect of stress on subjects' perception of the speaker's certainty in the embedded proposition. Bayesian models estimate the probability distribution over parameter values in a model rather than try to find a single point estimate. Their output provides a quantification of uncertainty after accounting for data. This uncertainty can be displayed with a credible interval. We report a 90% credible interval, which provides the range of parameter values such that there is a 95% chance that the value is above the bottom of the range and a 95% chance that the value is below the top of the range. If zero is within the credible interval, then the data was insufficient to determine whether any effect is positive or negative and that a null effect is still a plausible hypothesis. The Median (found in Table 2) gives the best estimate of the effect size, i.e., the number of points changed on the scale in that condition. The model was fit with the *rstanarm* package in R (Stan Development Team, 2016).

For the Mixed Effects model, predicate type was coded using two variables Non-factive Diff. (1 for Non-factive; 0 for Factive and Unembedded) and Unembedded Diff. (1 for Unembedded; 0 for Factive and Non-factive).

Stress was included by a variable Pred. Stress: 1 if the predicate was stressed (or in the unembedded condition where there was no focal stress); 0 if the embedded subject was stressed. We also included the interactions between the stress variable and the two predicate type variables. The intercept, thus, modelled certainty ratings for sentences with factive predicates and Subject Stress. Only random intercepts for subject and item were included, since more complex models failed to converge.

3.5 Results and Discussion

The Conditional Inference Tree (see Figure 5) clustered (most) factives together as a single group (blue font on x-axis). The only exception was *be informed*, which patterned with some of the adjectival non-factives.¹⁶ Adjectival non-factives (orange, italics) were gradually ranked higher than the verbal non-factives (orange, plain text), but lower than the factives (blue). Factives and non-factives were rated below the unembedded conditions (black), however the factives (even with Subject Stress) were much closer to the unembedded conditions than to the verbal non-factives (orange, plain text). A surprising result was that adjectival non-factives did not neatly behave like either verbal non-factives or factives, nor did they behave like a coherent class. Instead there was a gradient difference between *be hopeful* which was fairly non-factive like, *be concerned* which was more factive like (similar to *be informed*) and *be worried* which was somewhere in the middle.

Stress has a small, but significant effect within the factive category, which was supported by the Mixed Effect analysis, for which all credible values according to the Bayesian model (Table 2) were positive (meaning that being in the Predicate Stress condition reliably led to higher certainty ratings). However, the magnitude of the difference between the Factive and Non-factive categories (model estimate of -1.9 points, as seen in the

¹⁶See Anand & Hacquard (2014) for an argument that its verbal counterpart *inform* is non-factive, contra Schlenker (2008).

Non-Factive Diff. row of Table 2) was an order of magnitude larger than the difference between Subject and Predicate Stress for factives (model estimate of 0.2, as seen in the Pred. Stress row).

In addition to the expected effect of stress in the factive category, there was also a reliable effect of stress with both the verbal non-factives and in the unembedded condition. In the unembedded condition, the effect of stress was stronger than with factives, and in the same direction (stress on the subject led to decreased ratings). This effect is surprising since the speaker is actually directly asserting the proposition in these cases. We interpret the effect in the unembedded condition as being due to at least some participants interpreting stress on the subject as a question (an interpretation that was promoted by a tendency for the recordings to include a slight rising intonation at the end of the utterances with subject stress). This interpretation is corroborated by comments left by two participants at the end of the experiment. We therefore leave this to the side for the remainder of the discussion.¹⁷ For verbal non-factives, the effect of stress was in the **opposite** direction: subject stress led to increased ratings. Figure 6, showing the mean ratings collapsed across predicate types, illustrate clearly these findings.

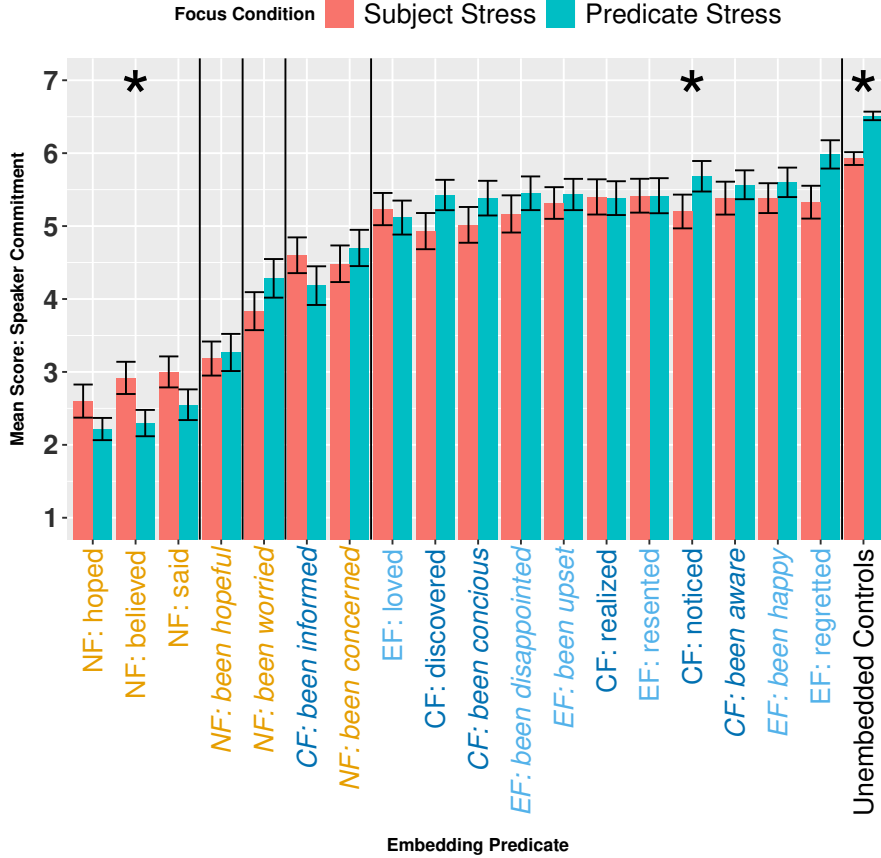


Figure 5: Mean certainty ratings by embedding predicate and stress conditions (black lines indicate clusters from the Conditional Inference Tree model with stars indicating that a cluster contained stress based sub-clusters according to Conditional Inference Trees; NF=Non-factive, CF=Cognitive factive, EF=Emotive factive).

4 Current Proposal

In our first experiment, we found that the effect of prosody is much smaller than the difference between factive and non-factive predicates, contrary to the predictions made by the accounts in Section 2.1.3. However, we also found that prosody has an effect on inferences from *non-factive* predicates. The effect on non-factive predicates is not predicted by either the pragmatic or standard lexical theories. The pragmatic accounts argue that stress on content in the embedded clause causes presuppositions (and their certainty judgments) to be lost, not gained. The lexical accounts are silent on the consequences of prosodic focus altogether.

¹⁷ An anonymous reviewer also raises the concern that this final rise might have been a confound in the sentences involving factive attitude verbs. While this is possible, it's worth noting that such an effect should in fact result in even *lower* certainty ratings than would follow from the effect of focus alone; thus making the estimated effect of focus a generous one— and hence not a problem for the current account (Section 4).

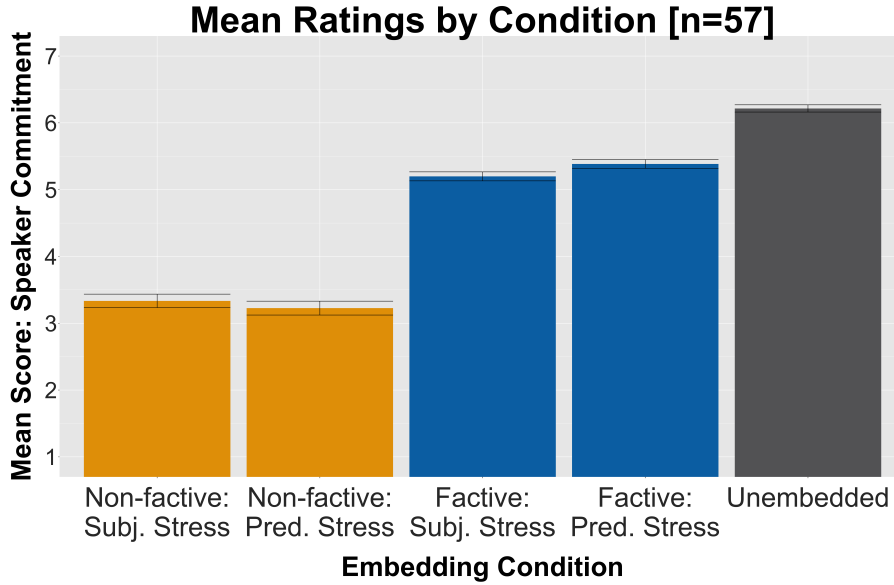


Figure 6: Mean certainty ratings by embedding predicate types and stress condition.

	5% LB	Median	90% UB
Factives (Intercept)	5.0	5.2	5.4
Non-Factive Diff.	-2.0	-1.9	-1.7
Unemb. Diff.	0.6	0.7	0.9
Pred. Stress (Factive)	0.03	0.2	0.3
N.F. Stress. Interact.	-0.5	-0.3	-0.04
Unemb. Stress Interact.	0.2	0.4	0.6

Table 2: Parameter estimates from the Bayesian Mixed Effects Model.

To account for the data in embedded cases, we propose that the standard lexical account of presupposition triggering and projection should be adopted, and then supplemented with an independent account of the effects of prosody. The lexical theory explains the observed large difference between non-factive and factive predicates (the former come with lexically encoded presuppositions, while the latter do not). The effect of prosody, we propose, is completely independent from lexical factivity, thus giving rise to the weak effect of prosody *across* predicate types (factive and non-factive predicates). Thus, the final interpretation of an utterance is a synthesis of multiple inferences based on lexically encoded content, presupposition triggering and projection, and pragmatic reasoning about QUDs (as well as other inferences not discussed here, e.g., implicatures), which may conflict with one another (details about this process are discussed in the remainder of this section).¹⁸

From the pragmatic account, we adopt the assumption that stress reflects the presence of particular QUDs. Our proposal assumes that these QUDs themselves give rise to particular inferences about the current state of the Common Ground (and are hence similar to presuppositional inferences about the presence of a proposition in the Common Ground). Depending on the nature of these inferences, they can provide support for or against the probability that the embedded proposition is held to be true. Thus, we assume that the certainty measure that we collect (i.e., to what extent participants assume that the speaker is committed to the truth of p) reflects the participants' estimation of the speaker's estimate of the probability that the embedded proposition is true. Such probabilities will be affected by the total sets of inferences and assertions generated by the speaker's utterance. This conjecture (that prosodic differences can give rise to differential preferences for particular QUDs) is supported by the experimental results reported in Section 5 below.¹⁹

Our proposal assumes three different types of inferences that can arise from any of our utterances: (1) the asserted content of the utterance, which for the embedded conditions *never* entail p (the assertions are only about the attitude holder's emotional/cognitive relation to p); (2) the projected presuppositional content of the

¹⁸As highlighted by an anonymous reviewer, this is a feature that the present account shares with Abrusán (2011, 2016). This reviewer also suggests that these results *would* be compatible with a revised version of Abrusán's account, if one assumes that the effects of the secondary, pragmatic mechanism are weaker than those of the grammatical mechanism. As it currently stands, however, it is clear that the empirical consequence of her account is that with focus in the embedded clause, no presupposition should be generated at all (see Section 2.1.3.3). This revised account would also give no insight into the effect found for non-factive predicates.

¹⁹Note that the gradient effect of different inferences on certainty has been independently empirically established in Cummins & Rohde (2015).

PRED. COND.	STRESS COND.	ASSERTION	PRESUPPOSITION	QUD INFERENCE
Factive	Subject Stress	It is possible that John discovered Anna left town	It is CG that Anna left town	It is CG that someone left town, but not CG who that person is
Factive	Predicate Stress	It is possible that John discovered Anna left town	It is CG that Anna left town	It is CG that John has some relationship with the proposition Anna left town
Non-factive	Subject Stress	It is possible that John believed Anna left town	N/A	It is CG that someone left town, but not CG who that person is
Non-factive	Predicate Stress	It is possible that John believed Anna left town	N/A	It is CG that John has some relationship with the proposition Anna left town

Table 3: Complete set of inferences in each condition; CG=Common Ground (bolded inferences in a row are contradictory.)

utterance, which only make claims about the status of the current Common Ground; and (3) the inferences from the QUD, which also only make claims about the current Common Ground. Table 3 shows the inferences for the four relevant embedded conditions. These three types of inferences need to be reconciled in order for the final meaning of the utterance to be determined. Given that these inferences can be contradictory (see the bolded elements from Table 3), there must be a mechanism for resolving the contradictions in determining the ultimate meaning of the utterance.²⁰

Our model assumes (following the current literature on the effects of focus; see discussion in Section 2.1.3) that focus on the matrix predicate naturally gives rise to the QUD “What cognitive (or emotive) relationship does John have with the proposition Anna left town?”. We assume that subject stress can give rise to at least three possible QUDs: “Who left town?”, “Who did John discover that they left town?” and “Who might John discover that they left town?”. Of these three possible QUDs, only one has implications that are relevant for the Common Ground status of the proposition “Anna left town”, namely “Who left town?”. This question implies that it is Common Ground that someone has left town (while the questions that include John’s cognitive states have no direct implications about town leavers in the actual world). Crucial for our analysis of the effect of focus is only that the question “Who left town?” be *more accessible* in Subject Stress conditions than in the Predicate Stress conditions (a hypothesis that is explicitly tested, and supported, in Experiment 2 discussed in the next section).²¹

To capture gradient responses in certainty, we adopt the formal device of modeling current conversational states as probability distributions over possible worlds rather than sets of possible worlds, e.g., that there is a probability of 0.1 that the real world is W_a , rather than that W_a is a member of the set of candidates for the real world. This move to probability distributions over worlds is similar to the move taken by Rational Speech Act models; e.g., Goodman & Frank 2016 and citations therein. Given that this is a probabilistic model, the laws of probability must be observed, in particular that the probability over all possible worlds must sum to 1. The goal of conversation under such a model is to concentrate the probability distribution (i.e., move the probability of any given world close to either 1 or 0 and away from 1 divided by the number of possible worlds).

For the purpose of the remainder of this section, we introduce a simple model of the set of possible worlds relevant for the discussion at hand. For ease of discussion, we assume that the relevant proposition is “Anna left town” and that there are only two possible candidates for town leavers: Anna and Bob. This creates four possible worlds: W_a in which Anna left town, W_b in which Bob left town, W_{ab} in which both Anna and Bob left town, and W_n in which no one left town. Table 4 shows the baseline probability over the worlds and the meaning of the two main inferences (the presupposition and the QUD “Who left town?”). Crucially, the question “Who left town?” rules out the world in which no one left town (since the question gives rise to the inference that someone left town). The presupposition “Anna left town” puts all of the probability mass on the worlds in which Anna in fact left town. For simplicity we assume that the probability mass is equally distributed over the remaining worlds in each case.

²⁰Note that this is only a contradiction if we assume that “Anna left town” is assumed to mean “Only Anna left town”. While the exclusivity of statements is a natural pragmatic consequence of the Maxim of Quantity, we will assume a non-exhaustive interpretation below and show that while it does not directly contradict the presupposition, its inference of uncertainty with respect to the Common Ground is still in tension with the inference from the presupposition. If an exhaustive interpretation was adopted, the effects of focus would be slightly larger (since the QUD would rule out both the possibility that no one left town and that more than one person left town). Crucially, however, the direction of the effect would be the same.

²¹It is worthwhile to note that the QUD “Who left town?” does not even need to be the current QUD, it merely needs to be assumed to be on the QUD stack (i.e., it is possible that some participants reconstruct “Who did John discover that they left town?” as the current QUD, but that this is a sub-topic of the broader QUD of “Who left town?”). As long as the question is present on the QUD stack, it has implications for the structure of the Common Ground.

	W_a	W_{ab}	W_b	W_n
Baseline (B)	0.25	0.25	0.25	0.25
Presupposition (P): Anna left town	0.5	0.5	0	0
QUD (Q): Who left town?	0.33	0.33	0.33	0

Table 4: Various inferences and their formal representation as probability distributions over possible worlds.

	P(A)	W_a	W_{ab}	W_b	W_n
Non-Factive, Predicate Stress (B)	0.5	0.25 (1/4)	0.25 (1/4)	0.25 (1/4)	0.25 (1/4)
Non-Factive, Subject Stress (B+Q)	0.58	0.29 (7/24)	0.29 (7/24)	0.29 (7/24)	0.13 (3/24)
Factive, Predicate Stress (B+P)	0.76	0.38 (3/8)	0.38 (3/8)	0.13 (1/8)	0.13 (1/8)
Factive, Subject Stress (B+P+Q)	0.72	0.36 (13/36)	0.36 (13/36)	0.19 (7/36)	0.08 (3/36)

Table 5: Probability over worlds for each condition via averaging of inferences; probability estimated to two decimal points (exact fraction in parentheses); Probability of Anna leaving town is the sum of W_a and W_{ab} .

The fact that neither the presupposition nor the QUD are actually asserted in any of the embedded utterances means that the reconstructed model of the Common Ground is only being indirectly inferred by the eavesdropper (or participant in the conversation). Thus, the baseline model (B from Table 4) in which all worlds are possible is always a live possibility. The eavesdropper must then combine this default baseline with any other inferences derived from the utterance to reconstruct a plausible model of the Common Ground. For mathematical ease, we assume that the assigned probability in the reconstructed model is the average of the probabilities contributed to that world by each of the inferences at play.

We assume that the certainty scores given in Experiment 1 are a reflection of the probability given in the first column of Table 5 (for P(A) the probability that Anna left town with or without Bob).²² Namely, for non-Factive verbs, the existence of the QUD inference in the Subject Stress condition causes a small rise in the estimated certainty that Anna left town with respect to the Predicate Stress condition, since the probability that no one left town (W_n) has decreased relative to the baseline. For factive verbs, Subject Stress decreases the probability (and thus the certainty rating) that Anna left town relative to the presupposition, since it increases the probability that only Bob left town. Notice also that this explains why the factive conditions show slightly lower certainty than the unembedded condition. That is, the baseline is still on the table in the factive condition, since the proposition “Anna left town” is only inferred about the Common Ground, and not explicitly asserted, as in the unembedded case (where presumably the P(A) that Anna left town is 1 after the assertion).²³

5 Experiment 2 (QUD Experiment)

5.1 Design

Both our new account and the pragmatic account rely on the assumption that changes in stress evoke different QUDs and associated focus alternative sets (FAS). Our second experiment is designed to explicitly test the availability of various QUDs with different stress placements. In particular, we contrast stress on the matrix predicate (41-a) with stress on the embedded subject (41-b). The objective is to determine whether a QUD like ‘Who left town: was it Anna or someone else?’ is a more viable QUD with Subject Stress than Predicate Stress, as our model assumes (see Table 3). To accomplish this objective, we crossed the prosodic variation in response sentences (Predicate Stress vs. Subject Stress) with three different types of contexts (background + explicit question) designed to elicit different QUDs, as shown in (42). This experiment assumes that in the context of explicit questions, the explicit questions (and relevant previous context) determine the QUD.

- (41) Prosodic variation
- a. John might’ve [discovered]_F that Anna left town. Predicate Stress
 - b. John might’ve discovered that [Anna]_F left town. Subject Stress
- (42) Background: Remember when we were looking at John’s cousin’s diary...
- a. Control 1: Predicate stress (41-a) ceiling condition
There was something about Anna leaving town.

²²The true linking hypothesis between this model and actual experimental results are likely to be more complex. In particular, it is unlikely that each type of inference is actually given equal weight in determining overall meaning. Nevertheless, the *pattern* of probability distributions mirrors the pattern of certainty ratings seen in the experiment.

²³An anonymous reviewer asks about the intriguing finding that the *adjectival* non-factives show higher levels of projection than the *verbal* non-factives. Here, we do not attempt to capture this particular observation in terms of the current proposal, as we believe this effect to be orthogonal to the one discussed here. We thus leave this problem for future research.

- How did John find out about it?*²⁴
- b. Control 2: Subject stress (41-b) ceiling condition
There was something about John discovering that someone left town.
Was it Anna or Aaron who left town?
- c. Critical condition: by hypothesis (41-a) < (41-b)
There was something about someone leaving town.
Was it Anna or Aaron who left town?

The two control contexts were designed so that the intuitive QUD for each stress condition was targeted. The bolded lines were used as a natural way to generate the otherwise island-violating Subject Stress control QUD (‘Was it Anna or Aaron who John discovered went sailing?’) The Predicate Stress control (42-a) backgrounded the embedded proposition and left open what the relationship was between the attitude holder and the embedded proposition. The Subject Stress control (42-b) backgrounded the attitude holder’s attitude to the embedded proposition and foregrounded the focus alternatives from the embedded proposition. Finally, the Critical condition (42-c) targeted whether a complex sentence with Subject Stress (e.g. (41-b)) is ever viable in a context where the current QUD is only about the embedded proposition to the exclusion of the matrix subject (e.g. ‘Who left town: was it Anna or Aaron?’).

Figure 7 shows a screenshot of what a trial looks like. For each trial, the participants were presented with the initial line of the context. They then pressed a key twice to reveal the remaining two lines. Crucially, all of the contexts ended in a question, whose acceptability with respect to the different stress conditions was being tested. After all three lines of the context had been revealed, the participants pressed a key to reveal two sound files, representing the two stress conditions in (41) (using the same audio from Expt. 1), which they were told contained two possible answers to the question. Each sound file played automatically, and participants could not rate the sound files until they had listened to it. The participants had the option of replaying the sound files as many times as they wished. After listening to the sound files, they were asked to rate the acceptability of the two responses in the sound files as answers to the above question on a 7 point Likert scale ranging from “Not Acceptable” to “Completely Acceptable”. We included the two sound files representing the two stress conditions with each question context to explicitly encourage participants to contrast the two stress conditions for each question context, while still being able to get a sense of whether either response was considered acceptable in a particular context. Response times were not collected.

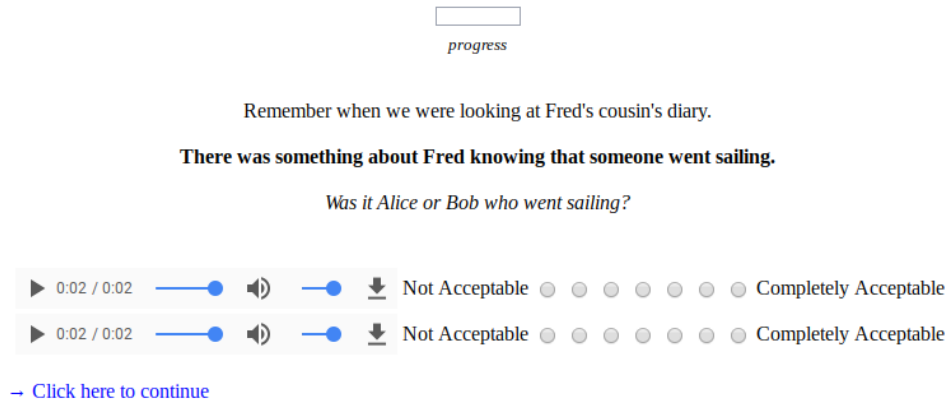


Figure 7: Screenshot of an experimental trial

5.2 Participants

76 undergraduate students, recruited through the University of Pennsylvania’s Psychology department’s subject pool, participated in the study for course credit. The participants were given a link to the experiment to take the experiment on their own over the internet. The experiment was implemented in Ibex.²⁵ It took approximately 10 minutes to complete. Some participants took the experiment twice. In these cases, only the first set of results were included in the analysis. The data from all participants were included in the analysis.

²⁴The question in this condition varied by predicate type in order to make sure that the question was maximally compatible with the predicate; see Section 5.3.

²⁵See <http://spellout.net/ibexexps/SchwarzLabArchive/THFactQUD/experiment.html?id=Archive> for an archived version of the experiment.

5.3 Materials

A subset of the auditory stimuli from the first experiment were used in this experiment (see the Appendix for a list of the exact stimuli). Each subject saw 12 items (4 of each context type) for which the rating on both stress patterns was gathered (giving a total of 24 ratings per subject). The order of the two stress patterns was randomized for each trial. The experiment included a mix of non-factive, cognitive factive and emotive factive matrix predicates (each subject heard 6 factive and 6 non-factive items).²⁶ Each of the 12 items was shown in each context type between subjects.

The questions in the control contexts were manipulated to be maximally appropriate for the different predicates. In the Subject Stress control, the context varied depending on the predicate used in the actual sentences. For the Predicate Stress control, the question in the context varied between: ‘How did John feel about it?’, ‘Did John know that Anna left town?’, and ‘How did John find out about it?’ depending on the nature of the embedding predicate.

5.4 Predictions

We included the Control contexts to provide baselines for availability of a question, since the contexts were designed to provide the most straightforward representation of the QUD that each stress condition would elicit (i.e., the QUD including both matrix and embedded material with the expected effect of focus). The predicate stress control context (Control 1; (42-a)) was predicted to receive high ratings with Predicate Stress and low ratings with Subject Stress. The subject stress control context (Control 2; (42-b)) was predicted to receive high ratings with Subject Stress and low ratings with Predicate Stress. In order for our explanation of prosodic effects on factive presupposition projection to be viable, the QUD represented by the Critical condition (42-c) (namely a QUD only representing a question on the embedded proposition) must be available in the Subject Stress condition and not available in the Predicate Stress condition. Therefore, our account predicts that the Critical condition context would receive low ratings in the Predicate Stress condition and high ratings in the Subject Stress condition.

However, the QUD from the audio file is ambiguous between a question about John’s relationship with the embedded proposition (a more complete QUD) and a question concerning merely the proposition itself (a partial QUD). Hence, we expect that the participants would give slightly lower ratings in the Critical condition than in the subject stress control condition where the QUD incorporates both matrix and embedded proposition material, thus clearly licensing the matrix clause in the answer. If the QUD is only ‘Was it Anna or Aaron who left town?’, the embedding proposition about John needs independent licensing and is thus predicted to not always be licit. In the context of Experiment 1, however, we predict that those independent licensing conditions are readily available and thus the difference between the Critical context and subject stress context should be small.

5.5 Statistical Methods

We designed the experiment to encourage participants to contrast the two stress conditions. Our hypothesis relies on there being a difference in the availability of particular questions in the two stress conditions. Since every trial included two ratings (one for the Predicate Stress audio and one for the Subject Stress audio), the result from each trial was reduced to the rating in the Predicate stress condition minus the rating in the Subject stress condition for statistical analysis. This difference in their score represents the size and direction of the difference between the two conditions.

A Bayesian linear mixed effects model was fit to predict this difference score using the *rStanarm* packages (Stan Development Team, 2016). We used a linear model (instead of an ordinal model), since the difference score between two ordinal scales is predicted to be normally distributed. The model included factivity (1 for Factive; 0 for Non-factive), factive type (1 for Emotive Factive; 0 for other predicate types), context type, and the interaction between context type and both factivity and factive type as fixed effects. Intercept and context random effects were included for both participant and item. Context was coded with two variables: (1) the effect of having a question of the form ‘Was it X or Y who ...’, which was shared between the Critical and subject stress control context (0 for predicate stress control; 1 for subject stress control and Critical) and (2) the effect of the difference between the Critical condition and the subject stress control (i.e., the effect of the difference in framing for the context question), which was 0 for the two Control conditions and 1 for the Critical condition.

²⁶The predicates included were: *been concerned*, *been disappointed*, *been hopeful*, *been informed*, *been upset*, *been worried*, *believed*, *discovered*, *hoped*, *loved*, *noticed*, and *said*.

5.6 Results and Discussion

Figure 8 shows the mean results from the experiment for all the factive and non-factive verbs. We see that as predicted in the predicate stress control, the Predicate Stress audio file was judged acceptable (around 6), while the Subject Stress audio file was judged unacceptable. In the subject stress control condition, the ratings flipped with the Subject Stress audio file being judged acceptable and the Predicate Stress audio file being judged unacceptable. Crucially for our theory, the Critical condition is judged similarly to the subject stress control and not to the predicate stress control, validating our assumption (in Section 4) that a QUD on only the embedded clause is licensed by a complex sentence with stress on the embedded subject. As predicted, in the Critical condition, the acceptability rating for the Subject Stress audio file is slightly lower than for the Control condition, which indicates that participants were sensitive to the context manipulation, yet were generally still willing to accept "John might have discovered/believed/... that ANNA left town" as an acceptable answer to "Was it Anna or Bill that left town?".

Table 6 shows the 90% posterior interval from the model of the difference between the ratings for Predicate and Subject Stress. Neither a main effect of factivity/factive type nor an interaction between factive type and the context manipulation was found (i.e., the model estimates that the effects are small and could go in either direction), which is consistent with the notion that the QUD derived by each stress condition was the same independent of the lexical identity of the embedding predicate. This lack of an effect can be seen in Figure 8(b) by the fact that the Factive and Non-Factive panels show the same effect in every condition.

The Pred. Stress Control (Intercept) shows that there was a substantial effect of stress condition in the predicate stress control (namely the Predicate Stress condition was rated ~ 3.3 points higher than the Subject Stress condition), which is reflected in the predicate stress Control bar of Figure 8. This effect of stress was reversed in both the subject stress Control and Critical condition, where both conditions with the question "Was it Anna or Aaron who left town" were rated on average ~ 2.7 points higher (3.3 - 6). This effect was slightly (~ 0.4 point) smaller in the Critical condition (as seen in the difference between the 'Subject Stress Control' and 'Critical Item' bars), which indicates that (at least some) participants were sensitive to the context manipulation outside of the final question.

	5% LB	Median	95% UB
Pred. Stress Control (Intercept)	2.96	3.3	3.62
Effect of Factivity	-0.33	0.1	0.54
Emotive vs. Cognitive	-0.97	-0.4	0.09
Effect of Question Type	-6.64	-6.0	-5.35
Effect of Critical Item	0.2	0.4	0.71
Factivity x Question Type	-1.06	-0.4	0.16
Factivity x Critical Item	-0.58	0.0	0.60
Factive Type x Question Type	-0.26	0.5	1.28
Factive Type x Critical Item	-0.53	0.2	1.00

Table 6: 90% posterior intervals for effect sizes on difference score

6 Discussion

Our experiment successfully replicated the results from Tonhauser (2016): stress in the embedded clause (Subject Stress) leads to decreased certainty ratings for the factive (speaker commitment) inferences introduced by the factive predicates under investigation. However, we crucially find that this effect is substantially smaller than the difference associated with the traditional lexical distinction between factive and non-factive predicates, with the former patterning overall very closely to directly asserted, unembedded, content.

The inclusion of baseline comparisons for projection and non-projection in our first study (Section 3) thus puts the overall results in a very different perspective. The relatively small size of the effect of prosodic focus on factives, in combination with the substantially higher certainty ratings found for the factives in both stress conditions (but importantly, in the Subject Stress condition), compared to non-factive predicates, argues against the 'pragmatic' accounts reviewed in Section 2.1.3, whereby prosodically mediated focus in the embedded clause, as a signal of the QUD, is able to either completely eliminate the factive inference or prevent it from projecting. Nevertheless, the existence of a robust (if small) effect of prosody on judgments of certainty about whether the speaker is committed to the embedded content still requires an explanation, even if a lexical approach to presupposition triggering and projection is adopted.

When looking at the impact of focus, we have also provided novel evidence that prosodic focus impacts speaker certainty inferences for *all* predicate types (both factives and non-factives). One surprising lexical contrast with regards to the prosodic effects was a gradient difference between verbal and adjectival non-factives.

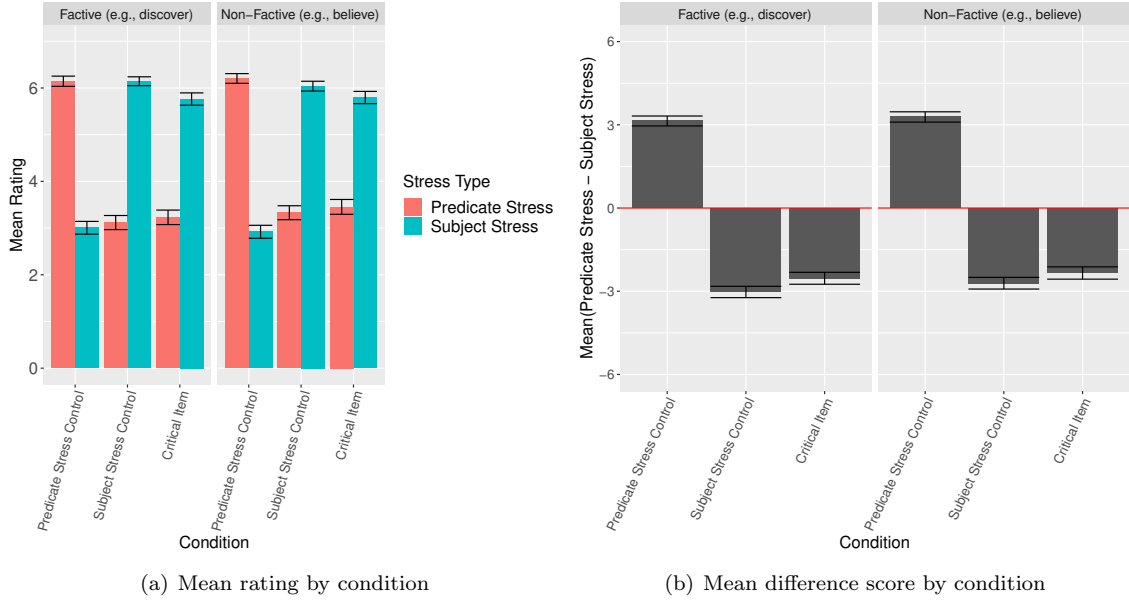


Figure 8: Rating graphs

Adjectival non-factives (to varying extents) showed more projection-like behaviour than verbal non-factives. We found that for factives, focus in the embedded clause **decreased** certainty in comparison to focus on the matrix predicate. For verbal non-factives, interestingly, the effect of focus was in the *opposite* direction: focus on the embedded subject **increased** certainty in comparison to focus on the matrix predicate. This *interaction* of prosodic focus and predicate type is predicted neither on the pragmatic nor on the lexical accounts discussed in Section 2. Importantly, however, while these focus effects were significant, they were all an order of magnitude smaller than the lexical differences between factive and non-factive predicates.

We take these findings to support a novel account of how focus interacts with factive presupposition triggering/projection, which we outlined in Section 4. On this account, the QUD-inferences generated by focus-placement in the embedded clause will either strengthen (for non-factives) or weaken (for factives) the inference that the speaker is committed to the embedded proposition, by giving the hearer cues as to the current state of the Common Ground. These independent inferences need to be combined with the inferences of the presupposed and asserted contents of the utterance. This explains the observed interaction between Stress Type and Predicate Type. In the case of focus on material in clauses embedded under *non-factive* predicates, the QUD inferences supplement the lack of a factive inference from non-factive predicates by giving rise to an existence inference: focus on the embedded subject generates a QUD that entails that for *some individual*, the embedded predicate holds in the Common Ground (e.g. *someone left town*). Here, the existence inference generated by focus is stronger than any inferences from the non-factive predicate (i.e., no inference). Thus, prosody can give rise to effects resembling a weak factive presupposition.²⁷ In the case of focus on material in clauses embedded under *factive* predicates, however, this type of QUD inference conflicts with the factive inference. Here, the existence inference generated by focus in the embedded clause is weaker than the truth inference generated by the factive predicate (that for a *specific* individual, the embedded predicate holds in the Common Ground; e.g. *Anna left town*). This conflicting QUD inference can then weaken the inference drawn from the lexically factive predicate. However, it does not eliminate the factive inference entirely, as per the pragmatic accounts of Abrusán (2011, 2016), Simons et al. (2010, 2017), and Tonhauser (2016), discussed in Section 2.1.3.

Of course, there is a sense in which the current proposal is similar to these pragmatic accounts, in that it predicts that prosodically mediated focus gives rise to QUD-inferences which may weaken the inference from the factive verb of speaker commitment to p. However, we differ crucially from these authors on two points. First, in terms of the type of effect that focus has; we show that focus in the embedded clause merely *makes available* a QUD that weakens the factive inference (Expt. 2). Secondly, in terms of the magnitude of the focus-based effect on the factive inference; we show that this is an order of magnitude smaller than the effect of the type of predicate (factive vs. non-factive) (Expt. 1), a fact that is predicted on the current account, but unexpected on previous accounts. Because our proposal separates QUD inferences from presuppositionality, focus does not uniquely determine a ‘non-factive’ QUD or eliminate a factive presupposition, but merely makes available a

²⁷ It’s worth noticing that previous lexical and pragmatic accounts, in their current form, are not able to capture this observation without invoking additional theoretical machinery. On the current account, this effect falls out as a welcome consequence of the theory itself.

‘non-factive’ inference, alongside other components of meaning, leading to the small effect of prosody.

Finally, this paper has emphasized the need to distinguish between different types of ‘presuppositional’ effects. Most strikingly, we have seen a clear contrast between cases like (3)–(5), where the presence of a first person conditional or an explicit ignorance context seems to entirely remove the inference of speaker commitment to *p*, and cases like (16)/(24), where we have shown that prosodic focus in the embedded clause lead only to a small *weakening* of this inference. As proponents of the pragmatic theory have pointed out, following Beaver (2010), the factors standardly taken to trigger local accommodation are not present for sentences like those in (16)/(24) (cf. Abrusán 2011, pg. 523). We agree with the claim that (16)/(24) should not be analyzed as involving local accommodation. However, our conclusions are based on different considerations, specifically the main empirical finding of our experimental investigation (Section 3), that the effect of focus is much weaker than has previously been assumed in the literature.

In our view, the examples in (3)–(5) are also qualitatively different from (16)/(24). The proposals reviewed here all take the observation —that focus affects presuppositions in a way that is better explained by a QUD-based pragmatic account than by a local accommodation-based lexical account— to motivate a move away from both a lexical account of presupposition triggering, and away from using local accommodation as a theoretical tool to explain instances of non-projection in embedded environments. We take this move not to be warranted. What our results show, is that focus in the embedded clause only slightly weakens the inference that *p* is true. In Section 4, we presented a proposal which accounts for the observed *weakening* of the inference that *p* is true in (factive) sentences with focus in the embedded clause, by appealing to an interaction between a lexically triggered factive inference and aspects of the discourse structure (namely the QUD). This model also accounted for the observed *strengthening* of the commitment to *p* inference in the corresponding non-factive sentences. We take this view to be fully compatible with a picture whereby examples like (3)–(5) involve local accommodation of a lexically triggered inference, thus entirely *removing* the inference that *p* is Common Ground.²⁸

7 Concluding remarks

Prosodically mediated pragmatics does impact the interpretation of presupposed content in the context of embedding operators. However, the observed effect is not strong enough to account for the existence or non-existence of presupposition triggering or projection. We propose that presupposition triggering and projection, as semantic processes, are unaffected by the prosodic contour of an utterance. Instead, we take the present results to favor a traditional lexical account of factive presupposition generation and projection, thus straightforwardly capturing the large differences between predicate types (factive vs. non-factive predicates). To account for the (small) effects of prosody, we have proposed an independent pragmatic process of inference resolution, where the ultimate interpretation of an utterance is derived probabilistically from the synthesis of multiple lexical and pragmatic inferences about the state of the Common Ground.

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²⁸In our discussion of Abrusán (2011, 2016) in Section 2.1.3.3, we also noted the importance of not conflating the inference that *p* is true (which may be suspended only in certain *embedded* contexts) and the inference that *p* is (*not-*)*at issue* in the discourse (which may vary also in *unembedded* contexts, depending on aspects of the QUD; à la Simons 2007). On the Common Ground model of factivity (following Stalnaker 1974, *et seq*), these two dimensions are typically seen as two sides of the same coin. For an analysis of factivity that explicitly distinguishes between these two dimensions of meaning (and their respective sources), see Djärv (2019).

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A Experimental Items

Experimental Item	Predicates (Experiment 2 in bold)
John might've believed that Anna left town.	believed , discovered , regretted
John might've believed that Lisa visited the city.	believed , discovered , regretted
John might've believed that Nancy attended the graduation.	believed, discovered, regretted
John might've believed that Maggie won the game.	believed, discovered, regretted
John might've believed that Karen moved to the West Coast.	believed, discovered, regretted
John might've believed that Amy quit her job.	believed, discovered, regretted
Jen might've believed that Laura left the organization.	believed, discovered, regretted
Jen might've believed that Maria got divorced.	believed, discovered, regretted
Jen might've hoped that Kathy got married.	hoped , realized, loved
Jen might've hoped that Kate invited her mother to the party.	hoped, realized, loved
Jen might've hoped that Joanna baked a cake.	hoped , realized, loved
Jen might've hoped that Hannah travelled to Asia.	hoped, realized, loved
Bob might've hoped that Sharon ran the Philadelphia Marathon.	hoped, realized, loved
Bob might've hoped that Maya knitted him a sweater.	hoped, realized, loved
Bob might've hoped that Sally fixed her bike.	hoped, realized, loved
Bob might've hoped that Eve visited her parents.	hoped, realized, loved
Bob might've said that Becky started a new job.	said , noticed , resented
Bob might've said that Sue bought a new car.	said , noticed , resented
Mandy might've said that Ruth moved to Paris.	said, noticed, resented
Mandy might've said that Jackie dropped out of college.	said, noticed, resented
Mandy might've said that Lesley left her job.	said, noticed, resented
Mandy might've said that Nancy failed the test.	said, noticed, resented
Mandy might've said that Rita left the party early.	said, noticed, resented
Mandy might've said that Beth missed the appointment.	said, noticed, resented
Steve might've been concerned that Ryan left his wife.	be concerned , aware, upset
Steve might've been concerned that Andrew sold his old car.	be concerned , aware, upset
Steve might've been concerned that Richard bought an expensive sound system.	be concerned, aware, upset
Steve might've been concerned that James left school.	be concerned, aware, upset
Steve might've been concerned that Martin moved to Canada.	be concerned, aware, upset
Steve might've been concerned that Larry ate too much.	be concerned, aware, upset
Mary might've been concerned that Mike messed up the interview.	be concerned, aware, upset
Mary might've been concerned that Robin left the team.	be concerned, aware, upset
Mary might've been worried that Chris lied about his age.	be worried , conscious, disappointed
Mary might've been worried that James made the wrong choice.	be worried , conscious, disappointed
Mary might've been worried that Rob missed the meeting.	be worried, conscious, disappointed
Mary might've been worried that Dave moved back to Chicago.	be worried, conscious, disappointed
Jake might've been worried that Matt drank a lot at the dinner.	be worried, conscious, disappointed
Jake might've been worried that Ted skipped the meeting.	be worried, conscious, disappointed
Jake might've been worried that Tom didn't visit his parents.	be worried, conscious, disappointed
Jake might've been worried that Ben bought an ugly car.	be worried, conscious, disappointed
Jake might've been hopeful that Joel quit smoking.	be hopeful , informed , happy
Jake might've been hopeful that Nick fell in love.	be hopeful , informed , happy
Meg might've been hopeful that Will bought a house.	be hopeful, informed, happy
Meg might've been hopeful that Ed went to yoga class.	be hopeful, informed, happy
Meg might've been hopeful that Andy travelled to South America.	be hopeful, informed, happy
Meg might've been hopeful that Dan prepared dinner.	be hopeful, informed, happy
Meg might've been hopeful that Jim bought new clothes.	be hopeful, informed, happy
Meg might've been hopeful that Colin started a new job.	be hopeful, informed, happy