

Prosodic cues to presupposition projection*

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Abstract

In English utterances with factive predicates, the content of the clausal complement of the predicate may project, i.e., taken to be a commitment of the speaker, even when the factive predicate is embedded under an entailment canceling operator (e.g., Kiparsky & Kiparsky 1971; Karttunen 1971). Based on impressionistic judgments, Beaver (2010) and Simons, Beaver, Roberts & Tonhauser (to appear) suggested that whether the content of the complement of an utterance with a factive predicate projects depends on the information structure of the utterance and, since information structure is prosodically marked, on the prosodic realization of the utterance. This paper describes the results of three perception experiments designed to explore the influence of the prosodic realization of an utterance with a factive predicate on the projection of the content of the complement. The results of the experiments suggest that the prosodic realization of such utterances provides a cue to the projectivity of the content of the complement. These findings provide empirical support for the question-based analysis of projection advanced in Simons et al. to appear.

Keywords: Presuppositions, factive predicates, prosody, Questions Under Discussion

1 Introduction

Projective content is utterance content that may be taken to be a commitment of the speaker (or the author, in written language) even when the content is introduced by an expression in the scope of an entailment canceling operator. The author of the blog post headline in (1), for instance, may be taken to be committed to the content of the complement (here, that the author is married with a kid) even though the complement clause that introduces this content is embedded under sentential negation, an entailment canceling operator:

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- (1) My family doesn't know that I am married with a kid.¹

A content that may be taken to be a commitment of the speaker even though it was contributed by an expression in the scope of an entailment canceling operator, like negation, an epistemic possibility modal, a question or the antecedent of a conditional, is called 'projective content'. Classical analyses of examples like (1), such as Heim 1983 and van der Sandt 1992, attribute the projective behavior of the content of the complement to the predicate itself. On such analyses, the content of the complement is specified by the predicate, e.g., *know* in (1), to be a presupposition, which means that the content of the complement must be entailed by or satisfied in (depending on the details of the analysis) the common ground of the interlocutors prior to the utterance being interpreted. As a consequence, the content is taken to be a commitment of the speaker. The fact that the content of the complement is not interpreted in the scope of the entailment canceling operator, e.g., negation in (1), gives the impression of the content projecting over negation. Predicates like *know* that presuppose the content of the complement are called 'factive predicates'.

It is well-known that the content of the complement of factive predicates is not always taken to be a commitment of the speaker (see, e.g., Karttunen 1971), i.e., does not always project over entailment canceling operators. In the naturally occurring example in (2), for instance, the author is not taken to be committed to the content of the complement of the factive predicate *discover*, that the method is wombat-proof:

- (2) They [the mattress springs] also work well to deter rabbits & foxes from digging into the chook-pen (Hen-run). Dig a shallow trench the width of a single mattress, then place the springs flat in the trench. [...] I haven't tried this with wombats, though, & if anyone discovers that the method is also wombat-proof, I'd really like to know! (adapted from Beaver 2010: 79)

To account for such examples, classical analyses resort to 'local accommodation': the basic idea is that the presupposed content of the complement can be accommodated in the local context of the embedding operator (the conditional in (2)), if adding the content of the complement to the common ground would lead to a contradiction, un informativity or problems with binding (Heim 1983; van der Sandt 1992). In (2), for instance, the linguistic context leading up to the relevant utterance, in particular the utterance *I haven't tried this [method] with wombats*, strongly suggests that the author is not committed to the method being wombat-proof. Local accommodation of the content of the complement in the antecedent of the conditional is licensed in this example to avoid attributing a contradicting belief to the author.

Beaver 2010, a paper that has been circulated since 2002, advanced the idea that the prosodic realization of an utterance with a factive predicate influences the

¹ <http://community.babycenter.com/post/a42276010>

projectivity of the content of the complement. Beaver (2010: 95) proposed that “the crucial factor determining projection behavior is . . . the choice between an accented or deaccented propositional complement”. To illustrate, consider the title of Beaver’s paper in (3), a naturally occurring question with the factive predicate *noticed*:

- (3) Have you ever noticed that your belly button lint colour is related to the colour of your clothing?

Beaver (2010: 97) suggested that “[i]f you read the title aloud, and stress “noticed” then” the content of the complement, that your belly button lint is related to the color of your clothing, projects. But “if you do not accent “notice,” and place the main accent within the complement” (*ibid.*), then the content of the complement does not necessarily project.

The examples in (4) serve to further illustrate the relation between the information structure of an utterance and the projection of the content of the complement. In these examples, angle brackets ([]_F) identify focused expressions (see, e.g., Rooth 1992). Beaver (2010: 93) claimed that (4a), in which the last word of the clausal complement of *discover* is narrowly focused, “does not imply that the student is guilty”, i.e., the content of the complement is not a commitment of the speaker. (4b), on the other hand, where the factive predicate *discover* is focused and the complement clause is de-accented, “conjures up an image of complicity between the all-knowing professor and the guilty student”, i.e., here the speaker is committed to the student’s work being plagiarized.

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

In sum, Beaver (2010) claimed that the content of the complement of an utterance with a factive predicate projects if it is de-accented but does not project if an expression in the clausal complement is narrowly focused. Beaver (2010) limited this claim to short complement clauses: “. . . when the factive complement is long, it is likely to contain some pitch accents. For the moment I make no claims about whether presupposition has any intonational correlates in the case of long factive complements” (p.95).

The claim that the prosodic realization of utterances with factive predicates influences the projection of the content of the complement was recently picked up again in Simons et al. to appear. In particular, Simons and her colleagues pointed out that when an expression in the clausal complement is narrowly focused, a content

other than the content of the complement may project. To illustrate, consider the first sentence of B's utterance in the naturally occurring example in (5), which can be produced with a prosodic prominence on *stormwater*: from an utterance of this sentence, B is not taken to be committed to liking stormwater (the content of the complement clause), but only committed to liking *something*. As clarified in the next sentence, that something is fly-fishing for trout.

- (5) A: When did you discover you liked stormwater?
 B: I didn't discover that I liked stormwater, I discovered that I loved fly-fishing for trout.²

In (6), a constructed example from [Simons et al. to appear](#), the first sentence of B's utterance contains the factive predicate *find out* and the sentence is realized with prosodic prominence on *Harry*, as indicated by capital letters. An utterance of this sentence does not commit B to *Harry* having a graduation party, but only to somebody having a graduation party. That somebody, as clarified in the next sentence, is Harriet. Finally, in the naturally occurring example (7), the author is taken to be committed to the metabolite of Ketamine having *some* side effects, not to having no side effects (*NO* was capitalized in the original).

- (6) adapted from [Simons et al. to appear](#): 5
 A: James just found out that Harry's having a graduation party, and I just can't understand why he's so upset about it.
 B: He didn't find out that HARRY's having a graduation party, he found out that HARRIET is having a graduation party.
 (7) [The scientists] didn't discover that [the metabolite of Ketamine] has NO side effects. They discovered that it has no dissociative or hallucinatory side effects.³

Classical projection analyses would need to appeal to local accommodation to account for the fact that the speakers/authors of the examples in (5) to (7) are not taken to be committed to the contents of the complements of the relevant sentences. Such analyses currently have nothing to say about why narrow focus on an expression in the clausal complement would result in the content of the complement not projecting, especially in examples like (3) and (4a), where contextual information that might justify an appeal to local accommodation is not available. Crucially, since only the content of the complement is lexically specified to be a presupposition, such analyses, as currently formulated, have nothing to say about the projection of the

² <http://science.unctv.org/content/whats-my-story-water-quality-engineer>

³ <http://sciencenewsjournal.com/antidepressant-compound-located-may-come-zero-side-effects/>

contents that are observed to project in these examples, namely that the speaker likes something, in (5), that somebody is having a graduation party, in (6), and that the metabolite of Ketamine has some side effects, in (7).⁴

If prosody indeed influences projection, as claimed in Beaver 2010 and Simons et al. to appear based on impressionistic judgments, then this influence constitutes a litmus test for theories of projection: theories that predict this influence are more empirically adequate than theories that do not. In this paper, I describe three perception experiments designed to explore whether listeners attend to the prosodic realization of utterances with factive predicates in interpreting whether the content of the complement projects. Experiments 1 and 2 were designed to explore the hypothesis that the content of the complement of an utterance with a factive predicate embedded under an entailment canceling operator is less likely to project if an expression in the complement clause is narrowly focused than if the complement clause is de-accented, as suggested by Beaver (2010) and Simons et al. (to appear) for examples like those in (3) and (4). Experiment 3 was designed to explore the hypothesis that the degree of prosodic prominence of the last content word of the complement clause has an influence on the projectivity of the content of the complement. The results from these three experiments suggest that listeners are able to identify cues to the projection of the content of the complement from the prosodic realization of utterances with factive predicates.

The paper proceeds as follows. In section 2, I discuss Cummins & Rohde's (2015) experimental investigation of the influence of prosody on the projection of a range of presuppositions. Experiments 1 and 2 are described in section 3 and Experiment 3 in section 4. In section 5, I briefly argue that the experimental findings provide empirical motivation for a question-based analysis of projection like the one proposed in Simons et al. to appear. Section 6 concludes the paper.

2 Cummins & Rohde 2015

Cummins & Rohde's (2015) perception experiment 2 was designed to explore the hypothesis that the prosodic realization of utterances with presuppositions triggers influences whether the presupposition projects. The stimuli in their experiment were based on 20 negated sentences that each featured a different presupposition trigger: in addition to the factive predicates *regret*, *know*, *aware*, *happy*, *relieved* and *sorry*, the presupposition triggers included the change of state predicates *stop*, *finish*, *return*, *return to*, *leave*, *arrive*, *restore* and *go back*, the implicative predicates *avoid*, *forget* and *manage* and the iterative expressions *repeat*, *rewrite* and *again*. Utterances of the 20 stimuli sentences were recorded in two prosodic conditions,

⁴ Other analyses of the projection with factive predicates (e.g., Schlenker 2008; Abrusán 2011) cannot be discussed here for reasons of space.

a “neutral” condition and a “focus” condition (p.6f.). In the focus condition, the prosodic realization of stimuli was described as “plac[ing] a pitch accent on the last word of the sentence” (p.7). The prosodic realization of the stimuli in the neutral condition was not described.

Each participant listened to utterances of the 20 sentences, half in the focus condition and half in the neutral condition. For each of the 20 utterances, they answered a question about the status of the relevant content. For instance, for utterances of the sentence in (8), participants were asked to respond to the question ‘How likely is it that Bill argued with his boss?’. Responses were given on a 7-point Likert scale, with ‘1’ labeled as ‘unlikely’ and ‘7’ labeled as ‘likely’.

(8) Bill doesn’t regret arguing with his boss. (Cummins & Rohde 2015: 7)

Cummins and Rohde found that participants gave significantly lower ratings to utterances in the focus condition (mean = 5.97) than to utterances in the neutral condition (mean = 6.15).

Discussion Cummins & Rohde (2015) established that the prosodic realization of the 20 sentences with a wide range of presupposition triggers influences the projection of the presuppositions investigated. These findings constitute an important step towards establishing what theories of projection need to be able to account for. Unfortunately, the conclusions we can draw from their study about the influence of prosody on projection are limited (as acknowledged by the authors on p.8) since the prosodic realizations of the stimuli were insufficiently described. Furthermore, it appears that stimuli in a given conditions may even had different prosodic realizations: “our materials were not constructed in such a way as to control their prosodic properties: the sentences were merely read by a native speaker who was trying to convey an intended meaning” (p.8). Since no information was provided about the meaning the native speaker was trying to convey for the stimuli in the two conditions, it is difficult to establish a systematic influence of prosody on presupposition projection.

3 Experiments 1 and 2

Experiments 1 and 2 were designed to explore the hypothesis that the content of the complement of an utterance with a factive predicate embedded under an entailment canceling operator is less likely to project if an expression in the complement clause is narrowly focused than if the complement clause is de-accented. Gradient certainty ratings were collected using Amazon’s Mechanical Turk service.⁵

⁵ The materials, data and the R code for generating the figures and analyses of the three experiments reported on in this paper are available at <https://github.com/judith-tonhauser/SALT26-paper>.

3.1 Methods

3.1.1 Participants

Participants for Experiments 1 and 2 were recruited on Amazon’s Mechanical Turk platform and paid 70 cents for their participation. Participants had US IP addresses and at least 99% of Human Intelligence Tasks (HITs) approved. The responses from participants who were not self-reported native speakers of American English were excluded, as were the responses from participants who gave an incorrect response to one or both control stimuli. In Experiment 1, 50 participants were recruited and responses from 3 participants were excluded. The remaining 47 participants (18 female, 29 male) ranged in age from 22-67 years old (median: 31 years). In Experiment 2, 55 participants were recruited and responses from 6 participants were excluded. The remaining 49 participants (17 female, 32 male) ranged in age from 21-57 years old (median: 34 years). One of these 49 participants had previously participated in Experiment 1.

3.1.2 Materials

The materials used in Experiments 1 and 2 were recordings of the 15 target sentences and the 2 control sentences in Table 1. The target sentences (D1 to N3) consisted of an embedding operator (the modal adverb *perhaps*), a clause-embedding factive predicate and a short complement clause consisting of a pronoun and a verb phrase. The following five factive predicates occurred in the target stimuli: *discovered*, *realized*, *knew*, *was aware* and *noticed*. The control stimuli (based on sentences C1 and C2) were included to assess whether participants were paying attention.

Utterances of the 17 sentences in Table 1 were recorded with a female talker in a sound-attenuated room. The recordings were made with the built-in microphone of a MacBook Air laptop computer using the Praat software (Boersma & Weenink 2016) with a sampling rate of 44,100Hz. The talker was instructed to produce the target stimuli sentences in three prosodic conditions. In the first condition, henceforth referred to as the H*-on-predicate condition, the sentences were produced with a high tone pitch accent on the predicate (and no other pitch accents), a low intermediate phrase accent and a low intonational phrase boundary (H* L-L% in the Tones and Break Indices (ToBI) annotation system, Beckman & Ayers Elam 1997), as illustrated in the top panel of Figure 1.

In the second condition, the L+H*-on-content condition, the last content word of the complement clause⁶ was produced with a complex pitch accent consisting of a low tone that preceded a high tone that was aligned with the stressed syllable of

⁶ That content word was *cheating* in R3 and *missing* in N1.

D1	Perhaps he discovered that she's a widow.
D2	Perhaps she discovered that he's a father.
D3	Perhaps she discovered that he's Canadian.
R1	Perhaps he realized that she's wealthy.
R2	Perhaps she realized that he had a virus.
R3	Perhaps he realized that she was cheating on him.
K1	Perhaps she knew that he was a criminal.
K2	Perhaps he knew that she was married.
K3	Perhaps she knew that he was wrong.
A1	Perhaps she was aware that he's a vegetarian.
A2	Perhaps she was aware that he was unreliable.
A3	Perhaps she was aware that he had bad reviews.
N1	Perhaps he noticed that she was missing something.
N2	Perhaps she noticed that he had bad breath.
N3	Perhaps he noticed that she was hungry.
<hr/>	
C1	I am tired.
C2	I was invited to the party.

Table 1 Sentences for target and control stimuli in the three experiments

that word.⁷ The sentence was realized without any other pitch accents and, again, a low intermediate phrase accent and a low intonational phrase boundary (L+H* L-L% in ToBI notation), as illustrated in the middle panel of Figure 1. In the third condition, the L+H*-on-pronoun condition, the pronoun of the complement clause was produced with a complex pitch accent consisting of a low tone that preceded a high tone that was aligned with the stressed syllable of that word. The sentence was realized without any other pitch accents and, again, a low intermediate phrase accent and a low intonational phrase boundary (L+H* L-L%), as illustrated in the bottom panel of Figure 1. The two control sentences were recorded with a H* on the last content word and a L-L% intermediate phrase accent/intonational phrase boundary.

In English, stressed syllables that are realized with high tone pitch accents typically have longer durations than syllables that are de-accented (e.g., Eady & Cooper 1986). The stimuli used in Experiments 1 and 2 were submitted to a duration analysis. Duration values were obtained for the predicate, the pronoun of the clausal complement and the last word of the clausal complement. Table 2 shows the mean duration values of the relevant words across the three conditions. Pitch accented

⁷ In this condition, the clausal complement of stimulus A2 was erroneously produced in the present tense (... *he's unreliable*).

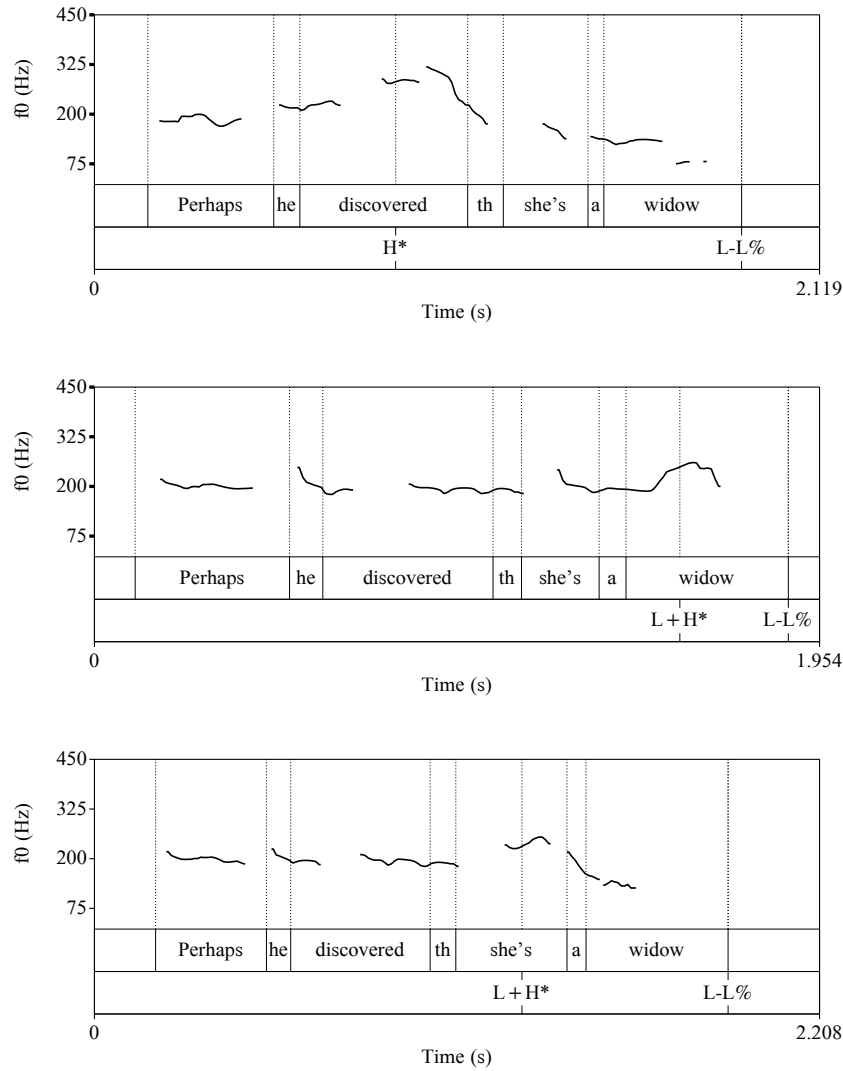


Figure 1 Target stimulus sentence *Perhaps he discovered that she's a widow* in the H*-on-predicate condition (top panel), the L+H*-on-content condition (middle panel) and the L+H*-on-pronoun condition (bottom panel)

words were clearly longer than de-accented words.

In Experiment 1, the interpretation of target stimuli in the H*-on-predicate condition was compared to the interpretation of the target stimuli in the L+H*-on-content condition. Two lists each containing 15 target stimuli were created

Condition	duration (ms)		
	predicate	pronoun	last content word
H*-on-predicate	364	170	536
L+H*-on-content	322	158	557
L+H*-on-pronoun	301	272	527

Table 2 Experiments 1 and 2: Mean duration values

such that each of the 15 target stimuli sentences occurred on both lists, either in the H*-on-predicate condition or in the L+H*-on-content condition (each list had 7 or 8 utterances in each of the two prosodic conditions). In Experiment 2, the interpretation of target stimuli in the H*-on-predicate condition was compared to the interpretation of the target stimuli in the L+H*-on-pronoun condition. As in Experiment 1, two lists of 15 target stimuli were created such that each of the 15 target stimuli sentences occurred on both lists, either in the H*-on-predicate condition or in the L+H*-on-pronoun condition (each list had either 7 or 8 utterances in one of the two prosodic conditions). The two control stimuli were added to the four lists of the two experiments, for a total of 17 stimuli per list.

3.1.3 Procedure

In both experiments, each participant was randomly assigned to one of the two lists and presented with the 17 stimuli in random order. Participants were told to imagine that they are at a party and, upon entering the kitchen, they hear somebody say something about some other people. Participants were instructed to listen to each stimulus (as often as they wanted) and to answer the question presented with the stimulus. They gave their response on a 7-point Likert scale labeled at four points: No, not certain/1, Possibly not certain/3, Possibly certain/5, Yes, certain/7, as shown in Figure 2. A response lower than 6 to the control stimuli counted as incorrect.

At the end of the experiments, participants filled out a brief questionnaire about their age, their gender, their native language(s) and, if English is a native language, whether it is American English, as opposed to e.g., Indian or Australian English. Participants were told that they would be paid no matter how they responded to these questions, to encourage them to answer truthfully.

3.2 Data analysis

The statistical analyses reported in this paper used ordinal mixed-effects regression models predicting response from the fixed effect of prosody and the following

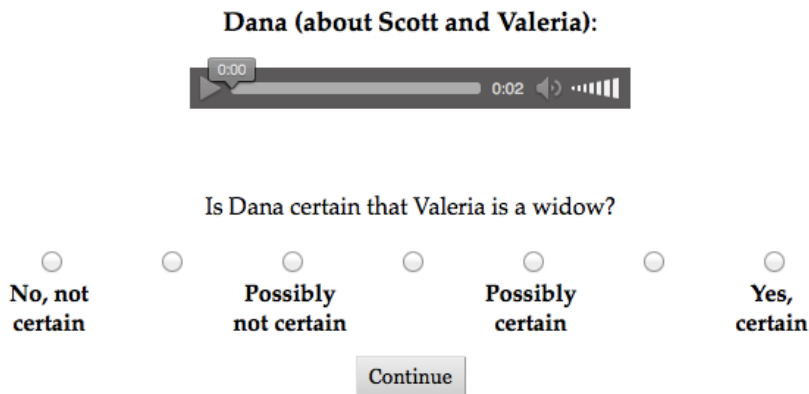


Figure 2 Screenshot of the response task in Experiments 1 and 2

random effects structure: random by-participant intercepts, random-by-participant slopes for the fixed effect and random by-item intercepts. Results were obtained using the `ordinal` package (Christensen 2013) in R.

3.3 Results and discussion

The mean responses (with 95% confidence intervals) to the target stimuli in the two conditions of Experiments 1 and 2 are shown in the left and right panels of Figure 3, respectively. The participants' response means are shown as grey dots. As expected, in Experiment 1, stimuli in the L+H*-on-content condition received significantly lower responses than stimuli in the H*-on-predicate condition ($\beta = -0.49$, $SE = 0.24$, $z = -2$, $p < .05$). Likewise, in Experiment 2, stimuli in the L+H*-on-pronoun condition received significantly lower responses than stimuli in the H*-on-predicate condition ($\beta = -0.68$, $SE = 0.27$, $z = -2.5$, $p < .05$).

These results show that the projectivity of the content of the complement is influenced by the prosodic realization of the utterance with the factive predicate. Specifically, listeners in Experiments 1 and 2 attended to the locations of pitch accents in identifying whether the speaker was committed to the content of the complement: when the utterance was produced with a pitch accent on an expression in the complement clause, the speaker was less likely to be taken to be committed to the content of the complement than when the utterance was produced with a de-accented complement clause and a pitch accent on the factive predicate. These results confirm the claims made in Beaver's 2010 and Simons et al. to appear.

As discussed in section 1, the content of the complement of a factive predicate is classically analyzed as a presupposition. Examples in which the content of the

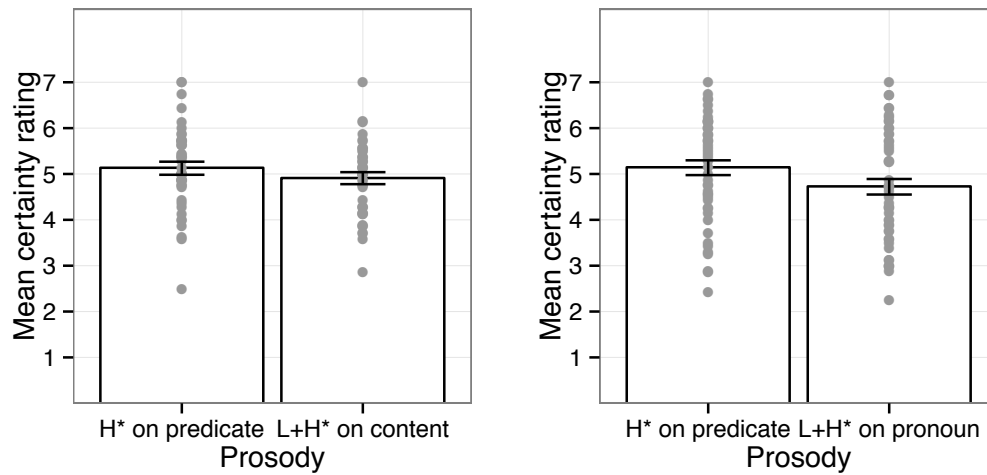


Figure 3 Mean responses (with 95% confidence intervals) and participants' means in Experiment 1 (left panel) and Experiment 2 (right panel).

complement is not a commitment of the speaker are attributed to local accommodation, which is licensed if projecting the content of the complement to the common ground leads to a contradiction, un informativity or problems with binding. However, given that the contexts in which the stimuli of Experiments 1 and 2 were interpreted provided only minimal information about the interlocutors, these context cannot plausibly be assumed to license local accommodation. Classical analyses, as currently formulated, can therefore neither account for the influence of prosody on interpretation nor account for why the stimuli in Experiments 1 and 2 were able to receive non-projecting interpretations.

Experiments 1 and 2 established that listeners attend to the presence/absence of a pitch accent on the factive predicate or an expression in the clausal complement in identifying whether the speaker is committed to the content of the complement. Research on the interpretation of prosody has shown that listeners also attend to the type of pitch accent realized on an expression. [Ito & Speer \(2008\)](#), for instance, found that listeners are more likely to assign a contrastive interpretation to adjectives realized with a L+H* pitch accent than adjectives realized with a H* pitch accent (see also [Watson, Tanenhaus & Gunlogson 2008](#)). Such findings raise the question of whether listeners also attend to pitch accent type in identifying speaker commitment to the content of the complement. Experiment 3 addresses this question.

4 Experiment 3

Experiment 3 was designed to explore the hypothesis that the type of pitch accent realized on the predicate and the last content word of the clausal complement has an influence on the projectivity of the content of the complement. In this experiment, the predicate and the last content word of 15 sentences with factive predicates were realized with pitch accents in both prosodic conditions. In the first condition, illustrated in (9a), the pitch accent on the predicate was relatively more prominent than the pitch accent on the last content word; in the second condition, shown in (9b), the pitch accent on the predicate was relatively less prominent than the pitch accent on the last content word.⁸

- (9) a. Perhaps he disCOVERed that she's a WIdow.
 H* (L+)H* L-L%
- b. Perhaps he disCOVERed that she's a WIdow.
 (L+)H* !H* L-L%

Since the less prominent pitch accent on the last content word in (9b) can signal that the content of the complement is information that the interlocutors already share (see, e.g., Ayers 1996: 27), the expectation is that when the last content word is more prosodically prominent, as in (9a), the speaker is less likely to be taken to be committed to the content of the complement than when the last content word is relatively less prosodically prominent, as in (9b).

4.1 Methods

4.1.1 Participants

As with Experiments 1 and 2, participants for Experiment 3 were recruited on Amazon's Mechanical Turk platform and paid 70 cents for their participation. The qualification requirements and exclusion criteria were the same as in Experiments 1 and 2. 55 participants were recruited and responses from 2 participants were excluded; the remaining 53 participants (20 female, 33 male) ranged in age from 21-64 years old (median: 32 years). 6 of these 53 participants had previously participated in Experiment 1 and (a different) 6 in Experiment 2.

4.1.2 Materials

In Experiment 3, the 15 target stimuli sentences shown in Table 1 were produced in two prosodic conditions, except that the clausal complement of stimulus A2 was

⁸ These realizations were attested in productions collected in an ongoing production experiment.

in the present tense (...*he's unreliable*). The control stimuli were the same as in Experiments 1 and 2. For the stimuli in the first condition, the H*-(L+)H* condition, the talker was instructed to produce the sentences with a high tone pitch accent on the predicate and a high tone pitch accent on the last content word, followed by a low intermediate phrase accent and a low intonational phrase boundary. Some of the pitch accents on the last content word in this condition may however be considered L+H* pitch accents rather than H* pitch accents.⁹ A sample stimulus in this condition is shown in the top panel in Figure 4. In the second condition, the (L+)H*-!H* condition, the talker was instructed to produce the stimuli with a high tone pitch accent on the predicate, a down-stepped high tone pitch accent on the last content word of the complement clause, a low intermediate phrase accent and a low intonational phrase boundary, as shown in the lower panel in Figure 4. Some of the H* pitch accents on the predicate may, again, be considered L+H* pitch accents.

The target stimuli of Experiment 3 were submitted to phonetic analysis. Duration values were obtained for the predicate and the last content word of the clausal complement, and F0 peak values were obtained for the pitch accent associated with the stressed syllables of these expressions. Table 3 shows the mean duration and mean F0 peak values of the relevant expressions.

Condition	predicate		last content word	
	F0 (Hz)	duration (ms)	F0 (Hz)	duration (ms)
H*-(L+)H*	221	430	240	575
(L+)H*-!H*	257	451	205	584

Table 3 Experiment 3: Mean duration and mean peak F0 values

The duration values of the predicates and last content words across the two conditions are roughly comparable, consistent with the fact that they are realized with a pitch accent in both conditions. In the H*-(L+)H* condition, the F0 peak on the predicate is on average 19 Hz lower than the F0 peak on the last content word, whereas it is on average 52 Hz higher in the (L+)H*-!H* condition. These measurements show that the pitch accent on the last content word is relatively more prosodically prominent in the H*-(L+)H* condition than the predicate in the (L+)H*-!H* condition. The fact that the predicate in the (L+)H*-!H* condition is on average 21 ms longer than in the H*-(L+)H* condition is compatible with the observation

⁹ H* and L+H* are distinct accents in the ToBI system, but they are often confused in ToBI annotations (Syrdal & McGory 2000) and some authors consider the distinction between the two accents to be continuous rather than categorical (for discussion, see Ito & Speer 2008: 547f.).

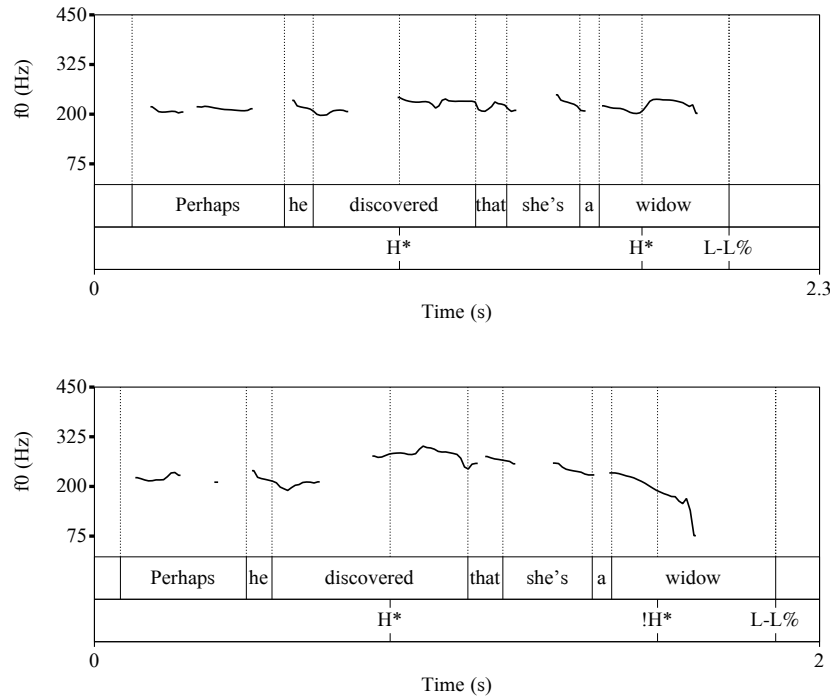


Figure 4 Target stimulus sentence *Perhaps he discovered that she's a widow* in the H*-(L+)H* condition (upper panel) and the (L+)H*-!H* condition (lower panel)

that some of the pitch accents on the predicate in the (L+)H*-!H* condition may be better analyzed as L+H* than as H* pitch accents. Likewise, the fact that the F0 peak on the predicate in the (L+)H*-!H* condition is on average 36 Hz higher than the F0 peak on the predicate in the H*-(L+)H* condition is compatible with the observation that some of the pitch accents on the predicate in that condition may be better analyzed as L+H* pitch accents than H* pitch accents.

In Experiment 3, the interpretation of target stimuli in the H*-(L+)H* condition was compared to the interpretation of the target stimuli in the (L+)H*-!H* condition. Two lists each containing 15 target stimuli were created such that each of the 15 target stimulus sentences occurred on both lists, either in the H*-(L+)H* condition or in the (L+)H*-!H* condition (each list had 7 or 8 utterances in each of the two prosodic conditions). The two control stimuli were added to the two lists, for a total of 17 stimuli per list.

4.1.3 Procedure

The procedure of Experiment 3 was identical to the procedure of Experiments 1 and 2 described in section 3.1.3.

4.2 Results and discussion

The mean responses (with 95% confidence intervals) to the target stimuli in the two conditions of Experiment 3 in Figure 5, respectively. The participants' response means are again shown as grey dots. As expected, stimuli in the H*-(L+)H* condition received significantly lower responses than stimuli in the (L+)H*-!H* condition ($\beta = -0.3$, $SE = 0.15$, $z = -2$, $p < .05$).

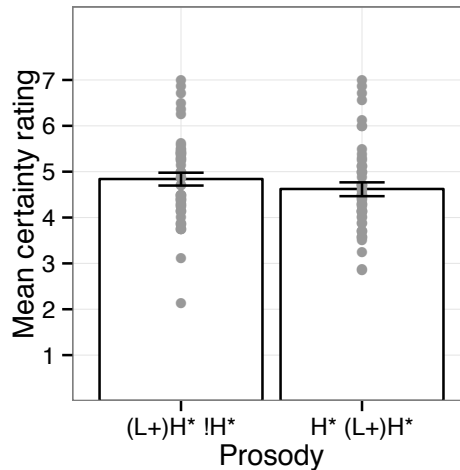


Figure 5 Mean responses (with 95% confidence intervals) and participants' means in Experiment 3

These results show that the projectivity of the content of the complement of utterances with factive predicate is influenced by the type of pitch accent realized on the predicate and the last content word of the complement. Specifically, listeners were more likely to take the speaker to be committed to the content of the complement when the pitch accent on the last content word was less prosodically prominent than the pitch accent on the predicate than when the pitch accent on last content word was more prosodically prominent than the pitch accent on the predicate. These results suggest that, in identifying speaker commitment to the content of the complement, listeners attend not only to the presence/absence of pitch accents on the predicate and

on expressions in the clausal complement (Experiments 1 and 2) but also to the type of pitch accent that is realized on these expressions. As mentioned above, classical analyses of presupposition projection cannot account for the observed influence of prosody on projection or predict why the stimuli in Experiment 3 were able to receive non-projecting interpretations.

5 Accounting for the influence of prosody on projection

The results of the three experiments discussed in the preceding two sections provide evidence for the influence of prosody on projection beyond that provided in Cummins & Rohde 2015. In particular, the three experiments show that the prosodic realization of an utterance with a factive predicate embedded under an entailment canceling operator influences whether the content of the complement projects: Experiments 1 and 2 showed that listeners attend to the presence/absence of pitch accents and Experiment 3 that listeners attend to the type of pitch accent. These results establish the need for a theory of projection that predicts the influence of prosody on projection. This section illustrates how the results of the three experiments can be captured in the question-based account of projection presented in Simons et al. to appear.

5.1 Simons et al. to appear

A central assumption that underlies the account of projection developed in Simons et al. to appear is that focus marking, whether prosodic, morphological or syntactic, is a conventional indicator of the question addressed by that utterance. This assumption is empirically motivated by the observation that utterances must be congruent with the questions they address (e.g., Paul 1880, 1919; von Stechow 1990; Rooth 1992). The question-answer pairs in (10a) and (10b) illustrate question-answer congruence: J's utterance in (10a), with *Turkish* prosodically prominent, is congruent with M's question in (10a), but not with M's question in (10b), and vice versa for J's utterance in (10b), where *David* is prosodically prominent.

- (10) David, Mandy, Craige and Judith are having lunch at a place that serves Turkish, Lebanese and Irish coffee.
- a. M: What kind of coffee does David like?
J: David likes TURkish coffee.
 - b. M: Who likes Turkish coffee?
J: DAvid likes Turkish coffee.

Question-answer congruence is straightforwardly modeled in an alternative semantics framework (cf., Rooth 1985, 1992), which analyzes both the focus semantic

value of the answer and the meaning of the question in terms of alternatives. In such a framework, the meanings of the questions in (10a) and (10b) are sets of propositions that are answers to the questions, as shown in (11a) and (12a), respectively. In alternative semantics, the focus semantic meanings of the answers in (10aJ) and (10bJ) are focus alternatives sets, i.e., sets of propositions derived by abstracting over the focused expressions, as shown in (11b) and (12b).

- (11) a. $[(10aM)]^{M,g} = \{\text{David likes Turkish coffee, David likes Lebanese coffee, David likes Irish coffee}\}$
 b. $[(10aJ)]^{M,g} = \{\text{David likes Turkish coffee, David likes Lebanese coffee, David likes Irish coffee, David likes cold coffee, ...}\}$
- (12) a. $[(10bM)]^{M,g} = \{\text{David likes Turkish coffee, Craig likes Turkish coffee, Mandy likes Turkish coffee, Judith likes Turkish coffee}\}$
 b. $[(10bJ)]^{M,g} = \{\text{David likes Turkish coffee, Craig likes Turkish coffee, Mandy likes Turkish coffee, Judith likes Turkish coffee, Adam likes Turkish coffee, ...}\}$

The observation that answers are congruent with the questions they address is modeled by requiring the meaning of the question to be a subset of the focus alternatives set of the answer. For instance, the answer in (10aJ) is congruent with the question in (10aM) because the meaning of the question, given in (11a), is a subset of the meaning of the answer, given in (11b). But the answer in (10aJ) is not congruent with the question in (10aM) because the meaning of the question, given in (12a), is not a subset of the meaning of the answer.

Utterances that are not made in response to an interrogative utterance (an explicit question) are taken to address an implicit question (see, e.g., Roberts 2012). Consequently, given question-answer congruence, the focus marking of an utterance that addresses an implicit question provides a cue to the question that the utterance addresses. This idea is already found in Halliday 1967: 208: “[a] specific question is derivable from any information unit except one with unmarked focus”. For instance, Halliday argues (p.207f.) that *JOHN painted the shed yesterday* implies the question *Who painted the shed yesterday* or the question *Did Mary paint the shed yesterday?* whereas *John PAINTed the shed yesterday* implies the question *What did John do to the shed yesterday?* or *Did John mend the shed yesterday?*. See Most & Saltz 1979 for empirical evidence that listeners can identify questions that utterances with prosodic marking of focus address.

Simons et al. (to appear) proposed that a content of an utterance projects if that content is entailed by the Current Question of the utterance.¹⁰ The Current Question

¹⁰ The *if* here is intended: the content of the complement may also project for other reasons than being entailed by the Current Question.

of an utterance is defined as follows (see also [Beaver & Clark 2008](#)):

(13) slightly adapted from [Simons et al. to appear](#): 9

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:

- (i) The proposition expressed is a member of the Current Question and
- (ii) The Current Question has at least one additional member.

To illustrate, consider again B's response in the example in (6), given in (14), with focus marking on the subject noun phrase of the clausal complement:

(14) He (James) didn't find out that [HARRY]_F's having a graduation party...

The focus alternatives set of this utterance, which is calculated by abstracting over the focus-marked subject of the clausal complement, is a set of propositions of the following form:¹¹

(15) { p : for some entity a , James found out that a is having a graduation party}

The Current Question of the utterance is contextually-restricted subset of (15). Under the assumption that the alternatives in the Current Question are restricted to humans having graduation parties and from the observation that *find out* is veridical (i.e., entails the truth of the clausal complement), it follows that every proposition in the Current Question entails that somebody is having a graduation party. [Simons et al. \(to appear: 10\)](#) define the entailments of a question as those propositions that are entailed by all the alternatives of the question. By this definition, the Current Question of (14) entails that somebody is having a graduation party but not that Harry is having a graduation party. By the hypothesis that content projects if it is entailed by the Current Question, a speaker who utters (14) is thus predicted to be committed to somebody having a graduation party, but not to Harry having one.

Crucially, this question-based account of projection predicts that prosody influences projection in English by virtue of prosody marking focus and focus, in turn, indicating the Current Question. The next two sections discuss how this question-based account of projection accounts for the results of the three experiments.

5.2 Accounting for the results of Experiments 1 and 2

To start, consider the three sentences in (16), which as argued below, are compatible with the prosodic realizations of *Perhaps he discovered that she's a widow* in the

¹¹ See [Simons et al. to appear](#) for arguments for why negation is not included in the domain over which the focus alternatives set is calculated.

H*-on-predicate, L+H*-on-content and L+H*-on-pronoun conditions, respectively, of Experiments 1 and 2.

- (16) a. Perhaps he [disCOVered]_F that she's a widow.
 b. Perhaps he discovered that she's [a WIdow]_F.
 c. Perhaps he discovered that [SHE]_F's a widow.

The focus alternatives sets of these three sentences are given in (17):¹²

- (17) a. {*p*: for some relation *R*, he *R* that she's a widow}
 b. {*p*: for some property *P*, he discovered that she *P*}
 c. {*p*: for some entity *a*, he discovered that *a* is a widow}

As discussed above, the Current Questions that the three sentences in (16) address are subsets of these focus alternatives sets. It is straightforward to see that the content of the complement of *Perhaps he discovered that she's a widow* – that she's a widow – is not entailed by the Current Questions that (16b) and (16c) address: not all of the propositions in the sets in (17b) and (17c) entail that she's a widow. (E.g., the set in (17b) contains the proposition that she's a baby, which does not entail that she's a widow.) Since the content of the complement is not entailed by the Current Questions that (16b) and (16c) address, it is predicted that the content of the complement does not project from utterances of these sentences.

The focus alternatives set in (17a), on the other hand, is compatible with Current Questions that entail the content of the complement as well as with ones that don't. Crucially, if the relations *R* in the Current Question are contextually restricted to veridical ones, as in (18a), then the Current Question of (16a) entails the content of the complement, which is therefore predicted to project from an utterance of (16a). If, on the other hand, the relations *R* in the Current Question include non-veridical ones, as in (18b), then the Current Question of (16a) does not entail the content of the complement, which is therefore not predicted to project.

- (18) a. {he discovered that she's a widow, he knew that she's a widow, he was happy that she's a widow}
 b. {he discovered that she's a widow, he thought that she's a widow, he speculated that she's a widow}

Without further context, it is impossible to identify how the focus alternatives set of an utterance of (16a) is restricted and, hence, which alternatives are included in the Current Question of (16a). What is crucial, however, is that (16a) has Current

¹² I assume that the epistemic modal adverb is not part of the domain over which the focus alternatives set is calculated.

Questions that entail the content of the complement, whereas (16b) and (16c) do not. Simons et al.'s account therefore predicts that (16a) is more likely to receive a projecting interpretation than (16b) and (16c).

The prosodic realizations of the stimuli of Experiments 1 and 2 are compatible with the focus markings of the sentences in (16). In particular, stimuli in the H*-on-predicate condition realized a H* pitch accent on the predicate, which is compatible with focus marking of the predicate, as in (16a); stimuli in the L+H*-on-content condition realized a L+H* pitch on the last content word of the clausal complement, which is compatible with focus marking of the verb phrase of that complement, as in (16b); and stimuli in the L+H*-on-pronoun condition realized a L+H* pitch on the pronoun of the clausal complement, which is compatible with focus marking of that pronoun, as in (16c). If the stimuli in Experiments 1 and 2 were interpreted with these foci, then Simons et al.'s account predicts that stimuli in the H*-on-predicate condition are more likely to receive projecting interpretations than stimuli in the L+H*-on-content or L+H*-on-pronoun conditions. And this prediction is correct, as shown in section 3.

The experimental results also show, however, that the stimuli in the L+H*-on-content and L+H*-on-pronoun conditions were not always taken to mean that the speaker was not committed to the content of the complement. One possible explanation for this finding comes from the fact that these stimuli may be compatible with focus markings other than those discussed above. Stimuli in the L+H*-on-content condition, for instance, may be compatible not just with the verb phrase of the clausal complement being focused, but also with the entire complement clause or the verb phrase of the matrix clause being focused. Consider the possibility in (19a) in which the complement clause is focused. The corresponding focus alternatives set in (19b) consists of propositions that vary with respect to what he discovered.

- (19) a. Perhaps he discovered that [she's a Widow]_F.
 b. {*p*: for some proposition *q*, he discovered *q*}

It is plausible to assume that the Current Question that (19a) addresses may be restricted to those alternatives in the focus alternatives set in (19b) for which the propositions *q* that he stands in the 'discover' relation to are true propositions. (See Simons et al. to appear: §4.3 for an argument.) Interpreting an utterance of (19a) relative to this Current Question would lead a hearer to take the speaker to be committed to the content of the complement, since that content is one of the true propositions in the Current Question.

Another possible explanation for the finding that stimuli in the L+H*-on-content and L+H*-on-pronoun conditions were not always taken to mean that the speaker was not committed to the content of the complement is that the cue from the meaning of the factive predicate, that the content of the complement projects, is stronger than the

cue from prosody, that the content of the complement does not project. Recall that on classical analyses, discussed in section 1, the content of the complement is lexically specified by the predicate to be a presupposition, which requires it to be entailed by or satisfied in the common ground. While Simons and her colleagues don't assume that this content is conventionally specified to project, they do recognize that this content has a strong tendency to be taken to be a commitment of the speaker. It is possible that the prosodic cues to non-projection are more difficult to recognize than the cues from the meaning of the predicate.

5.3 Accounting for the results of Experiment 3

In Experiment 3, the stimuli in the two conditions had more complex prosodic realizations than the stimuli in Experiments 1 and 2 since they featured a pitch accent on the factive predicate as well as on the last content word of the clausal complement. As such, these stimuli are potentially compatible with several information structural analysis. In this section, I entertain an analysis according to which the prosodically more prominent expressions indicate the foci of the utterances: that is, stimuli in the $H^*-(L+)H^*$ condition are focused on the last content word, as shown in (20a), and stimuli in the $(L+)H^*!H^*$ condition are focused on the predicate, as shown in (20b).

- (20) a. Perhaps he disCOVERed that she's [a WIdow]_F.
 b. Perhaps he [disCOVERed]_F that she's a WIdow.

Under this assumption, the pitch accents realized on the factive predicate in stimuli in the $H^*-(L+)H^*$ condition and on the last content word in stimuli in the $(L+)H^*!H^*$ condition could be due to the factive predicate and the last content word not being given in the context of utterance or due to prosodic structure (e.g., Ladd 2008).¹³

The focus alternatives sets of the two sentences in (20) are given in (21):

13 A more tenuous possibility is that the factive predicate in the $H^*-(L+)H^*$ condition and the last content word in the $(L+)H^*!H^*$ condition are contrastive topics (Roberts 2012; Büring 2003). Roberts (2012) takes contrastive topics to be realized with a $(L+)H^*$ pitch accent, followed by a low intermediate phrase accent and a high intonational phrase boundary (L-H%). Liberman & Pierrehumbert (1984: 173ff.) showed that the difference between the F0 peak of the first pitch accent and the F0 peak of the second pitch accent was greater in sentences in which a contrastive topic preceded a focus than in sentences in which a focus preceded a contrastive topic. The stimuli from Experiment 3 only partially match these descriptions. First, in both conditions, both the predicate and the last content word were realized with high tone pitch accents. Second, the pitch accent on the last content word was relatively more prominent than the pitch accent on the predicate in the $H^*-(L+)H^*$ condition, and relatively less so in the $(L+)H^*!H^*$ condition. Third, the difference between the F0 peak of the first pitch accent (on the predicate) and the F0 peak of the second pitch accent (on the last content word) was greater in the $(L+)H^*!H^*$ condition than in the $H^*-(L+)H^*$ condition. Crucially, however, the utterances in the two conditions only were realized as a single intonational phrase (though some may be taken to realize a high intermediate phrase accent after the predicate). Nevertheless, if the stimuli were to be

- (21) a. $\{p: \text{for some property } P, \text{ he discovered that she } P\}$ = (17b)
 b. $\{p: \text{for some relation } R, \text{ he } R \text{ that she's a widow}\}$ = (17a)

As discussed for (17b) above, the propositions in the focus alternatives set in (21a) do not entail the content of the complement, that she's a widow. As a consequence, Current Questions that are contextual restrictions of the set in (21a) do not entail the content of the complement either. In contrast, and as discussed for (17a) above, there are Current Questions for (20b) that are subsets of the focus alternatives set in (21b) and entail the content of the complement. It follows that (20b) is compatible with Current Questions that entail the content of the complement, but that (20a) is not. Simons et al.'s account therefore predicts that the content of the complement is more likely to project from utterances of (20b) than from utterances of (20a). Thus, if the stimuli in the (L+)H*-*H* condition of Experiment 3 were taken to have the focus marking as in (20b) and the stimuli in the H*-(L+)H* condition were taken to have the focus marking as in (20a), then Simons et al.'s account predicts that stimuli in the (L+)H*-*H* condition are more likely than stimuli in the H*-(L+)H* condition to receive an interpretation in which the content of the complement is taken to be a commitment of the speaker. This prediction is correct, as shown in section 4.

Recall, however, that an utterance with a pitch accent on the last content word of the clausal complement is also potentially compatible with focus marking of the entire complement clause. As discussed for (19a) above, such utterances may be taken to address Current Questions that do commit the speaker to the truth of the content of the complement. Thus, if the clausal complement was taken to be focused for stimuli in the H*-(L+)H* condition, then the content of the complement is taken to be a commitment of the speaker. The results of Experiment 3 seem to suggest that such interpretations of the stimuli in the H*-(L+)H* condition are less accessible than interpretations according to which only the last content word is focused, as illustrated in (20a). Whether that is a case and why that might be remain questions for future research.

5.4 Summary

Simons et al. to appear propose that utterance content projects if it is entailed by the Current Question of the utterance or if the Current Question entails that the content is true. Since the Current Question is taken to be a contextually restricted subset of the focus alternatives set of the utterance, and since focus is be prosodically marked in English, Simons et al.'s account correctly predicts that prosody influences projection, as suggested by the results of the three experiments discussed in sections 3 and 4.

taken to realize contrastive topics and foci, the focus alternatives sets of the stimuli would be as in (21), with the predictions as discussed.

This section has also shown that the empirical findings of the three experiments can be accounted for under Simons et al.'s (to appear) proposal by assuming that prosodic realizations of the stimuli in the three experiments indicate particular foci for the stimuli.

6 Conclusions

The content of the complement of a factive predicate is classically analyzed as a presupposition, i.e., as content that projects globally unless doing so results in a contradiction, un informativity or problems with binding (Heim 1983; van der Sandt 1992). This paper has provided empirical evidence that the projectivity of the content of the clausal complement is influenced by the prosodic realization of the utterance with the factive predicate. These findings thus provide support for the claims that were made in Beaver 2010 and Simons et al. to appear based on impressionistic judgments. Crucially, since the non-projecting interpretations observed in the three experiments cannot be attributed to local accommodation, these findings constitute a challenge for classical analyses of projection. The paper also showed that Simons et al.'s (to appear) question-based analysis of projection can provide an account of the experimental findings by taking the prosody of an utterance to provide a cue to the focus of the utterance, which in turn provides a cue to the Current Question of the utterance and, hence, the commitments of the speaker.

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